Bachelor of Computer Applications
[Online Mode]

JAN 2026 Batch

Student Handbook

** The University reserves its right to update / change any part of these regulations as approvedby the competent authority*

Table of Content

1. About the Program

This is a three-year bachelor's program leading to the grant of a Bachelor of Computer Applications (BCA) Degree from Jain (Deemed-to-be University). This program will preparea learner for multiple roles across a broad spectrum of industries in a chosen area of Electivein Computer Science. It is a three-year undergraduate degree program focused on computer applications and software development. It provides a strong foundation in computer science, programming, and IT fundamentals. Practical training through labs and projects is an integral part of the curriculum.

BCA graduates are in high demand due to the ever-growing IT industry.
Their skills and knowledge make them versatile assets to organizations across various sectors.

- Programming Proficiency: Strong command over languages like C, C++, Java, Python, etc.
- Database Management: Skilled in handling databases using SQL and other tools.
- Web Development: Expertise in HTML, CSS, JavaScript, and web application development.
- Problem-Solving: Excellent analytical and problem-solving abilities.
- Adaptability: Ability to learn new technologies and trends quickly.

Program Outcomes

PO1	Apply fundamental principles of mathematics, computer science, and relevant domains to solve basic computing problems.
PO2	Identify and analyze computing problems using core computer science concepts, developing solutions suitable for entry-level applications.
PO3	Design and develop computer-based solutions for simple to moderately complex problems, using current programming languages and development environments.
PO4	Conduct basic experiments, analyze data, and interpret results to improve computer applications and systems.
PO5	Select and apply appropriate techniques, resources, and modern computing tools for a range of application development tasks.
PO6	Understand the impact of digital technologies on society and explore innovative applications of computing in various domains.
PO7	Recognize the importance of professional ethics, cyber security, and social responsibilities in the field of computing.
PO8	Communicate effectively on computing activities with the community, both verbally and in writing, and develop clear documentation and presentations.

PO9	Function effectively as an individual and as a member or leader in diverse teams on computing projects.
PO10	Recognize the need for ongoing learning in the rapidly changing field of computer applications and develop skills for continuous self-improvement.

Program Specific Outcomes (PSOs) – Computer Science and IT

PSO1: Core Computing Proficiency

Demonstrate competence in foundational computing areas including programming, data structures, algorithms, operating systems, and computer architecture. Apply these principles to solve structured problems using languages like C, Python, and Java.

PSO2: System Design and Development

Design, develop, and test software systems and web-based applications using modern development environments and frameworks. Integrate advanced database systems, cloud platforms, and blockchain technologies to build scalable and secure solutions.

PSO3: Professional and Ethical Practice

Apply project management principles, software engineering practices, and testing methodologies to deliver reliable IT solutions. Exhibit awareness of cybersecurity, ethical responsibilities, and effective communication in collaborative and societal contexts

Program Specific Outcomes (PSOs) - Data Science and Analytics

PSO1: Data-Driven Problem Solving

Apply statistical, algorithmic, and programming techniques to extract insights from structured and unstructured data using tools such as Python, R, and SQL. Demonstrate proficiency in designing predictive models and performing exploratory data analysis.

PSO2: Technology Integration for Scalable Solutions

Design and implement scalable data-centric applications using modern computing environments, including cloud platforms, big data frameworks, and blockchain technologies. Leverage software engineering principles and project management practices to deliver robust solutions.

PSO3: Ethical and Communicative Competence in Analytics

Demonstrate awareness of ethical considerations, data privacy, and social impact in analytics workflows. Communicate findings effectively through visualizations, reports, and presentations tailored to technical and non-technical audiences.

Program Specific Outcomes (PSOs) – Cyber Security

PSO 1: Apply foundational computing and programming skills to design secure systems and analyze vulnerabilities across networks and applications.

PSO 2: Implement cybersecurity techniques including cryptography, ethical hacking, digital forensics, and threat intelligence to protect digital assets.

PSO 3: Integrate cloud security, blockchain, and defensive technologies to build resilient, scalable, and ethically governed cyber solutions.

Program Specific Outcomes (PSOs) – Artificial Intelligence

PSO 1: Apply core computing principles and programming skills to build efficient AI-driven solutions using C, Python, Java, and R.

PSO 2: Design and deploy intelligent systems using machine learning, deep learning, NLP, and computer vision for real-world applications.

PSO 3: Integrate emerging technologies and software engineering practices to develop scalable, ethical, and socially responsible IT solutions.

Program Specific Outcomes (PSOs) – Cloud Computing:

PSO 1: Apply computing fundamentals and programming skills to design, develop, and deploy cloud-based applications using modern platforms and tools.

PSO 2: Implement and manage cloud infrastructure, services, and security protocols across AWS, Azure, and GCP environments for scalable solutions.

PSO 3: Integrate DevOps practices, microservices, and IoT with cloud technologies to solve real-world problems ethically and collaboratively.

2. Electives Offered

The following electives are offered:

Table: Choice of Elective

Sl. No.	Electives
1	Computer Science and IT
2	Data Science & Analytics
3	Cyber Security
4	Artificial Intelligence
5	Cloud Computing

** Elective offered for a batch may vary based on Industry and/or University requirements*

Indication of Elective: Candidate is required to indicate his/her elective at the time of admission. Elective cannot be changed after the commencement of the Program.

3. Admission

Eligibility: Pass in the (10+2) examination from State Board / CBSE / NIOS / IGCSE / IB / ICSE recognized by the State or Central Government.
Candidates who are due to appear in the (10+2) examination are also eligible to apply.

Academic Documents: A colour scan of the below-mentioned original document is requiredto be uploaded on the admission portal at the time of seeking admission -

i. Grade sheet of Class 10 ii. Grade sheet of Class 12 iii. Aadhar Card for Indian Nationals and Passport for Foreign Nationals

Scans from a photocopy or a faxed copy are not accepted. The University reserves the right to demand a hard-copy of the original document as part of the process of verifying the authenticity and may revoke the admission at any time for non-fulfillment of any eligibility requirements.

Admission Intake: There will be two intakes in a year – the **January** Cycle and the **July** Cycle.

4. Duration and Credits

The duration of the BCA Program is 3 years divided into 6 Semesters. The concept of credit issued to define the weightage of a course in the curriculum.
A total of 3,285 learning hours ensures that a student has acquired knowledge at par with the on-campus mode of delivery and learning over the three years.

4A. Multiple Entry and Multiple Exit Option

In accordance with the provisions of the National Education Policy (NEP) 2020, University Grants Commission (UGC) Regulations and the National Credit Framework (NCrF), learners enrolled in the **BCA (Online)** programme may avail the Multiple Entry and Multiple Exit (MEME) option, subject to fulfillment of the prescribed credit requirements and University regulations.

Semester	Credits	Min. Credits Requirement	Exit options
I	21	42	Exit after 1st year (I & II Semesters) – The candidate will be awarded a Certificate witha minimum of 40 credits, on the Successful Completion of the First Year (Two Semesters)
II	21		
III	21	84	Exit after completing 2nd year (III & IV Semesters) – The candidate will be awarded aDiploma Certificate with a minimum of 80 (40 + 40) credits, on the successful completion of the Second Year (Four Semesters)
IV	21		
V	21	126	Exit after 3rd year (V & VI Semesters) – The candidate will be awarded with Bachelor's Degree in Computer Applications with a minimum of 124 (40 + 40 + 24) credits onthe Successful Completion of the Third Year (Six Semesters)
VI	22		

Semester	Discipline Specific Core	Skill Enhancement Course	Ability Enhancement Compulsory Course (Credits)	General Elective (3- Credits)	Discipline Specific Elective	Learning Lab	Total Credits
I	3(12)	1(3)	1(4)	-	-	2(2)	21
II	3(12)	1(3)	1(4)	-	-	2(2)	21
III	4(16)	-	1(3)	-	-	2(2)	21
IV	1(4)	-	-	1(3)	3(12)	2(2)	21
V	1(4)	1(3)	-	-	3(12)	2(2)	21
VI	-	-	-	-	5(22)	-	22
	12(48)	3(9)	3(11)	1(3)	11(46)	10(10)	127

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5. Program Delivery

Mode of Program delivery: Online

Pedagogy: Program delivery follows the prescribed four Quadrants approach resulting in maximum learner engagement. Each course involves 120 hours of learning (1 credit equals 30 learning hours). A combination of the following formats will be used: two-way live onlineaudio-video lectures, pre-recorded audio-video lecture available on the Learning Management System (LMS), multimedia content, interactions through the discussion forum on the LMS, exhaustive e-content/printed material for in-depth reference, self-study activities that Includes Assignments, Quiz and Multiple Choice Questions (MCQ), Essay-type questions,Case Study etc., individual and group projects, programming exercise, dissertation, Massive Open Online Courses (MOOC) and various experiential learning methods.

Learning Management System: Our LMS platform has been designed to engage and inspirea learner by providing access to all the learning resources including texts, videos, screencastsand lecture recordings; participate in discussion forums; communicate with the faculty and the program team. A learner has the option to take-up the several quizzes and the MCQs thatfollow at the end of every unit of the course, track learning progress, submit assignments andmuch more.

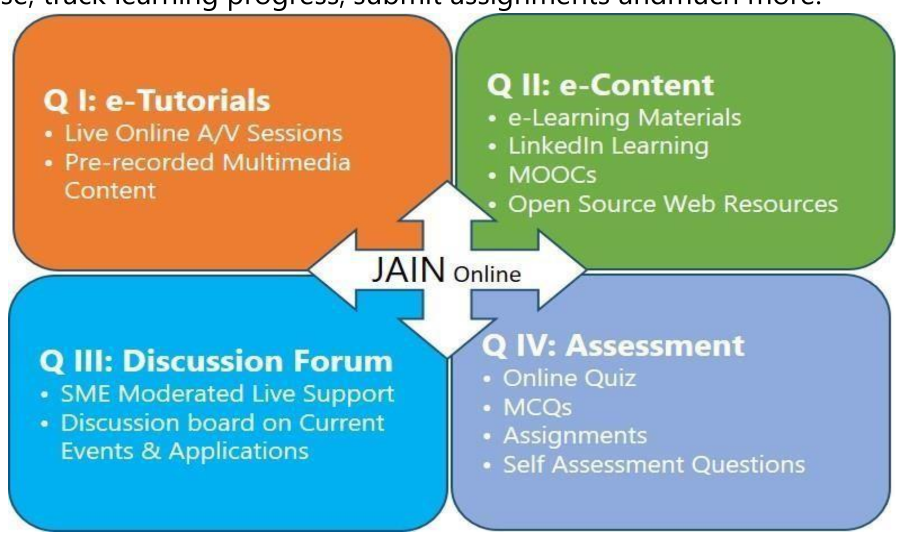

Fig: Four Quadrant Approach

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e-Learning Material: A learner is provided access to an exhaustive and customized Self-Learning Material (SLM) on the LMS. The SLM will also indicate sources of additional readings and resources available on the internet.

Medium of instruction: The medium of instruction and examination is English.

e-Tutorials: Two-way live interactive sessions will be scheduled on Saturday for 5-7 hours.

6. Assessment Scheme

The performance of students will be based on Continuous Assessment (CA) and End Semester Examination (ESE) as per the weightage given in the following table:

Table: Distribution of Weightage (CA: ESE)

Assessment Type	Weightage (%)
Continuous Assessment	30
End Semester Examination	70
Total	**100**

Assessment of performance in Research Project is based on – Project Synopsis (Weightage 15%) Interim Report (Weightage 15%) Five-minute Video Presentation on the project (Weightage 20%) and Project Report (Weightage 50%)

Note: The Components of the Research Project should be submitted in sequential manner only viz., Project Synopsis, Interim Report followed by Project Report after which the Video Presentation is can be submitted.

7. Criteria for Continuous Assessment

The assessment scheme is designed not only to assess the attainment of course outcomes by the learner but also to help and guide them to undertake systematic studies. The Continuous Assessment (CA) marks will be awarded based on Three Assignments.

There are three Continuous Assessments. Each continuous assessment will be for 30 marks.

- The first assessment will be scheduled after the completion of Module 2 of the course (Post Week 5). (Questions will be from Module 1 and Module 2).
- The second assessment will be scheduled after the completion of Module 4 of the course (Post Week 10). (Questions will be from Module 3 and Module 4).
- The third assessment will be scheduled after the completion of Module 5 of the course (Post Week 12). (Questions will be from Module 1, 2, 3, 4 and 5 (weightage approx. 50%).
- The average of the best two scores out of the three assessments will be considered as the Continuous Assessment marks.

Assessment Details:
Window Period: According to Calendar of Events
Maximum Duration: 60 minutes in a single sitting (After Login)
Number of attempts: One
Portion: 2 Modules for CA1 and CA2; All 5 Modules for CA3
NOTE: Once you start attempting the assessment, you do not have the option of pausing orcompleting it partially. You have to complete the entire assessment in a single attempt.
These MCQs will be based on the application of concepts learned (real-life or hypothetical situations) and case studies and will require substantial preparation by the learners.

Each question in the CA and ESE will be carefully mapped to the attainment of CourseOutcomes considering the levels as per Bloom's Taxonomy.

Continuous Assessment Structure for Lab Courses

CA Component	Type	Marks
CA 1	Program Execution	25
CA 2	Program Execution	25
CA 3	Program Execution	25
Practice Questions	Program Practice	25
Total IA marks		100

I. **Question Structure and Marks Allocation for Each CA**

Part A: 1 out of 2 Question = 10 Marks Part B: 1 out of

2 Question = 15 Marks **Total Marks per CA: 25**

Marks

II. Practice Questions

Number of Practice Questions: 10

Learners must complete the execution of practice questions on the Virtual Lab platform within a duration of 12 weeks.

Question Type	Number of Questions	Marks per Questions	Total Marks
Section 1	5	2	10
Section 2	5	3	15
Total	-	-	25

Additional Information on Assessment:

1. Each MCQ will have four options of which only one of them will be correct.
2. There will be no negative marking for selecting a wrong response, hence studentsare advised to attempt all the questions.
3. The assessment will have to be attempted online as per the schedule notified.
4. A learner will be required to take an assignment in a single sitting of a maximum60 minutes (based on login).
5. The assessment can be attempted only once during the schedule announced usingany device.
6. Courses may have a different pattern of CA.

8. End-Semester Examination

Examination mode: Online Proctored Examination

System requirement: A desktop or laptop computer with a working webcam and microphone facility connected to a stable and non-shared internet connection for theentire duration of the examination.

Exam Date: The University will conduct End Semester Examination (ESE) for both odd and even Semesters twice a year. ESEs are usually conducted around the 18th Week from the commencement of the Semester. The schedule of examination may changeas per guidelines issued by the University Grants Commission (UGC) and/or relevant authority.

Eligibility: The student should have 75% participation in all activities of the program.

Examination fee and registration: In the first attempt, a learner has to register for all the courses of the Semester by paying the prescribed examination fee. Forsubsequent attempts, a learner can pay the examination fee on per-course basis. Theprescribed examination fee will have to be paid as per the due date and is non- refundable nor will be adjusted towards subsequent examinations in case a student does not appear in examinations of any courses.

Exam Duration: 180 Minutes, Single sitting (based on login)
Maximum Marks: 70

Eligibility for Pass: A learner shall be declared to have passed in a course if he/she secures a minimum C Grade in that course.
In addition,

i) A minimum of 40% marks in aggregate (Total of scores in Continuous Assessmentand End Semester Examination) is required to secure a C Grade; and
ii) A minimum of 25 marks should be scored separately out of 70 marks in the End Semester Examination.

Similarly, a learner shall be declared to have passed in Master Thesis / Project if he/she secures;

i) A minimum of 40% marks in aggregate

9. Grading Scheme

The University awards the grades and grade points for each course as per the table below:

Table: Grade and Grade Point

Grade	A+	A	B+	B	C+	C	F
Corresponding	10	9	8	7	6	5	0

Grade Point							
Percentage of Marks	≥90 - ≤100	≥80 - <90	≥70 - <80	≥60 - <70	≥50 - <60	≥40 - <50	< 35
CLASS	Outstanding	Excellent	VeryGood	Good	Above Average	Pass	Fail

The Semester performance of a student will be indicated as "Semester Grade Point Average (SGPA). The SGPA will be weighted average of Grade Points of all letter grades received by a student for all the Course Modules in the semester.

The final Grade Card will indicate Cumulative Grade Point Average (CGPA) and shallbe based only on Grade Points obtained in courses for which Modules have been earned.

9. Question Paper Pattern

The End Semester Examination (ESE) for 70 marks will have the following pattern* –

Section – A: 50 Marks
(A learner is advised to assign 90 -120 minutes to this section)
This section will have 50 MCQs of 1 mark each with varying difficulty levels. Each MCQ will have four options of which only one of them will be correct. There will be no negative marking for selecting a wrong response, hence learners are advised to attempt all the questions.

Section - B: 20 Marks
(A learner is advised to assign 60-90 minutes to this section)
This section will have a 6 descriptive questions requiring descriptive answers of 5 marks each, and students will be required to answer any 4 of them. Generally, a word count of 200 to 300 words is sufficient to provide a satisfactory answer to a 5-mark question.
** Certain Courses may have a different pattern of ESE.*

System requirement: A desktop or laptop computer with a working webcam and microphone facility connected to a stable and non-shared internet connection for the entire duration of the examination.

Exam Date: The University will conduct End Semester Examination (ESE) for both odd and even Semesters twice a year. ESEs are usually conducted around the 18th Week from the commencement of the Semester. The schedule of examination may change as per guidelines issued by the University Grants Commission (UGC) and/or relevant authority.

Eligibility: The student should have 75% participation in all activities of the program.

Examination fee and registration: In the first attempt, a learner has to register for all the

courses of the Semester by paying the prescribed examination fee. For subsequent attempts, a learner can pay the examination fee on a per-course basis. The prescribed examination fee will have to be paid as per the due date and is non-refundable nor will be adjusted towards subsequent examinations in case a student does not appear in examinations of any courses.
Exam Duration: 180 Minutes, Single sitting (based on login)

Maximum Marks: 70

Eligibility for Pass: A learner shall be declared to have passed a course if he/she secures aminimum C Grade in that course.
In addition,

i) A minimum of 40% marks in aggregate (Total of scores in Continuous Assessment andEnd Semester Examination) is required to secure a C Grade; and

ii) A minimum of 25 marks should be scored separately out of 70 marks in the End Semester Examination.

Similarly, a learner shall be declared to have passed in Master Thesis / Project if he/shesecures:
i) A minimum of 40% marks in aggregate.

10. Grading System

The University awards the grades and grade points for each course as per the below table:

Table: Grade and Grade Point

Grade	**A+**	**A**	**B+**	**B**	**C+**	**C**	**D**	**F**
Qualitative Description	Outstanding	Excellent	Very Good	Good	Above Average	Pass	Borderline	Fail
Grade Point	10	9	8	7	6	5	4	0
Percentageof Marks	-	-	-	-	-	Not less than40	35– lower limit of C	< 35
Those awarded D (Borderline) will be taken up for moderation/review by the University's ModerationBoard. This is a temporary grade and it will not be reflected in the final results. It will either be converted to C after moderation as per rules or it will be treated as Fail (F).								

The Semester performance of a student will be indicated as "Semester Grade Point Average (SGPA). The SGPA will be the weighted average of Grade Points of all letter grades received by a student for all the Course units in the semester.
The final Grade Card will indicate Cumulative Grade Point Average (CGPA) and shall be basedonly on Grade Points obtained in courses for which units have been earned.

11. Question Paper Pattern

The End Semester Examination (ESE) for 70 marks will have the following pattern* –

Section – A: 50 Marks
(A learner is advised to assign 90 - 120 minutes to this section)
This section will have 50 MCQs of 1 mark each with varying difficulty levels. Each MCQ will have four options of which only one of them will be correct. There will be no negative markingfor selecting a wrong response, hence learners are advised to attempt all the questions.

Section - B: 20 Marks
(A learner is advised to assign 60 - 90 minutes to this section)
This section will have 6 questions requiring descriptive answers of 5 marks each and the students will be required to answer any 4 of them. Generally, a word count of 200 to 300 words is sufficient to provide a satisfactory answer to a 5 mark question.

** Certain Courses may have a different pattern of ESE.*

12. Re-examination Policy

A. A learner has to register by paying a prescribed fee to reappear for End SemesterExamination as per notification issued by the University subject to completion of a program within the maximum period prescribed.
B. The Continuous Assessment marks originally secured by the learner, in the first appearance in the course(s) if any, will be carried forward.

13. Promotion Policy

Learners will be promoted from one year to another provided they have paid all the fee duesand do not have any discipline cases pending against them. Appearing in the CA may be considered while deciding the promotion. They should however note that they have to pass in each course as per the passing requirements and earn the minimum credit units required for the award of a degree/ qualification.

14. Award of Degree

The Learner will be awarded the Master of Commerce degree upon fulfillment of thefollowing criteria:

i) Must have passed all the courses of the four semesters;
ii) Must have complied with all other assessment guidelines and criteria notified during the conduct of the Program.
iii) Must have submitted the UG Convocation degree certificate.
The Degree Certificate will indicate the elective opted by the learner.

15. Semester Break

With prior approval, a learner may be allowed to take a break (temporary withdrawal) from the Program for a Semester or more for valid reasons of health/career. The learner shall be allowed to continue the program after re-registration as per the university norms.

16. Thesis / Research Project

Students undertake a project after the end of fifth semester. It provides an opportunity for the students to apply classroom learning and practice in an industry environment. The duration of the project is a minimum of 8 weeks. A learner can work with a company as an intern, undertake project, perform activities identified by the company and assist the organization in its functions or alternatively can carry out an independent research in the chosen elective area. The learner is required to submit a project report in the prescribed

format. Learners are encouraged to convert their research into a paper/case and publish in association with a mentor.

The assessment will be according to pre-defined Rubrics based on performance Indicators like Similarity Check (Plagiarisms), Quality of References, Continuity of Work, Attainment of Learning Outcomes and Overall Quality in terms of potential of publishing/ Patenting. Whilethe students will give a certificate of it being his/ her original work, they will also give a No Objection Certificate of it being published or patented under the name of JAIN (Deemed-to-be University).

17. Academic Integrity and Ethics

a. A learner who has committed an act of academic dishonesty will be deemed to have failedto meet a basic requirement of satisfactory academic performance. Thus, academic dishonesty is not only a basis for disciplinary action but also is relevant to the evaluation of student's level of performance and progress.

b. Where there has been violation of the basic ethos and principles of academic integrity and ethics, the Dean/Board of Examiners/Course Coordinator may use their discretion during the

Semester on the disciplinary action to be taken.

c. Academic dishonesty includes, but is not necessarily limited, to the following:

i. Using more than one gadget/device during the conduct of the online examination;
ii. Switching off the webcam during the conduct of the online examination;
iii. Cheating or knowingly assisting another learner in committing an act of cheating;
iv. Unauthorized possession of learning material, examination materials, destruction orhiding of relevant materials;
v. Act of plagiarism;
vi. Unauthorized changing of marks or marking on examination records.

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PO1	Apply fundamental principles of mathematics, computer science, and relevant domains to solve basic computing problems.
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Course Matrix and Syllabus

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Elective: Computer Science and IT

Semester-1

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBX0AE101	English	AECC	30	70	4
25VBT0C102	Fundamentals of Mathematics	CC	30	70	4
25VBT0C103	Problem Solving using C	CC	30	70	4
25VBT0C104	Computer Architecture	CC	30	70	4
26VBX0S105	Essentials of Generative AI	SEC	30	70	2
25VBT0L101	Problem Solving using C Lab	SEC	100		1
Total No of Credits					**19**

Semester-2

Course code	Course Name	Course category	CA	ESE	Credits
25VBX0AE205	Communicative English	AECC	30	70	4
25VBT0C201	Operating System	CC	30	70	4
25VBT0C202	Data Structures using C	CC	30	70	4
25VBT0C203	Relational Database Systems	CC	30	70	4
25VBT0L201	Data Structures using C Lab	SEC	100	-	1
25VBT0L202	Relational Database Systems Lab	SEC	100	-	1
Total No of Credits					**18**

Semester-3

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C301	Python Programming	CC	30	70	4
25VBT0C302	Design and Analysis of Algorithms	CC	30	70	4
25VBT0C303	Software Engineering	CC	30	70	4
25VBT0C304	Computer Networks	CC	30	70	4
25VBT0C305	Environmental, Social, and Governance (ESG) in IT	AECC	30	70	3
25VBT0L301	Python Programming Lab	SEC	100	-	1
25VBT0L302	Design and Analysis of Algorithms Lab	SEC	100	-	1
Total No of Credits					21

Semester-4

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C401	Web Technologies	CC	30	70	4
25VBT0C402	Java Programming	DSE	30	70	4
25VBT1E403	Advanced Database System	DSE	30	70	4
25VBT1E404	Information Security	DSE	30	70	4
25VBT0C404	Quantitative Techniques	GE	30	70	3
25VBT0L401	Web Technologies Lab	SEC	100	-	1
25VBT0L402	Java Programming Lab	SEC	100	-	1
Total No of Credits					21

Semester-5

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBT0C501	Block chain Technologies	CC	30	70	4
25VBT0C502	IT Project management	DSE	30	70	4
25VBT1E503	Cloud Computing	DSE	30	70	4
25VBT1E504	Advanced Web Technologies	DSE	30	70	4
25VBT1E505	Big Data Analytics	DSE	30	70	4
25VBT0C503	Advanced Software Development Practices	SEC	30	70	2
Total No of Credits					**22**

Semester-6

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBT1E601	Artificial Intelligence and Machine Learning	DSE	30	70	4
25VBT1E602	Data Visualization	DSE	30	70	4
25VBT1E603	Software Testing	DSE	30	70	4
25VBT1E604	Internet of Things	DSE	30	70	4
25VBT0P605	Project	DSE			6
Total No of Credits					**22**

Legend

CC	Core Course
DSE	Discipline Specific Elective
SEC	Skill Enhancement Courses
AECC	Ability Enhancement Compulsory Course
GE	Generic Elective

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Semester I

Courses

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Course Title:	English
Course Code:	25VBX0AE101
Semester:	**I**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course introduces learners to literature, rhetorical practices, grammar, and academic writing. Through engagement with poetry, prose, drama, and structured writing tasks, students will gain foundational skills in critical reading, effective communication, and literary appreciation.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Examine literary texts in historical contexts and be sensitive to their social relevance	L4
CO2	Explain the process of communicating and interpreting human experiences from different cultures through literary representations	L2
CO3	Gain practical knowledge in the correct use of grammatical elements to express in English	L3
CO4	Appraise the art of rhetoric through speech and writing	L5
CO5	Develop higher order language skills, such as reading and writing, through texts centered on diverse themes and topics in literature	L5

Course Module

No. of Hours:24

Module 1: Foundations of Literature and Language
Scope of Module: Explore how literature reflects language and meaning, and how rhetoric is constructed in influential speeches.
Topics: Literal and metaphorical meanings in literature, Shakespeare's Sonnet 18, Robert Frost's *Stopping by Woods on a Snowy Evening*, introduction to rhetoric, Aristotle's modes of appeal, discourse analysis, Martin Luther King Jr.'s *I Have a Dream* speech, oratory and audience connection, speeches of Brutus and Mark Antony.
Learning Outcome: *Comprehend concrete and abstract meanings of words and phrases, and discuss rhetorical construction of speeches.*

No. of Hours:24

Module 2: Poetic and Prose Expressions
Scope of Module: Analyze language symbolism, Indian English poetry, and the art of prose expression.
Topics: Symbolism in poetry, Blake's *The Tyger*, Hughes' *Hawk Roosting*, early Indian English poetry and themes, Sarojini Naidu's *In Salutation to the Eternal Peace*, Nissim Ezekiel's *The Professor*, prose as a distinct form, types and function of prose, Bertrand Russell's *In Praise of Idleness*.
Learning Outcome: *Explain poetic symbolism, and examine Indian and Western prose for theme and style.*

No. of Hours:24

Module 3: Grammar and Sentence Structuring
Scope of Module: Explore grammatical concepts, including sentence construction, reported speech, and paragraph writing.
Topics: Phrases, clauses, sentence types, components of a sentence, active and passive voice, conversion rules, reported speech, simple, compound, complex sentence structures, linkers, synthesis, transformation, paragraph structure and types, examples from literature.
Learning Outcome: *Demonstrate grammatical proficiency, including sentence synthesis and paragraph writing.*

No. of Hours:24

Module 4: Argumentation and Debate
Scope of Module: Develop structured argumentative and debating skills using classical and contemporary contexts.
Topics: Structure of argument (claim, reason, support, warrant), logical flow, Frederick Copleston vs Bertrand Russell radio debate, elements of a good case, defense and rebuttal strategies, importance of debate, analyzing contemporary topics.
Learning Outcome: *Develop an understanding of logical argumentation and apply strategies for debate*

No. of Hours:24

Module 5: Essay Writing and Text Performance
Scope of Module: Explore essay forms, dramatic theory, and literary performance in Western and Indian contexts.
Topics: Essay types – compare and contrast, cause and effect, Feynman's *The Value of Science*, Chesterton's *On Running After One's Hat*, Charles Lamb's *Dream Children: A Reverie*, dramatic theory by Aristotle and Bharata, Vijay Tendulkar's *Silence! The Court is in Session.*
Learning Outcome*: Appraise techniques for academic and personal essay writing, and analyze dramatic forms across cultures.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

1. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
2. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
3. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings:

Book

- Gupta, S. C. (2018). Comprehensive English Grammar & Composition. Arihant Prakashan

Online Articles, Journals, and Whitepapers

- British Council Learn English Articles, JSTOR Language and Literature Studies, Routledge Journals on Rhetoric and Composition

Web-based Resources

- Grammarly Handbook, Purdue OWL, YouTube Channels on Poetry in Performance, Project Gutenberg Literature Database

Recommended Software/Tools:

1. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
2. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
3. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
4. **Miro** – for mind-mapping essay structures.
5. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	2	3	1	1	2	1	1
CO3	1	1	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	3	2	1	1	1	2	1
Articulation	1	1	1.4	1.8	2	1	1	1.2	1.2	1

Note: The Articulation is indicative of how a particular course maps to a PO.

Articulation is calculated as:

$$= \frac{\text{Sum of CO Mappiung Levels for a perticular PO}}{\text{No.of COs that mapped to that PO}}$$

Example:1

$$Articulation\ of\ \boldsymbol{PO1} = \frac{(3+2+3+2+3)}{5} = 2.6$$

Example: 2

$$Articulation\ of\ \boldsymbol{PO7} = \frac{(1+1)}{2} = 1.0$$

Course Title:	Fundamentals of Mathematics
Course Code:	25VBT0C102
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces foundational mathematical concepts essential for problem-solving and application in computing and data analysis. It includes matrix algebra, calculus, vector algebra, and 3-D geometry to develop logical reasoning and analytical abilities among students.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Learn to carry out matrix operations, including inverses and determinants, and solve systems of equations using multiple methods.	L3
CO2	Demonstrate the idea of differentiation from first principles and work with derivatives as rates of change in mathematical models.	L3
CO3	Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions.	L4
CO4	Demonstrate vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.	L3
CO5	Apply matrix theory for solving systems of linear equations and compute eigenvalues and eigenvectors required for the matrix diagonalization process	L3

Course Modules

No. of Hours:24

Module 1: Matrices and Linear Algebra
Scope of Module: This module introduces students to matrix operations, properties of determinants, and methods for solving linear systems using algebraic and matrix techniques.
Topics: Types of matrices including row, column, diagonal, scalar, unit and zero matrices, algebra of matrices including addition, scalar multiplication and transpose, inverse of a matrix using elementary operations, definition and expansion of determinants up to 3x3, minors and cofactors, properties of determinants, adjoint and inverse of matrices, singular and non-singular matrices, consistency of linear systems, solving equations using Cramer's rule, matrix rank, echelon and normal form, solving linear systems using Gauss elimination, Gauss-Jordan, Gauss-Seidel and LU decomposition.
Learning Outcome: *Solve linear systems using matrix operations and analyze determinant-based consistency and inverse properties.*

No. of Hours:24

Module 2: Eigenvalues, Eigenvectors, and Vector Algebra
Scope of Module: This module explores the concepts of eigenvalues, eigenvectors, vector operations, and geometric representations of vectors in space.
Topics: Definition and computation of eigenvalues and eigenvectors, Rayleigh's power method for dominant eigenvalue, diagonalization of matrices, linear transformation and matrix reduction, types of vectors including unit, zero and position vectors, magnitude and direction of vectors, vector addition and scalar multiplication, dot product and its geometric meaning, projection of vectors, cross product and scalar triple product, area and volume calculation using vectors.
Learning Outcome: *Compute eigenvalues, eigenvectors, and apply vector operations in solving spatial problems and geometric modeling.*

No. of Hours:24

Module 3: Differential Calculus and Applications
Scope of Module: This module introduces the principles and rules of differentiation and applies them to various types of functions and curve-based problems.
Topics: Continuity of functions at a point and over intervals, derivatives of algebraic and trigonometric functions, exponential and logarithmic functions, derivatives of composite, inverse trigonometric and parametric functions, second-order derivatives, nth-order derivatives, and Leibnitz theorem, angle between curves and pedal equations, polar curve representations and applications.
Learning Outcome: *Apply differentiation techniques to model change, analyze polar curves, and solve advanced calculus problems.*

No. of Hours:24

Module 4: Integral Calculus and Vector Calculus
Scope of Module: This module focuses on integration methods, definite and indefinite integrals, and introductory vector calculus concepts.
Topics: Indefinite integrals using substitution, trigonometric identities, partial fractions and integration by parts, definite integrals and reduction formulae for powers of sine and cosine, vector function derivatives including velocity and acceleration, scalar and vector point functions, gradient, divergence, curl, Laplacian operators, solenoidal and irrotational vectors.
Learning Outcome: *Solve definite and indefinite integrals and apply differential vector calculus operators in applied mathematics.*

No. of Hours:24

Module 5: Three-Dimensional Geometry
Scope of Module: This module develops spatial reasoning through the study of 3D geometry including direction cosines, lines and planes.
Topics: Direction cosines and direction ratios, vector and cartesian equations of a straight line, angle between two lines, shortest distance between skew lines, vector and cartesian equations of planes, angle between two planes, coplanar lines and intersection of lines with planes.
Learning Outcome: *Analyze three-dimensional shapes using vector and cartesian methods and solve problems involving lines and planes in space.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic understanding of algebra and geometry from secondary education..

Pedagogy / Teaching Methodology:

- ✓ Conceptual and problem-based learning
- ✓ Interactive class exercises and proofs
- ✓ Assignments and quizzes using math software.

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Mathematics – I by Prof. Jitendra Kumar (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/111105038

2. Mathematics for Computer Science by MIT Open Courseware: https://ocw.mit.edu

Suggested Readings:

Book

- Applied Mathematics and Scientific Computing: International Conference on Advances in Mathematical Sciences, Vellore, India, December 2017 – Volume II (Trends in Mathematics), Springer, 2019

Online Articles, Journals, and Whitepapers

- Research articles from *SpringerLink*, *Mathematics Today*, and *Elsevier Journal of Mathematical Analysis*
- Whitepapers on matrix theory, calculus, and vector analysis from *AMS (American Mathematical Society)* and *SIAM (Society for Industrial and Applied Mathematics)*

Web-based Resources

- Khan Academy (topics: Calculus, Linear Algebra, Vectors, 3D Geometry
- MIT OpenCourseWare for Mathematics
- Interactive simulations and problem sets on Desmos, GeoGebra, and Brilliant.org.

Recommended Software/Tools (If applicable):

1. MATLAB/Octave
2. SageMath
3. Python (NumPy, Matplotlib)
4. GeoGebra for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global

2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	-	2	2	2	2	2
CO2	3	2	3	2	-	2	1	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.6	2.6	3	2.2	1	2	1.6	1.8	2.2	2.8

Course Title:	Problem Solving using C
Course Code:	25VBT0C103
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:
This course introduces students to the C programming language with an industry-focused approach. Emphasis is placed on problem-solving, structured programming, memory efficiency, and modular design. The course prepares students to handle real-world applications in embedded systems, system-level development, and performance-sensitive software solutions.

Course Outcomes(COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand and apply the core concepts of the C language including syntax, control flow, and data types.	L3
CO2	Develop modular and efficient code using functions, arrays, and structures.	L6
CO3	Manage memory effectively using pointers and dynamic memory allocation.	L3
CO4	Handle file operations and system-level programming tasks.	L3
CO5	Apply modern development tools, debugging practices, and implement mini-projects that solve real-world problems.	L5

Course Modules:

No. of Hours:24

Module 1: Programming Foundations and C Basics
Scope of Module: Introduce software concepts, basic C syntax, and structured programming methodology.

Topics: Role of programming in systems and embedded development, history and importance of C, variables, constants, keywords, data types, operators, input/output (printf, scanf, gets, puts), expressions, conditional statements (if, if-else, switch), looping (for, while, do-while), break, continue, goto, code documentation and commenting practices.
***Learning Outcome* :-** *Implement basic control structures and understand the foundations of structured programming in C.*

No. of Hours:24

Module 2: Functions, Arrays and Strings
Scope of Module: Focus on modular programming and data handling through arrays and string operations.
Topics: Function declaration and definition, argument passing methods, recursion, return types, arrays (1D, 2D), basic algorithms (sorting, searching), string manipulation using standard functions, multidimensional string arrays, arrays in function arguments, memory usage with arrays.
***Learning Outcome* :-** *Design modular programs using functions and implement logic-driven operations with arrays and strings.*

No. of Hours:24

Module 3: Structures, Unions, Pointers and Memory Management
Scope of Module: Introduce advanced C constructs for optimized data storage and dynamic memory operations.
Topics: Structures and nested structures, unions and memory overlap, arrays of structures, pointers: declaration, arithmetic, arrays with pointers, pointers to structures, dynamic memory (malloc, calloc, realloc, free), storage classes (auto, extern, static, register), pointer pitfalls and best practices.
***Learning Outcome* :** *Apply pointer concepts and structured data storage to optimize program memory usage.*

No. of Hours:24

Module 4: File Systems, Command-Line Tools, and Build Automation
Scope of Module: Enable students to use persistent storage and build scalable projects using system-level tools.

Topics: Text and binary file handling (fopen, fclose, fread, fwrite, fprintf, fscanf), command-line argument usage, preprocessor directives (#define, #include, macros), header file creation, build tools (Makefile basics), version control systems (Git), compiler flags, debugging with gdb, introduction to CI/CD tools for C.
Learning Outcome: *Manage files, automate builds and integrate version control in a modern development pipeline.*

No. of Hours:24

Module 5: Industry Use Cases and Project-Based Application
Scope of Module: Apply knowledge in practical, time-bound projects aligned with industry-relevant themes.
Topics: Development of mini projects: menu-driven programs (e.g., ATM interface, student grade system), real-time input handling and validation, implementation of logging systems using file I/O, structuring code for modularity and readability, application testing using manual test cases, integration of Git for version tracking.
Learning Outcome: **-** *Design and deploy small-scale C projects using structured programming and version-controlled collaboration within limited timeframes.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites :

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Programming in C by Prof. Anupam Basu (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/106105085

Suggested Readings

Book

- Let Us C by Yashwant Kanetkar, 6th Edition, PBP Publication

Web-based Resources

- GeeksforGeeks – Advanced C tutorials
- OnlineGDB and HackerRank – Practice platforms
- GNU Compiler Collection (GCC) docs and POSIX C reference

Recommended Software/Tools (If applicable):

1. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	3	2	2	2	1	2	2	2	2	2
CO2	2	3	3	2	-	3	2	2	2	3
CO3	2	3	3	3	-	3	2	2	2	3
CO4	2	2	3	3	-	3	2	2	2	3
CO5	3	3	3	3	-	3	2	2	3	3
Articulation	2.4	2.6	2.8	2.6	1	2.8	2	2	2.2	2.8

Course Title:	Computer Architecture
Course Code:	25VBT0C104
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description

This course introduces students to the organization and architecture of computer systems. It covers internal structures, memory systems, I/O organization, instruction execution, and emerging processor technologies. The course develops analytical skills to evaluate hardware and architectural features in computing systems.

Course Outcomes(Cos)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	To establish a strong foundation in principles and architectural concepts of computer systems.	L2
CO2	Gain insight on the functionality of different subsystems, such as the processor, input/output, and memory devices.	L3
CO3	Design and analyze simple arithmetic and logical units and their operations	L3
CO4	Comprehend the concepts of parallel computing and hardware technologies	L5
CO5	Develop insight into memory hierarchy and correlate with the concept of virtual and cache memory	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Structure and Instruction Set
Scope of Module: This module introduces basic components of computer systems, their instruction formats, and data representation.
Topics: Computer types, functional units, basic operational concepts, bus structures, instruction formats, number representation, arithmetic operations on signed and unsigned data, memory locations and addressing, memory read/write operations
Learning Outcome: *Develop insight on computer framework and identify the performance issues in computer systems*

No. of Hours :24

Module 2: Machine Instructions, I/O Systems, and Memory Organization
Scope of Module: This module explains instruction execution and system-level operations including input/output handling and memory management basics.
Topics: Addressing modes, assembly language instructions, input and output operations, subroutines, instruction encoding, accessing I/O devices, interrupt mechanism and hardware, direct memory access, standard I/O interfaces including PCI, SCSI and USB, basic memory organization including RAM, ROM, memory hierarchy principles, speed and cost trade-offs.
Learning Outcome: *Understand addressing techniques, memory operations, and standard interfaces for efficient I/O operations.*

No. of Hours :24

Module 3: Advanced Memory and Arithmetic Units
Scope of Module: This module introduces concepts of cache and virtual memory, logic gates and arithmetic units.
Topics: Cache memory organization and mapping techniques, replacement algorithms, performance optimization in cache, virtual memory and address translation, logic gates and flip flops, addition and subtraction of signed numbers, fast adder designs including carry look-ahead adder.
Learning Outcome: *Analyze the logic behind memory systems, understand arithmetic circuitry and apply memory design techniques.*

No. of Hours :24

Module 4: Instruction Processing and Parallel Architectures
Scope of Module: This module describes instruction execution cycles, control design, pipelining and modern parallel processing concepts.
Topics: Basic processing unit design, instruction execution steps, multiple bus organization, hardwired and microprogrammed control, pipelining basics, instruction hazards, data hazards, impact on instruction sets, parallel computer models including multiprocessors and multicomputers, PRAM and VLSI models.
Learning Outcome: *Analyze execution flow and design of control units, and explore the foundations of parallel computer architectures.*

No. of Hours :24

Module 5: Performance, Processor Technologies and Storage
Scope of Module: This module addresses performance metrics, advanced processor types, scalable performance and memory management techniques.
Topics: Performance metrics and speedup laws, program partitioning and scheduling, interconnection networks, CISC and RISC architectures, superscalar and VLIW processors, vector and symbolic processors, hierarchical and virtual memory technology, TLB, paging, segmentation, cache addressing modes, associative caches, SIMD processing, storage systems, I/O interfacing, RAID levels and performance reliability.
Learning Outcome: *Evaluate processor performance, understand advanced architecture models and memory storage strategies.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites :

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Computer Organization and Architecture by Prof. John Jose (IIT Guwahati) NPTEL: https://nptel.ac.in/courses/106103206

Suggested Readings

Book

- *Computer Organization and Architecture: Designing for Performance* by William Stallings, 10th Edition, Pearson.

Online Articles, Journals, and Whitepapers

- Research articles from *IEEE Xplore*, *ScienceDirect*, and *Journal of Parallel and Distributed Computing*
- Whitepapers on processor design, memory hierarchy, and instruction set architectures from *Intel*, *ARM*, and *ACM Computing Surveys*

Web-based Resources

- MIT OpenCourseWare – Computer System Organization and Architecture.
- Simulators and tools like EduMIPS64, Logisim, and Multi2Sim.

Recommended Software/Tools (If applicable):

1. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title:	**Essentials of Generative AI**
Course Code:	**26VBX0S105**
Semester:	**I**
Credits:	**2**
Course Type	**Skill Enhancement Course**
Learning Hours	60
Live Sessions	**12 hours**

Course Outcomes:

CO1: Understand Generative AI and LLMs in depth
CO2: Create text, image, and voice content using AI
CO3: Automate daily tasks and business workflows
CO4: Build AI agents that act independently
CO5: Design and deploy simple AI apps without coding

Course Modules

Module 1: Generative AI Prompt Engineering for Real Workflows

What is Generative AI and how it's transforming industries, Structure of an effective prompt: *Role → Task → Context → Output,* Common prompting mistakes and how to fix them, How large language models (LLMs) like ChatGPT, Claude, and Google AI Studio work, advanced prompting (few-shot, iterative, style-based), Using your own files in ChatGPT and Claude (RAG basics), Research and summarization using AI

Learning Outcome: Students will be able to understand how Generative AI works and master the art of prompting.

Module 2: Creative AI and Voice & Audio Creation

Understanding AI image generation, creating posters, campaign assets, and product visuals, building brand identity using Krea.ai, Generating realistic voiceovers using ElevenLabs, Script writing and tone control with ChatGPT & Claude, Integrating voice into short videos or podcasts ***Learning Outcome:*** Students will be able to use AI to generate visuals, voiceovers, and creative storytelling content.

Module 3: AI Automation & Productivity

Logic of triggers, actions, and workflows, setting up automation between apps (Gmail, Sheets, Drive), Connecting OpenAI to Make.com for intelligent automation, creating social media Management Workflow and research automation flows, automating daily reports and reminders, building personal productivity dashboards, Integrating Claude and ChatGPT into existing workflows

Learning Outcome: Automate daily workflows and tasks using AI and no-code tools.

Module 4: Advanced AI Agents & Decision Flows

Introduction to n8n as a visual AI workflow builder, understanding nodes, triggers, and data passing, Using OpenAI node for smart responses and actions, designing multi-step reasoning workflows, Connecting Google Sheets, Slack, and other APIs, building autonomous agents that perform specific tasks

Learning Outcome: Students will be able to build AI agents that can think, decide, and act automatically.

Module 5: AI App Building & Deployment

Fundamentals of UI/UX for AI apps, structuring front-end and AI back-end flows, designing app logic using n8n and Make.com, integrating OpenAI and Claude APIs to your apps, handling user inputs and dynamic responses, using Google AI Studio to experiment with models, hosting and testing your AI app online, adding analytics and monitoring usage, final demo preparation and peer feedback

Learning Outcome: Students will be able to learn to design, connect, and deploy simple AI apps using no-code tools

Semester-II

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J P Nagar 6th Phase
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Course Title:	Communicative English
Course Code:	25VBX0AE205
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course equips students with foundational and advanced communication techniques necessary for academic, personal, and professional success. Through practice-driven modules, students will develop their verbal, written, digital, and intercultural communication competence to become effective communicators.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Articulate the elements and processes involved in effective communication	L2
CO2	Analyze and differentiate between various forms of communication, recognizing their unique functions	L4
CO3	Apply diverse approaches to enhance listening and reading skills, leading to improved comprehension	L3
CO4	Demonstrate the ability to convey messages fluently and appropriately in diverse social and professional scenarios	L3
CO5	Employ advanced writing strategies to craft compelling and actionable written communication	L5

Course Modules

No. of Hours: 24

Module 1: Communication Foundations and Contexts
Scope of Module: Explore the process, types, and importance of communication with reference to global standards.
Topics: English as a global lingua franca, 21st-century communication needs, process and types of communication, workplace language skills, situational dialogues, formal and informal styles, communication barriers and management, verbal and non-verbal cues
Learning Outcome: *Explain the process and significance of effective communication in both workplace and societal contexts*

No. of Hours: 24

Module 2: Grammar, Reading, and Dialogue
Scope of Module: Build grammatical accuracy and comprehension through structured reading and dialogue practices
Topics: Essentials of good English (parts of speech, sentence structures), subject-verb agreement, discourse markers, reading strategies, textual understanding using *The English Teacher* by R.K. Narayan, direct and indirect dialogue, conversation control, dialogue in different scenarios, Einstein-Tagore discussion
Learning Outcome: *Apply grammar principles and reading skills for improved comprehension and communication*

No. of Hours:24

Module 3: Digital and Collaborative Communication
Scope of Module: Focus on the use of technology for learning, presenting, and collaborating in professional environments.
Topics: Online resources for language and research (Google Scholar, INFLIBNET, Project Gutenberg), writing essays and reports, persuasive and narrative writing, organizing reports, group presentations, public speaking, simulated interviews, using PPTs, ICT platforms, blogs, social media, email etiquette, virtual meeting tools
Learning Outcome: *Utilize digital tools and collaborative strategies for professional communication and presentation*

No. of Hours:24

Module 4: Argumentation, Networking, and Global Communication

Scope of Module: Develop effective argumentation, negotiation, and multicultural communication skills.
Topics: Pillars of argument, logic structures, radio debate analysis, art of debate and rebuttal, negotiation principles, conflict resolution, difficult conversations, networking language and strategies, global communication etiquette, multicultural sensitivity, handling communication barriers
Learning Outcome: *Demonstrate critical thinking, negotiation, and networking skills in global and multicultural communication settings*

No. of Hours:24

Module 5: Life Writing and Official Correspondence
Scope of Module: Explore reflective writing forms and develop professional written communication skills.
Topics: Official letter formats and styles, email writing (salutations, CC, BCC), resume and cover letters, types of life writing (memoirs, journals, biographies, testimonials), *The Diary of Anne Frank*, importance of life writing in reflecting social and personal history
Learning Outcome: *Craft effective official communications and explore personal expression through reflective writing forms*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites :

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.

- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

1. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
2. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
3. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings

Book

- *Elements of Style* by William Strunk Jr. and E. B. White

Online Articles, Journals, and Whitepapers

- George Orwell's *Why I Write* (orwellfoundation.com)
- *The Sense of Style* by Steven Pinker
- Steven Earnshaw (Ed.). *The Handbook of Creative Writing*. Edinburgh University Press

Web-based Resources

- British Council Learn English, BBC Learning English, ELLLO, Purdue OWL Writing Lab, Grammarly Blog

Recommended Software/Tools:

1. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
2. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
3. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
4. **Miro** – for mind-mapping essay structures.
5. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	2	2	1	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	2	2	3	2
CO5	3	3	3	2	3	2	2	2	3	3
Articulation	2.2	2.2	2.6	1.8	2.2	2	2	2	2.2	2.4

Course Title:	Operating System
Course Code:	25VBT0C201
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course provides an in-depth understanding of operating system concepts such as process management, memory organization, scheduling, file systems, I/O systems, and protection mechanisms. Through theoretical foundations and case studies (Linux), students will gain insight into how an OS functions as a system software and as a resource manager**.**

Course Outcomes (Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Gain insight into the basic operating system structure & concept of process management.	L2
CO2	Develop a strong foundation on process scheduling, process synchronization & concept of deadlock.	L3
CO3	Analyze and apply concepts related to process management, scheduling, and multithreaded programming.	L4
CO4	Evaluate various memory management strategies, such as paging and segmentation, and analyze the complexity and cost associated with virtual memory techniques	L5
CO5	Design and implement solutions for file systems, understand the structure and functioning of I/O systems and create strategies for security mechanisms and protection in operating systems.	L5

Course Modules

No. of Hours:24

Module 1: Fundamentals of Operating System
Scope of Module: Introduces the architecture, structures, and basic services of modern operating systems and their interactions with hardware.
Topics: Introduction to Operating Systems, Computer System Architecture, Types of Operating Systems, Operating System Structure, Operating System Operations, Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, OS Design & Implementation, Virtual Machines, OS Generation, System Boot
Learning Outcome: *Comprehend the fundamentals, structure, and services of operating systems.*

No. of Hours:24

Module 2: Process Management and Scheduling
Scope of Module: Focuses on process lifecycle, scheduling techniques, and multithreading concepts for efficient CPU management.
Topics: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication (IPC), Multithreaded Programming, Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling
Learning Outcome: Analyze and apply process management, scheduling algorithms, and multithreaded programming.

No. of Hours:24

Module 3: Synchronization and Deadlocks
Scope of Module: Examines concurrency issues in multi-process systems and methods to avoid synchronization and deadlock problems.
Topics: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Synchronization Problems, Monitors, Deadlock Introduction, System Model, Deadlock Characterization, Deadlock Handling Methods, Deadlock Prevention, Avoidance, Detection, Recovery
Learning Outcome: *Evaluate process synchronization mechanisms and methods to handle deadlocks in operating systems.*

No. of Hours:24

Module 4: Memory and Storage Management
Scope of Module: Explores how operating systems handle memory through allocation strategies and virtual memory mechanisms.
Topics: Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation, Virtual Memory Concepts, Virtual Address Space, Demand Paging, Copy-On-Write, Page Replacement Algorithms, Frame Allocation, Thrashing, Overview of Mass Storage, Disk Structure, Disk Scheduling, RAID Concepts
Learning Outcome: *Evaluate memory and storage management techniques including paging and virtual memory.*

No. of Hours:24

Module 5: File Systems, I/O, Protection and Case Study
Scope of Module: Describes file organization, I/O hardware-software interface, and protection strategies along with a case study on Linux.
Topics: File Concepts, Access Methods, Directory & Disk Structure, File Mounting & Sharing, File System Implementation, Directory Implementation, Allocation & Free-Space Management, Efficiency & Performance, I/O System Overview, Application I/O Interface, Kernel I/O Subsystem, STREAMS, Goals and Principles of Protection, Access Matrix, Access Control, Security Threats, Distributed Systems Overview, Case Study: Linux OS Design, Kernel Modules, Process & Memory Management, File Systems in Linux
Learning Outcome: *Design and assess file systems, I/O, protection mechanisms, and explore the Linux operating system.*

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**
4	**12**

5	**10**

Note: Min no of pre recordings 10**.**

Prerequisites :

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Operating System Fundamentals by Prof. Niket Kaushik (IIT Roorkee)
NPTEL: https://nptel.ac.in/courses/106107191

Suggested Reading:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, *Operating System Concepts*, Wiley

Suggested Tools / Activities:

1. Linux command line practice
2. OS simulation tools (like LittleOS Book, Nachos, or PintOS – demonstration level)
3. Process scheduling simulations (Gantt chart practice)
4. Visualization of paging, segmentation, and memory management
5. VirtualBox for exploring Linux file systems

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	1	2	1
CO2	3	3	3	3	3	1	–	1	2	1
CO3	3	3	3	3	3	1	–	1	2	2
CO4	3	2	3	3	3	1	1	1	2	3
CO5	3	1	1	3	3	2	1	1	1	1
Articulation	3	2.2	2.4	2.8	3	1.2	1	1	1.8	1.6

Course Title:	Data Structures using C
Course Code:	25VBT0C202
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of data structures using the C programming language. It covers linear and non-linear structures, recursion, memory management, and algorithmic problem-solving through arrays, stacks, queues, linked lists, trees, and graphs. The course emphasizes practical implementation and performance analysis.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Comprehend fundamentals of Data Structures & its applications for solving real-world problems.	L2
CO2	Infer and develop applications of Linear Data Structures including stacks, queues, and lists.	L2
CO3	Interpret and apply Non-Linear Data Structures & their applications.	L3
CO4	Implement, analyze, and evaluate the searching algorithms	L5
CO5	Apply sorting algorithms to sort various types of data.	L3

Course Modules

No. of Hours:24

Module 1: Fundamentals of Data Structures & Pointers
Scope of Module: Introduces the concept and classification of data structures and deepens the understanding of pointers and memory management in C.
Topics: Introduction to Data Structures, Primitive and Non-Primitive Types, Linear vs Non-Linear Structures, Operations on Data Structures, Introduction to Algorithms, Characteristics & Elements of Algorithms, Pointer Basics, Pointer with Functions, Pass by Reference, Array of Pointers, Pointer to Arrays, Dynamic Memory Allocation, Structures and Unions, Self-referential Structures
Learning Outcome: *Understand the fundamental concepts of Data Structures and pointer-based memory operations.*

No. of Hours:24

Module 2: Arrays, Strings & Recursion
Scope of Module: Focuses on basic linear data representations and recursive algorithm strategies.
Topics: Linear Arrays: Representation, Traversing, Insertion, Deletion, Searching, Sorting, Dynamic Arrays, Multi-dimensional Arrays, String Concepts, String Operations, Pattern Matching Algorithms, Recursion: Direct and Indirect, Factorial, GCD, Fibonacci, Tower of Hanoi
Learning Outcome: *Apply array and string operations, and implement recursive solutions for mathematical and problem-solving tasks.*

No. of Hours:24

Module 3: Stacks and Queues
Scope of Module: Explores the stack and queue structures and their applications in computation.
Topics: Stack Definition, Operations, Array and Dynamic Representation, Polish & Reverse Polish Notations, Infix to Postfix Conversion, Postfix Evaluation, Queue Concepts: Operations, Array and Dynamic Representation, Circular Queue, Dequeue, and other types pf queues, Applications (e.g., Mazing Problem)
Learning Outcome: *Design and implement linear data structures using stacks and queues for solving expression and system-related problems.*

No. of Hours:24

Module 4: Linked Lists and Trees
Scope of Module: Covers linked list variants and hierarchical data structures with traversal techniques.

Topics: Singly Linked List: Representation, Traversal, Insertion, Deletion, Doubly and Circular Linked Lists, Linked Stacks and Queues, Applications, Trees: Terminology, Binary Trees, Complete Binary Trees, Representation, Binary Tree Traversals (Inorder, Preorder, Postorder), Binary Search Trees: Insertion, Deletion, Searching, Expression Tree Evaluation
Learning Outcome: *Analyze and apply dynamic structures like linked lists and trees to manage and process data efficiently.*

No. of Hours:24

Module 5: Graphs, Sorting & Searching
Scope of Module: Focuses on non-linear graphs and foundational algorithms for data organization and retrieval.
Topics: Graphs: Directed, Undirected, Representation (Matrix, Adjacency List), BFS and DFS Traversals, Sorting Techniques: Bubble, Insertion, Selection, Quick, Heap Sort, Searching Algorithms: Linear, Binary, Interpolation, Jump Search
Learning Outcome: *Implement and analyze graph traversal, sorting, and searching algorithms based on performance and use cases.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites :

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Data Structures and Algorithms using C by Prof. Naveen Garg (IIT Delhi) NPTEL: https://nptel.ac.in/courses/106102064

Suggested Reading:

- Seymour Lipschutz, *Data Structures*, Schaum's Outlines
- Horowitz, Sahni, Anderson-Freed, *Fundamentals of Data Structures in C*
- Yashavant Kanetkar, *Data Structures Through C*
- NPTEL / GeeksforGeeks / HackerRank (Practice Problems)

Suggested Tools / Activities:

1. Turbo C / GCC on Linux or Windows
2. Implementing stacks, queues, trees in C
3. Dry-run and trace recursion and sorting programs
4. Mini-project: Student Record System, Expression Evaluation
5. Practical lab with GDB (for pointer/stack memory visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	1	–	1	–	2
CO3	3	3	3	3	3	–	2	–	1	2
CO4	3	2	3	3	3	2	–	2	–	3
CO5	3	2	3	2	3	1	–	1	–	2
Articulation	3	2.6	2.8	2.4	2.6	1.3	2	1.3	1	2.2

Course Title:	Relational Database Systems
Course Code:	25VBT0C203
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of relational database design, implementation, and management. Students will learn how to design databases using ER models, normalize schemas, write complex SQL queries, and understand transaction management and emerging trends like NoSQL and Big Data. Emphasis is placed on applying theoretical knowledge through hands-on practice.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand basic database concepts, architectures, and advantages over traditional file systems.	L2
CO2	Create and interpret ER/EER diagrams and convert them into relational schemas.	L6
CO3	Analyze database designs using normalization techniques for optimized performance and data integrity.	L4
CO4	Construct and execute SQL queries for database operations.	L5
CO5	Explore advanced databases and evaluate their applicability in different contexts.	L5

Course Modules

No. of Hours:24

Module 1: Database Fundamentals and Architecture
Scope of Module: Introduces students to databases, their characteristics, architecture, and the distinction between DBMS and traditional file systems.
Topics: Database Characteristics, File-Based Systems vs. DBMS, Types of Data Processing and Access Methods, Data Models Overview, DBMS vs. RDBMS, Database Applications, Schemas and Instances, Three-Schema Architecture, Data Independence, DDL, DML, DCL, TCL, Centralized vs. Client/Server Architecture, DBMS Classification
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data.*

No. of Hours: 24

Module 2: Data Modeling with ER/EER and Relational Design
Scope of Module: Focuses on designing data models using ER and EER diagrams and converting them into relational models.
Topics: Entity, Attributes, Relationships, ER Symbols, Weak Entities, Keys, Constraints, Advanced ER Concepts, UML-based EER Diagrams, ER-to-Relational Mapping, Subclasses, Superclasses,Specialization, Generalization, Relational Schema Design, Relational Model Concepts, Constraints, Update Operations, Transactions
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data. Design ER/EER diagrams and map them into normalized relational schemas.*

No. of Hours: 24

Module 3: SQL and Relational Algebra
Scope of Module: Covers data definition and manipulation in SQL and introduces relational algebra for query formulation.
Topics: SQL Data Types, DDL, DML, Constraints, Keys (Primary, Foreign, Alternate), INSERT, UPDATE, DELETE, SELECT Queries, Aggregate Functions, GROUP BY, HAVING, JOINs (Inner, Outer, Cross), Subqueries, Relational Algebra Operators, Unary & Binary Operations, Set Theory Operations, Grouping and Aggregation in Algebra
Learning Outcome: *Write efficient SQL queries and use relational algebra to express data operations.*

No. of Hours: 24

Module 4: Normalization, Transactions & Concurrency Control
Scope of Module: Deals with schema refinement, functional dependencies, transaction behaviour, and concurrency mechanisms.
Topics: Informal Design Guidelines, 1NF, 2NF, 3NF, BCNF, Multivalued Dependencies, 4NF, 5NF, Join Dependencies, ACID Properties, Transaction States, Serializability, Conflict & View Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols, Deadlock Detection & Prevention
Learning Outcome: *Normalize relational schemas and implement safe, concurrent transaction handling in DBMS.*

No. of Hours:24

Module 5: Database Recovery, NoSQL & Emerging Trends
Scope of Module: Explores recovery methods, non-relational databases, and current trends in the field.
Topics: Recovery Concepts, Types of Failures, Log-Based Recovery, Shadow Paging, ARIES Recovery Algorithm, Introduction to NoSQL, Types (Key-Value, Column, Document, Graph), Big Data & Hadoop Overview, Introduction to Data Warehousing and Data Mining, Database Security Concepts
Learning Outcome:*Explore database recovery techniques and evaluate modern database trends and technologies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites :

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Database Management System by Prof. P. P. Chakrabarti (IIT Kharagpur) NPTEL: https://nptel.ac.in/courses/106105175

Suggested Reading:

- Ramez Elmasri & Shamkant Navathe, *Fundamentals of Database Systems*, Pearson
- Silberschatz, Korth, & Sudarshan, *Database System Concepts*, McGraw-Hill
- NPTEL Database Management Systems Modules
- Practice Resources: SQLZoo, LeetCode (SQL), DB-Fiddle

Suggested Tools / Activities:

1. Use of MySQL / PostgreSQL / Oracle XE
2. Lab practice: SQL query execution, ER diagram to schema mapping
3. Projects: Library Management System, Online Store Schema Design
4. Tools: DB Designer, SQL Workbench, pgAdmin, MongoDB Compass (for NoSQL demos)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	3	2	1
CO2	3	3	3	3	3	2	–	2	2	1
CO3	3	3	3	3	3	1	–	1	2	1
CO4	3	3	3	3	3	1	2	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1.5	1.6	2	1.4

Semester III

Course Title:	Python Programming *
Course Code:	25VBT0C301
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamental concepts of Python programming, covering syntax, data types, control structures, functions, and object-oriented principles. It also explores data structures, file handling, databases, web services, and networking. The course emphasizes problem-solving using Python and provides hands-on experience with real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic syntax, data types, and control structures in Python.	L2
CO2	Apply functions, modules, and object-oriented concepts to solve problems.	L3
CO3	Develop programs using file handling, exceptions, and standard libraries.	L3
CO4	Analyze and implement data structures such as lists, dictionaries, and tuples.	L4
CO5	Design real-world applications using Python frameworks and libraries.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Python and Basic Programming Concepts

Scope of Module: This module covers Python programming basics, syntax, variables, mathematical operations, and debugging techniques. It also introduces expressions, Boolean logic, and user input handling.
Topics: Introduction to programming concepts, Python as a programming language, writing and running Python scripts, variables and assignment statements, data types (integers, floats, and strings), arithmetic operations and expressions, Boolean expressions and logical operators, modulus operator and integer division, order of operations in expressions, working with user input and output, string operations and concatenation, naming conventions and keywords, writing meaningful comments in code, debugging techniques and best practices, common syntax errors and troubleshooting.
Learning Outcome: *Understand the fundamental concepts and terminology of Python programming while developing the ability to write and debug simple programs*.

No. of Hours: 24

Module 2: Functions, Iteration, and String Manipulation
Scope of Module: This module explores functions, control structures like loops, and handling string operations, enabling efficient program flow and data processing.
Topics: Function definitions and structure, function calls and return values, built-in functions in Python, parameters and arguments in functions, type conversion functions, recursive functions and base cases, iteration using while loops, iteration using for loops, using break and continue statements, nested loops and loop efficiency, string sequences and indexing, string slicing and concatenation, string immutability and methods, string formatting techniques, debugging functions and loops.
Learning Outcome: *Implement functions, loops, and string operations effectively for structured programming in Python.*

No. of Hours: 24

Module 3: Data Structures – Lists, Dictionaries, and Tuples
Scope of Module: This module covers essential Python data structures, including lists, dictionaries, and tuples, focusing on operations and efficient data handling.
Topics: Introduction to lists and their properties, list indexing and slicing, adding and removing list elements, list mutability and copying, iterating over lists using loops, list comprehensions and filtering, dictionary creation and key-value pairs, accessing and updating dictionary values, looping through dictionaries, dictionary operations and methods, introduction to tuples and immutability, tuple assignment and multiple return values, tuples as dictionary keys, comparing lists, dictionaries, and tuples, debugging common data structure issues.
Learning Outcome: *Analyze and manipulate Python's core data structures to store, retrieve, and* **process data effectively.**

No. of Hours: 24

Module 4: File Handling, Object-Oriented Programming, and Inheritance
Scope of Module: This module introduces file handling, object-oriented programming, and inheritance principles to build reusable and structured code.
Topics: Reading and writing text files, handling different file formats, file paths and directory navigation, exception handling in file operations, object-oriented programming (OOP) concepts, defining classes and objects, attributes and instance methods, encapsulation and data hiding, mutability of objects and copying, understanding object lifecycles, inheritance and subclassing, overriding methods in subclasses, polymorphism and method resolution order, class diagrams and object hierarchies, debugging OOP-based programs.
Learning Outcome:Develop structured, reusable programs using file handling, OOP, and inheritance concepts in Python.

No. of Hours: 24

Module 5: Databases, Web Services, and Networking
Scope of Module: This module explores database management, web services, APIs, and network programming, enabling interaction with external data sources and networked systems.
Topics: Introduction to databases and SQL, creating and managing tables in SQL, writing and executing SQL queries, relational database modeling and normalization, handling multiple tables and relationships, constraints and data integrity, introduction to web services and APIs, understanding XML and JSON formats, parsing XML and JSON in Python, working with third-party APIs, introduction to networking concepts, sending and receiving data over networks, Python sockets for client-server communication, web scraping techniques using Python, debugging network and database programs.
Learning Outcome: *Develop proficiency in handling databases, web services, and networking concepts for real-world applications.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12

5	**11**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of programming logic and flowcharts
- Familiarity with any programming language (C/C++ preferred)
- Logical reasoning and problem-solving mindset

Pedagogy / Teaching Methodology

- ✓ Hands-on coding sessions in labs and online IDEs
- ✓ Mini-projects on text processing, games, or web apps
- ✓ Weekly coding challenges and debugging practice
- ✓ Group tasks involving script design or automation
- ✓ Integration with tools like Jupyter Notebooks, GitHub, and Colab

Certificate / Value Added Courses

1. Python for Everybody – Coursera (University of Michigan)
2. Google IT Automation with Python – Coursera
3. Introduction to Python – edX (Microsoft)
4. Automate the Boring Stuff with Python – Udemy

Suggested Readings

- Eric Matthes, *Python Crash Course*
- Charles Dierbach, *Introduction to Computer Science Using Python*
- Mark Lutz, *Learning Python*
- Al Sweigart, *Automate the Boring Stuff with Python*
- Guido van Rossum (online documentation): https://docs.python.org/3/

Recommended Software / Tools

1. **IDE/Editors:**
    a. Jupyter Notebook
    b. Visual Studio Code
    c. PyCharm (Community Edition)
    d. Thonny (for beginners)
2. **Online Platforms:**
    a. Google Colab
    b. Replit
    c. HackerRank / LeetCode (for Python practice)
3. **Libraries and Frameworks:**
    a. NumPy, Pandas (for data analysis)
    b. Tkinter, PyQt (for GUI development)
    c. Flask, Django (for web development)
    d. Matplotlib, Seaborn (for data visualization)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	3	-	1	1	1

CO2	3	3	3	3	3	2	1	1	1	1
CO3	2	3	2	2	3	2	1	1	2	-
CO4	3	3	2	2	2	2	1	2	1	1
CO5	2	3	3	3	3	3	1	1	1	1
Articulation	2.6	3	2.4	2.4	2.6	2.4	1	1.2	1.2	1

Course Title:	Design and Analysis of Algorithms *
Course Code:	25VBT0C302
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course explores the fundamental principles and advanced techniques in algorithm design and analysis. Students will learn to develop computational solutions for problems like searching and sorting, apply divide-and-conquer, greedy, and dynamic programming techniques, and analyze algorithmic efficiency. The course will also cover space-time tradeoffs, iterative improvements, and approaches to solving NP-hard problems, providing industry-relevant problem-solving skills.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic algorithmic strategies and their time/space complexities.	L2
CO2	Apply divide and conquer, greedy, and dynamic programming paradigms to solve problems.	L3
CO3	Analyze algorithm efficiency using Big-O, Big-Ω, and Big-Θ notations.	L4
CO4	Evaluate and compare the performance of different algorithms.	L5
CO5	Design efficient algorithms for real-world problems using suitable techniques.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Algorithm Design and Analysis
Scope of Module:

This module introduces fundamental algorithm concepts, including problem-solving strategies, computational limits, and performance analysis. It covers basic searching, sorting techniques, and asymptotic notation for algorithm efficiency.
Topics: Definition and importance of algorithms, understanding problem complexity and computational constraints, importance of selecting appropriate data structures, algorithm design techniques, methods of specifying an algorithm, proving correctness of an algorithm, performance analysis and computational efficiency, space complexity and time complexity, asymptotic notations including Big-O, Omega, and Theta, mathematical analysis of recursive and non-recursive algorithms, selection sort and bubble sort fundamentals, sequential search and brute-force string matching, closest-pair problem using brute-force technique, convex hull problem using brute-force method, exhaustive search techniques.
Learning Outcome: *Understand the role of algorithms in problem-solving and analyze algorithm efficiency using mathematical models.*

No. of Hours: 24

Module 2: Divide and Conquer and Decrease and Conquer Approaches
Scope of Module: This module delves into the divide-and-conquer and decrease-and-conquer techniques, helping students analyze problems that can be solved by breaking them into smaller subproblems.
Topics: Introduction to divide-and-conquer strategy, recurrence equations and their significance, finding maximum and minimum elements, merge sort algorithm and analysis, quick sort algorithm and complexity, binary search and efficiency, binary tree traversals and their properties, multiplication of large integers using divide-and-conquer, Strassen's matrix multiplication algorithm, closest-pair problem using divide-and-conquer, convex hull problem via divide-and-conquer, insertion sort algorithm and its efficiency, depth-first search algorithm (DFS), breadth-first search algorithm (BFS), topological sorting and its applications.
Learning Outcome: *Analyze and implement divide-and-conquer and decrease-and-conquer techniques to optimize problem-solving.*

No. of Hours: 24

Module 3: Space-Time Tradeoffs, Greedy Approach, and Iterative Improvement
Scope of Module: This module focuses on space-time tradeoffs, string matching algorithms, and greedy techniques for optimization problems. Students will explore graph algorithms and iterative improvement techniques in optimization.

Topics: Introduction to space-time tradeoff principles, sorting by counting methods, input enhancement in string matching, Boyer-Moore algorithm for string matching, Horspool's algorithm and performance analysis, hashing fundamentals and applications, open hashing vs. closed hashing, Prim's algorithm for minimum spanning trees, Kruskal's algorithm using disjoint subsets, union-find method in Kruskal's algorithm, Dijkstra's algorithm for shortest path, Huffman tree construction and encoding, simplex method for linear programming, geometric interpretation of linear programming, maximum-flow problem and optimization strategies.
Learning Outcome: *Apply space-time tradeoffs, greedy techniques, and iterative improvement methods to solve optimization problems.*

No. of Hours: 24

Module 4: Transform and Conquer, Dynamic Programming, and Algorithmic Optimization
Scope of Module: This module covers algorithm transformation strategies, pre-sorting techniques, dynamic programming principles, and optimization algorithms used in shortest path problems and combinatorial optimization.
Topics: Introduction to transform and conquer approach, pre-sorting and its advantages, Gaussian elimination method, balanced search trees and their importance, heaps and heap sort algorithm, Horner's rule and its applications, binary exponentiation technique, problem reduction approach, overview of dynamic programming, computing binomial coefficients using dynamic programming, Warshall's algorithm for transitive closure, Floyd's algorithm for all-pairs shortest paths, principle of optimality in dynamic programming, optimal binary search trees, knapsack problem and memory functions.
Learning Outcome: *Design and implement dynamic programming solutions for combinatorial optimization problems.*

No. of Hours: 24

Module 5: Limitations of Algorithmic Power and Approximation Algorithms
Scope of Module: This module examines the theoretical limitations of algorithmic power, computational complexity classes, and approximation algorithms for NP-hard problems. It also introduces backtracking and branch-and-bound methods.

Topics:
Introduction to lower-bound arguments, trivial lower bounds and problem complexity, information-theoretic arguments in complexity analysis, adversary arguments and decision trees, complexity classes: P, NP, and NP-complete problems, challenges in numerical algorithms, backtracking technique and its applications, N-Queens problem using backtracking, sum of subsets problem using backtracking, branch-and-bound method for optimization, knapsack problem using branch-and-bound, traveling salesperson problem and branch-and-bound, approximation algorithms for NP-hard problems, traveling salesman problem approximation techniques, knapsack problem approximation methods.

Learning Outcome: Analyze computational complexity, apply backtracking and branch-and-bound techniques, and develop approximation algorithms for NP-hard problems.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites :

- Knowledge of basic programming (C/C++/Python)
- Understanding of discrete mathematics
- Familiarity with data structures

Pedagogy

- ✓ Whiteboard algorithm walkthroughs
- ✓ Pseudocode-to-code transformation exercises
- ✓ Complexity analysis using real-world problems
- ✓ Case studies and project-based learning

Value Added Courses / Certificates

1. Algorithmic Toolbox – Coursera
2. Data Structures and Algorithms – Udacity

Suggested Readings

- Thomas H. Cormen et al., Introduction to Algorithms
- Jon Kleinberg & Éva Tardos, Algorithm Design
- Anany Levitin, Introduction to the Design & Analysis of Algorithms

Recommended Tools

1. Python/C++ IDEs (e.g., VS Code, Code::Blocks)
2. Online judges: HackerRank, LeetCode, Codeforces

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	-	1	2	3
CO2	2	3	2	2	1	1	-	1	1	1

CO3	2	2	3	2	2	2	1	1	1	1
CO4	1	1	2	1	3	2	1	1	1	2
CO5	1	2	2	3	2	2	1	2	2	2
Articulation	1.8	2.2	2.4	2	2.2	1.8	1	1.2	1.4	1.8

Course Title:	Software Engineering
Course Code:	25VBT0C303
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamentals of software engineering, including software development models, agile methodologies, requirements engineering, software design, testing, maintenance, and emerging trends. Students will explore industry-standard practices, software quality assurance, and modern development approaches such as DevOps, cloud computing, and AI-driven software engineering. By the end of the course, students will be equipped with the skills **to** design, develop, test, and maintain software systems efficiently.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the phases of software development life cycle (SDLC).	L2
CO2	Apply appropriate process models for software projects.	L3
CO3	Analyze software requirements and specifications.	L4
CO4	Evaluate software design methodologies and testing techniques.	L5
CO5	Create documentation and design for real-world software applications.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Engineering

Scope of Module: This module introduces software engineering principles, software processes, and different software application domains.
Topics Covered: The nature of software, defining software, software application domains, the unique nature of web applications, software engineering and the software process, software engineering practice, software myths, a generic process model, defining a framework activity, identifying a task set, process assessment and improvement, prescriptive process models (waterfall, incremental, **evolutionary,** concurrent), specialized process models (component-based development, formal methods model, aspect-oriented development), the Unified Process and its phases, personal and team process models (PSP, TSP).
Learning Outcome: *Define software engineering principles, differentiate between software application domains, and describe various software process models.*

No. of Hours: 24

Module 2: Agile Development and Requirements Engineering
Scope of Module: This module explores agile methodologies and techniques for requirements gathering, analysis, and modeling.
Topics Covered: The concept of agility and its impact on the cost of change, agile process and principles, the politics of agile development, human factors in agility, extreme programming (XP) and its process, industrial XP, adaptive software development, Scrum framework, dynamic systems development method (DSDM), feature-driven development (FDD), lean software development, agile modeling, requirements engineering and stakeholders, developing use cases and UML models, requirements modeling for web applications.
Learning Outcome: *Explain agile methodologies, analyze software requirements, and apply modeling strategies for software specification.*

No. of Hours: 24

Module 3: Software Design and Architecture
Scope of Module: This module focuses on software design principles, architectural styles, and user interface design strategies.
Topics: The role of design in software engineering, the design process, software quality guidelines and attributes, evolution of software design, design concepts, the design model, software architecture, architectural genres and styles, component-level design, object-oriented view of components, designing class-based components, user interface design, web application interface design, interface analysis and guidelines, interface design steps.
Learning Outcome: *Apply software design principles, develop architectural models, and implement*

user interface design guidelines.

No. of Hours: 24

Module 4: Software Quality and Testing
Scope of Module: This module focuses on software quality assurance, verification, validation, and testing strategies.
Topics: Software quality and its dimensions, the software quality dilemma, achieving software quality through engineering methods, cost impact of software defects, review metrics and their use, software quality assurance (SQA) and its elements, SQA tasks, goals, and metrics, formal approaches to SQA, statistical software quality assurance, software reliability and availability, a strategic approach to software testing, verification and validation, unit testing, security testing, debugging and the debugging process.
Learning Outcome*: Analyze software quality assurance strategies and implement software testing techniques for defect prevention and validation.*

No. of Hours: 24

Module 5: Software Maintenance and Emerging Trends
Scope of Module: This module covers software maintenance techniques, risk management, and evolving trends in software engineering.
Topics: Software maintenance and evolution, legacy system maintenance, capability maturity models (CMM), software project risk management, risk mitigation strategies, software configuration management, change control, refactoring strategies, version control systems, release management, continuous integration and deployment (CI/CD), DevOps practices, cloud computing and microservices, AI in software development, future trends in software engineering.
Learning Outcome: *Evaluate software maintenance strategies, implement cost estimation models, and explore emerging trends in software engineering.*

Module	No of Pre Recordings
1	10
2	12
3	10

4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Familiarity with basic programming
- Understanding of software applications

Pedagogy

- ✓ SDLC-based project development
- ✓ Use case modeling and UML design
- ✓ Agile and traditional model simulation
- ✓ Code review and testing labs

Value Added Courses / Certificates

1. Software Processes and Agile Practices – Coursera
2. Software Engineering Essentials – edX

Suggested Readings

- Ian Sommerville, *Software Engineering*
- Roger Pressman, *Software Engineering: A Practitioner's Approach*
- Pankaj Jalote, *An Integrated Approach to Software Engineering*

Recommended Tools

1. Visual Paradigm, StarUML (UML modeling)
2. GitHub (Version control)
3. JIRA (Agile project management)
4. Selenium, JUnit (Testing)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development

3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	-	1	1	1
CO2	2	3	2	3	2	1	1	1	1	1
CO3	2	2	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	2	-	1	3	2
CO5	1	1	1	1	3	2	2	3	2	1
Articulation	1.8	1.8	2	1.8	2.2	1.4	1.3	1.4	1.6	1.2

Course Title:	Computer Networks
Course Code:	25VBT0C304
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a comprehensive introduction to computer networks, covering fundamental networking principles, architectures, and protocols. Students will explore different network layers, their functionalities, and the mathematical calculations associated with data transmission. The course also introduces advanced networking concepts such as cloud computing, IoT, and network security.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand network architectures, protocols, and models.	L2
CO2	Apply network principles to configure and troubleshoot basic networks.	L3
CO3	Analyze different layers of the OSI and TCP/IP models.	L4
CO4	Evaluate network performance and security mechanisms.	L5
CO5	Design secure and scalable network infrastructures.	L5

Course Modules

No. of Hours:24

Module 1: Fundamentals of Computer Networks
Scope of Module: This module introduces fundamental networking concepts, network models, and physical layer functionalities. It provides an overview of computer networks, transmission media, and error detection mechanisms.
Topics: Overview of computer networks and their importance, Historical evolution of networking technologies, Network types and their applications (LAN, MAN, WAN), Network topologies and their impact on performance, The OSI reference model: layers and their functions, The TCP/IP model: comparison with OSI model, Analog and digital signals in networking, Transmission media: guided and unguided media, Signal encoding techniques and modulation schemes, Multiplexing techniques: FDM, TDM, and WDM, Spread spectrum techniques and their applications, Transmission errors: causes and effects, Error detection techniques: parity checks and checksums, Error correction mechanisms: Hamming code and CRC, Physical layer functions and performance metrics.
Learning Outcome: Explain the fundamental concepts of computer networks, transmission media, and error detection techniques

No. of Hours:24

Module 2: Data Link Layer and Medium Access Control
Scope of Module:
This module explores the data link layer, its role in error detection, flow control, and MAC protocols for wired and wireless networks.
Topics Covered:
Framing methods and techniques in data transmission, Flow control mechanisms: stop-and-wait and sliding window protocols, Error detection techniques: CRC, checksums, and parity bits, Error correction methods: Hamming code and ARQ techniques, Medium Access Control (MAC) protocols and their importance, CSMA/CD: collision detection and resolution, CSMA/CA: collision avoidance in wireless networks, Ethernet standards and frame structure, Token Ring: access method and frame structure, Wireless LAN standards: IEEE 802.11 and Wi-Fi, Bluetooth technology and applications, MAC addressing and its role in data link layer, LAN switching techniques: circuit switching vs. packet switching, Virtual LANs (VLANs) and their configurations, Data link layer security threats and mitigation techniques
Learning Outcome:*Describe data link layer functions, error detection techniques, and MAC protocols in wired and wireless networks.*

No. of Hours: 24

Module 3: Network Layer and Transport Layer
Scope of Module: This module covers network-layer functionalities, IP addressing, subnetting, and transport-layer protocols, including TCP and UDP.
Topics: Introduction to the network layer and its services, IP addressing schemes: IPv4 and IPv6, Subnetting techniques and IP address allocation, Routing algorithms: distance vector vs. link state, Static and dynamic routing protocols: RIP, OSPF, and BGP, ICMP protocol and error reporting in networks, IPv4 and IPv6 coexistence strategies, Address Resolution Protocol (ARP) and its working, Network Address Translation (NAT) and its applications, Transport layer functions and its role in networking, TCP and UDP: comparison and applications, Connection establishment and termination in TCP, Congestion control and flow control in TCP, Error detection and correction in transport layer, QoS mechanisms and performance optimization techniques
Learning Outcome: Analyze IP addressing, subnetting, and routing algorithms, and describe transport-layer services.

No. of Hours:24

Module 4: Network Security, Wireless & Multimedia Network
Scope of Module: This module covers network security principles, wireless communication fundamentals, and multimedia networking technologies.
Topics Covered: Network security threats and vulnerabilities, Cryptography basics: symmetric vs. asymmetric encryption, Authentication mechanisms and secure communication, Integrity and confidentiality mechanisms in networking, Wireless transmission fundamentals and radio communication, Cellular networks: architecture and mobile IP, IEEE 802.11 standard and wireless LAN protocols, Bluetooth technology: architecture and applications, Wireless security threats and mitigation techniques, Streaming and real-time communication protocols, Quality of Service (QoS) in multimedia networking, Voice over IP (VoIP) and its applications, Video conferencing protocols and challenges, Delay-sensitive traffic management in multimedia applications, Performance optimization for wireless and multimedia networks
Learning Outcome: Understand and apply multimedia networking protocols to ensure secure, efficient, and high-quality real-time communication over wireless and mobile networks.

No. of Hours: 24

Module 5: Advanced Networking and Emerging Technologies
Scope of Module: This module introduces advanced networking concepts such as network management, cloud computing, IoT, and blockchain.

Topics Covered: SNMP protocol and network monitoring techniques, Fault management and performance optimization in networks, Configuration management in enterprise networks, Distributed computing fundamentals and architectures, Client-server vs. peer-to-peer networking models, Distributed file systems and coordination algorithms, Cloud computing models: IaaS, PaaS, SaaS, Virtualization techniques and resource management, Cloud security challenges and privacy concerns, IoT architecture and components, Communication protocols for IoT applications, IoT security challenges and mitigation techniques, Software-Defined Networking (SDN) architecture and benefits, Network Function Virtualization (NFV) and its impact, Blockchain technology in networking and its applications
Learning Outcome: Evaluate network management strategies, cloud computing models, and emerging technologies like IoT, SDN, and blockchain.

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10**.**

Prerequisites :

- Basic computer system knowledge
- Understanding of binary arithmetic
- Familiarity with operating systems

Pedagogy

- ✓ Packet tracer simulations (Cisco)
- ✓ Layer-by-layer protocol analysis
- ✓ Wireshark labs and trace evaluations
- ✓ Network design mini-projects

Value Added Courses / Certificates

1. Computer Networking – Coursera (Stanford)
2. Cisco CCNA Introduction – NetAcad

Suggested Readings

- Andrew S. Tanenbaum, *Computer Networks*
- Behrouz A. Forouzan, *Data Communications and Networking*
- William Stallings, *Data and Computer Communications*

Recommended Tools

1. Cisco Packet Tracer
2. Wireshark
3. GNS3, NS2/NS3 simulators

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	3	2	1	1	1	1	-	1	1	1
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	3	1	-	2	2	1
CO4	1	2	2	3	2	2	1	2	2	1
CO5	1	1	1	1	1	1	2	1	3	3
Articulation	1.8	2	1.8	1.8	1.6	1.2	1.5	1.4	1.8	1.4

Course Title:	Environmental, Social, and Governance (ESG) in IT
Course Code:	25VBT0C305
Semester:	**III**
Credits:	**3**
Course Type	Core Course
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth exploration of Environmental, Social, and Governance (ESG) principles and their critical application within the Information Technology (IT) sector. Students will examine how ESG factors influence IT operations, strategy, and policy-making, gaining insights into sustainable practices, ethical considerations, and effective governance in technology-driven environments. Through case studies and practical projects, learners will develop the skills necessary to integrate ESG considerations into IT frameworks, ensuring responsible and sustainable technological development.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand environmental principles and sustainability concepts.	L2
CO2	Identify the effects of human activities on ecosystems.	L3
CO3	Analyze environmental challenges and sustainability goals (SDGs).	L4
CO4	Evaluate policies and practices for sustainable development.	L5
CO5	Propose eco-friendly solutions for community or industry applications.	L5

Course Modules:

No. of Hours: 18

Module 1: Introduction to ESG and Digital Responsibility
Scope of Module: This module lays the foundation of ESG principles and their relevance to the IT industry. It explores the global push toward sustainability, ethical tech development, and corporate responsibility.
Topics: Definition and Origin of ESG, Importance of ESG in IT, Sustainable Development Goals (SDGs) and IT alignment, Environmental Impact of Digital Technologies, Ethical Considerations in Tech Development, IT and Climate Change, ESG Ratings and Digital Business Performance, Role of IT Professionals in ESG, Green Certifications and IT Compliance, Digital Transformation and ESG Goals, Circular Economy in IT, Impact of Cloud and Data Centers on Environment, Tech Industry ESG Benchmarks, Digital Minimalism and Eco-design, Global ESG Reporting Frameworks.
Learning Outcome: *Understand ESG foundations, the importance of responsible tech, and the environmental impact of digital systems.*

No. of Hours: 18

Module 2: Environmental Sustainability in IT
Scope of Module: Focuses on sustainable computing, energy-efficient infrastructure, and green software engineering.
Topics: Green IT Practices, Energy-Efficient Hardware and Systems, Carbon Footprint of IT Operations, Sustainable Data Center Management, E-Waste Management and Recycling, Renewable Energy Use in Tech Firms, Virtualization and Cloud Sustainability, Lifecycle Assessment of IT Products, Power Management in Devices, Paperless Office and Digital Workflows, Sustainable Supply Chains in IT, Greener Coding Practices, Use of AI for Environmental Monitoring, IoT in Smart Environment Systems, IT and Climate Action Technologies.
Learning Outcome: *Evaluate IT strategies that promote environmental sustainability and carbon reduction.*

No. of Hours: 18

Module 3: Social Responsibility and Inclusion in Technology
Scope of Module: Covers how IT contributes to equity, digital literacy, accessibility, and ethical labor practices.
Topics: Digital Inclusion and Access to Technology, Gender Equality in Tech, Accessibility Standards (WCAG, ADA), Ethical Labor in Tech Supply Chains, Community Engagement through Technology, Corporate Social Responsibility (CSR) in IT, Digital Literacy and Education Programs, Tech for Good Initiatives, Bridging the Digital Divide, AI Bias and Fairness, Inclusive Design Principles, Social Impact Assessment in Tech Projects, Diversity in IT Workforce, Data for Social Good, Digital Safety and Well-being.
Learning Outcome: *Analyze IT's role in promoting social responsibility and inclusive technology design.*

No. of Hours:18

Module 4: Governance, Ethics, and Regulation in IT
Scope of Module: Discusses governance mechanisms, risk management, data ethics, and compliance in the IT context.
Topics: IT Governance Models, Data Privacy and Protection Laws (GDPR, PDP Bill India), Cyber Ethics and Accountability, Risk Management in Tech Projects, Regulatory Compliance in IT, Digital Rights Management, Transparent AI and Algorithm Auditing, Corporate Governance in IT Companies, Role of CIOs in ESG Governance, ESG Metrics and KPIs in Tech, Open Data and Public Interest, Whistleblowing Mechanisms in Tech Industry, IT Policy Frameworks, Blockchain for Governance Transparency, ESG Risks in IT Investments.
Learning Outcome: *Explore ethical governance practices, digital compliance, and risk management in IT.*

No. of Hours: 18

Module 5: ESG Implementation and Case Studies in IT
Scope of Module: Focuses on practical ESG integration into IT systems, success stories, frameworks, and tools.
Topics: ESG Strategy Development in Tech Organizations, Sustainability Reporting Tools (GRI, SASB), Role of CIOs and IT Managers in ESG, Measuring ESG Performance in IT Projects, ESG-Focused Software Development Lifecycle (SDLC), ESG Dashboards and Analytics, Green Procurement for IT Assets, Case Studies: Google, Microsoft, Infosys ESG Programs, IT in Disaster Response and Crisis Management, ESG Risk Mitigation Frameworks, ESG Investment in Tech Startups, ESG Certifications for IT Professionals, Open-source Tools for ESG Monitoring, ESG KPIs in Software Products, ESG Innovation Labs and Incubators.
Learning Outcome: *Apply ESG principles through frameworks, tools, and real-world tech case studies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- General awareness of science and ecology
- Basic understanding of social issues

Pedagogy

- ✓ Eco-surveys and field visits
- ✓ Case studies on climate change and pollution
- ✓ Group discussions on policy impacts
- ✓ Sustainable campus or local community projects

Value Added Courses / Certificates

1. Sustainable Development Goals – edX
2. Introduction to Sustainability – Coursera

Suggested Readings

- Erach Bharucha, *Environmental Studies*
- R.Rajagopalan, *Environmental Studies from Crisis to Cure*
- UNEP Reports and SDG Guidelines

Recommended Tools

1. ArcGIS (for environment mapping)
2. SDG Tracker
3. OpenLCA (for life cycle assessment)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Concerns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	3	2	1	2
CO2	2	3	2	2	3	2	3	2	1	2
CO3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	2	3	2	3	3	3	2	3
CO5	1	2	3	3	3	3	3	3	3	3
Articulation	2	2.2	2.2	2.2	2.6	2.6	2.8	2.6	1.8	2.6

Semester IV

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Course Title:	Web Technologies
Course Code:	25VBT0C401
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces students to essential web development technologies, covering both front-end and back-end aspects. Students will learn to design, develop, and deploy interactive websites using HTML, CSS, JavaScript, and server-side scripting with PHP or Node.js, along with database integration. The course focuses on hands-on learning and equips students for careers in web development, UI/UX design, and full-stack engineering.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the structure and design principles of web applications.	L2
CO2	Develop interactive and responsive web pages using HTML, CSS, and JavaScript.	L3
CO3	Implement dynamic web applications using server-side scripting.	L3
CO4	Connect web applications with databases for data management.	L4
CO5	Deploy and manage complete web applications using modern web tools.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Web Technologies

Scope of Module: Covers the fundamentals of how the web works, including protocols, architecture, and core components.
Topics: Introduction to Internet and Web, Web Servers and Clients, HTTP and HTTPS Protocols, URL and URI Concepts, DNS and Hosting Basics, Static vs. Dynamic Websites, Web Browsers and Developer Tools, MIME Types and Web Content Types, TCP/IP and Sockets Overview, Browser Rendering Process, HTML Document Structure, Responsive Design Principles, Introduction to Web Accessibility (WCAG), Browser Compatibility Issues, Role of Web Standards (W3C).
Learning Outcome: *Understand the core architecture and functioning of the web ecosystem.*

No. of Hours: 24

Module 2: Frontend Technologies – HTML,CSS,JavaScript HTML,CSS,JavaScript
Scope of Module: Focuses on creating structured, styled, and interactive user interfaces using frontend technologies.
Topics: HTML5 Elements and Semantics, Forms and Validation, CSS3 Selectors and Properties, Responsive Design with Media Queries, CSS Frameworks (Bootstrap/Tailwind), Flexbox and Grid Layouts, Introduction to JavaScript Syntax, DOM Manipulation, Events and Event Handling, JavaScript Functions and Scope, Objects and Arrays, Form Validation with JavaScript, ES6 Features (Let, Const, Arrow Functions), Browser Storage (LocalStorage, SessionStorage), Introduction to AJAX and Fetch API.
Learning Outcome: *Build responsive, accessible, and interactive front-end user interfaces*

No. of Hours: 24

Module 3: Server-Side Programming and Backend Integration
Scope of Module: Introduces backend development and connecting frontend applications to databases and servers.
Topics: Introduction to Server-Side Scripting, Node.js and Express.js Basics, RESTful API Design, Routing and Middleware in Express, Working with JSON Data, Handling HTTP Requests and Responses, Templating Engines (EJS, Handlebars), Introduction to PHP (Optional), Error Handling in Server-Side Apps, Session Management and Cookies, Uploading and Handling Files, Working with Forms (POST, GET), Basic Authentication and Authorization, Connecting Frontend with Backend APIs, Building a Simple Full-Stack App.
Learning Outcome: *Create and connect server-side logic to client-side interfaces using web frameworks.*

No. of Hours: 24

Module 4: Databases and Web Integration
Scope of Module: Focuses on integrating databases into web applications and managing data using queries.
Topics: Relational Databases Overview (MySQL, PostgreSQL), NoSQL Databases (MongoDB), Database Design Basics, CRUD Operations in SQL, Mongoose with MongoDB in Node.js, Connecting Backend to Database, Query Parameters and Filtering, ORM Basics (Sequelize/Mongoose), Data Validation and Sanitization, Indexing and Performance Tuning, Managing Relationships and Joins, Authentication Data Storage, Environment Variables and DB Security, Transactions and Error Handling, Integrating Search in Web Applications.
Learning Outcome: *Design and connect databases to dynamic web applications for persistent storage.*

No. of Hours: 24

Module 5: Web Deployment, Security, and Modern Trends
Scope of Module: Covers web application deployment, security, DevOps integration, and modern web development trends.
Topics: Deployment on Platforms (Vercel, Netlify, Heroku), Git and GitHub for Version Control, Continuous Deployment Pipelines, Domain Registration and DNS Setup, SSL Certificates and HTTPS, Security Best Practices (XSS, CSRF, SQL Injection), HTTPS and Secure Headers, Content Delivery Networks (CDN), CORS Policy and Management, Progressive Web Apps (PWA), Introduction to Single Page Applications (React, Angular), WebSockets and Real-Time Communication, SEO Optimization for Web Apps, Lighthouse and Performance Auditing, Introduction to JAMstack Architecture.
Learning Outcome: *Deploy, secure, and optimize modern web applications using best practices*

.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12

5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- ➢ Basic understanding of programming concepts (e.g., loops, functions)
- ➢ Exposure to HTML or any markup language is beneficial
- ➢ Logical reasoning and analytical thinking

Pedagogy / Teaching Methodology:

- ✓ Hands-on coding with integrated browser tools
- ✓ Live problem-solving through lab exercises
- ✓ Real-world project-based learning
- ✓ Git-based version tracking and collaboration
- ✓ Assignments, quizzes, and mini-projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Web Development by NPTEL (IIT Madras)
   https://nptel.ac.in/courses/106105084
2. Responsive Web Design by freeCodeCamp
   https://www.freecodecamp.org/learn
3. Full Stack Open 2024 by University of Helsinki
   https://fullstackopen.com/en/
4. HTML, CSS, and JS for Web Developers (Coursera)
   https://www.coursera.org/learn/html-css-javascript-for-web-developers

Suggested Readings:

- Jon Duckett, *HTML & CSS: Design and Build Websites, Wiley*
- Robin Nixon, *Learning PHP, MySQL & JavaScript, O'Reilly*
- Ethan Brown, *Web Development with Node and Express*, O'Reilly
- MDN Web Docs: https://developer.mozilla.org/
- W3Schools Reference: https://www.w3schools.com/

Recommended Software/Tools (If applicable):

1. Visual Studio Code
2. Node.js + npm
3. Postman for REST API testing
4. MongoDB Atlas and phpMyAdmin

5. Bootstrap, Tailwind CSS
6. Heroku / Netlify / Vercel for deployment
7. React / Angular (for SPA introduction)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	2	3	2	–	–	2
CO2	3	3	3	2	3	3	3	–	1	3
CO3	3	3	3	3	3	3	2	1	1	3
CO4	3	3	2	3	3	3	3	–	1	3
CO5	3	3	3	3	3	3	3	2	2	3
Articulation	3	2.8	2.6	2.75	2.8	3	2.6	1.5	1.25	2.8

Course Title:	Java Programming *
Course Code:	25VBT0C402
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to the fundamental principles of Object-Oriented Programming (OOP) using Java. It covers basic to advanced Java concepts including classes, objects, inheritance, polymorphism, exception handling, multithreading, and file I/O. The course emphasizes writing robust and efficient programs that solve real-world problems using Java's extensive features and libraries.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Develop a strong foundation in OOP concepts and core Java programming principles.	L2
CO2	Apply core Java constructs such as variables, loops, arrays, and control statements to develop simple applications.	L3
CO3	Apply exception handling techniques to manage runtime errors effectively.	L3
CO4	Develop multithreaded applications and implement synchronization mechanisms.	L4
CO5	Design and implement Java applications to solve real-world problems using complete Java concepts.	L5

Course Modules

No. of Hours : 24

Module 1: Object-Oriented Concepts and Java Fundamentals

Scope of Module:
Covers the basic structure of object-oriented programming and introduces Java as an OOP language.

Topics:
Introduction to the key principles of object-oriented programming including objects, classes,abstraction,encapsulation, inheritance,polymorphism, and abstract classes, Java programming fundamentals, understanding bytecode, and the Java development kit (JDK), Java Runtime Environment (JRE), and Java Virtual Machine (JVM), primitive data types, literals, variables, typecasting, operators, and shorthand assignments, control flow constructs including if-else, switch statements, and input reading, looping constructs like for, while, do-while,and enhanced for-loops with break, continue, and nesting techniques.

Learning Outcome: *Understand the fundamentals of Java and OOP principles, and apply control statements and loops in programs.*

No. of Hours : 24

Module 2:Classes, Objects, Methods, and Arrays

Scope of Module:
Explores the core building blocks of Java programs including class design, object instantiation, and method usage.

Topics:
Class fundamentals, object declaration, method definitions, constructors (default and parameterized), the use of this keyword, scanner class, garbage collection, and the finalize() method, constructor and method overloading, recursion, static and final keywords, and access control, inner and nested classes, array handling(one-dimensional and multi-dimensional arrays), alternative array declarations, enhanced for-loops, and array references, Java built-in functions for arrays and array-based problem-solving.

Learning Outcome: *Comprehend and implement class structures, object interaction, method overloading, and array operations***.**

No. of Hours: 24

Module 3:Working with Strings, Inheritance, and Interfaces

Scope of Module:
Focuses on handling string data, using inheritance to model hierarchies, and applying interfaces for abstraction.

Topics:
String class, constructors, length property, string comparison, character extraction, string modification, case conversion, StringBuffer and StringBuilder formutable strings, inheritance in depth, including member access, method overriding, super keyword usage, constructor chaining, abstract classes, dynamic method dispatch, the Object class, Interface concepts include creating and implementing interfaces, multiple inheritance using interfaces, extending interfaces, constants and variables in interfaces, distinguishing between interfaces and abstract classes.

***Learning Outcome**: Implement inheritance and interfaces to build reusable and flexible code structures while managing string data effectively.*

No. of Hours : 24

Module 4: Exception Handling and Multithreading
Scope of Module: Introduces robust programming techniques using exception handling and explores process-based multitasking with threads
Topics: Introduction to Java's exception handling model including try-catch-finally blocks, throw and throws keywords, exception hierarchy, multiple catch blocks, nested try statements, and handling subclass exceptions, custom exception creation, exception subclasses, chained exceptions, and exception handling with method overriding, multithreading fundamentals, the main thread, creating and managing threads using the Thread class and Runnable interface, thread priorities, lifecycle management, synchronization using methods and synchronized blocks.
***Learning Outcome:** Design applications that handle runtime errors gracefully and manage concurrent execution using multithreading.*

No. of Hours : 24

Module 5: Java File I/O and Real-World Applications
Scope of Module: Covers input/output operations using Java I/O streams and applies learned concepts to build complete Java applications.
Topics: Introduction to JavaI/O classes and interfaces, byte and character stream classes, stream hierarchy, text and binaryfile handling,file reading, writing, random access files, serialization and deserialization,Java-based applications combining all key concepts including classes, objects, inheritance, exception handling, file operations, and multithreading, use cases such as calculators, student record systems, file processors, and real-time data handling apps .
***Learning Outcome:** Design complete Java programs incorporating object-oriented principles, exception handling, file operations, and multithreading*

Module	**No of Pre Recordings**
1	**10**
2	**12**

3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs like Eclipse or IntelliJ
- ✓ Real-time code walkthroughs and live debugging
- ✓ Mini-projects like file processors, calculators, and student record systems
- ✓ Case studies based on real-world Java applications
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Java Programming and Software Engineering Fundamentals – Duke University
2. Oracle Java Tutorials
3. JetBrains Academy: Java Developer Track
4. Udacity: Java Programming Basics

Suggested Readings:

- Herbert Schildt, *Java: The Complete Reference*, McGraw Hill
- Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall

- Kathy Sierra and Bert Bates, *Head First Java*, O'Reilly Media
- Y. Daniel Liang, *Introduction to Java Programming and Data Structures*, Pearson

Recommended Software/Tools:

1. Java Development Tools**:** Eclipse, IntelliJ IDEA, NetBeans
2. JDK Version: Java SE 17 or latest LTS version
3. Build Tools: Maven, Gradle
4. Version Control: Git/GitHub
5. Text Editors: VS Code, Notepad++

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

PO										
CO1	3	3	3	–	2	–	–	1	–	2
CO2	2	3	3	–	3	–	–	1	1	2
CO3	2	3	3	2	3	–	1	–	–	2
CO4	2	3	3	2	3	2	2	1	–	2
CO5	1	2	3	3	3	3	2	2	2	3
Articulation	2	2.8	3	2.3	2.8	2.5	1.6	1.25	1.5	2.2

Course Title:	Advanced Database System
Course Code:	25VBT1E403
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course builds upon fundamental database concepts and focuses on advanced topics including normalization techniques, query optimization, transaction management, distributed and NoSQL databases, and database security. It equips students with skills to design and manage modern, complex, and scalable database systems widely used in industries like banking, e-commerce, healthcare, and cloud services.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand advanced database models and architectures.	L2
CO2	Apply normalization and query optimization techniques.	L3
CO3	Design and implement distributed and NoSQL databases.	L6
CO4	Analyze concurrency, transactions, and recovery mechanisms.	L4
CO5	Evaluate database performance using indexing and tuning methods.	L5

Course Modules

No. of Hours: 24

Module 1: Advanced Data Modeling and Relational Theory
Scope of Module: Focuses on extended ER modelling, normalization beyond 3NF, and relational theory.
Topics: Extended E-R Model (Generalization, Specialization, Aggregation), Enhanced ER Diagrams, Mapping

EER to Relational Model, Relational Algebra – Advanced Operations, Relational Calculus (Tuple and Domain), Functional Dependencies, Multivalued Dependencies, Join Dependencies, 4NF and 5NF, BCNF and Higher Normal Forms, Decomposition Strategies, Lossless-Join and Dependency Preservation, Integrity Constraints, Relational Design Theories, Design Pitfalls and Heuristics.
Learning Outcome: *Design complex relational models using advanced modeling and normalization techniques.*

No. of Hours: 24

Module 2: Query Optimization and Performance Tuning
Scope of Module: Explores techniques for optimizing SQL queries and improving database performance.
Topics: Phases of Query Processing, Query Parsing and Translation, Evaluation Plan and Strategies, Heuristic Optimization, Cost-Based Optimization, Join Algorithms (Nested Loop, Sort Merge, Hash Join), Use of Indexes in Optimization, Query Execution Engine, Materialized Views, View Maintenance, Indexing Strategies (B-Tree, Bitmap), Statistics and Histograms, Query Hints and Plan Caching, SQL Tuning Tools, Database Profiling and Monitoring.
Learning Outcome: *Analyze and optimize queries for improved execution efficiency*

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No. of Hours: 24

Module 3: Transactions, Concurrency, and Recovery
Scope of Module: Focuses on transaction processing fundamentals, concurrency control, and recovery techniques.
Topics: ACID Properties, Transaction Lifecycle, Schedules and Serializability, Conflict and View Serializability, Locking Protocols (2PL, Strict 2PL), Deadlock Handling (Prevention, Detection, Recovery), Timestamp Ordering, Multi-version Concurrency Control, Validation Techniques, Granularity of Locks, Recovery Techniques (Log-Based, Shadow Paging), Write-Ahead Logging (WAL), Checkpoints and Rollback, Isolation Levels (Read Committed, Serializable), Performance Issues in Concurrency.
Learning Outcome: *Ensure transaction integrity and consistency through concurrency control and recovery mechanisms.*

No. of Hours: 24

Module 4: Distributed and Parallel Databases
Scope of Module: Covers database design and management in distributed and parallel environments.
Topics: Distributed Database Architecture, Fragmentation (Horizontal, Vertical), Data Replication and Allocation, Distributed Query Processing, Two-Phase Commit Protocol, CAP Theorem, Distributed Transactions, Parallel Databases Overview, Inter-query and Intra-query Parallelism, Data Partitioning Strategies, Shared-Nothing and Shared-Disk Architectures, Parallel Joins and Aggregation, Load Balancing in Distributed Systems, Big Data Storage Systems, Cloud-based Database Deployment.

Learning Outcome: *Design and manage distributed and parallel databases for scalability and efficiency.*

No. of Hours: 24

Module 5: NoSQL and Emerging Database Technologies
Scope of Module: Introduces NoSQL paradigms and modern trends in data storage and management.
Topics: Introduction to NoSQL Databases, Types of NoSQL (Key-Value, Document, Column, Graph), MongoDB Basics, CRUD Operations in MongoDB, Indexing and Aggregation in NoSQL, Data Modeling in Document Stores, CAP vs BASE, Graph Databases (Neo4j Basics), JSON and BSON Formats, Polyglot Persistence, Use Cases of NoSQL, NewSQL Overview, Time-Series Databases, Multi-Model Databases, Trends in Data Lakes and Lakehouses.
Learning Outcome: *Apply NoSQL and modern database technologies to meet varied data processing needs.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites

- Knowledge of relational databases
- Basic SQL and ER modeling

Pedagogy

- ✓ Case studies on NoSQL, distributed DBs
- ✓ SQL and MongoDB lab sessions
- ✓ Query optimization exercises
- ✓ Mini-projects with real datasets

Certificates / Value Added Courses

1. MongoDB for Developers – MongoDB University
2. [Advanced SQL – Mode Analytics/Udemy]
3. [Database Systems – Stanford Online (edX)]

Suggested Readings

- Elmasri & Navathe, Fundamentals of Database Systems
- Ramez Elmasri, Advanced Database Systems
- Hector Garcia-Molina, Database System Implementation

Recommended Tools

1. MySQL/PostgreSQL
2. MongoDB, Neo4j
3. Apache Cassandra
4. Oracle DB

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	-	3	2	3	2	2
CO2	2	2	3	3	-	3	2	3	3	3

CO3	2	2	2	2	1	-	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1	3	2	2.5	2.4	2.8

Course Title:	Information Security
Course Code:	25VBT1E404
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth understanding of the principles and practices of information security. Students will explore topics such as threats and vulnerabilities, cryptography, network security, risk management, ethical hacking, and security policies. The course prepares students to protect organizational assets from cyber threats and ensures secure system development and maintenance, aligning with modern industry needs.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand core concepts of confidentiality, integrity, and availability.	L2
CO2	Apply cryptographic algorithms for data protection.	L3
CO3	Analyze threats, vulnerabilities, and security attacks.	L4
CO4	Evaluate authentication, authorization, and intrusion detection systems.	L5
CO5	Design security policies and risk management strategies.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Information Security

Scope of Module: Provides an overview of information security principles, challenges, and models.
Topics: Definition of Information Security, CIA Triad, Information Security Goals, Threats and Vulnerabilities, Risk Assessment and Management, Security Policies and Standards, Attack Vectors and Techniques, Malware Types and Prevention, Security Models (Bell-LaPadula, Biba, Clark-Wilson), OSI and TCP/IP Security Layers, Social Engineering Attacks, Insider Threats, Security Lifecycle, Components of Secure System, Security in the Modern Enterprise.
Learning Outcome: *Explain fundamental concepts, threats, and objectives of information security.*

No. of Hours: 24

Module 2: Cryptographic Techniques
Scope of Module: Covers classical and modern cryptography, including encryption, decryption, and hashing.
Topics: Basics of Cryptography, Symmetric vs Asymmetric Encryption, Classical Ciphers (Caesar, Vigenère), Modern Ciphers (DES, AES), Public Key Cryptography (RSA, ECC), Key Distribution and Management, Digital Signatures, Hash Functions (SHA, MD5), Message Authentication Codes (MAC), Digital Certificates, PGP and S/MIME, Cryptanalysis Techniques, Cryptographic Protocols, Block chain Basics and Cryptography, Quantum Cryptography Overview.
Learning Outcome: *Apply cryptographic algorithms to secure data and ensure authenticity.*

No. of Hours: 24

Module 3: Network and System Security
Scope of Module: Focuses on securing network infrastructure and operating systems.
Topics: Network Threats (Sniffing, Spoofing, DoS, MITM), Firewalls and Types, Intrusion Detection and Prevention Systems (IDS/IPS), Virtual Private Networks (VPN), Secure Protocols (SSL/TLS, HTTPS, SSH), Wireless Network Security (WEP, WPA2), Operating System Hardening, Patch Management, Host-Based Security Tools, Security Logs and Auditing, Secure Boot and BIOS Security, DNS Security, Email Security (SPF, DKIM, DMARC), Security Testing Tools (Nmap, Wireshark), Network Segmentation and Isolation.
Learning Outcome: *Implement network and system-level security controls to mitigate risks.*

No. of Hours: 24

Module 4: Authentication and Access Control
Scope of Module: Explores user authentication, access control models, and identity management.
Topics: Authentication Fundamentals, Password-based Authentication, Multi-Factor Authentication, Biometrics, Tokens and Smart Cards, OAuth and OpenID, Single Sign-On (SSO), Kerberos Protocol,

Access Control Principles, Discretionary Access Control (DAC), Mandatory Access Control (MAC), Role-Based Access Control (RBAC), Access Control Lists (ACLs), Identity and Access Management (IAM), Cloud IAM Solutions, Session Management and Authorization Techniques.
Learning Outcome: *Apply access control models and authentication techniques to protect resources.*

No. of Hours: 24

Module 5: Security Governance, Legal and Ethical Aspects
Scope of Module: Covers cybersecurity governance, ethics, and legal compliance frameworks.
Topics: Information Security Governance, Security Policy Development, Risk Management Frameworks (ISO/IEC 27001), IT Compliance (SOX, HIPAA, GDPR), Data Privacy Principles, Cybercrime and Laws in India (IT Act 2000), Digital Evidence and Forensics Basics, Ethics in Cybersecurity, Security Audit and Compliance, Security Awareness Training, Incident Response Planning, Business Continuity Planning (BCP), Disaster Recovery Planning (DRP), Security Metrics and Reporting, Role of CISO and Security Teams.
Learning Outcome: *Demonstrate awareness of legal, ethical, and governance aspects in information security.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- Computer networks and OS basics
- Logical reasoning

Pedagogy

- ✓ Simulations of attacks and defenses
- ✓ Case studies on data breaches

- ✓ Practical labs on encryption tools

Certificates / Value Added Courses

1. [Cybersecurity Basics – IBM/Coursera]
2. [Certified Ethical Hacker – EC-Council]
3. [Information Security Analyst – Google Coursera]

Suggested Readings

- William Stallings, Cryptography and Network Security
- Charles P. Pfleeger, Security in Computing
- Michael E. Whitman, Principles of Information Security

Recommended Tools

1. Wireshark, Metasploit
2. Kali Linux
3. OpenSSL, Nmap
4. Burp Suite

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	-	3	2	3	2	2
CO2	2	2	3	3	-	3	2	3	3	3
CO3	2	2	2	2	1	-	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1	3	2	2.5	2.4	2.8

Course Title:	Quantitative Techniques
Course Code:	25VBT0C404
Semester:	**IV**
Credits:	**3**
Course Type	Core Course
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course aims to equip students with the mathematical and statistical tools required for decision-making and problem-solving in computer applications and business scenarios. It covers topics such as linear programming, probability, statistics, correlation, regression, and queuing theory. These quantitative techniques are essential for data analysis, operations research, and software modeling.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the fundamentals of quantitative methods and their applications in computer science.	L2
CO2	Solve optimization problems using linear programming and graphical methods.	L3
CO3	Apply concepts of probability and distributions in real-life decision-making.	L3
CO4	Analyze data using correlation, regression, and index numbers.	L4
CO5	Demonstrate the use of queuing theory and statistical decision-making tools.	L5

Course Modules

No. of Hours*: 18*

Module 1: Linear Algebra and Equations
Scope of Module: Covers matrix operations, system of linear equations, and their computational applications.
Topics: Types of Matrices, Matrix Operations, Determinants and Properties, Inverse of a Matrix, Solving

Linear Equations (Cramer's Rule, Matrix Inversion), Gauss Elimination Method, Rank of a Matrix, Eigenvalues and Eigenvectors, Applications in Computer Graphics, Linear Dependence and Independence, Linear Transformation, Diagonalization, Vector Spaces, Basis and Dimension, Applications in Data Science.
Learning Outcome: *Use matrix algebra to solve linear systems and perform transformations in computing.*

No. of Hours: 18

Module 2: Descriptive Statistics
Scope of Module: Focuses on summarizing and interpreting data using various statistical measures.
Topics: Types of Data, Data Collection Methods, Frequency Distribution, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Variance, Standard Deviation), Skewness and Kurtosis, Percentiles and Quartiles, Data Visualization (Histograms, Pie Charts, Box Plots), Cross-tabulation and Contingency Tables, Correlation Analysis, Covariance, Scatter Plots, Use of Excel/SPSS for Data Analysis, Real-life Data Interpretation.
Learning Outcome: *Analyze and describe data using statistical measures and visualizations.*

No. of Hours: 18

Module 3: Linear Programming and Optimization
Scope of Module: Explores techniques for modeling and solving optimization problems using LPP.
Topics: Introduction to Linear Programming, Formulating LPPs, Graphical Method, Simplex Method, Duality in LPP, Sensitivity Analysis, Transportation Problem, Assignment Problem, Degeneracy and Unbalanced Problems, Maximization and Minimization Models, Profit and Cost Optimization, Integer Programming, Decision Variables and Constraints, Real-world Applications, Use of Solver Tools in Excel.
Learning Outcome: *Formulate and solve optimization problems using linear programming techniques.*

No. of Hours: 18

Module 4: Probability and Distributions
Scope of Module: Introduces probability concepts and probability distributions for quantitative reasoning.
Topics: Basic Probability Rules, Conditional Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Expected Value and Variance, Binomial Distribution, Poisson Distribution, Normal Distribution, Central Limit Theorem, Applications in Risk Analysis, Z-scores and Standardization, Probability Trees, Joint and Marginal Probabilities, Monte Carlo Simulations, Statistical Applications in IT.
Learning Outcome: *Apply probability and distributions to evaluate uncertain events and risks.*

No. of Hours: 18

Module 5: Decision Theory and Forecasting
Scope of Module: Focuses on decision-making techniques and forecasting tools for business applications.
Topics: Decision-Making Under Certainty, Uncertainty, and Risk, Payoff Tables and Decision Trees, Expected Monetary Value, Maximax, Maximin, Minimax Regret, Forecasting Techniques (Moving Average, Exponential Smoothing), Time Series Analysis, Trend and Seasonality Detection, Regression Models, Index Numbers, Error Analysis (MAD, MSE), Use of Forecasting in Business and IT, Software Tools for Decision Analysis.
Learning Outcome: *Implement decision analysis and forecasting models for planning and problem-solving.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning
- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. NPTEL: Probability and Statistics
   https://nptel.ac.in/courses/111105090
2. Coursera: Statistics with Excel
   https://www.coursera.org/learn/basic-statistics-excel
3. edX: Data Science: Probability
   https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
4. MIT OpenCourseWare: Introduction to Probability and Statistics
   https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings:

- Richard I. Levin & David S. Rubin, Statistics for Management, Pearson
- S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House
- Taha H. A., Operations Research: An Introduction, Pearson
- Vohra N.D., Quantitative Techniques in Management, Tata McGraw-Hill
- Online articles from JSTOR, ScienceDirect, and SpringerLink for research-based insights

Recommended Software/Tools (If applicable):

1. Microsoft Excel (with Solver add-in)
2. SPSS for statistical analysis
3. R or Python (NumPy, SciPy, Pandas, Statsmodels)
4. Tableau or Power BI for data visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	2	3	2	2
CO2	3	2	3	3	2	3	2	3	3	2
CO3	3	2	2	2	2	-	1	1	1	2
CO4	2	3	3	3	2	1	1	2	2	3
CO5	3	3	3	2	2	-	1	2	3	2
Articulation	2.8	2.6	2.6	2.6	2	2.3	1.4	2.2	2.2	2.2

Semester V

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
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Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
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Course Title:	Block Chain Technologies
Course Code:	25VBT0C501
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the foundational and advanced aspects of blockchain technology. Students will explore blockchain architecture, cryptographic techniques, smart contracts, and application platforms. They will also evaluate block chain's impact on security, privacy, business ecosystems, and societal implications. The course emphasizes practical skills through development environments and case studies.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the fundamental concepts of blockchain technology.	L2
CO2	Explore various blockchain platforms and their applications.	L3
CO3	Develop skills to design and implement blockchain-based solutions.	L4
CO4	Analyze the security and privacy aspects of blockchain.	L4
CO5	Assess the impact of blockchain technology on business and society.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Blockchain Technology
Scope of Module: Introduces the basics, architecture, and cryptographic foundation required for understanding blockchain systems.
Topics: Introduction to Blockchain Technology, History and Evolution of Blockchain, Types of Blockchains: Public, Private, Consortium, Applications of Blockchain Technology, Components of Blockchain:

Blocks, Chains, Nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Smart Contracts and Their Execution, Blockchain Forks, Basic Cryptographic Concepts: Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Cryptographic Algorithms Used in Blockchain
Learning Outcome: - *Gain foundational understanding of blockchain principles, architecture, and cryptography.*

No. of Hours: 24

Module 2: Blockchain Platforms and Development
Scope of Module: Focuses on blockchain ecosystems and hands-on development using Ethereum and other platforms.
Topics: Bitcoin and Ethereum: Structure and Functionality, Hyperledger Fabric, Ripple, Corda and Other Blockchain Platforms, Setting Up Blockchain Development Environment, Writing Smart Contracts in Solidity, Deploying Smart Contracts on Ethereum, Decentralized Applications (DApps), Detailed Study of Smart Contracts, Smart Contract Development and Testing, Real World Use Cases of Smart Contracts
Learning Outcome: - *Explore and implement blockchain-based solutions using various platforms and tools.*

No. of Hours: 24

Module 3: Blockchain Security, Privacy and Compliance
Scope of Module: Analyzes the threats and solutions related to blockchain security, privacy regulations, and standards.
Topics: Security Issues in Blockchain, Attacks on Blockchain: 51% Attack, Sybil Attack, Privacy Solutions in Blockchain, Regulatory and Legal Implications, Data Privacy Laws and Regulations, Blockchain's Role in Ensuring Data Privacy, Case Studies on Privacy Issues in Blockchain, Overview of Popular Cryptocurrencies, Cryptocurrency Mining and Transactions, Regulatory Aspects of Cryptocurrencies, International Standards for Blockchain Technology, Frameworks and Protocols for Blockchain Development, Compliance and Best Practices
Learning Outcome: - *Evaluate security vulnerabilities, privacy frameworks, and compliance in blockchain systems.*

No. of Hours: 24

Module 4: Blockchain Applications in Industry and Society
Scope of Module: Explores how blockchain is transforming industries and provides real-world use cases across various domains.

Topics: Blockchain in Financial Services: Cryptocurrencies, Payment Systems, Supply Chain Management, Healthcare and Identity Management, Government and Public Services, Impact of Blockchain on Business Models, Case Studies in Finance, Supply Chain and Healthcare, Blockchain for Enterprise Solutions, Emerging Research Areas in Blockchain, Potential Future Applications, Ethical and Societal Implications
***Learning Outcome:** - Assess real-world blockchain use cases, societal impacts, and business transformation through blockchain.*

No. of Hours: 24

Module 5: Advanced Blockchain Integration and Emerging Trends
Scope of Module: Covers the integration of blockchain with other technologies and future innovations.
Topics: Interoperability and Scalability in Blockchain, Blockchain and the Internet of Things (IoT), Blockchain and Artificial Intelligence (AI), Future Trends and Innovations in Blockchain, Integrating Blockchain with Cloud Platforms, Use Cases of Blockchain in Cloud Computing, Advantages and Challenges
***Learning Outcome:** - Analyze the integration of blockchain with emerging technologies and its future direction.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of cryptography and networking
- Familiarity with distributed systems

- Programming experience (preferably in JavaScript, Python, or Solidity)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for smart contract development using Solidity
- ✓ Simulations and projects involving blockchain platforms like Ethereum and Hyperledger
- ✓ Case study discussions on real-world blockchain implementations
- ✓ Group activities on blockchain architecture and DApp design
- ✓ Evaluation through mini-projects, quizzes, and practical assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Blockchain Specialization – University at Buffalo & SUNY
2. IBM Blockchain Foundation Developer Course
3. edX: Blockchain Fundamentals – UC Berkeley
4. Blockchain Council: Free Blockchain Courses

Suggested Readings:

- Arvind Narayanan et al., Bitcoin and Cryptocurrency Technologies, Princeton University Press
- Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly
- Imran Bashir, Mastering Blockchain, Packt Publishing
- Don Tapscott & Alex Tapscott, Blockchain Revolution, Penguin

Recommended Software/Tools:

1. Smart Contract Development**:** Remix IDE, Truffle, Hardhat
2. Blockchain Platforms**:** Ethereum, Hyperledger Fabric, Corda

3. Languages**:** Solidity, JavaScript, Go
4. Testing and Deployment**:** Ganache, MetaMask, Infura
5. Development Environments: Visual Studio Code, Docker
6. Version Control: Git/GitHub

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	–	1	1	2
CO2	2	–	2	2	–	3	2	–	1	2
CO3	2	3	–	2	–	2	2	2	–	2
CO4	2	3	2	–	2	–	3	2	1	2
CO5	1	2	1	2	1	3	–	2	2	–
Articulation	2	2.5	1.5	1.75	1.6	2.5	2.3	1.75	1.25	2

Course Title:	IT Project Management
Course Code:	25VBT0C502
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course equips students with the principles, tools, and techniques of project management tailored for IT environments. It covers planning, execution, monitoring, and controlling aspects of software and technology-related projects.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand fundamental project management concepts and processes in IT.	L2
CO2	Develop project plans including scope, schedule, and cost estimations.	L3
CO3	Apply project management tools for effective monitoring and control.	L3
CO4	Manage project risks, quality, resources, and stakeholder communication.	L4
CO5	Evaluate real-world IT projects using industry standards and methodologies.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Project Management
Scope of Module: Covers fundamental concepts, roles, and project life cycle in IT project management.
Topics: Definition of Project and Project Management, Characteristics of IT Projects, Project Constraints (Scope, Time, Cost), Project Life Cycle, Project Manager's Role and Responsibilities, Stakeholders and Organizational Structures, Project Environment, PMBOK Framework, Project Success Factors,

Project Selection Methods, Feasibility Analysis, Project Charter, Work Breakdown Structure (WBS), Agile vs Waterfall, Case Studies in IT Projects.
Learning Outcome: *Understand the fundamentals and environment of IT project management*

No. of Hours: 24

Module 2: Project Planning and Scheduling
Scope of Module: Focuses on creating detailed project plans with clear timelines and resource estimations.
Topics: Project Scope Management, Defining Requirements, Scope Statement, Time Management Processes, Activity Sequencing, Gantt Charts, Critical Path Method (CPM), PERT Analysis, Resource Allocation, Cost Estimation Techniques, Budgeting and Cost Baselines, Resource Calendars, Milestone Planning, Project Scheduling Tools (MS Project, OpenProject), Change Control Processes, Planning Challenges.
Learning Outcome: *Develop effective project schedules and cost plans.*

No. of Hours: 24

Module 3: Project Execution, Monitoring, and Control
Scope of Module: Emphasizes execution strategies and project performance tracking methods.
Topics: Executing the Project Plan, Communication and Team Management, Status Meetings and Reporting, Performance Measurement Techniques, Earned Value Management (EVM), Key Performance Indicators (KPIs), Monitoring Schedule and Cost Variances, Issue Tracking, Scope Creep Handling, Quality Assurance vs Quality Control, Forecasting Project Progress, Change Requests and Impact Analysis, Tools for Monitoring (Dashboards, KPIs), Conflict Management in Teams.
Learning Outcome: *Monitor, control, and steer IT projects toward success*

No. of Hours: 24

Module 4: Risk, Quality, and Resource Management
Scope of Module: Covers identification, analysis, and mitigation of risks, along with quality and resource planning.
Topics: Risk Management Process, Risk Identification and Analysis, Qualitative and Quantitative Risk Assessment, Risk Response Planning, Risk Register, Quality Management Concepts, Quality Planning and Metrics, Resource Planning and Acquisition, Team Building and Motivation, Human Resource Constraints, Communication Plans, Stakeholder Engagement Strategies, Conflict Resolution, Leadership Styles in Project Management, Ethical and Legal Issues.
Learning Outcome: *Manage project risks, quality, and resources effectively.*

No. of Hours: 24

Module 5: Project Closure and Advanced Topics
Scope of Module: Focuses on closing activities, evaluation techniques, and emerging project management practices.
Topics: Project Closure Process, Final Deliverables and Sign-offs, Lessons Learned Documentation, Post-Implementation Review, Project Evaluation Metrics, Maintenance and Support Plans, Project Auditing, Introduction to Agile, Scrum and Kanban, Role of Scrum Master and Product Owner, Sprint Planning and Backlogs, Use of JIRA and Trello, DevOps and CI/CD Concepts, Global and Virtual Teams, Trends in IT Project Management.
Learning Outcome: *Execute closure procedures and evaluate advanced project methodologies*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of software development life cycle (SDLC)
- Familiarity with organizational structure and communication models
- General awareness of business operations and team dynamics

Pedagogy / Teaching Methodology:

- ✓ Interactive lectures with case study discussions
- ✓ Hands-on use of project planning and tracking tools
- ✓ Group-based project simulations
- ✓ Problem-based and scenario-driven assignments
- ✓ Project presentations and peer feedback

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Project Management Principles and Practices (Coursera – University of California, Irvine)
   https://www.coursera.org/specializations/project-management
2. NPTEL: Project Management for Managers
   https://nptel.ac.in/courses/110105083
3. Introduction to Scrum Master Training (edX – LearnQuest)
   https://www.edx.org/course/scrum-master-training
4. Project Management for Software Engineers (Udemy or Free YouTube Lectures)

Suggested Readings:

- PMBOK® Guide – A Guide to the Project Management Body of Knowledge, PMI
- Schwalbe, K., Information Technology Project Management, Cengage Learning
- Hughes & Cotterell, Software Project Management, McGraw-Hill
- Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling
- Online resources: PMI.org, ProjectManagement.com, tutorials on MS Project, JIRA

Recommended Software/Tools (If applicable):

1. Microsoft Project / OpenProject
2. JIRA, Trello, ClickUp,GanttProject or TeamGantt

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	3	2	2
CO2	2	2	3	3	2	3	2	3	3	3
CO3	2	2	2	2	2	2	1	1	2	3
CO4	2	3	3	3	2	2	-	2	2	3
CO5	3	3	3	2	1	1	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	2	2.2	1.6	2.2	2.4	2.8

Course Title:	Cloud Computing
Course Code:	25VBT1E503
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamental concepts and practices of cloud computing, including cloud service models, deployment models, virtualization, and cloud infrastructure. Students will explore popular cloud platforms, understand security issues, and develop cloud-native applications. This course prepares students for careers in cloud administration, DevOps, and scalable software development—skills highly demanded in today's tech-driven industry.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand cloud service models and deployment types.	L2
CO2	Apply virtualization and containerization concepts.	L3
CO3	Analyze cloud storage, networking, and resource provisioning.	L4
CO4	Evaluate scalability, availability, and performance in cloud platforms.	L5
CO5	Design cloud-based applications using services like AWS, Azure, or GCP.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Cloud Computing
Scope of Module: Provides an overview of the cloud computing paradigm, architecture, and evolution.
Topics: Definition of Cloud Computing, Characteristics of Cloud (On-Demand, Broad Network Access), Evolution from Traditional Computing to Cloud, Benefits and Challenges of Cloud, Cloud

Deployment Models (Public, Private, Hybrid, Community), Cloud Service Models (IaaS, PaaS, SaaS), Cloud Reference Architecture (NIST), Cloud Providers Overview (AWS, Azure, GCP), Virtualization vs. Cloud Computing, Scalability and Elasticity Concepts, Cloud Economics and Pricing Models, Use Cases in Various Industries, Cloud Migration Strategy Basics, Green Cloud Computing, Future of Cloud and Edge Integration.
Learning Outcome: *Understand cloud computing models, characteristics, and architecture.*

No. of Hours: 24

Module 2: Virtualization and Resource Management
Scope of Module: Covers concepts of virtualization and how resources are provisioned, managed, and monitored in cloud systems.
Topics: Virtualization Fundamentals (Hypervisors, VMs), Types of Virtualization (Hardware, OS, Application), Containerization with Docker, Orchestration with Kubernetes, Resource Provisioning and Allocation, Load Balancing Techniques, Elasticity and Auto-scaling, Cloud Storage Virtualization, Network Virtualization (SDN), Virtual Machine Migration, Multi-Tenancy and Isolation, Tools for Monitoring and Performance (Prometheus, Grafana), Cost Optimization Techniques, Role of APIs in Cloud Resource Management, Virtual Desktop Infrastructure (VDI).
Learning Outcome: *Explore how virtualization enables scalable and efficient cloud environments.*

No. of Hours: 24

Module 3: Cloud Service Models and Application Development
Scope of Module: Focuses on IaaS, PaaS, SaaS models and their application in developing cloud-native applications.
Topics: Understanding IaaS (Compute, Storage, Network Services), PaaS Platforms (Google App Engine, Azure App Service), SaaS Characteristics and Examples (Gmail, Salesforce), Application Design for Cloud, 12-Factor App Methodology, Serverless Computing (Functions as a Service), Backend-as-a-Service (BaaS), API Gateways and Microservices Architecture,CI/CD Pipelines in Cloud, DevOps and DevSecOps in Cloud, Container Deployment in PaaS, App Monitoring and Troubleshooting, Stateless vs. Stateful Services, Event-Driven Architecture, Data Processing in the Cloud (ETL).
Learning Outcome: *Design and deploy applications using various cloud service models*

No. of Hours: 24

Module 4: Cloud Security and Compliance
Scope of Module: Introduces cloud security concepts, tools, policies, and compliance frameworks.
Topics: Cloud Security Architecture and Shared Responsibility Model, Identity and Access Management

(IAM), Authentication and Authorization in Cloud, Data Encryption at Rest and in Transit, Secure API Access, DDoS Mitigation Strategies, Role of Firewalls and Security Groups, Compliance Standards (GDPR, HIPAA, ISO/IEC 27001), Security in Multi-Cloud Environments, Cloud Security Tools (AWS Inspector, Azure Security Center), Security Incident and Event Management (SIEM), Key Management Services (KMS), Security Best Practices for DevOps, Security Automation and Orchestration, Risk Assessment and Governance.
Learning Outcome: *Implement secure practices and ensure compliance in cloud environments*

No. of Hours: 24

Module 5: Practical Cloud Platforms and Emerging Trends
Scope of Module: Explores major cloud platforms and emerging technologies in the field of cloud computing.
Topics: Hands-on with AWS (EC2, S3, RDS), Azure Basics (VM, Blob Storage, Functions), Google Cloud Platform Overview (Compute Engine, Cloud Functions), Introduction to Terraform and IaC (Infrastructure as Code), Hybrid Cloud and Multi-Cloud Strategies, Edge Computing with Cloud Integration, Cloud-Native Architecture, FinOps: Financial Management in Cloud, AI and ML Services in Cloud (SageMaker, Vertex AI), Big Data on Cloud (EMR, BigQuery), Disaster Recovery in Cloud, Observability in Cloud Systems, Green and Sustainable Cloud Practices, Quantum Computing in the Cloud, Careers in Cloud Computing.
Learning Outcome: *Use leading cloud platforms and explore future trends and innovations.*

Module	**No of Pre Recordings**
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Networking and OS basics
- Programming fundamentals

Pedagogy

- ✓ Labs on AWS/GCP/Azure
- ✓ Docker and Kubernetes hands-on
- ✓ Mini-projects with cloud deployment

Certificates / Value Added Courses

1. [AWS Cloud Practitioner – AWS Academy]
2. [Google Cloud Fundamentals – Coursera]
3. [Introduction to Cloud – edX/Microsoft]

Suggested Readings

- Rajkumar Buyya, Cloud Computing
- Anthony T. Velte, Cloud Computing: A Practical Approach
- Thomas Erl, Cloud Computing: Concepts, Technology & Architecture

Recommended Tools

1. AWS Educate, GCP Free Tier
2. Docker, Kubernetes
3. Terraform, Ansible

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	3	2	2
CO2	2	2	3	3	2	3	2	3	3	3
CO3	2	2	2	2	2	2	-	1	2	3
CO4	2	3	3	3	2	2	-	2	2	3
CO5	3	3	3	2	3	3	2	2	3	3
Articulation	2.2	2.4	2.6	2.6	2.4	2.6	2	2.2	2.4	2.8

Course Title:	Advanced Web Technologies
Course Code:	25VBT1E504
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course equips students with in-depth knowledge of modern web technologies and full-stack development. It emphasizes building responsive, dynamic, and scalable web applications using frontend and backend frameworks, API integrations, and advanced deployment techniques.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand modern web architectures and frameworks.	L2
CO2	Apply front-end technologies like React, Angular, or Vue.	L3
CO3	Develop server-side applications using Node.js, Django, or Flask.	L3
CO4	Analyze performance, security, and SEO optimization.	L4
CO5	Design and deploy full-stack applications.	L6

Course Modules

No. of Hours: 24

Module 1: Advanced Frontend Development
Scope of Module: Covers modern UI development using frameworks and responsive design practices.
Topics: JavaScript ES6+ Features, Single Page Applications (SPA), React.js Components and Props, State and Lifecycle in React, React Hooks and Context API, Routing with React Router, Form Handling and Validation, Redux for State Management, Material UI and Styled Components, Webpack and Babel,

TypeScript with React, Progressive Web Apps (PWA), Responsive Design Techniques, Accessibility in Web Design, UI Testing with Jest.
Learning Outcome: *Develop dynamic, modular, and user-friendly interfaces using advanced JavaScript frameworks.*

No. of Hours: 24

Module 2: Backend Technologies and Frameworks
Scope of Module: Introduces server-side programming using Node.js and popular backend frameworks.
Topics: Node.js Architecture and Event Loop, Express.js Fundamentals, Middleware Functions, Routing in Express, REST API Development, Error Handling, Session and Authentication (JWT, OAuth), File Uploads and Streaming, MVC Design Pattern, Data Validation and Sanitization, Logging and Debugging, WebSockets and Real-Time Communication, GraphQL Basics, API Documentation with Swagger, Security Best Practices in Backend.
Learning Outcome: *Build efficient and secure backend applications with APIs and data management.*

No. of Hours: 24

Module 3: Database Integration and Management
Scope of Module: Focuses on integrating and managing databases in full-stack applications.
Topics: Introduction to NoSQL and SQL Databases, MongoDB CRUD Operations, MongoDB Aggregation Framework, Mongoose ODM in Node.js, Schema Design and Validation, Transactions in MongoDB, Indexing and Performance Optimization, MySQL and PostgreSQL Integration, ORMs like Sequelize, Relational vs Document Databases, Data Modeling Techniques, Backup and Restore, Cloud Databases (Firebase, MongoDB Atlas), Connection Pooling, Handling Data Consistency.
Learning Outcome: *Design and interact with databases efficiently in web-based environments.*

No. of Hours: 24

Module 4: API Development and Integration
Scope of Module: Covers creating and consuming APIs including REST and GraphQL.
Topics: RESTful API Principles, CRUD with REST, API Authentication and Authorization, CORS Handling, Postman for API Testing, Rate Limiting and Throttling, API Versioning, GraphQL vs REST, Building GraphQL APIs with Apollo Server, Fetch and Axios for API Calls, Async/Await and Promises, Error and Status Codes, Integrating Third-Party APIs (Google Maps, Stripe, etc.), OAuth Integrations, API Gateway and Reverse Proxy (Nginx).
Learning Outcome: *Create and consume APIs to enable interactive and data-driven applications.*

No. of Hours: 24

Module 5: Deployment, DevOps, and Web Security
Scope of Module: Covers deployment techniques, DevOps tools, and securing web applications.
Topics: Deployment on Cloud (Heroku, Netlify, Vercel), Docker for Web Applications, CI/CD Pipelines (GitHub Actions), Environment Variables and Config Management, Reverse Proxy and Load Balancing, HTTPS and SSL Certificates, Authentication Mechanisms, OWASP Top 10 Vulnerabilities, SQL Injection and XSS Prevention, Content Security Policy (CSP), Secure Cookies and CSRF Protection, Static Code Analysis, Logging and Monitoring (ELK Stack), CDN and Caching Strategies, Performance Testing and Optimization.
Learning Outcome: *Deploy and secure full-stack applications with automation and performance tools.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites

- HTML, CSS, JS basics
- Introductory programming

Pedagogy

- ✓ Full-stack web app labs
- ✓ Weekly sprints and project-based learning
- ✓ GitHub collaboration and deployment on Netlify/Heroku

Certificates / Value Added Courses

1. [Full Stack Web Development – Coursera]
2. [React for Beginners – Udemy]
3. [Node.js Developer – edX]

Suggested Readings

- Jon Duckett, HTML & CSS and JavaScript & jQuery
- Ethan Brown, Web Development with Node and Express
- Eric Freeman, Head First HTML and CSS

Recommended Tools

1. Visual Studio Code
2. React, Angular, Vue.js
3. Node.js, Django, Flask
4. MongoDB, Firebase

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	2	2	2	3	2	3	1	3	2	2
CO2	2	2	3	3	3	3	1	3	3	3
CO3	2	2	2	2	2	2	-	3	2	3
CO4	2	3	3	3	3	2	-	2	2	3
CO5	3	3	3	2	2	2	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	2.4	2.4	1	2.6	2.4	2.8

Course Title:	Big Data Analytics
Course Code:	25VBT1E505
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course explores the concepts, technologies, and tools used in big data analytics. It covers distributed computing, data processing frameworks, and advanced analytics techniques to handle vast volumes of structured and unstructured data effectively.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the fundamentals and challenges of big data and its ecosystem.	L2
CO2	Implement distributed data storage and processing using Hadoop and MapReduce.	L3
CO3	Utilize data processing frameworks like Spark for real-time analytics.	L3
CO4	Analyze structured and unstructured data using big data tools.	L4
CO5	Apply machine learning techniques to large-scale datasets for predictive analytics.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Big Data and Ecosystem
Scope of Module: Introduces the concept of big data, its characteristics, and the evolving ecosystem.
Topics: Definition and Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Structured vs Unstructured Data, Data Lifecycle and Sources, Traditional vs Big Data Approaches, Applications of Big Data, Big Data Architecture, Role of Data Scientists and Engineers, Data Storage and Computation Challenges, Types of Analytics (Descriptive, Predictive, Prescriptive), Big Data Use Cases in Industry, Data Acquisition Techniques, Data Cleaning and Preprocessing, Introduction to Hadoop Ecosystem, Big Data Technologies Overview, Trends in Big Data.
Learning Outcome: *Understand big data concepts, architecture, and real-world applications.*

No. of Hours: 24

Module 2: Hadoop Framework and MapReduce Programming
Scope of Module: Covers Hadoop ecosystem components and the basics of distributed data processing.
Topics: HDFS Architecture and Components, Data Replication and Fault Tolerance, HDFS Commands and File Operations, Hadoop Cluster Setup, YARN Architecture and Resource Management, MapReduce Programming Model, Writing and Running MapReduce Jobs, Input and Output Formats, Combiner and Partitioner, Counters in MapReduce, Joins and Sorting in MapReduce, Hadoop Streaming, Limitations of MapReduce, Hadoop Configuration Files, Performance Tuning in Hadoop, Hadoop Security Basics.
Learning Outcome: *Build and execute distributed data processing workflows using Hadoop and MapReduce.*

No. of Hours: 24

Module 3: Apache Spark and Real-Time Data Processing
Scope of Module: Focuses on in-memory data processing with Spark and its libraries.
Topics: Introduction to Apache Spark, Spark Core and RDDs, Transformations and Actions in RDD, Lazy Evaluation and Lineage, DataFrames and Datasets, Spark SQL and Querying, Spark Streaming and DStream Concepts, Structured Streaming, Windowed Operations, Spark MLlib Overview, GraphX for Graph Processing, Spark vs Hadoop Comparison, Fault Tolerance in Spark, Cluster Managers (YARN, Mesos, Standalone), Performance Tuning in Spark, Real-Time Data Processing Use Cases.
Learning Outcome: *Process large-scale data in real-time using Spark and its ecosystem.*

No. of Hours: 24

Module 4: Data Analytics and Visualization Techniques
Scope of Module: Explores data analytics techniques and tools for big data visualization.

Topics: Data Exploration and Profiling, Statistical Analysis of Big Data, Correlation and Regression Analysis, Clustering and Classification Basics, Text Analytics and Natural Language Processing, Sentiment Analysis, Data Reduction Techniques, Use of Python/R in Analytics, Data Wrangling with Pandas, Visualizing Big Data with Matplotlib and Seaborn, Tableau for Big Data Visualization, Dashboards and Storytelling with Data, Exploratory Data Analysis (EDA), BI Tools Overview, Challenges in Big Data Visualization.
Learning Outcome: *Perform data analysis and visualize insights effectively from big datasets.*

No. of Hours: 24

Module 5: Machine Learning and Big Data Applications
Scope of Module: Covers ML algorithms and applications in large-scale data environments.
Topics: Introduction to Machine Learning Concepts, Supervised vs Unsupervised Learning, ML Algorithms in Big Data (Decision Trees, K-Means, Naive Bayes), Feature Engineering in Big Data, Model Evaluation Metrics (Accuracy, Precision, Recall, F1), MLlib in Spark, Model Training and Tuning, Hyperparameter Optimization, Scalable ML Pipelines, Use Cases in Fraud Detection, Recommendation Systems, Predictive Maintenance, Customer Segmentation, Industry Applications of Big Data Analytics, Ethical Issues and Data Governance in Big Data.
Learning Outcome: *Apply machine learning algorithms to extract insights from big datasets.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge (preferably in Python/Java)
- Understanding of database systems and SQL
- Familiarity with data structures and algorithms
- Exposure to basic statistics and linear algebra

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using Hadoop, Spark, and visualization tools
- ✓ Real-world case studies and use case discussions
- ✓ Live demonstrations of data processing pipelines
- ✓ Mini-projects simulating real-time big data problems

Certificate / Value Added Courses Recommended:

1. **Big Data Specialization by Coursera (UC San Diego)**
   https://www.coursera.org/specializations/big-data
2. **Hadoop Platform and Application Framework (edX)**
   https://onlinecourses.nptel.ac.in/noc21_cs55/preview
3. **Introduction to Big Data with Apache Spark (edX/Databricks)**
   https://www.edx.org/course/introduction-to-big-data-with-apache-spark
4. **IBM Data Engineering Professional Certificate (Coursera)**
   https://www.coursera.org/professional-certificates/ibm-data-engineer

Suggested Readings:

- Tom White, **"Hadoop: The Definitive Guide"**, O'Reilly Media
- Jules S. Damji et al., **"Learning Spark: Lightning-Fast Data Analytics"**, O'Reilly
- Bill Franks, **"Taming the Big Data Tidal Wave"**, Wiley
- Vignesh Prajapati, **"Big Data Analytics with R and Hadoop"**, Packt Publishing

Recommended Software/Tools:

1. **Hadoop Ecosystem Tools**: HDFS, MapReduce, Hive, Pig
2. **Apache Spark Stack**: Spark Core, Spark SQL, Spark Streaming, MLlib
3. **Visualization Tools:** Tableau, Power BI, Matplotlib, Seaborn
4. **Programming Languages**: Python, R

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)

4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	2	3	1	3	2	2
CO2	2	2	3	3	2	3	1	3	3	3
CO3	2	2	2	2	2	3	1	-	2	3
CO4	2	3	3	3	3	2	1	2	2	3
CO5	3	3	3	2	2	2	1	2	3	-
Articulation	2.4	2.4	2.8	2.6	2.2	2.6	1	2.5	2.4	2.75

Course Title:	Advanced Software Development Practices
Course Code:	25VBT0C503
Semester:	**V**
Credits:	**2**
Course Type	Core Course
Learning Hours	60
Live Sessions	**12 hours**

Course Description

This course introduces advanced principles, methodologies, and tools essential for modern software development. Emphasizing Agile methodologies, clean coding practices, scalable architecture, DevOps integration, quality assurance, and security, it equips learners with industry-ready skills to design, develop, and manage robust software systems.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Apply software development principles to design scalable and maintainable applications.	L3
CO2	Analyze software design patterns and architecture to solve real-world problems.	L4
CO3	Employ modern tools and practices such as version control, CI/CD, and testing in the development process.	L4
CO4	Demonstrate team collaboration, documentation, and agile methodologies in software projects.	L3
CO5	Evaluate software quality attributes including performance, security, and usability.	L5

Course Modules

No. of Hours: 12

Module 1: Foundations of Modern Software Development

Scope of Module: This module introduces the evolution of software development practices and explores traditional and modern software life cycle models. It also emphasizes Agile methodologies, focusing on the Scrum framework and real-world team roles.
Topics: History and evolution of software development, software development methodologies including Waterfall, Iterative, Spiral and V-Model, Agile manifesto and principles, introduction to Scrum including roles, ceremonies and artifacts, product backlog, sprint planning and burndown charts, comparison between Agile and traditional models, case study on Scrum in practice
Learning Outcome:-Explain the evolution of software development practices and their implementation using traditional SDLC models and Agile methodologies.

No. of Hours: 12

Module 2: Designing Scalable and Maintainable Software
Scope of Module: This module focuses on the planning and design phase of software development. It covers capturing system requirements and applying design principles and architecture models that ensure maintainability and scalability.
Topics: Functional and non-functional requirements, requirement elicitation techniques including interviews, surveys and use cases, requirement specification and validation, SOLID principles, DRY and KISS principles, cohesion and coupling, modular design, refactoring strategies, architectural patterns including MVC, layered and microservices, system requirement and design documentation
Learning Outcome: - Learning Outcome: Apply design principles and architecture models to create maintainable and scalable software solutions.

No. of Hours: 12

Module 3: Practical Tools for Development and Quality Assurance
Scope of Module: This module introduces essential tools and techniques for writing efficient, testable, and reusable code. Students explore version control systems, reusable design patterns, and automated testing strategies.
Topics: Design patterns including Factory, Singleton, Observer and Strategy, advantages of design patterns in real-world applications, Git basics including initializing, cloning, committing and pushing repositories, branching and merging, resolving conflicts and using GitHub for collaboration, unit testing concepts, test-driven development including Red-Green-Refactor cycle, testing frameworks like JUnit and PyTest, test coverage analysis

Learning Outcome: Use design patterns, version control, and TDD practices to improve code quality and development efficiency.

No. of Hours: 12

Module 4: DevOps Integration and Agile Project Management
Scope of Module: Students will learn how to automate software build and deployment processes using DevOps tools and manage Agile projects using tracking tools.
Topics: DevOps culture and principles, CI/CD concepts and benefits, setting up CI/CD pipelines using Jenkins or GitHub Actions, Infrastructure as Code tools and principles, Agile project management using Jira and Trello, sprint planning and backlog grooming, progress tracking using Kanban boards and velocity charts, team collaboration and documentation techniques
Learning Outcome: Integrate DevOps automation tools and Agile project management platforms to enhance software delivery efficiency.

No. of Hours: 12

Module 5: Software Security, Quality, and Project Implementation
Scope of Module: This final module prepares students to deliver secure, high-quality software by integrating secure coding principles, evaluating software performance, and implementing a capstone mini project.
Topics: Secure coding principles and OWASP Top 10, input validation and secure authentication, software quality attributes including reliability, maintainability and usability, code quality metrics such as code coverage, defect density and cyclomatic complexity, software documentation including README, code comments and user manuals, project planning steps including defining scope, scheduling and risk management, preparing and presenting final deliverables, peer review and reflection
Learning Outcome: Apply quality and security practices to implement a complete mini software project with proper documentation and reporting.

Module	**No of Pre Recordings**
1	10
2	12

3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of programming (Java/Python recommended)
- Familiarity with object-oriented principles
- Understanding of software development lifecycle concepts

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for version control, CI/CD pipelines, and Agile project tools
- ✓ Group-based mini software projects
- ✓ Live coding sessions and design pattern workshops
- ✓ Sprint-based evaluations and peer reviews
- ✓ Practical demos using industry-standard tools

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Agile Software Development – University of Minnesota
2. Udacity: Agile Software Development
3. edX: DevOps Practices and Tools – Linux Foundation
4. GitHub Learning Lab: Intro to GitHub

Suggested Readings:

- Robert C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, Prentice Hall
- Erich Gamma et al., *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison-Wesley
- Gene Kim, Jez Humble, and Patrick Debois, *The DevOps Handbook*, IT Revolution
- Martin Fowler, *Refactoring: Improving the Design of Existing Code*, Addison-Wesley

Recommended Software/Tools:

1. Version Control**:** Git, GitHub
2. Testing Tools**:** JUnit, PyTest
3. CI/CD: Jenkins, GitHub Actions
4. Agile Management Tools**:** Jira, Trello

5. Code Analysis: SonarQube, Codacy
6. Development Environments**:** VS Code, IntelliJ IDEA, Eclipse
7. Documentation**:** Markdown, Doxygen, Swagger

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	3	2	3	2	2
CO2	2	2	3	3	2	3	2	3	3	3
CO3	2	2	2	2	1	2	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1.6	2.6	2	2.5	2.4	2.8

Semester VI

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Course Title:	Artificial Intelligence and Machine Learning
Course Code:	25VBT1E601
Semester:	**VI**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course introduces the fundamentals of artificial intelligence (AI) and machine learning (ML), covering core concepts, algorithms, and practical applications. It includes hands-on learning with data analysis and model building.

Course Outcomes (COs)

CO	Course Outcome	BTL
CO1	Understand AI concepts, history, and applications.	L2
CO2	Apply supervised and unsupervised ML techniques.	L3
CO3	Analyze datasets using feature engineering and selection.	L4
CO4	Evaluate classification, regression, and clustering models.	L5
CO5	Build and deploy intelligent systems for real-world problems.	L6

Course Modules

Module 1: Introduction to Artificial Intelligence
Scope of Module: Covers the foundations of AI, intelligent agents, and problem-solving.
Topics: Definition and History of AI, Applications of AI, Intelligent Agents and Environments, PEAS

Representation, Types of Agents, Problem Solving Agents, Uninformed Search Strategies (BFS, DFS), Informed Search Strategies (Greedy, A*), Game Playing – Minimax Algorithm, Alpha-Beta Pruning, Knowledge Representation, Propositional Logic, First-Order Logic, Inference in FOL, Planning in AI, Natural Language Understanding.
Learning Outcome: *Explain AI fundamentals and apply basic problem-solving techniques.*

No. of

Hours: 24

No. of Hours: 24

Module 2: Machine Learning Basics and Supervised Learning
Scope of Module: Introduces ML concepts and supervised learning methods.
Topics: What is Machine Learning, Types of Learning (Supervised, Unsupervised, Reinforcement), ML Workflow, Data Preprocessing, Feature Engineering, Regression Models (Linear, Polynomial), Classification Algorithms (K-NN, Decision Tree, Random Forest, SVM), Evaluation Metrics (Accuracy, Precision, Recall, F1-Score), Bias-Variance Tradeoff, Cross Validation, Overfitting and Underfitting, Model Selection, Feature Scaling, Hyperparameter Tuning, Case Studies in Supervised Learning.
Learning Outcome: *Apply supervised learning models and evaluate their effectiveness.*

No. of Hours:24

Module 3: Unsupervised and Reinforcement Learning
Scope of Module: Covers unsupervised learning techniques and reinforcement learning principles.
Topics: Clustering Algorithms (K-Means, Hierarchical, DBSCAN), Association Rule Mining, Dimensionality Reduction (PCA, t-SNE), Applications of Unsupervised Learning, Introduction to Reinforcement Learning, Markov Decision Processes, Q-Learning, Exploration vs Exploitation, Deep Q-Networks, Use Cases of Reinforcement Learning, Evaluation Metrics for RL, Applications in Games and Robotics, AI in Recommendation Systems.
Learning Outcome: *Implement unsupervised and reinforcement learning algorithms.*

No. of Hours: 24

Module 4: Deep Learning and Neural Networks
Scope of Module: Focuses on deep learning models and architectures.
Topics: Introduction to Neural Networks, Perceptron and Multi-layer Perceptron, Activation Functions, Backpropagation Algorithm, Loss Functions, Gradient Descent Variants, CNNs – Convolutional

Neural Networks, RNNs – Recurrent Neural Networks, LSTM Networks, Regularization Techniques, Transfer Learning, Autoencoders, Deep Learning Frameworks (TensorFlow/Keras), Image and Text Classification, Applications in NLP and CV.
Learning Outcome: *Build and train deep learning models for complex tasks.*

No. of Hours: 24

Module 5: Tools, Libraries, and Applications of AI/ML
Scope of Module: Explores tools, real-world applications, and ethical considerations in AI/ML.
Topics: Overview of Python for ML, NumPy and Pandas for Data Handling, Scikit-Learn Basics, Matplotlib and Seaborn for Visualization, TensorFlow/Keras for Deep Learning, AI in Healthcare, Finance, Retail, Autonomous Systems, AI Ethics and Bias, Fairness in AI, Explainable AI (XAI), AI Governance, Data Privacy in ML, AI Project Lifecycle, Deployment of ML Models, Case Studies in Industry Applications.
Learning Outcome: *Use tools and libraries to develop real-world AI/ML solutions.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- Statistics, linear algebra basics
- Python programming

Pedagogy

- ✓ ML experiments using scikit-learn, TensorFlow
- ✓ Real-world datasets and Kaggle participation
- ✓ AI mini-projects with feedback

Certificates / Value Added Courses

1. [AI For Everyone – Coursera]
2. [Machine Learning – Stanford (Andrew Ng)]
3. [Deep Learning Specialization – Coursera]

Suggested Readings

- Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach
- Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow
- Tom Mitchell, Machine Learning

Recommended Tools

1. Python, Jupyter Notebook
2. scikit-learn, TensorFlow, Keras
3. Google Colab, Kaggle

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10

CO1	2	2	2	3	2	3	2	3	2	2
CO2	2	2	3	3	2	3	2	3	3	3
CO3	2	2	2	2	2	1	1	1	2	3
CO4	2	3	3	3	2	1	-	2	2	3
CO5	3	3	3	2	2	1	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	2	1.8	1.6	2.2	2.4	2.8

Course Title:	Data Visualisation
Course Code:	25VBT1E602
Semester:	**VI**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course aims to equip students with the knowledge and skills to represent complex datasets visually. It emphasizes the use of visualization tools and techniques to extract, analyze, and communicate data-driven insights effectively.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the principles and importance of data visualization.	L2
CO2	Apply design principles to create effective visual representations of data.	L3
CO3	Use data visualization tools like Tableau, Power BI, and Python libraries.	L3
CO4	Analyze datasets and build interactive dashboards for data storytelling.	L4
CO5	Evaluate and critique visualizations for clarity, efficiency, and impact.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Data Visualization

Scope of Module: Covers basic concepts, history, and the importance of visualization in decision-making.
Topics: Definition and Purpose of Data Visualization, History and Evolution of Visualization, Benefits of Visual Communication, Types of Data (Categorical, Numerical, Temporal, Spatial), Introduction to Exploratory vs Explanatory Visualization, Data Types and Levels of Measurement, Characteristics of Effective Visuals, Data-ink Ratio and Chartjunk, Understanding Audience Needs, Choosing the Right Chart Type, Introduction to Visualization Tools, Common Pitfalls in Visualization, Storytelling with Data, Role of Color and Perception, Ethical Considerations in Data Representation.
Learning Outcome: *Understand the fundamentals and design principles of data visualization.*

No. of Hours: 24

Module 2: Visual Design Principles and Charting Techniques
Scope of Module: Focuses on design elements, chart types, and aesthetics in creating visualizations.
Topics: Gestalt Principles in Visualization, Pre-attentive Attributes, Chart Selection Guidelines, Bar Charts, Line Charts, Pie Charts, Histograms, Boxplots, Scatter Plots, Heatmaps, Bullet Graphs, Treemaps, Choropleth Maps, Infographics Basics, Color Theory in Visualization, Use of Typography and Layout, Dashboard Design Principles.
Learning Outcome: *Apply visual design concepts to create meaningful and accurate charts.*

No. of Hours:24

Module 3: Data Processing and Visualization using Python
Scope of Module: Hands-on creation of visualizations using Python libraries for different datasets.
Topics: Data Import and Cleaning with Pandas, Exploratory Data Analysis (EDA), Matplotlib Basics and Plot Customization, Seaborn for Statistical Plots, Plotly for Interactive Visualization, Working with Time Series Data, Multi-Plot Layouts, Annotating Charts, Visualizing Missing Data, Correlation Heatmaps, Pairplots and Facets, Geographic Visualizations with Folium, Word Clouds for Text Data, Saving and Sharing Visuals, Best Practices in Python Visualization.
Learning Outcome: *Create diverse data visualizations using Python libraries.*

No. of Hours: 24

Module 4: Interactive Dashboards with Tableau and Power BI
Scope of Module: Covers the use of popular business intelligence tools for interactive analytics.

Topics: Tableau Environment Overview, Data Connection and Preparation in Tableau, Dimensions and Measures, Calculated Fields and Parameters, Filters and Sorting, Building Dashboards in Tableau, Storytelling and Navigation, Introduction to Power BI Interface, Power Query Editor, DAX Functions and Measures, Building Reports and Visuals in Power BI, Slicers and Filters, Publishing and Sharing Dashboards, Comparing Tableau and Power BI, Real-time Dashboard Design.
Learning Outcome: *Design interactive dashboards using Tableau and Power BI.*

No. of Hours: 24

Module 5: Advanced Topics and Applications in Data Visualization
Scope of Module: Explores specialized visualization methods and domain-specific applications.
Topics: Visualizing Networks and Graphs, Visual Analytics in Business Intelligence, Data Journalism and Narrative Visualization, Visualizing Survey Data, Visualizing Big Data, Real-Time Data Visualization, Dashboards for KPIs and Metrics, Accessibility in Visualization, Mobile-Responsive Visualizations, A/B Testing and Data Interpretation, Visualizing Machine Learning Outputs, Data Storyboarding, Evaluation and Critique of Visualizations, Industry Use Cases, Recent Trends and Tools in Visualization.
Learning Outcome: *Implement advanced visualization techniques for real-world applications.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of statistics and data types
- Familiarity with Excel or spreadsheet tools
- Basic programming knowledge (preferably Python)

- Awareness of business or analytical problem-solving approaches

Pedagogy / Teaching Methodology:

- Hands-on practice using Tableau, Power BI, and Python libraries (Matplotlib, Seaborn, Plotly)
- Real-world mini-projects and case studies
- Exploratory analysis and visual storytelling exercises
- Team-based dashboard development activities

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Google Data Analytics Professional Certificate – Coursera
2. Tableau Data Visualization – Coursera
3. Power BI for Beginners – Microsoft Learn
4. Data Visualization with Python – IBM / Coursera

Suggested Readings:

- Cole Nussbaumer Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*
- Nathan Yau, *Data Points: Visualization That Means Something*
- Alberto Cairo, *The Truthful Art: Data, Charts, and Maps for Communication*
- Claus O. Wilke, *Fundamentals of Data Visualization*

Recommended Software/Tools:

1. **Tableau** (Desktop or Public)
2. **Power BI** (Desktop version)
3. **Python Libraries:** Matplotlib, Seaborn, Plotly, Pandas, Folium, Wordcloud
4. **Jupyter Notebooks / Google Colab**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)

4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	1	1	3	2	1
CO2	2	3	3	3	3	2	1	2	2	1
CO3	2	3	3	2	3	1	1	1	2	1
CO4	2	3	3	3	3	1	1	1	2	2
CO5	3	3	3	2	3	2	1	1	2	2
Articulation	2.2	2.8	2.8	2.6	3	1.4	1	1.6	2	1.4

Course Title:	Software Testing
Course Code:	25VBT1E603
Semester:	**VI**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course offers a comprehensive understanding of software testing principles, techniques, and tools. It equips students with skills to ensure software reliability, quality, and performance through structured testing practices.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand software testing principles and lifecycle.	L2
CO2	Apply black-box and white-box testing techniques.	L3
CO3	Analyze test cases for coverage and effectiveness.	L4
CO4	Evaluate automated testing tools and frameworks.	L5
CO5	Design test strategies for different software applications.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Testing

Scope of Module: Introduces software testing basics, life cycle, and classifications.
Topics: Introduction to Software Testing, Objectives and Principles, Software Quality and Reliability, Software Development Life Cycle (SDLC) and Testing, Software Testing Life Cycle (STLC), Verification vs Validation, Types of Testing (Manual, Automated), Static vs Dynamic Testing, White-box Testing Overview, Black-box Testing Overview, Defect, Error, Failure Definitions, Bug Lifecycle, Testing Terminology, Testing Process Models, Role of Tester.
Learning Outcome: *Understand the basics and life cycle of software testing.*

No. of Hours: 24

Module 2: Test Design Techniques and Strategies
Scope of Module: Focuses on systematic test case development and testing methodologies.
Topics: Test Case Design, Boundary Value Analysis, Equivalence Class Partitioning, Decision Table Testing, State Transition Testing, Use Case Testing, Cause-Effect Graphing, Structural Testing (Statement, Branch, Path, Condition), Exploratory Testing, Ad-hoc Testing, Error Guessing, Software Testability, Levels of Testing (Unit, Integration, System, Acceptance), Test Coverage Criteria, Risk-based Testing, Mutation Testing.
Learning Outcome: *Design test cases using appropriate design techniques.*

No. of Hours:24

Module 3: Software Test Management and Metrics
Scope of Module: Deals with planning, executing, and managing testing activities.
Topics: Test Planning and Estimation, Test Strategy, Test Plan Components, Resource Allocation, Scheduling and Budgeting, Test Environment Setup, Test Data Management, Defect Management, Test Metrics and Measurements, Test Reporting and Documentation, Test Reviews and Audits, Entry and Exit Criteria, Test Deliverables, Test Summary Report, Quality Standards in Testing, Test Process Improvement.
Learning Outcome: *Plan and manage software testing projects effectively.*

No. of Hours: 24

Module 4: Automation Testing and Tools
Scope of Module: Covers automation tools and frameworks for efficient testing.
Topics: Need for Automation, Test Automation Frameworks, Record and Playback Tools, Selenium

WebDriver, TestNG Framework, Unit Testing Tools (JUnit), Load and Performance Testing Tools (JMeter), GUI Testing Tools, CI/CD Integration in Testing, Scripting in Automation, Keyword and Data-Driven Frameworks, Test Automation Best Practices, Version Control in Testing, Limitations of Automation, Tool Selection Criteria, Case Studies in Automation Testing.
Learning Outcome: *Automate test cases using industry-standard tools.*

No. of Hours: 24

Module 5: Advanced Topics and Emerging Trends in Testing
Scope of Module: Examines new approaches and practices in the evolving testing domain.
Topics: Agile Testing Practices, DevOps and Continuous Testing, Behavior-Driven Development (BDD), Test-Driven Development (TDD), Acceptance Test-Driven Development (ATDD), Mobile App Testing, Cloud-based Testing, Security Testing, Usability Testing, Regression Testing, Compatibility Testing, Globalization and Localization Testing, AI in Software Testing, Testing IoT Applications, Testing Microservices and APIs.
Learning Outcome: *Apply modern testing techniques in agile and emerging tech environments.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Knowledge of software development
- Programming basics

Pedagogy

- ✓ Hands-on with testing frameworks (JUnit, Selenium)

- ✓ Bug tracking using tools like Bugzilla
- ✓ Group testing assignments

Certificates / Value Added Courses

1. [Software Testing – Udemy/Coursera]
2. [ISTQB Foundation Level Certification]

Suggested Readings

- Glenford J. Myers, The Art of Software Testing
- Ron Patton, Software Testing
- Paul C. Jorgensen, Software Testing: A Craftsman's Approach

Recommended Tools

1. JUnit, TestNG
2. Selenium, Postman
3. Bugzilla, Jira

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	-	3	2	2
CO2	3	2	3	3	3	2	-	2	2	2
CO3	3	2	2	2	3	1	-	1	2	1
CO4	3	3	3	3	3	1	1	1	2	2
CO5	3	3	3	3	3	2	1	1	1	2
Articulation	3	2.4	2.6	2.8	3	1.4	1	1.6	1.8	1.8

Course Title:	Internet of Things
Course Code:	25VBT1E604
Semester:	**VI**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course introduces students to the IoT ecosystem, covering foundational technologies, communication protocols, sensor integration, data management, and applications in various domains. Students will gain hands-on experience in building IoT-based systems.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand IoT architecture and enabling technologies.	L2
CO2	Apply sensors, microcontrollers, and communication protocols.	L3
CO3	Analyze data acquisition and device management.	L4
CO4	Evaluate IoT security and cloud integration.	L5
CO5	Design IoT systems for smart applications.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to IoT and Architecture

Scope of Module: Covers the basics, architecture, and application areas of IoT.
Topics: Definition of IoT, Characteristics and Scope, IoT Ecosystem, IoT Reference Architecture, IoT Levels and Functional Blocks, Cyber-Physical Systems, Enabling Technologies, IoT vs M2M, Edge and Fog Computing, Smart Objects, IoT Design Principles, Applications in Smart Cities, Healthcare, Transportation, Agriculture, Environmental Monitoring, Industrial IoT (IIoT).
Learning Outcome: *Understand the IoT ecosystem and its architectural components.*

No. of Hours: 24

Module 2: IoT Hardware and Sensors
Scope of Module: Explores sensor types, microcontrollers, and interfacing techniques.
Topics: Overview of IoT Hardware Platforms (Arduino, Raspberry Pi, ESP32), Analog and Digital Sensors, Actuators, Sensor Characteristics, Sensor Interfacing, Data Acquisition Systems, Communication between Sensors and Controllers, GPIO, ADC, PWM, I2C, SPI Protocols, Interrupt Handling, Power Management, Basic Circuit Design for IoT, Prototyping Boards, Hands-on with Arduino and Sensors.
Learning Outcome: *Interface sensors and devices with controllers for IoT applications.*

No. of Hours: 24

Module 3: Communication Protocols in IoT
Scope of Module: Focuses on networking protocols and wireless technologies in IoT.
Topics: OSI Model Overview, IoT Communication Models, Network Topologies, MQTT Protocol, CoAP Protocol, HTTP/HTTPS in IoT, Bluetooth, BLE, ZigBee, LoRaWAN, Wi-Fi, NFC, RFID, Cellular Networks (3G/4G/5G), IP Addressing in IoT, IPv6, LPWAN, Security in Communication, Protocol Comparison and Use Cases.
Learning Outcome: *Apply appropriate protocols for device communication in IoT.*

No. of Hours: 24

Module 4: Data Management and Cloud Integration
Scope of Module: Introduces data processing, cloud platforms, and storage mechanisms in IoT.
Topics: IoT Data Lifecycle, Data Acquisition and Filtering, Time-Series Data, MQTT Brokers, Cloud Platforms (AWS IoT, Azure IoT, Google Cloud IoT), Firebase Realtime Database, Data Visualization Tools

(Things Board, Grafana), Edge vs Cloud Processing, Real-time Streaming, IoT Dashboards, Big Data in IoT, Data Security and Privacy, Integration with Mobile/Web Apps, Cloud Deployment Considerations.
Learning Outcome: *Manage and analyze IoT data using cloud and edge computing.*

No. of Hours: 24

Module 5: IoT Applications and Project Development
Scope of Module: Guides the design, development, and deployment of complete IoT projects.
Topics: End-to-End IoT Project Lifecycle, Problem Identification and Scope Definition, Requirement Gathering, Hardware Selection, Software Stack Design, Prototyping and Testing, Deployment and Monitoring, Smart Home Automation System, Weather Monitoring Station, Asset Tracking System, Industrial Monitoring Project, IoT Ethics and Challenges, Regulatory Frameworks, Green IoT, Future Trends in IoT.
Learning Outcome: *Develop and deploy practical IoT solutions for real-world scenarios.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- Electronics fundamentals
- C/Python programming

Pedagogy

- ✓ Hardware labs using Arduino/Raspberry Pi

- ✓ MQTT, Node-RED, sensor integration projects
- ✓ IoT mini-projects

Certificates / Value Added Courses

1. [IoT for Beginners – Microsoft Learn]
2. [Introduction to IoT – Cisco NetAcad]
3. [IoT and Embedded Systems – Coursera]

Suggested Readings

- Vijay Madisetti, Internet of Things: A Hands-On Approach
- Arshdeep Bahga & Vijay Madisetti, IoT: Principles and Paradigms
- Raj Kamal, Internet of Things: Architecture and Design

Recommended Tools

1. Arduino IDE, Tinkercad
2. Raspberry Pi, Blynk
3. Node-RED, ThingSpeak
4. MQTT, Firebase

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	-	-	-	-
CO2	3	2	3	3	3	2	-	-	-	-
CO3	3	2	2	2	3	1	-	-	-	-
CO4	3	3	3	3	3	1	2	-	-	-
CO5	3	3	3	2	3	2	1	-	-	-
Articulation	3	2.4	2.6	2.6	3	1.4	1.5	-	-	-

ELECTIVE:

Data Science and Analytics

Semester 1

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBX0AE101	English	AECC	30	70	4
25VBT0C102	Fundamentals of Mathematics	CC	30	70	4
25VBT0C103	Problem Solving using C	CC	30	70	4
25VBT0C104	Computer Architecture	CC	30	70	4
26VBX0S105	Essentials of Generative AI	SEC	30	70	2
25VBT0L101	Problem Solving using C Lab	SEC	100	-	1
Total No of Credits					**19**

Semester 2

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBX0AE205	Communicative English	AECC	30	70	4
25VBT0C201	Operating System	CC	30	70	4
25VBT0C202	Data Structures using C	CC	30	70	4
25VBT0C203	Relational Database Systems	CC	30	70	4
25VBT0L201	Data Structures using C Lab	SEC	100	-	1
25VBT0L202	Relational Database Systems Lab	SEC	100	-	1
Total No of Credits					**18**

Semester 3

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBT0C301	Python Programming	CC	30	70	4
25VBT0C302	Design and Analysis of Algorithms	CC	30	70	4
25VBT0C303	Software Engineering	CC	30	70	4
25VBT0C304	Computer Networks	CC	30	70	4
25VBT0C305	Environmental, Social, and Governance (ESG) in IT	AECC	30	70	3
25VBT0L301	Python Programming Lab	SEC	100	-	1
25VBT0L302	Design and Analysis of Algorithms Lab	SEC	100	-	1
Total No of Credits					**21**

Semester 4

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBT0C401	Web Technologies	CC	30	70	4
25VBT0C403	Predictive Analytics Using Machine Learning	DSE	30	70	4
25VBT2E403	Data Visualization Techniques	DSE	30	70	4
25VBT2E404	Statistical Analysis	DSE	30	70	4
25VBT0C404	Quantitative Techniques	GE	30	70	3
25VBT0L401	Web Technologies Lab	SEC	100	-	1
25VBT0L403	Predictive Analytics Using Machine Learning lab	SEC	100	-	1
Total No of Credits					**21**

Semester 5

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBT0C501	Block Chain Technologies	CC	30	70	4
25VBT0C502	IT Project Management	DSE	30	70	4
25VBT2E503	Fundamentals of Data science	DSE	30	70	4
25VBT1E505	Big Data Analytics	DSE	30	70	4
25VBT2E505	Natural Language Processing	DSE	30	70	4
25VBT0C503	Advanced Software Development Practices	SEC	30	70	2
Total No of Credits					**22**

Semester 6

Course Code	Course Title	Course Category	CA	ESE	Credits
25VBT2E601	Artificial Intelligence	DSE	30	70	4
25VBT2E602	Time Series Analysis	DSE	30	70	4
25VBT2E603	Data Mining Techniques	DSE	30	70	4
25VBT2E604	R Programming	DSE	30	70	4
25VBT0P605	Project	DSE	30	70	6
Total No of Credits					**22**
Overall Program Credits					**123**

Legend

Core Course

Discipline Specific Elective
Skill Enhancement Courses
Ability Enhancement Compulsory Course
Generic Elective

Semester I

Detailed Syllabus

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J P Nagar 6th Phase
Bengaluru – 560 078
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Course Title:	English
Course Code:	25VBX0AE101
Semester:	**I**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
Live Sessions:	**12 hours**

Course Description:

This course introduces learners to literature, rhetorical practices, grammar, and academic writing. Through engagement with poetry, prose, drama, and structured writing tasks, students will gain foundational skills in critical reading, effective communication, and literary appreciation.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Examine literary texts in historical contexts and be sensitive to their social relevance	L4
CO2	Explain the process of communicating and interpreting human experiences from different cultures through literary representations	L2
CO3	Gain practical knowledge in the correct use of grammatical elements to express in English	L3
CO4	Appraise the art of rhetoric through speech and writing	L5
CO5	Develop higher order language skills, such as reading and writing, through texts centered on diverse themes and topics in literature	L6

Course Module

No. of Hours:24

Module 1: Foundations of Literature and Language
Scope of Module: *Explore how literature reflects language and meaning, and how rhetoric is constructed in influential speeches.*
Topics: Literal and metaphorical meanings in literature, Shakespeare's Sonnet 18, Robert Frost's *Stopping by Woods on a Snowy Evening*, introduction to rhetoric, Aristotle's modes of appeal, discourse analysis, Martin Luther King Jr.'s *I Have a Dream* speech, oratory and audience connection, speeches of Brutus and Mark Antony.
Learning Outcome: *Comprehend concrete and abstract meanings of words and phrases, and discuss rhetorical construction of speeches.*

No. of Hours:24

Module 2: Poetic and Prose Expressions
Scope of Module: Analyze language symbolism, Indian English poetry, and the art of prose expression.
Topics: Symbolism in poetry, Blake's *The Tyger*, Hughes' *Hawk Roosting*, early Indian English poetry and themes, Sarojini Naidu's *In Salutation to the Eternal Peace*, Nissim Ezekiel's *The Professor*, prose as a distinct form, types and function of prose, Bertrand Russell's *In Praise of Idleness*.
Learning Outcome: *Explain poetic symbolism, and examine Indian and Western prose for theme and style.*

No. of Hours:24

Module 3: Grammar and Sentence Structuring
Scope of Module: Explore grammatical concepts, including sentence construction, reported speech, and paragraph writing.

Topics: Phrases, clauses, sentence types, components of a sentence, active and passive voice, conversion rules, reported speech, simple, compound, complex sentence structures, linkers, synthesis, transformation, paragraph structure and types, examples from literature.
Learning Outcome: *Demonstrate grammatical proficiency, including sentence synthesis and paragraph writing.*

No. of Hours:24

Module 4: Argumentation and Debate
Scope of Module: Develop structured argumentative and debating skills using classical and contemporary contexts.
Topics: Structure of argument (claim, reason, support, warrant), logical flow, Frederick Copleston vs Bertrand Russell radio debate, elements of a good case, defense and rebuttal strategies, importance of debate, analyzing contemporary topics.
Learning Outcome: *Develop an understanding of logical argumentation and apply strategies for debate*

No. of Hours:24

Module 5: Essay Writing and Text Performance
Scope of Module: Explore essay forms, dramatic theory, and literary performance in Western and Indian contexts.
Topics: Essay types – compare and contrast, cause and effect, Feynman's *The Value of Science*, Chesterton's *On Running After One's Hat*, Charles Lamb's *Dream Children: A Reverie*, dramatic theory by Aristotle and Bharata, Vijay Tendulkar's *Silence! The Court is in Session.*
***Learning Outcome**: Appraise techniques for academic and personal essay writing, and analyze dramatic forms across cultures.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12

5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

4. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
5. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
6. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings:

Book

- Gupta, S. C. (2018). Comprehensive English Grammar & Composition. Arihant Prakashan

Online Articles, Journals, and Whitepapers

- British Council Learn English Articles, JSTOR Language and Literature Studies, Routledge Journals on Rhetoric and Composition

Web-based Resources

- Grammarly Handbook, Purdue OWL, YouTube Channels on Poetry in Performance, Project Gutenberg Literature Database

Recommended Software/Tools:

6. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
7. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
8. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
9. **Miro** – for mind-mapping essay structures.
10. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Environmental concerns)
6	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	2	3	1	1	2	1	1
CO3	1	1	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	3	2	1	1	1	2	1
Articulation	1	1	1.4	1.8	2	1	1	1.2	1.2	1

Note: The Articulation is indicative of how a particular course maps to a PO.

Articulation is calculated as:

$$= \frac{\text{Sum of CO Mappiung Levels for a perticular PO}}{\text{No.of COs that mapped to that PO}}$$

Example:1

$$Articulation\ of\ \boldsymbol{PO1} = \frac{(3+2+3+2+3)}{5} = 2.6$$

Example: 2

$$Articulation\ of\ \boldsymbol{PO7} = \frac{(1+1)}{2} = 1.0$$

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Course Title:	Fundamentals of Mathematics
Course Code:	25VBT0C102
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces foundational mathematical concepts essential for problem-solving and application in computing and data analysis. It includes matrix algebra, calculus, vector algebra, and 3-D geometry to develop logical reasoning and analytical abilities among students.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Learn to carry out matrix operations, including inverses and determinants, and solve systems of equations using multiple methods.	L3
CO2	Demonstrate the idea of differentiation from first principles and work with derivatives as rates of change in mathematical models.	L3
CO3	Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions.	L4
CO4	Demonstrate vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.	L3
CO5	Apply matrix theory for solving systems of linear equations and compute eigenvalues and eigenvectors required for the matrix diagonalization process	L3

Course Modules

No. of Hours:24

Module 1: Matrices and Linear Algebra

Scope of Module: This module introduces students to matrix operations, properties of determinants, and methods for solving linear systems using algebraic and matrix techniques.
Topics: Types of matrices including row, column, diagonal, scalar, unit and zero matrices, algebra of matrices including addition, scalar multiplication and transpose, inverse of a matrix using elementary operations, definition and expansion of determinants up to 3x3, minors and cofactors, properties of determinants, adjoint and inverse of matrices, singular and non-singular matrices, consistency of linear systems, solving equations using Cramer's rule, matrix rank, echelon and normal form, solving linear systems using Gauss elimination, Gauss-Jordan, Gauss-Seidel and LU decomposition.
Learning Outcome: *Solve linear systems using matrix operations and analyze determinant-based consistency and inverse properties.*

No. of Hours:24

Module 2: Eigenvalues, Eigenvectors, and Vector Algebra
Scope of Module: This module explores the concepts of eigenvalues, eigenvectors, vector operations, and geometric representations of vectors in space.
Topics: Definition and computation of eigenvalues and eigenvectors, Rayleigh's power method for dominant eigenvalue, diagonalization of matrices, linear transformation and matrix reduction, types of vectors including unit, zero and position vectors, magnitude and direction of vectors, vector addition and scalar multiplication, dot product and its geometric meaning, projection of vectors, cross product and scalar triple product, area and volume calculation using vectors.
Learning Outcome: *Compute eigenvalues, eigenvectors, and apply vector operations in solving spatial problems and geometric modeling.*

No. of Hours:24

Module 3: Differential Calculus and Applications
Scope of Module: This module introduces the principles and rules of differentiation and applies them to various types of functions and curve-based problems.
Topics: Continuity of functions at a point and over intervals, derivatives of algebraic and trigonometric functions, exponential and logarithmic functions, derivatives of composite, inverse trigonometric and parametric functions, second-order derivatives, nth-order derivatives, and Leibnitz theorem, angle between curves and pedal equations, polar curve representations and applications.
Learning Outcome: *Apply differentiation techniques to model change, analyze polar curves, and solve advanced calculus problems.*

No. of Hours:24

Module 4: Integral Calculus and Vector Calculus
Scope of Module: This module focuses on integration methods, definite and indefinite integrals, and introductory vector calculus concepts.
Topics: Indefinite integrals using substitution, trigonometric identities, partial fractions and integration by parts, definite integrals and reduction formulae for powers of sine and cosine, vector function derivatives including velocity and acceleration, scalar and vector point functions, gradient, divergence, curl, Laplacian operators, solenoidal and irrotational vectors.
Learning Outcome: *Solve definite and indefinite integrals and apply differential vector calculus operators in applied mathematics.*

No. of Hours:24

Module 5: Three-Dimensional Geometry
Scope of Module: This module develops spatial reasoning through the study of 3D geometry including direction cosines, lines and planes.
Topics: Direction cosines and direction ratios, vector and cartesian equations of a straight line, angle between two lines, shortest distance between skew lines, vector and cartesian equations of planes, angle between two planes, coplanar lines and intersection of lines with planes.
Learning Outcome: *Analyze three-dimensional shapes using vector and cartesian methods and solve problems involving lines and planes in space.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic understanding of algebra and geometry from secondary education..

Pedagogy / Teaching Methodology:

- ✓ Conceptual and problem-based learning
- ✓ Interactive class exercises and proofs
- ✓ Assignments and quizzes using math software.

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Mathematics – I by Prof. Jitendra Kumar (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/111105038

4. Mathematics for Computer Science by MIT Open Courseware: https://ocw.mit.edu

Suggested Readings:

Book

- Applied Mathematics and Scientific Computing: International Conference on Advances in Mathematical Sciences, Vellore, India, December 2017 – Volume II (Trends in Mathematics), Springer, 2019

Online Articles, Journals, and Whitepapers

- Research articles from *SpringerLink*, *Mathematics Today*, and *Elsevier Journal of Mathematical Analysis*
- Whitepapers on matrix theory, calculus, and vector analysis from *AMS (American Mathematical Society)* and *SIAM (Society for Industrial and Applied Mathematics)*

Web-based Resources

- Khan Academy (topics: Calculus, Linear Algebra, Vectors, 3D Geometry
- MIT OpenCourseWare for Mathematics
- Interactive simulations and problem sets on Desmos, GeoGebra, and Brilliant.org.

Recommended Software/Tools (If applicable):

5. MATLAB/Octave
6. SageMath
7. Python (NumPy, Matplotlib)
8. GeoGebra for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development

3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	-	2	2	2	2	2
CO2	3	2	3	2	-	2	1	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.6	2.6	3	2.2	1	2	1.6	1.8	2.2	2.8

Course Title:	Problem Solving using C
Course Code:	25VBT0C103
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:
This course introduces students to the C programming language with an industry-focused approach. Emphasis is placed on problem-solving, structured programming, memory efficiency, and modular design. The course prepares students to handle real-world applications in embedded systems, system-level development, and performance-sensitive software solutions.

Course Outcomes(COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand and apply the core concepts of the C language including syntax, control flow, and data types.	L3
CO2	Develop modular and efficient code using functions, arrays, and structures.	L6
CO3	Manage memory effectively using pointers and dynamic memory allocation.	L3
CO4	Handle file operations and system-level programming tasks.	L3
CO5	Apply modern development tools, debugging practices, and implement mini-projects that solve real-world problems.	L6

Course Modules:

No. of Hours:24

Module 1: Programming Foundations and C Basics
Scope of Module: Introduce software concepts, basic C syntax, and structured programming methodology.

Topics: Role of programming in systems and embedded development, history and importance of C, variables, constants, keywords, data types, operators, input/output (printf, scanf, gets, puts), expressions, conditional statements (if, if-else, switch), looping (for, while, do-while), break, continue, goto, code documentation and commenting practices.
Learning Outcome **:-** *Implement basic control structures and understand the foundations of structured programming in C.*

No. of Hours:24

Module 2: Functions, Arrays and Strings
Scope of Module: Focus on modular programming and data handling through arrays and string operations.
Topics: Function declaration and definition, argument passing methods, recursion, return types, arrays (1D, 2D), basic algorithms (sorting, searching), string manipulation using standard functions, multidimensional string arrays, arrays in function arguments, memory usage with arrays.
Learning Outcome **:-** *Design modular programs using functions and implement logic-driven operations with arrays and strings.*

No. of Hours:24

Module 3: Structures, Unions, Pointers and Memory Management
Scope of Module: Introduce advanced C constructs for optimized data storage and dynamic memory operations.
Topics: Structures and nested structures, unions and memory overlap, arrays of structures, pointers: declaration, arithmetic, arrays with pointers, pointers to structures, dynamic memory (malloc, calloc, realloc, free), storage classes (auto, extern, static, register), pointer pitfalls and best practices.
Learning Outcome **:** *Apply pointer concepts and structured data storage to optimize program memory usage.*

No. of Hours:24

Module 4: File Systems, Command-Line Tools, and Build Automation
Scope of Module: Enable students to use persistent storage and build scalable projects using system-level tools.

Topics: Text and binary file handling (fopen, fclose, fread, fwrite, fprintf, fscanf), command-line argument usage, preprocessor directives (#define, #include, macros), header file creation, build tools (Makefile basics), version control systems (Git), compiler flags, debugging with gdb, introduction to CI/CD tools for C.
Learning Outcome: *Manage files, automate builds and integrate version control in a modern development pipeline.*

No. of Hours:24

Module 5: Industry Use Cases and Project-Based Application
Scope of Module: Apply knowledge in practical, time-bound projects aligned with industry-relevant themes.
Topics: Development of mini projects: menu-driven programs (e.g., ATM interface, student grade system), real-time input handling and validation, implementation of logging systems using file I/O, structuring code for modularity and readability, application testing using manual test cases, integration of Git for version tracking.
***Learning Outcome*: -** *Design and deploy small-scale C projects using structured programming and version-controlled collaboration within limited timeframes.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

2. Programming in C by Prof. Anupam Basu (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/106105085

Suggested Readings

Book

- Let Us C by Yashwant Kanetkar, 6th Edition, PBP Publication

Web-based Resources

- GeeksforGeeks – Advanced C tutorials
- OnlineGDB and HackerRank – Practice platforms
- GNU Compiler Collection (GCC) docs and POSIX C reference

Recommended Software/Tools (If applicable):

2. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	2	2	2	2
CO2	2	3	3	2	-	3	2	2	2	3
CO3	2	3	3	3	-	3	2	2	2	3
CO4	2	2	3	3	-	3	2	2	2	3
CO5	3	3	3	3	-	3	2	2	3	3
Articulation	2.4	2.6	2.8	2.6	1	2.8	2	2	2.2	2.8

Course Title:	Computer Architecture
Course Code:	25VBT0C104
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description

This course introduces students to the organization and architecture of computer systems. It covers internal structures, memory systems, I/O organization, instruction execution, and emerging processor technologies. The course develops analytical skills to evaluate hardware and architectural features in computing systems.

Course Outcomes(Cos)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	To establish a strong foundation in principles and architectural concepts of computer systems.	L2
CO2	Gain insight on the functionality of different subsystems, such as the processor, input/output, and memory devices.	L3
CO3	Design and analyze simple arithmetic and logical units and their operations	L3
CO4	Comprehend the concepts of parallel computing and hardware technologies	L5

CO5	Develop insight into memory hierarchy and correlate with the concept of virtual and cache memory	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Structure and Instruction Set
Scope of Module: This module introduces basic components of computer systems, their instruction formats, and data representation.
Topics: Computer types, functional units, basic operational concepts, bus structures, instruction formats, number representation, arithmetic operations on signed and unsigned data, memory locations and addressing, memory read/write operations
Learning Outcome: *Develop insight on computer framework and identify the performance issues in computer systems*

No. of Hours :24

Module 2: Machine Instructions, I/O Systems, and Memory Organization
Scope of Module: This module explains instruction execution and system-level operations including input/output handling and memory management basics.
Topics: Addressing modes, assembly language instructions, input and output operations, subroutines, instruction encoding, accessing I/O devices, interrupt mechanism and hardware, direct memory access, standard I/O interfaces including PCI, SCSI and USB, basic memory organization including RAM, ROM, memory hierarchy principles, speed and cost trade-offs.
Learning Outcome: *Understand addressing techniques, memory operations, and standard interfaces for efficient I/O operations.*

No. of Hours :24

Module 3: Advanced Memory and Arithmetic Units
Scope of Module: This module introduces concepts of cache and virtual memory, logic gates and arithmetic units.
Topics: Cache memory organization and mapping techniques, replacement algorithms, performance optimization in cache, virtual memory and address translation, logic gates and flip flops, addition and subtraction of signed numbers, fast adder designs including carry look-ahead adder.

Learning Outcome: *Analyze the logic behind memory systems, understand arithmetic circuitry and apply memory design techniques.*

No. of Hours :24

Module 4: Instruction Processing and Parallel Architectures
Scope of Module: This module describes instruction execution cycles, control design, pipelining and modern parallel processing concepts.
Topics: Basic processing unit design, instruction execution steps, multiple bus organization, hardwired and microprogrammed control, pipelining basics, instruction hazards, data hazards, impact on instruction sets, parallel computer models including multiprocessors and multicomputers, PRAM and VLSI models.
Learning Outcome: *Analyze execution flow and design of control units, and explore the foundations of parallel computer architectures.*

No. of Hours :24

Module 5: Performance, Processor Technologies and Storage
Scope of Module: This module addresses performance metrics, advanced processor types, scalable performance and memory management techniques.
Topics: Performance metrics and speedup laws, program partitioning and scheduling, interconnection networks, CISC and RISC architectures, superscalar and VLIW processors, vector and symbolic processors, hierarchical and virtual memory technology, TLB, paging, segmentation, cache addressing modes, associative caches, SIMD processing, storage systems, I/O interfacing, RAID levels and performance reliability.
Learning Outcome: *Evaluate processor performance, understand advanced architecture models and memory storage strategies.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

2. Computer Organization and Architecture by Prof. John Jose (IIT Guwahati) NPTEL: https://nptel.ac.in/courses/106103206

Suggested Readings

Book

- *Computer Organization and Architecture: Designing for Performance* by William Stallings, 10th Edition, Pearson.

Online Articles, Journals, and Whitepapers

- Research articles from *IEEE Xplore*, *ScienceDirect*, and *Journal of Parallel and Distributed Computing*
- Whitepapers on processor design, memory hierarchy, and instruction set architectures from *Intel*, *ARM*, and *ACM Computing Surveys*

Web-based Resources

- MIT OpenCourseWare – Computer System Organization and Architecture.
- Simulators and tools like EduMIPS64, Logisim, and Multi2Sim.

Recommended Software/Tools (If applicable):

2. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title:	**Essentials of Generative AI**
Course Code:	**26VBX0S105**
Semester:	**I**
Credits:	**2**
Course Type	**Skill Enhancement Course**
Learning Hours	60
Live Sessions	**12 hours**

Course Outcomes:

CO1: Understand Generative AI and LLMs in depth
CO2: Create text, image, and voice content using AI
CO3: Automate daily tasks and business workflows
CO4: Build AI agents that act independently
CO5: Design and deploy simple AI apps without coding

Course Modules

Module 1: Generative AI Prompt Engineering for Real Workflows

What is Generative AI and how it's transforming industries, Structure of an effective prompt: *Role → Task → Context → Output,* Common prompting mistakes and how to fix them, How large language models (LLMs) like ChatGPT, Claude, and Google AI Studio work, advanced prompting (few-shot, iterative, style-based), Using your own files in ChatGPT and Claude (RAG basics), Research and summarization using AI

Learning Outcome: Students will be able to understand how Generative AI works and master the art of prompting.

Module 2: Creative AI and Voice & Audio Creation

Understanding AI image generation, creating posters, campaign assets, and product visuals, building brand identity using Krea.ai, Generating realistic voiceovers using ElevenLabs, Script writing and tone control with ChatGPT & Claude, Integrating voice into short videos or podcasts ***Learning Outcome:*** Students will be able to use AI to generate visuals, voiceovers, and creative storytelling content.

Module 3: AI Automation & Productivity

Logic of triggers, actions, and workflows, setting up automation between apps (Gmail, Sheets, Drive), Connecting OpenAI to Make.com for intelligent automation, creating social media Management Workflow and research automation flows, automating daily reports and reminders, building personal productivity dashboards, Integrating Claude and ChatGPT into existing workflows

Learning Outcome: Automate daily workflows and tasks using AI and no-code tools.

Module 4: Advanced AI Agents & Decision Flows

Introduction to n8n as a visual AI workflow builder, understanding nodes, triggers, and data passing, Using OpenAI node for smart responses and actions, designing multi-step reasoning workflows, Connecting Google Sheets, Slack, and other APIs, building autonomous agents that perform specific tasks

Learning Outcome: Students will be able to build AI agents that can think, decide, and act automatically.

Module 5: AI App Building & Deployment

Fundamentals of UI/UX for AI apps, structuring front-end and AI back-end flows, designing app logic using n8n and Make.com, integrating OpenAI and Claude APIs to your apps, handling user inputs and dynamic responses, using Google AI Studio to experiment with models, hosting and testing your AI app online, adding analytics and monitoring usage, final demo preparation and peer feedback

Learning Outcome: Students will be able to learn to design, connect, and deploy simple AI apps using no-code tools

Semester-II

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
Bengaluru - 560 004
P: +91 80 4343 1000

Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
P: +91 80 4343 0100

Course Title:	Communicative English
Course Code:	25VBX0AE205
Semester:	**II**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course equips students with foundational and advanced communication techniques necessary for academic, personal, and professional success. Through practice-driven modules, students will develop their verbal, written, digital, and intercultural communication competence to become effective communicators.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Articulate the elements and processes involved in effective communication	L2
CO2	Analyze and differentiate between various forms of communication, recognizing their unique functions	L4
CO3	Apply diverse approaches to enhance listening and reading skills, leading to improved comprehension	L3
CO4	Demonstrate the ability to convey messages fluently and appropriately in diverse social and professional scenarios	L3
CO5	Employ advanced writing strategies to craft compelling and actionable written communication	L6

Course Modules

No. of Hours: 24

Module 1: Communication Foundations and Contexts
Scope of Module: Explore the process, types, and importance of communication with reference to global standards.
Topics: English as a global lingua franca, 21st-century communication needs, process and types of communication, workplace language skills, situational dialogues, formal and informal styles, communication barriers and management, verbal and non-verbal cues
Learning Outcome: *Explain the process and significance of effective communication in both workplace and societal contexts*

No. of Hours: 24

Module 2: Grammar, Reading, and Dialogue
Scope of Module: Build grammatical accuracy and comprehension through structured reading and dialogue practices
Topics: Essentials of good English (parts of speech, sentence structures), subject-verb agreement, discourse markers, reading strategies, textual understanding using *The English Teacher* by R.K. Narayan, direct and indirect dialogue, conversation control, dialogue in different scenarios, Einstein-Tagore discussion
Learning Outcome: *Apply grammar principles and reading skills for improved comprehension and communication*

No. of Hours:24

Module 3: Digital and Collaborative Communication
Scope of Module: Focus on the use of technology for learning, presenting, and collaborating in professional environments.
Topics: Online resources for language and research (Google Scholar, INFLIBNET, Project Gutenberg), writing essays and reports, persuasive and narrative writing, organizing reports, group presentations, public speaking, simulated interviews, using PPTs, ICT platforms, blogs, social media, email etiquette, virtual meeting tools

Learning Outcome: *Utilize digital tools and collaborative strategies for professional communication and presentation*

No. of Hours:24

Module 4: Argumentation, Networking, and Global Communication
Scope of Module: Develop effective argumentation, negotiation, and multicultural communication skills.
Topics: Pillars of argument, logic structures, radio debate analysis, art of debate and rebuttal, negotiation principles, conflict resolution, difficult conversations, networking language and strategies, global communication etiquette, multicultural sensitivity, handling communication barriers
Learning Outcome: *Demonstrate critical thinking, negotiation, and networking skills in global and multicultural communication settings*

No. of Hours:24

Module 5: Life Writing and Official Correspondence
Scope of Module: Explore reflective writing forms and develop professional written communication skills.
Topics: Official letter formats and styles, email writing (salutations, CC, BCC), resume and cover letters, types of life writing (memoirs, journals, biographies, testimonials), *The Diary of Anne Frank*, importance of life writing in reflecting social and personal history
Learning Outcome: *Craft effective official communications and explore personal expression through reflective writing forms*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

4. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
5. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
6. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings

Book

- *Elements of Style* by William Strunk Jr. and E. B. White

Online Articles, Journals, and Whitepapers

- George Orwell's *Why I Write* (orwellfoundation.com)
- *The Sense of Style* by Steven Pinker
- Steven Earnshaw (Ed.). *The Handbook of Creative Writing*. Edinburgh University Press

Web-based Resources

- British Council Learn English, BBC Learning English, ELLLO, Purdue OWL Writing Lab, Grammarly Blog

Recommended Software/Tools:

6. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
7. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
8. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
9. **Miro** – for mind-mapping essay structures.
10. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global

2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	2	2	1	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	2	2	3	2
CO5	3	3	3	2	3	2	2	2	3	3
Articulation	2.2	2.2	2.6	1.8	2.2	2	2	2	2.2	2.4

Course Title:	Operating System
Course Code:	25VBT0C201
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course provides an in-depth understanding of operating system concepts such as process management, memory organization, scheduling, file systems, I/O systems, and protection mechanisms. Through theoretical foundations and case studies (Linux), students will gain insight into how an OS functions as a system software and as a resource manager**.**

Course Outcomes (Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Gain insight into the basic operating system structure & concept of process management.	L2
CO2	Develop a strong foundation on process scheduling, process synchronization & concept of deadlock.	L3
CO3	Analyze and apply concepts related to process management, scheduling, and multithreaded programming.	L4
CO4	Evaluate various memory management strategies, such as paging and segmentation, and analyze the complexity and cost associated with virtual memory techniques	L5
CO5	Design and implement solutions for file systems, understand the structure and functioning of I/O systems and create strategies for security mechanisms and protection in operating systems.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Operating System
Scope of Module: Introduces the architecture, structures, and basic services of modern operating systems and their interactions with hardware.
Topics: Introduction to Operating Systems, Computer System Architecture, Types of Operating Systems, Operating System Structure, Operating System Operations, Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, OS Design & Implementation, Virtual Machines, OS Generation, System Boot
Learning Outcome: *Comprehend the fundamentals, structure, and services of operating systems.*

No. of Hours:24

Module 2: Process Management and Scheduling
Scope of Module: Focuses on process lifecycle, scheduling techniques, and multithreading concepts for efficient CPU management.
Topics: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication (IPC), Multithreaded Programming, Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling
Learning Outcome: Analyze and apply process management, scheduling algorithms, and multithreaded programming.

No. of Hours:24

Module 3: Synchronization and Deadlocks
Scope of Module: Examines concurrency issues in multi-process systems and methods to avoid synchronization and deadlock problems.
Topics: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Synchronization Problems, Monitors, Deadlock Introduction, System Model, Deadlock Characterization, Deadlock Handling Methods, Deadlock Prevention, Avoidance, Detection, Recovery

Learning Outcome: *Evaluate process synchronization mechanisms and methods to handle deadlocks in operating systems.*

No. of Hours:24

Module 4: Memory and Storage Management
Scope of Module: Explores how operating systems handle memory through allocation strategies and virtual memory mechanisms.
Topics: Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation, Virtual Memory Concepts, Virtual Address Space, Demand Paging, Copy-On-Write, Page Replacement Algorithms, Frame Allocation, Thrashing, Overview of Mass Storage, Disk Structure, Disk Scheduling, RAID Concepts
Learning Outcome: *Evaluate memory and storage management techniques including paging and virtual memory.*

No. of Hours:24

Module 5: File Systems, I/O, Protection and Case Study
Scope of Module: Describes file organization, I/O hardware-software interface, and protection strategies along with a case study on Linux.
Topics: File Concepts, Access Methods, Directory & Disk Structure, File Mounting & Sharing, File System Implementation, Directory Implementation, Allocation & Free-Space Management, Efficiency & Performance, I/O System Overview, Application I/O Interface, Kernel I/O Subsystem, STREAMS, Goals and Principles of Protection, Access Matrix, Access Control, Security Threats, Distributed Systems Overview, Case Study: Linux OS Design, Kernel Modules, Process & Memory Management, File Systems in Linux
Learning Outcome: *Design and assess file systems, I/O, protection mechanisms, and explore the Linux operating system.*

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**

4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

2. Operating System Fundamentals by Prof. Niket Kaushik (IIT Roorkee)
   NPTEL: https://nptel.ac.in/courses/106107191

Suggested Reading:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, *Operating System Concepts*, Wiley

Suggested Tools / Activities:

- Linux command line practice
- OS simulation tools (like LittleOS Book, Nachos, or PintOS – demonstration level)
- Process scheduling simulations (Gantt chart practice)
- Visualization of paging, segmentation, and memory management
- VirtualBox for exploring Linux file systems

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)

6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	1	2	1
CO2	3	3	3	3	3	1	–	1	2	1
CO3	3	3	3	3	3	1	–	1	2	2
CO4	3	2	3	3	3	1	1	1	2	3
CO5	3	1	1	3	3	2	1	1	1	1
Articulation	3	2.2	2.4	2.8	3	1.2	1	1	1.8	1.6

Course Title:	Data Structures using C
Course Code:	25VBT0C202
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of data structures using the C programming language. It covers linear and non-linear structures, recursion, memory management, and algorithmic problem-solving through arrays, stacks, queues, linked lists, trees, and graphs. The course emphasizes practical implementation and performance analysis.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Comprehend fundamentals of Data Structures & its applications for solving real-world problems.	L2
CO2	Infer and develop applications of Linear Data Structures including stacks, queues, and lists.	L2

CO3	Interpret and apply Non-Linear Data Structures & their applications.	L3
CO4	Implement, analyze, and evaluate the searching algorithms	L5
CO5	Apply sorting algorithms to sort various types of data.	L3

Course Modules

No. of Hours:24

Module 1: Fundamentals of Data Structures & Pointers
Scope of Module: Introduces the concept and classification of data structures and deepens the understanding of pointers and memory management in C.
Topics: Introduction to Data Structures, Primitive and Non-Primitive Types, Linear vs Non-Linear Structures, Operations on Data Structures, Introduction to Algorithms, Characteristics & Elements of Algorithms, Pointer Basics, Pointer with Functions, Pass by Reference, Array of Pointers, Pointer to Arrays, Dynamic Memory Allocation, Structures and Unions, Self-referential Structures
Learning Outcome: *Understand the fundamental concepts of Data Structures and pointer-based memory operations.*

No. of Hours:24

Module 2: Arrays, Strings & Recursion
Scope of Module: Focuses on basic linear data representations and recursive algorithm strategies.
Topics: Linear Arrays: Representation, Traversing, Insertion, Deletion, Searching, Sorting, Dynamic Arrays, Multi-dimensional Arrays, String Concepts, String Operations, Pattern Matching Algorithms, Recursion: Direct and Indirect, Factorial, GCD, Fibonacci, Tower of Hanoi
Learning Outcome: *Apply array and string operations, and implement recursive solutions for mathematical and problem-solving tasks.*

No. of Hours:24

Module 3: Stacks and Queues
Scope of Module: Explores the stack and queue structures and their applications in computation.

Topics: Stack Definition, Operations, Array and Dynamic Representation, Polish & Reverse Polish Notations, Infix to Postfix Conversion, Postfix Evaluation, Queue Concepts: Operations, Array and Dynamic Representation, Circular Queue, Dequeue, and other types pf queues, Applications (e.g., Mazing Problem)
Learning Outcome: *Design and implement linear data structures using stacks and queues for solving expression and system-related problems.*

No. of Hours:24

Module 4: Linked Lists and Trees
Scope of Module: Covers linked list variants and hierarchical data structures with traversal techniques.
Topics: Singly Linked List: Representation, Traversal, Insertion, Deletion, Doubly and Circular Linked Lists, Linked Stacks and Queues, Applications, Trees: Terminology, Binary Trees, Complete Binary Trees, Representation, Binary Tree Traversals (Inorder, Preorder, Postorder), Binary Search Trees: Insertion, Deletion, Searching, Expression Tree Evaluation
Learning Outcome: *Analyze and apply dynamic structures like linked lists and trees to manage and process data efficiently.*

No. of Hours:24

Module 5: Graphs, Sorting & Searching
Scope of Module: Focuses on non-linear graphs and foundational algorithms for data organization and retrieval.
Topics: Graphs: Directed, Undirected, Representation (Matrix, Adjacency List), BFS and DFS Traversals, Sorting Techniques: Bubble, Insertion, Selection, Quick, Heap Sort, Searching Algorithms: Linear, Binary, Interpolation, Jump Search
Learning Outcome: *Implement and analyze graph traversal, sorting, and searching algorithms based on performance and use cases.*

Module	No of Pre Recordings
1	10
2	11
3	12

4	**12**
5	**11**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

2. Data Structures and Algorithms using C by Prof. Naveen Garg (IIT Delhi) NPTEL: https://nptel.ac.in/courses/106102064

Suggested Reading:

- Seymour Lipschutz, *Data Structures*, Schaum's Outlines
- Horowitz, Sahni, Anderson-Freed, *Fundamentals of Data Structures in C*
- Yashavant Kanetkar, *Data Structures Through C*
- NPTEL / GeeksforGeeks / HackerRank (Practice Problems)

Suggested Tools / Activities:

- Turbo C / GCC on Linux or Windows
- Implementing stacks, queues, trees in C
- Dry-run and trace recursion and sorting programs
- Mini-project: Student Record System, Expression Evaluation
- Practical lab with GDB (for pointer/stack memory visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	1	–	1	–	2
CO3	3	3	3	3	3	–	2	–	1	2
CO4	3	2	3	3	3	2	–	2	–	3
CO5	3	2	3	2	3	1	–	1	–	2
Articulation	3	2.6	2.8	2.4	2.6	1.3	2	1.3	1	2.2

Course Title:	Relational Database Systems
Course Code:	25VBT0C203
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of relational database design, implementation, and management. Students will learn how to design databases using ER models, normalize schemas, write complex SQL queries, and understand transaction management and emerging trends like NoSQL and Big Data. Emphasis is placed on applying theoretical knowledge through hands-on practice.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic database concepts, architectures, and advantages over traditional file systems.	L2
CO2	Create and interpret ER/EER diagrams and convert them into relational schemas.	L6
CO3	Analyze database designs using normalization techniques for optimized performance and data integrity.	L4
CO4	Construct and execute SQL queries for database operations.	L5
CO5	Explore advanced databases and evaluate their applicability in different contexts.	L5

Course Modules

No. of Hours:24

Module 1: Database Fundamentals and Architecture
Scope of Module: Introduces students to databases, their characteristics, architecture, and the distinction between DBMS and traditional file systems.
Topics: Database Characteristics, File-Based Systems vs. DBMS, Types of Data Processing and Access Methods, Data Models Overview, DBMS vs. RDBMS, Database Applications, Schemas and Instances, Three-Schema Architecture, Data Independence, DDL, DML, DCL, TCL, Centralized vs. Client/Server Architecture, DBMS Classification
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data.*

No. of Hours: 24

Module 2: Data Modeling with ER/EER and Relational Design
Scope of Module: Focuses on designing data models using ER and EER diagrams and converting them into relational models.
Topics: Entity, Attributes, Relationships, ER Symbols, Weak Entities, Keys, Constraints, Advanced ER Concepts, UML-based EER Diagrams, ER-to-Relational Mapping, Subclasses, Superclasses,Specialization, Generalization, Relational Schema Design, Relational Model Concepts, Constraints, Update Operations, Transactions
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data. Design ER/EER diagrams and map them into normalized relational schemas.*

No. of Hours: 24

Module 3: SQL and Relational Algebra
Scope of Module: Covers data definition and manipulation in SQL and introduces relational algebra for query formulation.
Topics: SQL Data Types, DDL, DML, Constraints, Keys (Primary, Foreign, Alternate), INSERT, UPDATE, DELETE, SELECT Queries, Aggregate Functions, GROUP BY, HAVING, JOINs (Inner, Outer, Cross), Subqueries, Relational Algebra Operators, Unary & Binary Operations, Set Theory Operations, Grouping and Aggregation in Algebra
Learning Outcome: *Write efficient SQL queries and use relational algebra to express data operations.*

No. of Hours: 24

Module 4: Normalization, Transactions & Concurrency Control
Scope of Module: Deals with schema refinement, functional dependencies, transaction behaviour, and concurrency mechanisms.
Topics: Informal Design Guidelines, 1NF, 2NF, 3NF, BCNF, Multivalued Dependencies, 4NF, 5NF, Join Dependencies, ACID Properties, Transaction States, Serializability, Conflict & View Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols, Deadlock Detection & Prevention
Learning Outcome: *Normalize relational schemas and implement safe, concurrent transaction handling in DBMS.*

No. of Hours:24

Module 5: Database Recovery, NoSQL & Emerging Trends
Scope of Module: Explores recovery methods, non-relational databases, and current trends in the field.
Topics: Recovery Concepts, Types of Failures, Log-Based Recovery, Shadow Paging, ARIES Recovery Algorithm, Introduction to NoSQL, Types (Key-Value, Column, Document, Graph), Big Data & Hadoop Overview, Introduction to Data Warehousing and Data Mining, Database Security Concepts
Learning Outcome:*Explore database recovery techniques and evaluate modern database trends and technologies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

2. Database Management System by Prof. P. P. Chakrabarti (IIT Kharagpur) NPTEL: https://nptel.ac.in/courses/106105175

Suggested Reading:

- Ramez Elmasri & Shamkant Navathe, *Fundamentals of Database Systems*, Pearson
- Silberschatz, Korth, & Sudarshan, *Database System Concepts*, McGraw-Hill
- NPTEL Database Management Systems Modules
- Practice Resources: SQLZoo, LeetCode (SQL), DB-Fiddle

Suggested Tools / Activities:

- Use of MySQL / PostgreSQL / Oracle XE
- Lab practice: SQL query execution, ER diagram to schema mapping
- Projects: Library Management System, Online Store Schema Design
- Tools: DB Designer, SQL Workbench, pgAdmin, MongoDB Compass (for NoSQL demos)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	3	2	2	2	3	1	–	3	2	1
CO2	3	3	3	3	3	2	–	2	2	1
CO3	3	3	3	3	3	1	–	1	2	1
CO4	3	3	3	3	3	1	2	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1.5	1.6	2	1.4

JAIN CENTRE FOR DISTANCE AND ONLINE EDUCATION

JAIN ONLINE

Semester II

Common Course

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Centre for Distance & Online Education
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J P Nagar 6th Phase
Bengaluru – 560 078
P: +91 80 4343 0100

Course Title:	Python Programming
Course Code:	25VBT0C301
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces the fundamental concepts of Python programming, covering syntax, data types, control structures, functions, and object-oriented principles. It also explores data structures, file handling, databases, web services, and networking. The course emphasizes problem-solving using Python and provides hands-on experience with real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic syntax, data types, and control structures in Python.	L2
CO2	Apply functions, modules, and object-oriented concepts to solve problems.	L3
CO3	Develop programs using file handling, exceptions, and standard libraries.	L3
CO4	Analyze and implement data structures such as lists, dictionaries, and tuples.	L4
CO5	Design real-world applications using Python frameworks and libraries.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Python and Basic Programming Concepts
Scope of Module: This module covers Python programming basics, syntax, variables, mathematical operations, and debugging techniques. It also introduces expressions, Boolean logic, and user input handling.

Topics: Introduction to programming concepts, Python as a programming language, writing and running Python scripts, variables and assignment statements, data types (integers, floats, and strings), arithmetic operations and expressions, Boolean expressions and logical operators, modulus operator and integer division, order of operations in expressions, working with user input and output, string operations and concatenation, naming conventions and keywords, writing meaningful comments in code, debugging techniques and best practices, common syntax errors and troubleshooting.
Learning Outcome: *Understand the fundamental concepts and terminology of Python programming while developing the ability to write and debug simple programs.*

No. of Hours: 24

Module 2: Functions, Iteration, and String Manipulation
Scope of Module: This module explores functions, control structures like loops, and handling string operations, enabling efficient program flow and data processing.
Topics: Function definitions and structure, function calls and return values, built-in functions in Python, parameters and arguments in functions, type conversion functions, recursive functions and base cases, iteration using while loops, iteration using for loops, using break and continue statements, nested loops and loop efficiency, string sequences and indexing, string slicing and concatenation, string immutability and methods, string formatting techniques, debugging functions and loops.
Learning Outcome: *Implement functions, loops, and string operations effectively for structured programming in Python.*

No. of Hours: 24

Module 3: Data Structures – Lists, Dictionaries, and Tuples
Scope of Module: This module covers essential Python data structures, including lists, dictionaries, and tuples, focusing on operations and efficient data handling.
Topics: Introduction to lists and their properties, list indexing and slicing, adding and removing list elements, list mutability and copying, iterating over lists using loops, list comprehensions and filtering, dictionary creation and key-value pairs, accessing and updating dictionary values, looping through dictionaries, dictionary operations and methods, introduction to tuples and immutability, tuple assignment and multiple return values, tuples as dictionary keys, comparing lists, dictionaries, and tuples, debugging common data structure issues.
Learning Outcome: *Analyze and manipulate Python's core data structures to store, retrieve, and* process data effectively.

No. of Hours: 24

Module 4: File Handling, Object-Oriented Programming, and Inheritance
Scope of Module: This module introduces file handling, object-oriented programming, and inheritance principles to

build reusable and structured code.
Topics: Reading and writing text files, handling different file formats, file paths and directory navigation, exception handling in file operations, object-oriented programming (OOP) concepts, defining classes and objects, attributes and instance methods, encapsulation and data hiding, mutability of objects and copying, understanding object lifecycles, inheritance and subclassing, overriding methods in subclasses, polymorphism and method resolution order, class diagrams and object hierarchies, debugging OOP-based programs.
Learning Outcome: Develop structured, reusable programs using file handling, OOP, and inheritance concepts in Python.

No. of Hours: 24

Module 5: Databases, Web Services, and Networking
Scope of Module: This module explores database management, web services, APIs, and network programming, enabling interaction with external data sources and networked systems.
Topics: Introduction to databases and SQL, creating and managing tables in SQL, writing and executing SQL queries, relational database modeling and normalization, handling multiple tables and relationships, constraints and data integrity, introduction to web services and APIs, understanding XML and JSON formats, parsing XML and JSON in Python, working with third-party APIs, introduction to networking concepts, sending and receiving data over networks, Python sockets for client-server communication, web scraping techniques using Python, debugging network and database programs.
Learning Outcome: *Develop proficiency in handling databases, web services, and networking concepts for real-world applications.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Minimum number of pre-recordings is 10.

Prerequisites

- Basic understanding of programming logic and flowcharts
- Familiarity with any programming language (C/C++ preferred)
- Logical reasoning and problem-solving mindset

Pedagogy / Teaching Methodology

- ✓ Hands-on coding sessions in labs and online IDEs
- ✓ Mini-projects on text processing, games, or web apps
- ✓ Weekly coding challenges and debugging practice
- ✓ Group tasks involving script design or automation
- ✓ Integration with tools like Jupyter Notebooks, GitHub, and Colab

Certificate / Value Added Courses

5. Python for Everybody – Coursera (University of Michigan)
6. Google IT Automation with Python – Coursera
7. Introduction to Python – edX (Microsoft)
8. Automate the Boring Stuff with Python – Udemy

Suggested Readings

- Eric Matthes, *Python Crash Course*
- Charles Dierbach, *Introduction to Computer Science Using Python*
- Mark Lutz, *Learning Python*
- Al Sweigart, *Automate the Boring Stuff with Python*
- Guido van Rossum (online documentation): https://docs.python.org/3/

Recommended Software / Tools

4. **IDE/Editors:**
   a. Jupyter Notebook
   b. Visual Studio Code
   c. PyCharm (Community Edition)
   d. Thonny (for beginners)
5. **Online Platforms:**
   a. Google Colab
   b. Replit
   c. HackerRank / LeetCode (for Python practice)
6. **Libraries and Frameworks:**
   a. NumPy, Pandas (for data analysis)

b. Tkinter, PyQt (for GUI development)
c. Flask, Django (for web development)
d. Matplotlib, Seaborn (for data visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	-	1	1	1
CO2	3	3	3	3	3	2	1	1	1	1
CO3	2	3	2	2	3	2	1	1	2	-
CO4	3	3	2	2	2	2	1	2	1	1
CO5	2	3	3	3	3	3	1	1	1	1
Articulation	2.6	3	2.4	2.4	2.6	2.4	1	1.2	1.2	1

Course Title:	Design and Analysis of Algorithms
Course Code:	25VBT0C302
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course explores the fundamental principles and advanced techniques in algorithm design and analysis. Students will learn to develop computational solutions for problems like searching and sorting, apply divide-and-conquer, greedy, and dynamic programming techniques, and analyze algorithmic efficiency. The course will also cover space-time tradeoffs, iterative improvements, and approaches to solving NP-hard problems, providing industry-relevant problem-solving skills.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic algorithmic strategies and their time/space complexities.	L2
CO2	Apply divide and conquer, greedy, and dynamic programming paradigms to solve problems.	L3
CO3	Analyze algorithm efficiency using Big-O, Big-Ω, and Big-Θ notations.	L4
CO4	Evaluate and compare the performance of different algorithms.	L5
CO5	Design efficient algorithms for real-world problems using suitable techniques.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Algorithm Design and Analysis
Scope of Module: This module introduces fundamental algorithm concepts, including problem-solving strategies, computational limits, and performance analysis. It covers basic searching, sorting techniques, and asymptotic notation for algorithm efficiency.
Topics: Definition and importance of algorithms, understanding problem complexity and computational constraints, importance of selecting appropriate data structures, algorithm design techniques, methods of specifying an algorithm, proving correctness of an algorithm, performance analysis and computational efficiency, space complexity and time complexity, asymptotic notations including Big-O, Omega, and Theta, mathematical analysis of recursive and non-recursive algorithms, selection sort and bubble sort fundamentals, sequential search and brute-force string matching, closest-pair problem using brute-force technique, convex hull problem using brute-force method, exhaustive search techniques.
Learning Outcome: *Understand the role of algorithms in problem-solving and analyze algorithm efficiency using mathematical models.*

No. of Hours: 24

Module 2: Divide and Conquer and Decrease and Conquer Approaches
Scope of Module: This module delves into the divide-and-conquer and decrease-and-conquer techniques, helping students analyze problems that can be solved by breaking them into smaller subproblems.
Topics: Introduction to divide-and-conquer strategy, recurrence equations and their significance, finding maximum and minimum elements, merge sort algorithm and analysis, quick sort algorithm and complexity, binary search and efficiency, binary tree traversals and their properties, multiplication of large integers using divide-and-conquer, Strassen's matrix multiplication algorithm, closest-pair problem using divide-and-conquer, convex hull problem via divide-and-conquer, insertion sort algorithm and its efficiency, depth-first search algorithm (DFS), breadth-first search algorithm (BFS), topological sorting and its applications.
Learning Outcome: *Analyze and implement divide-and-conquer and decrease-and-conquer techniques to optimize problem-solving.*

No. of Hours: 24

Module 3: Space-Time Tradeoffs, Greedy Approach, and Iterative Improvement
Scope of Module: This module focuses on space-time tradeoffs, string matching algorithms, and greedy techniques for optimization problems. Students will explore graph algorithms and iterative improvement techniques in optimization.

Topics: Introduction to space-time tradeoff principles, sorting by counting methods, input enhancement in string matching, Boyer-Moore algorithm for string matching, Horspool's algorithm and performance analysis, hashing fundamentals and applications, open hashing vs. closed hashing, Prim's algorithm for minimum spanning trees, Kruskal's algorithm using disjoint subsets, union-find method in Kruskal's algorithm, Dijkstra's algorithm for shortest path, Huffman tree construction and encoding, simplex method for linear programming, geometric interpretation of linear programming, maximum-flow problem and optimization strategies.
Learning Outcome: *Apply space-time tradeoffs, greedy techniques, and iterative improvement methods to solve optimization problems.*

No. of Hours: 24

Module 4: Transform and Conquer, Dynamic Programming, and Algorithmic Optimization
Scope of Module: This module covers algorithm transformation strategies, pre-sorting techniques, dynamic programming principles, and optimization algorithms used in shortest path problems and combinatorial optimization.
Topics: Introduction to transform and conquer approach, pre-sorting and its advantages, Gaussian elimination method, balanced search trees and their importance, heaps and heap sort algorithm, Horner's rule and its applications, binary exponentiation technique, problem reduction approach, overview of dynamic programming, computing binomial coefficients using dynamic programming, Warshall's algorithm for transitive closure, Floyd's algorithm for all-pairs shortest paths, principle of optimality in dynamic programming, optimal binary search trees, knapsack problem and memory functions.
Learning Outcome: *Design and implement dynamic programming solutions for combinatorial optimization problems.*

No. of Hours: 24

Module 5: Limitations of Algorithmic Power and Approximation Algorithms
Scope of Module: This module examines the theoretical limitations of algorithmic power, computational complexity classes, and approximation algorithms for NP-hard problems. It also introduces backtracking and branch-and-bound methods.

Topics:
Introduction to lower-bound arguments, trivial lower bounds and problem complexity, information-theoretic arguments in complexity analysis, adversary arguments and decision trees, complexity classes: P, NP, and NP-complete problems, challenges in numerical algorithms, backtracking technique and its applications, N-Queens problem using backtracking, sum of subsets problem using backtracking, branch-and-bound method for optimization, knapsack problem using branch-and-bound, traveling salesperson problem and branch-and-bound, approximation algorithms for NP-hard problems, traveling salesman problem approximation techniques, knapsack problem approximation methods.

Learning Outcome: Analyze computational complexity, apply backtracking and branch-and-bound techniques, and develop approximation algorithms for NP-hard problems.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites

- Knowledge of basic programming (C/C++/Python)
- Understanding of discrete mathematics
- Familiarity with data structures

Pedagogy

- ✓ Whiteboard algorithm walkthroughs
- ✓ Pseudocode-to-code transformation exercises
- ✓ Complexity analysis using real-world problems
- ✓ Case studies and project-based learning

Value Added Courses / Certificates

3. Algorithmic Toolbox – Coursera
4. Data Structures and Algorithms – Udacity

Suggested Readings

- Thomas H. Cormen et al., *Introduction to Algorithms*
- Jon Kleinberg & Éva Tardos, *Algorithm Design*
- Anany Levitin, *Introduction to the Design & Analysis of Algorithms*

Recommended Tools

3. Python/C++ IDEs (e.g., VS Code, Code::Blocks)
4. Online judges: HackerRank, LeetCode, Codeforces

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	-	1	2	3
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	2	2	1	1	1	1
CO4	1	1	2	1	3	2	1	1	1	2
CO5	1	2	2	3	2	2	1	2	2	2
Articulation	1.8	2.2	2.4	2	2.2	1.8	1	1.2	1.4	1.8

Course Title:	Software Engineering
Course Code:	25VBT0C303
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces the fundamentals of software engineering**,** including software development models, agile methodologies, requirements engineering, software design, testing, maintenance, and emerging trends**.** Students will explore industry-standard practices, software quality assurance, and modern development approaches such as DevOps, cloud computing, and AI-driven software engineering**.** By the end of the course, students will be equipped with the skills **to** design, develop, test, and maintain software systems efficiently**.**

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the phases of software development life cycle (SDLC).	L2
CO2	Apply appropriate process models for software projects.	L3
CO3	Analyze software requirements and specifications.	L4
CO4	Evaluate software design methodologies and testing techniques.	L5
CO5	Create documentation and design for real-world software applications.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Engineering
Scope of Module: This module introduces software engineering principles, software processes, and different software application domains.
Topics Covered: The nature of software, defining software, software application domains, the unique nature of web

applications, software engineering and the software process, software engineering practice, software myths, a generic process model, defining a framework activity, identifying a task set, process assessment and improvement, prescriptive process models (waterfall, incremental, evolutionary, concurrent), specialized process models (component-based development, formal methods model, aspect-oriented development), the Unified Process and its phases, personal and team process models (PSP, TSP).
Learning Outcome: *Define software engineering principles, differentiate between software application domains, and describe various software process models.*

No. of Hours: 24

Module 2: Agile Development and Requirements Engineering
Scope of Module: This module explores agile methodologies and techniques for requirements gathering, analysis, and modeling.
Topics Covered: The concept of agility and its impact on the cost of change, agile process and principles, the politics of agile development, human factors in agility, extreme programming (XP) and its process, industrial XP, adaptive software development, Scrum framework, dynamic systems development method (DSDM), feature-driven development (FDD), lean software development, agile modeling, requirements engineering and stakeholders, developing use cases and UML models, requirements modeling for web applications.
Learning Outcome: *Explain agile methodologies, analyze software requirements, and apply modeling strategies for software specification.*

No. of Hours: 24

Module 3: Software Design and Architecture
Scope of Module: This module focuses on software design principles, architectural styles, and user interface design strategies.
Topics: The role of design in software engineering, the design process, software quality guidelines and attributes, evolution of software design, design concepts, the design model, software architecture, architectural genres and styles, component-level design, object-oriented view of components, designing class-based components, user interface design, web application interface design, interface analysis and guidelines, interface design steps.
Learning Outcome: *Apply software design principles, develop architectural models, and implement user interface design guidelines.*

No. of Hours: 24

Module 4: Software Quality and Testing

Scope of Module: This module focuses on software quality assurance, verification, validation, and testing strategies.
Topics: Software quality and its dimensions, the software quality dilemma, achieving software quality through engineering methods, cost impact of software defects, review metrics and their use, software quality assurance (SQA) and its elements, SQA tasks, goals, and metrics, formal approaches to SQA, statistical software quality assurance, software reliability and availability, a strategic approach to software testing, verification and validation, unit testing, security testing, debugging and the debugging process.
Learning Outcome: *Analyze software quality assurance strategies and implement software testing techniques for defect prevention and validation.*

No. of Hours: 24

Module 5: Software Maintenance and Emerging Trends
Scope of Module: This module covers software maintenance techniques, risk management, and evolving trends in software engineering.
Topics: Software maintenance and evolution, legacy system maintenance, capability maturity models (CMM), software project risk management, risk mitigation strategies, software configuration management, change control, refactoring strategies, version control systems, release management, continuous integration and deployment (CI/CD), DevOps practices, cloud computing and microservices, AI in software development, future trends in software engineering.
Learning Outcome: *Evaluate software maintenance strategies, implement cost estimation models, and explore emerging trends in software engineering.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites

- Familiarity with basic programming
- Understanding of software applications

Pedagogy

- SDLC-based project development
- Use case modeling and UML design
- Agile and traditional model simulation
- Code review and testing labs

Value Added Courses / Certificates

3. Software Processes and Agile Practices – Coursera
4. Software Engineering Essentials – edX

Suggested Readings

- Ian Sommerville, *Software Engineering*
- Roger Pressman, *Software Engineering: A Practitioner's Approach*
- Pankaj Jalote, *An Integrated Approach to Software Engineering*

Recommended Tools

5. Visual Paradigm, StarUML (UML modeling)
6. GitHub (Version control)
7. JIRA (Agile project management)
8. Selenium, JUnit (Testing)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)

4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	-	1	1	1
CO2	2	3	2	3	2	1	1	1	1	1
CO3	2	2	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	2	-	1	3	2
CO5	1	1	1	1	3	2	2	3	2	1
Articulation	1.8	1.8	2	1.8	2.2	1.4	1.3	1.4	1.6	1.2

Course Title:	Computer Networks
Course Code:	25VBT0C304
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a comprehensive introduction to computer networks, covering fundamental networking principles, architectures, and protocols. Students will explore different network layers, their functionalities, and the mathematical calculations associated with data transmission. The course also introduces advanced networking concepts such as cloud computing, IoT, and network security.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand network architectures, protocols, and models.	L2
CO2	Apply network principles to configure and troubleshoot basic networks.	L3
CO3	Analyze different layers of the OSI and TCP/IP models.	L4
CO4	Evaluate network performance and security mechanisms.	L5
CO5	Design secure and scalable network infrastructures.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Computer Networks
Scope of Module: This module introduces fundamental networking concepts, network models, and physical layer functionalities. It provides an overview of computer networks, transmission media, and error detection mechanisms.
Topics: Overview of computer networks and their importance, Historical evolution of networking technologies, Network types and their applications (LAN, MAN, WAN), Network topologies and their impact on performance, The OSI reference model: layers and their functions, The TCP/IP model:

comparison with OSI model, Analog and digital signals in networking, Transmission media: guided and unguided media, Signal encoding techniques and modulation schemes, Multiplexing techniques: FDM, TDM, and WDM, Spread spectrum techniques and their applications, Transmission errors: causes and effects, Error detection techniques: parity checks and checksums, Error correction mechanisms: Hamming code and CRC, Physical layer functions and performance metrics.
Learning Outcome: *Explain the fundamental concepts of computer networks, transmission media, and error detection techniques*

No. of Hours:24

Module 2: Data Link Layer and Medium Access Control
Scope of Module:
This module explores the data link layer, its role in error detection, flow control, and MAC protocols for wired and wireless networks.
Topics Covered:
Framing methods and techniques in data transmission, Flow control mechanisms: stop-and-wait and sliding window protocols, Error detection techniques: CRC, checksums, and parity bits, Error correction methods: Hamming code and ARQ techniques, Medium Access Control (MAC) protocols and their importance, CSMA/CD: collision detection and resolution, CSMA/CA: collision avoidance in wireless networks, Ethernet standards and frame structure, Token Ring: access method and frame structure, Wireless LAN standards: IEEE 802.11 and Wi-Fi, Bluetooth technology and applications, MAC addressing and its role in data link layer, LAN switching techniques: circuit switching vs. packet switching, Virtual LANs (VLANs) and their configurations, Data link layer security threats and mitigation techniques
Learning Outcome:*Describe data link layer functions, error detection techniques, and MAC protocols in wired and wireless networks.*

No. of Hours: 24

Module 3: Network Layer and Transport Layer
Scope of Module: This module covers network-layer functionalities, IP addressing, subnetting, and transport-layer protocols, including TCP and UDP.
Topics: Introduction to the network layer and its services, IP addressing schemes: IPv4 and IPv6, Subnetting techniques and IP address allocation, Routing algorithms: distance vector vs. link state, Static and dynamic routing protocols: RIP, OSPF, and BGP, ICMP protocol and error reporting in networks, IPv4 and IPv6 coexistence strategies, Address Resolution Protocol (ARP) and its working, Network Address Translation (NAT) and its applications, Transport layer functions and its role in networking, TCP and UDP: comparison and applications, Connection establishment and termination in TCP, Congestion control and flow control in TCP, Error detection and correction in transport layer, QoS mechanisms and performance optimization techniques

Learning Outcome: *Analyze IP addressing, subnetting, and routing algorithms, and describe transport-layer services.*

No. of Hours:24

Module 4: Network Security, Wireless & Multimedia Network
Scope of Module: This module covers network security principles, wireless communication fundamentals, and multimedia networking technologies.
Topics Covered: Network security threats and vulnerabilities, Cryptography basics: symmetric vs. asymmetric encryption, Authentication mechanisms and secure communication, Integrity and confidentiality mechanisms in networking, Wireless transmission fundamentals and radio communication, Cellular networks: architecture and mobile IP, IEEE 802.11 standard and wireless LAN protocols, Bluetooth technology: architecture and applications, Wireless security threats and mitigation techniques, Streaming and real-time communication protocols, Quality of Service (QoS) in multimedia networking, Voice over IP (VoIP) and its applications, Video conferencing protocols and challenges, Delay-sensitive traffic management in multimedia applications, Performance optimization for wireless and multimedia networks
Learning Outcome: *Understand and apply multimedia networking protocols to ensure secure, efficient, and high-quality real-time communication over wireless and mobile networks.*

No. of Hours: 24

Module 5: Advanced Networking and Emerging Technologies
Scope of Module: This module introduces advanced networking concepts such as network management, cloud computing, IoT, and blockchain.
Topics Covered: SNMP protocol and network monitoring techniques, Fault management and performance optimization in networks, Configuration management in enterprise networks, Distributed computing fundamentals and architectures, Client-server vs. peer-to-peer networking models, Distributed file systems and coordination algorithms, Cloud computing models: IaaS, PaaS, SaaS, Virtualization techniques and resource management, Cloud security challenges and privacy concerns, IoT architecture and components, Communication protocols for IoT applications, IoT security challenges and mitigation techniques, Software-Defined Networking (SDN) architecture and benefits, Network Function Virtualization (NFV) and its impact, Blockchain technology in networking and its applications
Learning Outcome: *Evaluate network management strategies, cloud computing models, and emerging technologies like IoT, SDN, and blockchain.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites

- Basic computer system knowledge
- Understanding of binary arithmetic
- Familiarity with operating systems

Pedagogy

- ✓ Packet tracer simulations (Cisco)
- ✓ Layer-by-layer protocol analysis
- ✓ Wireshark labs and trace evaluations
- ✓ Network design mini-projects

Value Added Courses / Certificates

3. Computer Networking – Coursera (Stanford)
4. Cisco CCNA Introduction – NetAcad

Suggested Readings

- Andrew S. Tanenbaum, *Computer Networks*
- Behrouz A. Forouzan, *Data Communications and Networking*
- William Stallings, *Data and Computer Communications*

Recommended Tools

4. Cisco Packet Tracer
5. Wireshark
6. GNS3, NS2/NS3 simulators

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	-	1	1	1
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	3	1	-	2	2	1
CO4	1	2	2	3	2	2	1	2	2	1
CO5	1	1	1	1	1	1	2	1	3	3
Articulation	1.8	2	1.8	1.8	1.6	1.2	1.5	1.4	1.8	1.4

Course Title:	Environmental, Social, and Governance (ESG) in IT
Course Code:	25VBT0C305
Semester:	**III**
Credits:	**3**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	90
Live Sessions	**12 hours**

Course Description:

This course provides an in-depth exploration of Environmental, Social, and Governance (ESG) principles and their critical application within the Information Technology (IT) sector. Students will examine how ESG factors influence IT operations, strategy, and policy-making, gaining insights into sustainable practices, ethical considerations, and effective governance in technology-driven environments. Through case studies and practical projects, learners will develop the skills necessary to integrate ESG considerations into IT frameworks, ensuring responsible and sustainable technological development.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand environmental principles and sustainability concepts.	L2
CO2	Identify the effects of human activities on ecosystems.	L3
CO3	Analyze environmental challenges and sustainability goals (SDGs).	L4
CO4	Evaluate policies and practices for sustainable development.	L5
CO5	Propose eco-friendly solutions for community or industry applications.	L6

Course Modules:

No. of Hours: 18

Module 1: Introduction to ESG and Digital Responsibility
Scope of Module: This module lays the foundation of ESG principles and their relevance to the IT industry. It explores the global push toward sustainability, ethical tech development, and corporate responsibility.

Topics: Definition and Origin of ESG, Importance of ESG in IT, Sustainable Development Goals (SDGs) and IT alignment, Environmental Impact of Digital Technologies, Ethical Considerations in Tech Development, IT and Climate Change, ESG Ratings and Digital Business Performance, Role of IT Professionals in ESG, Green Certifications and IT Compliance, Digital Transformation and ESG Goals, Circular Economy in IT, Impact of Cloud and Data Centers on Environment, Tech Industry ESG Benchmarks, Digital Minimalism and Eco-design, Global ESG Reporting Frameworks.
Learning Outcome: *Understand ESG foundations, the importance of responsible tech, and the environmental impact of digital systems.*

No. of Hours: 18

Module 2: Environmental Sustainability in IT
Scope of Module: Focuses on sustainable computing, energy-efficient infrastructure, and green software engineering.
Topics: Green IT Practices, Energy-Efficient Hardware and Systems, Carbon Footprint of IT Operations, Sustainable Data Center Management, E-Waste Management and Recycling, Renewable Energy Use in Tech Firms, Virtualization and Cloud Sustainability, Lifecycle Assessment of IT Products, Power Management in Devices, Paperless Office and Digital Workflows, Sustainable Supply Chains in IT, Greener Coding Practices, Use of AI for Environmental Monitoring, IoT in Smart Environment Systems, IT and Climate Action Technologies.
Learning Outcome: *Evaluate IT strategies that promote environmental sustainability and carbon reduction.*

No. of Hours: 18

Module 3: Social Responsibility and Inclusion in Technology
Scope of Module: Covers how IT contributes to equity, digital literacy, accessibility, and ethical labor practices.
Topics: Digital Inclusion and Access to Technology, Gender Equality in Tech, Accessibility Standards (WCAG, ADA), Ethical Labor in Tech Supply Chains, Community Engagement through Technology, Corporate Social Responsibility (CSR) in IT, Digital Literacy and Education Programs, Tech for Good Initiatives, Bridging the Digital Divide, AI Bias and Fairness, Inclusive Design Principles, Social Impact Assessment in Tech Projects, Diversity in IT Workforce, Data for Social Good, Digital Safety and Well-being.
Learning Outcome: *Analyze IT's role in promoting social responsibility and inclusive technology design.*

No. of Hours:18

Module 4: Governance, Ethics, and Regulation in IT
Scope of Module: Discusses governance mechanisms, risk management, data ethics, and compliance in the IT context.

Topics: IT Governance Models, Data Privacy and Protection Laws (GDPR, PDP Bill India), Cyber Ethics and Accountability, Risk Management in Tech Projects, Regulatory Compliance in IT, Digital Rights Management, Transparent AI and Algorithm Auditing, Corporate Governance in IT Companies, Role of CIOs in ESG Governance, ESG Metrics and KPIs in Tech, Open Data and Public Interest, Whistleblowing Mechanisms in Tech Industry, IT Policy Frameworks, Blockchain for Governance Transparency, ESG Risks in IT Investments.
Learning Outcome: *Explore ethical governance practices, digital compliance, and risk management in IT.*

No. of Hours: 18

Module 5: ESG Implementation and Case Studies in IT
Scope of Module: Focuses on practical ESG integration into IT systems, success stories, frameworks, and tools.
Topics: ESG Strategy Development in Tech Organizations, Sustainability Reporting Tools (GRI, SASB), Role of CIOs and IT Managers in ESG, Measuring ESG Performance in IT Projects, ESG-Focused Software Development Lifecycle (SDLC), ESG Dashboards and Analytics, Green Procurement for IT Assets, Case Studies: Google, Microsoft, Infosys ESG Programs, IT in Disaster Response and Crisis Management, ESG Risk Mitigation Frameworks, ESG Investment in Tech Startups, ESG Certifications for IT Professionals, Open-source Tools for ESG Monitoring, ESG KPIs in Software Products, ESG Innovation Labs and Incubators.
***Learning Outcome**: Apply ESG principles through frameworks, tools, and real-world tech case studies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Suggested Readings:

Prerequisites

- General awareness of science and ecology
- Basic understanding of social issues

Pedagogy

- ✓ Eco-surveys and field visits
- ✓ Case studies on climate change and pollution
- ✓ Group discussions on policy impacts
- ✓ Sustainable campus or local community projects

Value Added Courses / Certificates

3. Sustainable Development Goals – edX
4. Introduction to Sustainability – Coursera

Suggested Readings

- Erach Bharucha, *Environmental Studies*
- R.Rajagopalan, *Environmental Studies from Crisis to Cure*
- UNEP Reports and SDG Guidelines

Recommended Tools

4. ArcGIS (for environment mapping)
5. SDG Tracker
6. OpenLCA (for life cycle assessment)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Concerns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	3	2	1	2
CO2	2	3	2	2	3	2	3	2	1	2
CO3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	2	3	2	3	3	3	2	3
CO5	1	2	3	3	3	3	3	3	3	3
Articulation	2	2.2	2.2	2.2	2.6	2.6	2.8	2.6	1.8	2.6

Semester IV

Course Title	Web Technologies
Course Code	25VBT0C401
Semester	IV
Credits	4
Course Type	Core Course
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course introduces students to essential web development technologies, covering both front-end and back-end aspects. Students will learn to design, develop, and deploy interactive websites using HTML, CSS, JavaScript, and server-side scripting with PHP or Node.js, along with database integration. The course focuses on hands-on learning and equips students for careers in web development, UI/UX design, and full-stack engineering.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the structure and design principles of web applications.	L2
CO2	Develop interactive and responsive web pages using HTML, CSS, and JavaScript.	L3
CO3	Implement dynamic web applications using server-side scripting.	L3
CO4	Connect web applications with databases for data management.	L4
CO5	Deploy and manage complete web applications using modern web tools.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Web Technologies

Scope of Module: Covers the fundamentals of how the web works, including protocols, architecture, and core components.
Topics: Introduction to Internet and Web, Web Servers and Clients, HTTP and HTTPS Protocols, URL and URI Concepts, DNS and Hosting Basics, Static vs. Dynamic Websites, Web Browsers and Developer Tools, MIME Types and Web Content Types, TCP/IP and Sockets Overview, Browser Rendering Process, HTML Document Structure, Responsive Design Principles, Introduction to Web Accessibility (WCAG), Browser Compatibility Issues, Role of Web Standards (W3C).
Learning Outcome: - *Understand the core architecture and functioning of the web ecosystem.*

No. of Hours: 24

Module 2: Frontend Technologies – HTML, CSS, JavaScript
Scope of Module: Focuses on creating structured, styled, and interactive user interfaces using frontend technologies.
Topics: HTML5 Elements and Semantics, Forms and Validation, CSS3 Selectors and Properties, Responsive Design with Media Queries, CSS Frameworks (Bootstrap/Tailwind), Flexbox and Grid Layouts, Introduction to JavaScript Syntax, DOM Manipulation, Events and Event Handling, JavaScript Functions and Scope, Objects and Arrays, Form Validation with JavaScript, ES6 Features (Let, Const, Arrow Functions), Browser Storage (LocalStorage, SessionStorage), Introduction to AJAX and Fetch API.
Learning Outcome: - *Build responsive, accessible, and interactive front-end user interfaces.*

No. of Hours: 24

Module 3: Server-Side Programming and Backend Integration
Scope of Module: Introduces backend development and connecting frontend applications to databases and servers.
Topics: Introduction to Server-Side Scripting, Node.js and Express.js Basics, RESTful API Design, Routing and Middleware in Express, Working with JSON Data, Handling HTTP Requests and Responses, Templating Engines (EJS, Handlebars), Introduction to PHP (Optional), Error Handling in Server-Side Apps, Session Management and Cookies, Uploading and Handling Files, Working with Forms (POST, GET), Basic Authentication and Authorization, Connecting Frontend with Backend APIs, Building a Simple Full-Stack App.
Learning Outcome: - *Create and connect server-side logic to client-side interfaces using web frameworks.*

No. of Hours: 24

Module 4: Databases and Web Integration
Scope of Module: Focuses on integrating databases into web applications and managing data using queries.

Topics: Relational Databases Overview (MySQL, PostgreSQL), NoSQL Databases (MongoDB), Database Design Basics, CRUD Operations in SQL, Mongoose with MongoDB in Node.js, Connecting Backend to Database, Query Parameters and Filtering, ORM Basics (Sequelize/Mongoose), Data Validation and Sanitization, Indexing and Performance Tuning, Managing Relationships and Joins, Authentication Data Storage, Environment Variables and DB Security, Transactions and Error Handling, Integrating Search in Web Applications.
Learning Outcome: - *Design and connect databases to dynamic web applications for persistent storage.*

No. of Hours: 24

Module 5: Web Deployment, Security, and Modern Trends
Scope of Module: Covers web application deployment, security, DevOps integration, and modern web development trends.
Topics: Deployment on Platforms (Vercel, Netlify, Heroku), Git and GitHub for Version Control, Continuous Deployment Pipelines, Domain Registration and DNS Setup, SSL Certificates and HTTPS, Security Best Practices (XSS, CSRF, SQL Injection), HTTPS and Secure Headers, Content Delivery Networks (CDN), CORS Policy and Management, Progressive Web Apps (PWA), Introduction to Single Page Applications (React, Angular), WebSockets and Real-Time Communication, SEO Optimization for Web Apps, Lighthouse and Performance Auditing, Introduction to JAMstack Architecture.
Learning Outcome: - *Deploy, secure, and optimize modern web applications using best practices.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- ➢ Basic understanding of programming concepts (e.g., loops, functions)
- ➢ Exposure to HTML or any markup language is beneficial
- ➢ Logical reasoning and analytical thinking

Pedagogy / Teaching Methodology:

- ✓ Hands-on coding with integrated browser tools
- ✓ Live problem-solving through lab exercises
- ✓ Real-world project-based learning
- ✓ Git-based version tracking and collaboration
- ✓ Assignments, quizzes, and mini-projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Web Development by NPTEL (IIT Madras)
   https://nptel.ac.in/courses/106105084
6. Responsive Web Design by freeCodeCamp
   https://www.freecodecamp.org/learn
7. Full Stack Open 2024 by University of Helsinki
   https://fullstackopen.com/en/
8. HTML, CSS, and JS for Web Developers (Coursera)
   https://www.coursera.org/learn/html-css-javascript-for-web-developers

Suggested Readings:

- Jon Duckett, *HTML & CSS: Design and Build Websites*, Wiley
- Robin Nixon, *Learning PHP, MySQL & JavaScript*, O'Reilly
- Ethan Brown, *Web Development with Node and Express*, O'Reilly
- MDN Web Docs: https://developer.mozilla.org/
- W3Schools Reference: https://www.w3schools.com/

Recommended Software/Tools (If applicable):

8. Visual Studio Code
9. Node.js + npm
10. Postman for REST API testing
11. MongoDB Atlas and phpMyAdmin
12. Bootstrap, Tailwind CSS
13. Heroku / Netlify / Vercel for deployment
14. React / Angular (for SPA introduction)

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	2	3	2	–	–	2
CO2	3	3	3	2	3	3	3	–	1	3
CO3	3	3	3	3	3	3	2	1	1	3
CO4	3	3	2	3	3	3	3	–	1	3
CO5	3	3	3	3	3	3	3	2	2	3
Articulation	3	2.8	2.6	2.75	2.8	3	2.6	1.5	1.25	2.8

Course Title	Predictive Analytics Using Machine Learning
Course Code	25VBT0C403
Semester	IV
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course introduces students to the foundational mathematics, algorithms, and data handling techniques needed for predictive analytics using machine learning. Emphasis is placed on data preprocessing, regression models, clustering, and decision trees, implemented using Python. Students develop hands-on skills in building predictive models applicable to real-world problems.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Gain a foundational understanding of the mathematics required for machine learning	L2
CO2	Apply concepts of simple and multiple linear regression and logistic regression to build models	L3
CO3	Understand the working of support vector machines	L2
CO4	Understand the working of the KNN algorithm	L2
CO5	Learn to build predictive models using machine learning	L5

Course Modules

No. of Hours: 24

Module 1: Mathematical Foundations and Machine Learning Basics
Scope of Module: This module introduces the mathematical concepts and foundational principles of machine learning to establish a strong theoretical base

Topics: Lines, planes, functions, differentiation and chain rule, maxima and minima of functions, basics of linear algebra, vector operations, matrices, introduction to machine learning, use cases, difference between ML, AI and DL, categories of ML including supervised and unsupervised learning, difference between statistical models and ML, training and testing data, accuracy metrics
***Learning Outcome:* -** *Gain foundational mathematical knowledge and understand the principles and types of machine learning and their applications.*

No. of Hours: 24

Module 2: Data Preprocessing and Dimensionality Reduction
Scope of Module: This module explores data cleaning, transformation, and reduction techniques essential for preparing datasets for machine learning
Topics: Dirty data and missing values, noisy data handling, redundancy and integration, data transformation including normalization and smoothing, one-hot encoding, dimensionality reduction techniques such as PCA and FA, extraction of principal components and factor loading, eigenvalues and eigenvectors, factor interpretation and rotation, Bartlett's Test, communalities
***Learning Outcome:* -** *Preprocess and transform data using feature engineering and apply dimensionality reduction techniques like PCA and FA.*

No. of Hours: 24

Module 3: Clustering Algorithms and Unsupervised Learning
Scope of Module: This module introduces clustering algorithms used in unsupervised learning and evaluates their real-world applications
Topics: Hierarchical clustering and its types, agglomerative and divisive clustering, distance measures including Euclidean, Manhattan, Minkowski, clustering evaluation metrics, k-means clustering, cluster centroids, inertia and Dunn Index, choosing the right number of clusters, implementation walkthroughs using Python
***Learning Outcome:* -** *Implement clustering algorithms and evaluate their performance in unsupervised machine learning tasks.*

No. of Hours: 24

Module 4: Regression Techniques and Model Evaluation
Scope of Module: This module covers regression algorithms, model building, and evaluation metrics using real datasets in Python

Topics: Simple and multiple linear regression, interpretation of coefficients, standard error, p-values, R^2 and adjusted R^2, PC regression, multicollinearity and VIF, regression case studies, implementation in Python(python IDLE)
Learning Outcome: - *Build and evaluate linear regression models using Python and interpret regression outputs for informed analysis.*

No. of Hours: 24

Module 5: Classification Algorithms and Decision Trees
Scope of Module: This module focuses on classification models including Naïve Bayes and decision trees for predictive analytics.
Topics: Naïve Bayes algorithm, conditional probability, pros and cons of Naïve Bayes, decision trees for classification and regression, entropy, information gain, Gini index, overfitting and pruning, regularization methods, regression trees, case studies and real-world use.
Learning Outcome: - *Apply classification models like Naïve Bayes and decision trees to build and optimize predictive solutions.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic knowledge of Python programming
- Understanding of statistics, probability, and algebra
- Familiarity with data handling using spreadsheets or basic databases

Pedagogy / Teaching Methodology:

- ✓ Hands-on implementation using Python (Jupyter/IDLE)
- ✓ Mini-projects and real-world datasets for practice
- ✓ Conceptual teaching with mathematical derivations
- ✓ Code walkthroughs and pair programming exercises
- ✓ Quizzes and lab-based assessments

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Machine Learning by Stanford University (Coursera – Andrew Ng)
   https://www.coursera.org/learn/machine-learning
2. Applied Data Science with Python (University of Michigan – Coursera)
   https://www.coursera.org/specializations/data-science-python
3. Introduction to Machine Learning – NPTEL
   https://nptel.ac.in/courses/106105152
4. Practical Machine Learning – Johns Hopkins (Coursera)
   https://www.coursera.org/learn/practical-machine-learning

Suggested Readings:

- Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning*
- Tom Mitchell, *Machine Learning*, McGraw Hill
- Scikit-learn Documentation: https://scikit-learn.org
- Tutorials and articles from https://towardsdatascience.com
- Guides and blogs from https://analyticsvidhya.com

Recommended Software/Tools (If applicable):

1. Python (Anaconda distribution)
2. Jupyter Notebook / Google Colab
3. Scikit-learn, NumPy, Pandas, Matplotlib, Seaborn
4. SPSS or Excel for basic data exploration
5. GitHub for version control

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools

5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	3	2	2	1	2
CO2	2	3	3	3	–	3	2	2	2	3
CO3	2	3	3	3	–	2	2	2	2	3
CO4	2	2	3	2	–	–	–	1	2	2
CO5	3	3	3	3	–	–	2	2	3	3
Articulation	2.4	2.6	2.8	2.6	1	2.67	2	1.8	2	2.6

Course Title	Data Visualization Techniques
Course Code	25VBT2E403
Semester	IV
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course aims to equip students with the knowledge and skills to represent complex datasets visually. It emphasizes the use of visualization tools and techniques to extract, analyze, and communicate data-driven insights effectively.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the principles and importance of data visualization	L2
CO2	Apply design principles to create effective visual representations of data	L3
CO3	Use data visualization tools like Tableau, Power BI, and Python libraries	L3
CO4	Analyze datasets and build interactive dashboards for data storytelling	L4
CO5	Evaluate and critique visualizations for clarity, efficiency, and impact	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Data Visualization
Scope of Module: Covers basic concepts, history, and the importance of visualization in decision-making.
Topics: Definition and Purpose of Data Visualization, History and Evolution of Visualization, Benefits of Visual

Communication, Types of Data (Categorical, Numerical, Temporal, Spatial), Introduction to Exploratory vs Explanatory Visualization, Data Types and Levels of Measurement, Characteristics of Effective Visuals, Data-ink Ratio and Chartjunk, Understanding Audience Needs, Choosing the Right Chart Type, Introduction to Visualization Tools, Common Pitfalls in Visualization, Storytelling with Data, Role of Color and Perception, Ethical Considerations in Data Representation.

Learning Outcome: - *Understand the fundamentals and design principles of data visualization.*

No. of Hours: 24

Module 2: Visual Design Principles and Charting Techniques

Scope of Module:
Focuses on design elements, chart types, and aesthetics in creating visualizations.

Topics:
Gestalt Principles in Visualization, Pre-attentive Attributes, Chart Selection Guidelines, Bar Charts, Line Charts, Pie Charts, Histograms, Boxplots, Scatter Plots, Heatmaps, Bullet Graphs, Treemaps, Choropleth Maps, Infographics Basics, Color Theory in Visualization, Use of Typography and Layout, Dashboard Design Principles.

Learning Outcome: - *Apply visual design concepts to create meaningful and accurate charts.*

No. of Hours: 24

Module 3: Data Processing and Visualization using Python

Scope of Module:
Hands-on creation of visualizations using Python libraries for different datasets.

Topics:
Data Import and Cleaning with Pandas, Exploratory Data Analysis (EDA), Matplotlib Basics and Plot Customization, Seaborn for Statistical Plots, Plotly for Interactive Visualization, Working with Time Series Data, Multi-Plot Layouts, Annotating Charts, Visualizing Missing Data, Correlation Heatmaps, Pairplots and Facets, Geographic Visualizations with Folium, Word Clouds for Text Data, Saving and Sharing Visuals, Best Practices in Python Visualization.

Learning Outcome: - *Create diverse data visualizations using Python libraries.*

No. of Hours: 24

Module 4: Interactive Dashboards with Tableau and Power BI

Scope of Module:
Covers the use of popular business intelligence tools for interactive analytics.

Topics:
Tableau Environment Overview, Data Connection and Preparation in Tableau, Dimensions and Measures, Calculated Fields and Parameters, Filters and Sorting, Building Dashboards in Tableau, Storytelling and Navigation, Introduction to Power BI Interface, Power Query Editor, DAX Functions and Measures, Building Reports and Visuals in Power BI, Slicers and Filters, Publishing and Sharing Dashboards, Comparing Tableau and Power BI, Real-time Dashboard Design.

***Learning Outcome:* -** *Design interactive dashboards using Tableau and Power BI.*

No. of Hours: 24

Module 5: Advanced Topics and Applications in Data Visualization
Scope of Module: Explores specialized visualization methods and domain-specific applications.
Topics: Visualizing Networks and Graphs, Visual Analytics in Business Intelligence, Data Journalism and Narrative Visualization, Visualizing Survey Data, Visualizing Big Data, Real-Time Data Visualization, Dashboards for KPIs and Metrics, Accessibility in Visualization, Mobile-Responsive Visualizations, A/B Testing and Data Interpretation, Visualizing Machine Learning Outputs, Data Storyboarding, Evaluation and Critique of Visualizations, Industry Use Cases, Recent Trends and Tools in Visualization.
***Learning Outcome*: -** *Implement advanced visualization techniques for real-world applications.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- ➢ Basic understanding of statistics and data types
- ➢ Familiarity with spreadsheet tools (Excel/Google Sheets)
- ➢ Introductory programming experience (Python preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on lab sessions using Tableau, Power BI, and Python
- ✓ Mini-projects with real datasets and industry use cases
- ✓ Visual storytelling and critique-based evaluations

✓ Interactive dashboard creation and presentation
✓ Assignments, quizzes, and tool-based demonstrations

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Data Visualization with Python – Coursera (IBM)
   https://www.coursera.org/learn/python-for-data-visualization
2. Tableau Data Visualization – Udemy or free public tutorials
   https://public.tableau.com/en-us/s/resources
3. Power BI for Beginners – edX (DavidsonX)
   https://www.edx.org/course/analyzing-and-visualizing-data-with-power-bi
4. Data Storytelling and Dashboards – NPTEL
   https://nptel.ac.in/courses/110104073

Suggested Readings:

- Cole Nussbaumer Knaflic, *Storytelling with Data*, Wiley
- Alberto Cairo, *The Truthful Art*, New Riders
- Ben Jones, *Avoiding Data Pitfalls*, Wiley
- Yau Nathan, *Data Points*, Wiley
- Tableau Public Gallery: https://public.tableau.com
- Microsoft Power BI Docs: https://learn.microsoft.com/power-bi
- Seaborn & Plotly Docs: https://seaborn.pydata.org | https://plotly.com/python

Recommended Software/Tools (If applicable):

1. Tableau Public / Tableau Desktop
2. Microsoft Power BI
3. Python (Pandas, Matplotlib, Seaborn, Plotly, Folium, Wordcloud)
4. Excel/Google Sheets
5. Jupyter Notebook / Google Colab
6. Flourish / Datawrapper (for online visuals)
7. Canva / Figma for Infographics

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools

5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	1	3	2	1
CO2	3	3	3	3	3	2	1	2	2	1
CO3	3	3	3	3	3	1	1	1	2	1
CO4	3	3	3	3	3	1	1	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1	1.6	2	1.4

Course Title	Statistical Analysis
Course Code	25VBT2E404
Semester	IV
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course is designed to provide students with a strong foundation in statistical techniques essential for business decision-making. It includes probability theory, statistical inference, regression analysis, and forecasting methods. Practical exposure to modeling real-world data will empower students to derive actionable insights for data-driven decisions.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Develop a comprehensive understanding of statistical concepts and their applications in business	L2
CO2	Gain proficiency in designing and conducting statistical surveys, including data collection and analysis	L3
CO3	Acquire advanced skills in probability theory and statistical inference to solve complex business problems	L4
CO4	Master various regression techniques and their applications in predictive modeling	L4
CO5	Enhance expertise in modeling and forecasting methods to make informed business decisions	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Statistics and Statistical Surveys
Scope of Module: This module introduces the basics of statistics and the principles of designing statistical surveys.
Topics: History of statistics, definition and importance of statistics in business, basic statistical terminology, types and sources of data, primary and secondary data collection methods, definition and stages of a statistical survey, planning and execution steps
***Learning Outcome:* -** *To gain an insight on core concepts of statistics, its scope in business, and determine data collection approaches.*

No. of Hours: 24

Module 2: Probability and Distributions
Scope of Module: This module covers foundational probability concepts and key probability distributions.
Topics: Important probability terms, methods of assigning and measuring probabilities, conditional probability, Bayes' theorem, probability mass and cumulative distribution functions, expected value and variance for discrete and continuous distributions, probability density function and cumulative density function, plotting and interpretation(Matplotlib,Excel / Google Sheets).
***Learning Outcome:* -** *Develop a comprehensive understanding of probability theory and its application in statistical modeling.*

No. of Hours: 24

Module 3: Sampling and Statistical Inference
Scope of Module: This module provides techniques for sampling and making statistical inferences from sample data.
Topics: Sampling theory and methods, sampling vs non-sampling errors, central limit theorem, law of large numbers, sampling distribution and sample proportion, hypothesis testing basics, type I and II errors, normal distribution and area properties, large sample Z-tests for means and proportions, small sample t-tests, F test, Chi-square test for independence
***Learning Outcome:* -** *Apply sampling techniques and perform inferential statistical tests for analyzing real-world data.*

No. of Hours: 24

Module 4: Advanced Regression Techniques
Scope of Module: This module delves into regression diagnostics, generalized linear models, and correlation techniques.
Topics: R^2 and adjusted R^2, partial and multiple correlation, simple and multiple linear regression fitting, regression

assumptions and diagnostics, Elastic Net regression, introduction to generalized linear models, multicollinearity and VIF, case studies using regression models.

Learning Outcome: - *Gain proficiency in advanced regression concepts, including diagnostics, regularization, and predictive modeling.*

No. of Hours: 24

Module 5: Forecasting and Time Series Analysis

Scope of Module:
This module introduces students to forecasting models and time series techniques.

Topics:
Modeling and forecasting overview, linear and nonlinear models, trend analysis, exponential smoothing, linear and compound growth models, logistic curve fitting, moving averages, forecasting accuracy tests, Bayesian time series analysis

Learning Outcome: - *Apply various forecasting models and techniques including Bayesian analysis for business time series data.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- ➢ Basic understanding of algebra and data types
- ➢ Exposure to Excel or any spreadsheet software
- ➢ Interest in interpreting numerical and tabular data

Pedagogy / Teaching Methodology:

- ✓ Lab sessions with Excel / Google Sheets and statistical tools
- ✓ Step-by-step case study implementation

- ✓ Interactive quizzes and real-world datasets
- ✓ In-class problem solving using hypothesis testing and regression
- ✓ Mini-project on forecasting business trends

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Statistics for Data Science – NPTEL
   https://nptel.ac.in/courses/111104079
2. Business Statistics – Coursera (Wharton)
   https://www.coursera.org/learn/wharton-business-statistics
3. Introduction to Probability – edX (Harvard)
   https://pll.harvard.edu/course/statistics-and-r
4. Forecasting Models in Excel – Udemy
   https://www.udemy.com/course/excel-forecasting/

Suggested Readings:

- Ken Black, *Business Statistics: For Contemporary Decision Making*, Wiley
- Richard De Veaux et al., *Stats: Data and Models*, Pearson
- Andy Field, *Discovering Statistics Using SPSS*, SAGE
- OpenIntro Statistics: https://www.openintro.org/book/os/
- Investopedia Statistical Tools: https://www.investopedia.com/statistics-4689744
- StatTrek Tutorials: https://stattrek.com

Recommended Software/Tools (If applicable):

1. Microsoft Excel / Google Sheets
2. Python (NumPy, SciPy, Matplotlib, Statsmodels)
3. SPSS / R (optional advanced tools)
4. Data Analysis Toolpak (Excel Add-in)
5. JASP or Jamovi for GUI-based statistical analysis

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)

6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	–	–	1	1	2
CO2	2	3	3	3	3	2	2	2	2	3
CO3	3	1	3	3	3	2	–	2	2	1
CO4	2	3	1	3	3	2	–	2	2	3
CO5	1	2	3	3	3	3	2	3	3	3
Articulation	2.2	2.2	2.4	3	2.8	2.25	2	2	2	2.4

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Course Title	Quantitative Techniques
Course Code	25VBT0C404
Semester	IV
Credits	3
Course Type	Generic Elective
Learning Hours	90
Live Sessions	12 hours

Course Description:

This course aims to equip students with the mathematical and statistical tools required for decision-making and problem-solving in computer applications and business scenarios. It covers topics such as linear programming, probability, statistics, correlation, regression, and queuing theory. These quantitative techniques are essential for data analysis, operations research, and software modeling.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the fundamentals of quantitative methods and their applications in computer science.	L2
CO2	Solve optimization problems using linear programming and graphical methods.	L3
CO3	Apply concepts of probability and distributions in real-life decision-making.	L3
CO4	Analyze data using correlation, regression, and index numbers.	L4
CO5	Demonstrate the use of queuing theory and statistical decision-making tools.	L5

Course Modules

No. of Hours: 18

Module 1: Linear Algebra and Equations
Scope of Module: Covers matrix operations, system of linear equations, and their computational applications.

Topics: Types of Matrices, Matrix Operations, Determinants and Properties, Inverse of a Matrix, Solving Linear Equations (Cramer's Rule, Matrix Inversion), Gauss Elimination Method, Rank of a Matrix, Eigenvalues and Eigenvectors, Applications in Computer Graphics, Linear Dependence and Independence, Linear Transformation, Diagonalization, Vector Spaces, Basis and Dimension, Applications in Data Science.
Learning Outcome: - *Use matrix algebra to solve linear systems and perform transformations in computing.*

No. of Hours: 18

Module 2: Descriptive Statistics
Scope of Module: Focuses on summarizing and interpreting data using various statistical measures.
Topics: Types of Data, Data Collection Methods, Frequency Distribution, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Variance, Standard Deviation), Skewness and Kurtosis, Percentiles and Quartiles, Data Visualization (Histograms, Pie Charts, Box Plots), Cross-tabulation and Contingency Tables, Correlation Analysis, Covariance, Scatter Plots, Use of Excel/SPSS for Data Analysis, Real-life Data Interpretation.
Learning Outcome: - *Analyze and describe data using statistical measures and visualizations.*

No. of Hours: 18

Module 3: Linear Programming and Optimization
Scope of Module: Explores techniques for modeling and solving optimization problems using LPP.
Topics: Introduction to Linear Programming, Formulating LPPs, Graphical Method, Simplex Method, Duality in LPP, Sensitivity Analysis, Transportation Problem, Assignment Problem, Degeneracy and Unbalanced Problems, Maximization and Minimization Models, Profit and Cost Optimization, Integer Programming, Decision Variables and Constraints, Real-world Applications, Use of Solver Tools in Excel.
Learning Outcome: - *Formulate and solve optimization problems using linear programming techniques.*

No. of Hours: 18

Module 4: Probability and Distributions
Scope of Module: Introduces probability concepts and probability distributions for quantitative reasoning.
Topics: Basic Probability Rules, Conditional Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Expected Value and Variance, Binomial Distribution, Poisson Distribution, Normal Distribution, Central Limit

Theorem, Applications in Risk Analysis, Z-scores and Standardization, Probability Trees, Joint and Marginal Probabilities, Monte Carlo Simulations, Statistical Applications in IT.

Learning Outcome: - *Apply probability and distributions to evaluate uncertain events and risks.*

No. of Hours: 18

Module 5: Decision Theory and Forecasting

Scope of Module:
Focuses on decision-making techniques and forecasting tools for business applications.

Topics:
Decision-Making Under Certainty, Uncertainty, and Risk, Payoff Tables and Decision Trees, Expected Monetary Value, Maximax, Maximin, Minimax Regret, Forecasting Techniques (Moving Average, Exponential Smoothing), Time Series Analysis, Trend and Seasonality Detection, Regression Models, Index Numbers, Error Analysis (MAD, MSE), Use of Forecasting in Business and IT, Software Tools for Decision Analysis.

Learning Outcome: - *Implement decision analysis and forecasting models for planning and problem-solving.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning

- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. NPTEL: Probability and Statistics
   https://nptel.ac.in/courses/111105090
6. Coursera: Statistics with Excel
   https://www.coursera.org/learn/basic-statistics-excel
7. edX: Data Science: Probability
   https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
8. MIT OpenCourseWare: Introduction to Probability and Statistics
   https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings:

- Richard I. Levin & David S. Rubin, Statistics for Management, Pearson
- S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House
- Taha H. A., Operations Research: An Introduction, Pearson
- Vohra N.D., Quantitative Techniques in Management, Tata McGraw-Hill
- Online articles from JSTOR, ScienceDirect, and SpringerLink for research-based insights

Recommended Software/Tools (If applicable):

4. Microsoft Excel (with Solver add-in)
5. SPSS for statistical analysis
6. R or Python (NumPy, SciPy, Pandas, Statsmodels)

4. Tableau or Power BI for data visualization

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)

4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	–	2	–	–	–	–
CO2	3	3	3	2	–	3	–	–	–	–
CO3	3	3	3	2	–	2	–	–	–	–
CO4	3	3	3	3	2	2	–	–	–	–
CO5	3	3	3	3	2	3	–	–	–	–
Articulation	3	3	2.8	2.4	2	2.4	–	–	–	–

Semester V

Course Title	Block Chain Technologies
Course Code	25VBT0C501
Semester	V
Credits	4
Course Type	Core Course
Learning Hours	120
Live Sessions	12 hours

Course Description:
This course introduces the foundational and advanced aspects of blockchain technology. Students will explore blockchain architecture, cryptographic techniques, smart contracts, and application platforms. They will also evaluate blockchain's impact on security, privacy, business ecosystems, and societal implications. The course emphasizes practical skills through development environments and case studies.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of blockchain technology.	L2
CO2	Explore various blockchain platforms and their applications.	L3
CO3	Develop skills to design and implement blockchain-based solutions.	L4
CO4	Analyze the security and privacy aspects of blockchain.	L4
CO5	Assess the impact of blockchain technology on business and society.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Blockchain Technology
Scope of Module: Introduces the basics, architecture, and cryptographic foundation required for understanding blockchain systems.
Topics: Introduction to Blockchain Technology, History and Evolution of Blockchain, Types of Blockchains: Public, Private, Consortium, Applications of Blockchain Technology, Components of Blockchain: Blocks, Chains, Nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Smart

Contracts and Their Execution, Blockchain Forks, Basic Cryptographic Concepts: Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Cryptographic Algorithms Used in Blockchain
Learning Outcome: - *Gain foundational understanding of blockchain principles, architecture, and cryptography.*

No. of Hours: 24

Module 2: Blockchain Platforms and Development
Scope of Module: Focuses on blockchain ecosystems and hands-on development using Ethereum and other platforms.
Topics: Bitcoin and Ethereum: Structure and Functionality, Hyperledger Fabric, Ripple, Corda and Other Blockchain Platforms, Setting Up Blockchain Development Environment, Writing Smart Contracts in Solidity, Deploying Smart Contracts on Ethereum, Decentralized Applications (DApps), Detailed Study of Smart Contracts, Smart Contract Development and Testing, Real World Use Cases of Smart Contracts
Learning Outcome: - *Explore and implement blockchain-based solutions using various platforms and tools.*

No. of Hours: 24

Module 3: Blockchain Security, Privacy and Compliance
Scope of Module: Analyzes the threats and solutions related to blockchain security, privacy regulations, and standards.
Topics: Security Issues in Blockchain, Attacks on Blockchain: 51% Attack, Sybil Attack, Privacy Solutions in Blockchain, Regulatory and Legal Implications, Data Privacy Laws and Regulations, Blockchain's Role in Ensuring Data Privacy, Case Studies on Privacy Issues in Blockchain, Overview of Popular Cryptocurrencies, Cryptocurrency Mining and Transactions, Regulatory Aspects of Cryptocurrencies, International Standards for Blockchain Technology, Frameworks and Protocols for Blockchain Development, Compliance and Best Practices
Learning Outcome: - *Evaluate security vulnerabilities, privacy frameworks, and compliance in blockchain systems.*

No. of Hours: 24

Module 4: Blockchain Applications in Industry and Society
Scope of Module: Explores how blockchain is transforming industries and provides real-world use cases across various domains.
Topics: Blockchain in Financial Services: Cryptocurrencies, Payment Systems, Supply Chain Management, Healthcare and Identity Management, Government and Public Services, Impact of Blockchain on Business Models, Case Studies in Finance, Supply Chain and Healthcare, Blockchain for Enterprise Solutions, Emerging Research Areas in Blockchain, Potential Future Applications, Ethical and Societal Implications
Learning Outcome: - *Assess real-world blockchain use cases, societal impacts, and business transformation through blockchain.*

No. of Hours: 24

Module 5: Advanced Blockchain Integration and Emerging Trends
Scope of Module: Covers the integration of blockchain with other technologies and future innovations.
Topics: Interoperability and Scalability in Blockchain, Blockchain and the Internet of Things (IoT), Blockchain and Artificial Intelligence (AI), Future Trends and Innovations in Blockchain, Integrating Blockchain with Cloud Platforms, Use Cases of Blockchain in Cloud Computing, Advantages and Challenges
Learning Outcome: - *Analyze the integration of blockchain with emerging technologies and its future direction.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic understanding of cryptography and networking
- Familiarity with distributed systems
- Programming experience (preferably in JavaScript, Python, or Solidity)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for smart contract development using Solidity
- ✓ Simulations and projects involving blockchain platforms like Ethereum and Hyperledger
- ✓ Case study discussions on real-world blockchain implementations
- ✓ Group activities on blockchain architecture and DApp design

- ✓ Evaluation through mini-projects, quizzes, and practical assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

5. Coursera: Blockchain Specialization – University at Buffalo & SUNY
6. IBM Blockchain Foundation Developer Course
7. edX: Blockchain Fundamentals – UC Berkeley
8. Blockchain Council: Free Blockchain Courses

Suggested Readings:

- Arvind Narayanan et al., *Bitcoin and Cryptocurrency Technologies*, Princeton University Press
- Melanie Swan, *Blockchain: Blueprint for a New Economy*, O'Reilly
- Imran Bashir, *Mastering Blockchain*, Packt Publishing
- Don Tapscott & Alex Tapscott, *Blockchain Revolution*, Penguin

Recommended Software/Tools:

1. **Smart Contract Development:** Remix IDE, Truffle, Hardhat
2. **Blockchain Platforms:** Ethereum, Hyperledger Fabric, Corda
3. **Languages:** Solidity, JavaScript, Go
4. **Testing and Deployment:** Ganache, MetaMask, Infura
5. **Development Environments:** Visual Studio Code, Docker
6. **Version Control:** Git/GitHub

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)

4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	–	1	1	2
CO2	2	–	2	2	–	3	2	–	1	2
CO3	2	3	–	2	–	2	2	2	–	2
CO4	2	3	2	–	2	–	3	2	1	2
CO5	1	2	1	2	1	3	–	2	2	–
Articulation	2	2.5	1.5	1.75	1.67	2.5	2.33	1.75	1.25	2

Course Title	IT Project Management
Course Code	25VBT0C502
Semester	V
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course equips students with the principles, tools, and techniques of project management tailored for IT environments. It covers planning, execution, monitoring, and controlling aspects of software and technology-related projects.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand fundamental project management concepts and processes in IT.	L2
CO2	Develop project plans including scope, schedule, and cost estimations.	L3
CO3	Apply project management tools for effective monitoring and control.	L3
CO4	Manage project risks, quality, resources, and stakeholder communication.	L4
CO5	Evaluate real-world IT projects using industry standards and methodologies.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Project Management
Scope of Module: Covers fundamental concepts, roles, and project life cycle in IT project management.
Topics: Definition of Project and Project Management, Characteristics of IT Projects, Project Constraints (Scope, Time,

Cost), Project Life Cycle, Project Manager's Role and Responsibilities, Stakeholders and Organizational Structures, Project Environment, PMBOK Framework, Project Success Factors, Project Selection Methods, Feasibility Analysis, Project Charter, Work Breakdown Structure (WBS), Agile vs Waterfall, Case Studies in IT Projects.
Learning Outcome: - *Understand the fundamentals and environment of IT project management.*

No. of Hours: 24

Module 2: Project Planning and Scheduling
Scope of Module: Focuses on creating detailed project plans with clear timelines and resource estimations.
Topics: Project Scope Management, Defining Requirements, Scope Statement, Time Management Processes, Activity Sequencing, Gantt Charts, Critical Path Method (CPM), PERT Analysis, Resource Allocation, Cost Estimation Techniques, Budgeting and Cost Baselines, Resource Calendars, Milestone Planning, Project Scheduling Tools (MS Project, OpenProject), Change Control Processes, Planning Challenges.
Learning Outcome: - *Develop effective project schedules and cost plans.*

No. of Hours: 24

Module 3: Project Execution, Monitoring, and Control
Scope of Module: Emphasizes execution strategies and project performance tracking methods.
Topics: Executing the Project Plan, Communication and Team Management, Status Meetings and Reporting, Performance Measurement Techniques, Earned Value Management (EVM), Key Performance Indicators (KPIs), Monitoring Schedule and Cost Variances, Issue Tracking, Scope Creep Handling, Quality Assurance vs Quality Control, Forecasting Project Progress, Change Requests and Impact Analysis, Tools for Monitoring (Dashboards, KPIs), Conflict Management in Teams.
***Learning Outcome*: -** *Monitor, control, and steer IT projects toward success.*

No. of Hours: 24

Module 4: Risk, Quality, and Resource Management
Scope of Module: Covers identification, analysis, and mitigation of risks, along with quality and resource planning.
Topics: Risk Management Process, Risk Identification and Analysis, Qualitative and Quantitative Risk Assessment, Risk Response Planning, Risk Register, Quality Management Concepts, Quality Planning and Metrics, Resource Planning and Acquisition, Team Building and Motivation, Human Resource Constraints, Communication Plans, Stakeholder Engagement Strategies, Conflict Resolution, Leadership Styles in Project Management, Ethical and Legal Issues.

Learning Outcome: - *Manage project risks, quality, and resources effectively.*

No. of Hours: 24

Module 5: Project Closure and Advanced Topics
Scope of Module:
Focuses on closing activities, evaluation techniques, and emerging project management practices.
Topics:
Project Closure Process, Final Deliverables and Sign-offs, Lessons Learned Documentation, Post-Implementation Review, Project Evaluation Metrics, Maintenance and Support Plans, Project Auditing, Introduction to Agile, Scrum and Kanban, Role of Scrum Master and Product Owner, Sprint Planning and Backlogs, Use of JIRA and Trello, DevOps and CI/CD Concepts, Global and Virtual Teams, Trends in IT Project Management.
Learning Outcome: - *Execute closure procedures and evaluate advanced project methodologies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic understanding of software development life cycle (SDLC)
- Familiarity with organizational structure and communication models
- General awareness of business operations and team dynamics

Pedagogy / Teaching Methodology:

- ✓ Interactive lectures with case study discussions
- ✓ Hands-on use of project planning and tracking tools
- ✓ Group-based project simulations
- ✓ Problem-based and scenario-driven assignments
- ✓ Project presentations and peer feedback

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Project Management Principles and Practices (Coursera – University of California, Irvine)
   https://www.coursera.org/specializations/project-management
6. NPTEL: Project Management for Managers
   https://nptel.ac.in/courses/110105083
7. Introduction to Scrum Master Training (edX – LearnQuest)
   https://www.edx.org/course/scrum-master-training
8. Project Management for Software Engineers (Udemy or Free YouTube Lectures)

Suggested Readings:

- PMBOK® Guide – A Guide to the Project Management Body of Knowledge, PMI
- Schwalbe, K., Information Technology Project Management, Cengage Learning
- Hughes & Cotterell, Software Project Management, McGraw-Hill
- Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling
- Online resources: PMI.org, ProjectManagement.com, tutorials on MS Project, JIRA

Recommended Software/Tools (If applicable):

3. Microsoft Project / OpenProject
4. JIRA, Trello, ClickUp
5. GanttProject or TeamGantt

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	–	2	–	–	–	–
CO2	3	3	3	2	–	3	–	–	–	–
CO3	3	3	3	3	2	3	–	–	–	–
CO4	3	3	3	3	2	3	–	–	–	–

CO5	3	3	3	3	2	3	–	–	–	–
Articulation	3	2.8	2.8	2.75	2	2.8	–	–	–	–

Course Title	Fundamentals of Data Science
Course Code	25VBT2E503
Semester	V
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course provides a broad introduction to data science concepts, tools, and techniques including data handling, visualization, statistical modeling, machine learning, and cloud-based analytics. Students will gain practical skills using Python and data science libraries to develop, evaluate, and deploy data-driven solutions across multiple domains.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	To gain a comprehensive understanding of the fundamental concepts and methodologies in Data Science	L2
CO2	To develop practical skills in using various data science tools and programming languages	L3
CO3	To enhance their analytical thinking and problem-solving abilities across different industries	L4
CO4	To acquire knowledge of various machine learning and statistical modeling techniques	L4
CO5	To develop an awareness of the ethical implications and responsibilities associated with data science practices	L2

Course Modules

No. of Hours: 24

Module 1: Foundations of Data Science
Scope of Module: This module introduces the foundations and ethical practices in Data Science.
Topics: Definition and significance of Data Science, differences between Data Science, Data Analytics, Machine Learning, and Big Data, applications of Data Science in various industries, Data Science lifecycle and workflow, key roles in a Data Science team, tools and technologies used in Data Science, ethical considerations and challenges
Learning Outcome: -*Explain the basic concepts, significance, and applications of Data Science in various fields.*

No. of Hours: 24

Module 2: Data Wrangling and Exploratory Analysis
Scope of Module: This module covers data collection, preprocessing, and exploratory data analysis techniques.
Topics:
Types of data (structured, semi-structured, unstructured), data collection methods (surveys, APIs, web scraping), introduction to SQL and NoSQL, data cleaning and transformation (handling missing values, outliers, categorical encoding), merging datasets, descriptive statistics, data summarization, data visualization (histograms, box plots, scatter plots), correlation and covariance using Pandas and Matplotlib
Learning Outcome: - *Collect, clean, and explore data to uncover patterns and prepare for analysis.*

No. of Hours: 24

Module 3: Statistical and Machine Learning Foundations
Scope of Module: This module introduces probability, statistics, and the foundations of machine learning.
Topics: Probability theory, probability distributions (Normal, Binomial, Poisson), hypothesis testing, Bayesian statistics, statistical significance and confidence intervals, types of machine learning (supervised, unsupervised, reinforcement), training vs testing datasets, model evaluation metrics (accuracy, precision, recall, F1 score), overfitting and cross-validation
Learning Outcome: - *Apply statistical and machine learning techniques for analytical problem-solving.*

No. of Hours: 24

Module 4: Advanced Machine Learning and AI
Scope of Module: This module explores supervised and unsupervised learning techniques, NLP, and deep learning.
Topics: Supervised learning: linear and logistic regression, decision trees, SVM, KNN, random forests, boosting methods, unsupervised learning: K-means, hierarchical clustering, PCA, t-SNE, anomaly detection, NLP: tokenization, TF-

IDF, sentiment analysis, topic modeling, deep learning: neural networks, CNNs, RNNs, backpropagation, TensorFlow and PyTorch overview
Learning Outcome: - *Implement and evaluate machine learning and deep learning models for real-world applications.*

No. of Hours: 24

Module 5: Big Data, Cloud, and Project Management
Scope of Module: This module discusses big data tools, cloud platforms, and managing data science projects.
Topics: Introduction to Big Data and Hadoop ecosystem, Apache Spark, NoSQL databases (MongoDB, Cassandra), stream processing (Kafka, Flink), cloud computing fundamentals (AWS, Azure, GCP), deploying models in the cloud, serverless architecture, project lifecycle: problem definition, data prep, modeling, evaluation, communication, Agile in data science, AutoML, XAI, trends in quantum and ethical AI
Learning Outcome: - *Utilize big data and cloud platforms to manage and deploy scalable data science projects ethically*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- ➢ Basic programming knowledge in Python or similar language
- ➢ Familiarity with mathematical concepts like algebra and probability
- ➢ Understanding of databases and web basics is helpful

Pedagogy / Teaching Methodology:

- ✓ Hands-on Python coding using Jupyter Notebooks
- ✓ Use of real-world datasets from open sources (e.g., Kaggle, UCI)
- ✓ Concept explanation followed by coding walkthroughs

✓ Assignments on each module using GitHub submission
✓ Capstone project with evaluation and peer feedback

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. IBM Data Science Professional Certificate – Coursera
   https://www.coursera.org/professional-certificates/ibm-data-science
2. Data Science for Beginners – Microsoft Learn
   https://learn.microsoft.com/en-us/training/paths/data-science-for-beginners/
3. Data Science with Python – NPTEL
   https://nptel.ac.in/courses/106106212
4. CS109 Data Science – Harvard OpenCourseWare
   https://cs109.github.io/2023/

Suggested Readings:

- Joel Grus, *Data Science from Scratch*, O'Reilly
- Jake VanderPlas, *Python Data Science Handbook*, O'Reilly
- Wes McKinney, *Python for Data Analysis*, O'Reilly
- MIT OpenCourseWare – Introduction to Data Science
- Towards Data Science (Medium blog): https://towardsdatascience.com
- Analytics Vidhya: https://www.analyticsvidhya.com/

Recommended Software/Tools (If applicable):

1. Python (Anaconda Distribution)
2. Jupyter Notebook / Google Colab
3. Pandas, NumPy, Matplotlib, Seaborn, Scikit-learn
4. TensorFlow / PyTorch (for ML/DL)
5. Apache Spark, MongoDB, and AWS/Azure/GCP accounts
6. VS Code or PyCharm for coding environment

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	2	–	1	1	2
CO2	2	3	3	3	3	2	–	2	2	3
CO3	2	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	2	1	2	2	3
CO5	1	2	2	2	2	3	3	3	3	3
Articulation	2.2	2.8	2.6	2.8	2.6	2.4	2	2.2	2.2	2.8

Course Title	Big Data Analytics
Course Code	25VBT1E505
Semester	V
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course explores the concepts, technologies, and tools used in big data analytics. It covers distributed computing, data processing frameworks, and advanced analytics techniques to handle vast volumes of structured and unstructured data effectively.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamentals and challenges of big data and its ecosystem.	L2
CO2	Implement distributed data storage and processing using Hadoop and MapReduce.	L3
CO3	Utilize data processing frameworks like Spark for real-time analytics.	L3
CO4	Analyze structured and unstructured data using big data tools.	L4
CO5	Apply machine learning techniques to large-scale datasets for predictive analytics.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Big Data and Ecosystem
Scope of Module: Introduces the concept of big data, its characteristics, and the evolving ecosystem.

Topics: Definition and Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Structured vs Unstructured Data, Data Lifecycle and Sources, Traditional vs Big Data Approaches, Applications of Big Data, Big Data Architecture, Role of Data Scientists and Engineers, Data Storage and Computation Challenges, Types of Analytics (Descriptive, Predictive, Prescriptive), Big Data Use Cases in Industry, Data Acquisition Techniques, Data Cleaning and Preprocessing, Introduction to Hadoop Ecosystem, Big Data Technologies Overview, Trends in Big Data.
Learning Outcome: - *Understand big data concepts, architecture, and real-world applications.*

No. of Hours: 24

Module 2: Hadoop Framework and MapReduce Programming
Scope of Module: Covers Hadoop ecosystem components and the basics of distributed data processing.
Topics: HDFS Architecture and Components, Data Replication and Fault Tolerance, HDFS Commands and File Operations, Hadoop Cluster Setup, YARN Architecture and Resource Management, MapReduce Programming Model, Writing and Running MapReduce Jobs, Input and Output Formats, Combiner and Partitioner, Counters in MapReduce, Joins and Sorting in MapReduce, Hadoop Streaming, Limitations of MapReduce, Hadoop Configuration Files, Performance Tuning in Hadoop, Hadoop Security Basics.
Learning Outcome: - *Build and execute distributed data processing workflows using Hadoop and MapReduce.*

No. of Hours: 24

Module 3: Apache Spark and Real-Time Data Processing
Scope of Module: Focuses on in-memory data processing with Spark and its libraries.
Topics: Introduction to Apache Spark, Spark Core and RDDs, Transformations and Actions in RDD, Lazy Evaluation and Lineage, DataFrames and Datasets, Spark SQL and Querying, Spark Streaming and DStream Concepts, Structured Streaming, Windowed Operations, Spark MLlib Overview, GraphX for Graph Processing, Spark vs Hadoop Comparison, Fault Tolerance in Spark, Cluster Managers (YARN, Mesos, Standalone), Performance Tuning in Spark, Real-Time Data Processing Use Cases.
Learning Outcome: - *Process large-scale data in real-time using Spark and its ecosystem.*

No. of Hours: 24

Module 4: Data Analytics and Visualization Techniques
Scope of Module: Explores data analytics techniques and tools for big data visualization.
Topics: Data Exploration and Profiling, Statistical Analysis of Big Data, Correlation and Regression Analysis, Clustering

and Classification Basics, Text Analytics and Natural Language Processing, Sentiment Analysis, Data Reduction Techniques, Use of Python/R in Analytics, Data Wrangling with Pandas, Visualizing Big Data with Matplotlib and Seaborn, Tableau for Big Data Visualization, Dashboards and Storytelling with Data, Exploratory Data Analysis (EDA), BI Tools Overview, Challenges in Big Data Visualization.
Learning Outcome: - *Perform data analysis and visualize insights effectively from big datasets.*

No. of Hours: 24

Module 5: Machine Learning and Big Data Applications
Scope of Module: Covers ML algorithms and applications in large-scale data environments.
Topics: Introduction to Machine Learning Concepts, Supervised vs Unsupervised Learning, ML Algorithms in Big Data (Decision Trees, K-Means, Naive Bayes), Feature Engineering in Big Data, Model Evaluation Metrics (Accuracy, Precision, Recall, F1), MLlib in Spark, Model Training and Tuning, Hyperparameter Optimization, Scalable ML Pipelines, Use Cases in Fraud Detection, Recommendation Systems, Predictive Maintenance, Customer Segmentation, Industry Applications of Big Data Analytics, Ethical Issues and Data Governance in Big Data.
***Learning Outcome*: -** *Apply machine learning algorithms to extract insights from big datasets.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic programming knowledge (preferably in Python/Java)
- Understanding of database systems and SQL
- Familiarity with data structures and algorithms
- Exposure to basic statistics and linear algebra

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using Hadoop, Spark, and visualization tools
- ✓ Real-world case studies and use case discussions
- ✓ Live demonstrations of data processing pipelines
- ✓ Mini-projects simulating real-time big data problems

Certificate / Value Added Courses Recommended:

5. **Big Data Specialization by Coursera (UC San Diego)**
   https://www.coursera.org/specializations/big-data
6. **Hadoop Platform and Application Framework (edX)**
   https://onlinecourses.nptel.ac.in/noc21_cs55/preview
7. **Introduction to Big Data with Apache Spark (edX/Databricks)**
   https://www.edx.org/course/introduction-to-big-data-with-apache-spark
8. **IBM Data Engineering Professional Certificate (Coursera)**
   https://www.coursera.org/professional-certificates/ibm-data-engineer

Suggested Readings:

- Tom White, **"Hadoop: The Definitive Guide"**, O'Reilly Media
- Jules S. Damji et al., **"Learning Spark: Lightning-Fast Data Analytics"**, O'Reilly
- Bill Franks, **"Taming the Big Data Tidal Wave"**, Wiley
- Vignesh Prajapati, **"Big Data Analytics with R and Hadoop"**, Packt Publishing

Recommended Software/Tools:

5. **Hadoop Ecosystem Tools**: HDFS, MapReduce, Hive, Pig
6. **Apache Spark Stack**: Spark Core, Spark SQL, Spark Streaming, MLlib
7. **Visualization Tools**: Tableau, Power BI, Matplotlib, Seaborn
8. **Programming Languages**: Python, R

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	–	2	–	–	–	–
CO2	3	3	3	2	–	3	–	–	–	–
CO3	3	3	3	3	2	3	–	–	–	–
CO4	3	3	3	3	2	2	–	–	–	–
CO5	3	3	3	3	2	3	–	–	–	–
Articulation	3	3	2.8	2.6	2	2.6	–	–	–	–

Course Title	Natural Language Processing
Course Code	25VBT2E505
Semester	V
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course provides a comprehensive introduction to the field of Natural Language Processing (NLP). Students will learn how to process and analyze human language using computational techniques, covering fundamental linguistic concepts, preprocessing, syntactic and semantic analysis, sentiment mining, and real-world applications using modern NLP tools.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand fundamental concepts of Natural Language Processing and linguistic structure.	L2
CO2	Apply syntactic and semantic processing techniques to analyze natural language.	L3
CO3	Implement text preprocessing, vectorization, and basic NLP pipelines.	L3
CO4	Develop applications using NLP libraries and evaluate model performance.	L4
CO5	Analyze real-world NLP challenges in multilingual and domain-specific contexts.	L4

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Natural Language and Processing
Scope of Module: This module introduces the field of NLP and its applications. It covers the basics of natural language, linguistic structure, and how machines interpret language for information extraction and understanding.
Topics: Definition and scope of NLP, importance of NLP in modern applications, natural language vs formal language, structure of language and linguistic levels, morphology and word structure, parts of speech and their categories, syntactic structure and parse trees, semantics and meaning representation, pragmatics and context, challenges in language ambiguity and polysemy, types of NLP systems including rule-based, statistical and hybrid approaches
***Learning Outcome*: -** *Understand the basics of human language and the scope of Natural Language Processing.*

No. of Hours: 24

Module 2: Text Processing and Feature Representation
Scope of Module: This module covers the techniques required to prepare text for analysis. It also introduces how to convert textual data into numerical form using feature extraction techniques.
Topics: Tokenization methods including whitespace and regex-based, sentence segmentation and paragraph chunking, stop word removal and its impact on NLP tasks, stemming and lemmatization using NLTK and spaCy, text normalization including case folding and punctuation removal, regular expressions for information extraction, bag-of-words model, vectorization techniques using CountVectorizer and TF-IDF, sparse and dense matrix representations, cosine similarity for measuring document distance, visualizing term frequency distributions using word clouds
Learning Outcome: - *Apply text preprocessing and feature extraction techniques to convert raw text into usable inputs for NLP tasks.*

No. of Hours: 24

Module 3: Syntactic and Semantic Analysis
Scope of Module: This module explores how grammatical structures and meaning are captured in NLP. It introduces syntactic parsing techniques and semantic concepts for analyzing sentence structures and relationships.
Topics: Syntax and parse trees, phrase structure grammars and CFGs, constituency parsing vs dependency parsing, parsing tools in NLTK and spaCy, ambiguity in parsing and disambiguation techniques, named entity recognition and entity classification, introduction to WordNet and lexical databases, word sense disambiguation using Lesk algorithm, semantic similarity and relatedness, semantic role labeling and predicate-argument structure, applications of syntactic and semantic analysis in translation and question answering

***Learning Outcome: -** Analyze the structure and meaning of text using parsing and semantic interpretation techniques.*

No. of Hours: 24

Module 4: Text Classification and Sentiment Analysis

Scope of Module:
This module introduces the use of machine learning algorithms in NLP. It covers classification models used for sentiment analysis, spam detection, and topic categorization.

Topics:
Overview of text classification tasks, labeled datasets and supervised learning, text vectorization using TF-IDF and word embeddings, Naive Bayes classifier for sentiment analysis, support vector machines for text classification, training and testing splits for model evaluation, performance metrics including accuracy, precision, recall, F1-score and ROC curve, confusion matrix interpretation, sentiment lexicons including AFINN and VADER, polarity and subjectivity analysis, building pipelines with scikit-learn and evaluating model output

***Learning Outcome: -** Build and evaluate text classification and sentiment analysis models using machine learning techniques.*

No. of Hours: 24

Module 5: Real-world NLP Applications and Challenges

Scope of Module:
The final module addresses the complexities of working with multilingual and domain-specific language. It concludes with modern tools and libraries used in practical NLP development.

Topics:
Challenges in processing Indian languages including tokenization and transliteration, Unicode handling and script conversion, case studies on Hindi and Tamil NLP applications, introduction to word embeddings including Word2Vec and GloVe, n-gram language models and their limitations, introduction to deep learning in NLP, overview of transformer-based models such as BERT, implementation using Hugging Face Transformers, real-world applications in chatbots, question answering, text summarization, speech recognition and translation

***Learning Outcome: -** Apply NLP tools and techniques to real-world multilingual and domain-specific problems.*

Module	No of Pre Recordings
1	10
2	12
3	10

4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic knowledge of Python programming
- Understanding of linear algebra, probability, and statistics
- Familiarity with machine learning basics
- Exposure to regular expressions and basic linguistics (helpful but not mandatory)

Pedagogy / Teaching Methodology:

- ✓ Hands-on coding exercises using NLTK, spaCy, and Hugging Face
- ✓ Project-based learning for NLP applications (chatbots, sentiment analysis)
- ✓ Real-time demos and notebook-based tutorials
- ✓ Group activities for multilingual data challenges

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Natural Language Processing Specialization – DeepLearning.AI
2. Fast.ai: NLP Course
3. Hugging Face: Transformers Course
4. NPTEL: Natural Language Processing by Prof. Pushpak Bhattacharyya

Suggested Readings:

- Daniel Jurafsky and James H. Martin, *Speech and Language Processing*, Pearson
- Steven Bird, Ewan Klein, and Edward Loper, *Natural Language Processing with Python* (O'Reilly, NLTK Book)
- Yoav Goldberg, *Neural Network Methods in Natural Language Processing*, Morgan & Claypool
- Chris Manning, Hinrich Schütze, *Foundations of Statistical Natural Language Processing*, MIT Press

Recommended Software/Tools:

1. **Python Libraries**: NLTK, spaCy, Scikit-learn, Gensim, TextBlob, Transformers (Hugging Face)
2. **Development Tools**: Jupyter Notebook, Google Colab, VS Code
3. **Visualization**: WordCloud, Matplotlib, Seaborn
4. **Datasets & Corpora**: IMDB, SQuAD, Indian language datasets (AI4Bharat, IndicNLP)
5. **APIs/Platforms**: OpenAI API, Hugging Face Model Hub, Google Translate API

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	–	3	2	2	1	2
CO2	2	3	2	3	–	2	2	2	2	3
CO3	2	2	3	2	1	–	–	1	2	3
CO4	2	3	3	3	–	–	–	2	2	3
CO5	3	3	3	2	–	–	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title	Advanced Software Development Practices
Course Code	25VBT0C503
Semester	V
Credits	2
Course Type	Skill Enhancement Course
Learning Hours	60
Live Sessions	12 hours

Course Description

This course introduces advanced principles, methodologies, and tools essential for modern software development. Emphasizing Agile methodologies, clean coding practices, scalable architecture, DevOps integration, quality assurance, and security, it equips learners with industry-ready skills to design, develop, and manage robust software systems.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Apply software development principles to design scalable and maintainable applications.	L3
CO2	Analyze software design patterns and architecture to solve real-world problems.	L4
CO3	Employ modern tools and practices such as version control, CI/CD, and testing in the development process.	L4
CO4	Demonstrate team collaboration, documentation, and agile methodologies in software projects.	L3
CO5	Evaluate software quality attributes including performance, security, and usability.	L5

Course Modules

No. of Hours: 12

Module 1: Foundations of Modern Software Development
Scope of Module: This module introduces the evolution of software development practices and explores traditional and modern

software life cycle models. It also emphasizes Agile methodologies, focusing on the Scrum framework and real-world team roles.
Topics: History and evolution of software development, software development methodologies including Waterfall, Iterative, Spiral and V-Model, Agile manifesto and principles, introduction to Scrum including roles, ceremonies and artifacts, product backlog, sprint planning and burndown charts, comparison between Agile and traditional models, case study on Scrum in practice
Learning Outcome: - *Learning Outcome: - Explain the evolution of software development practices and their implementation using traditional SDLC models and Agile methodologies.*

No. of Hours: 12

Module 2: Designing Scalable and Maintainable Software
Scope of Module: This module focuses on the planning and design phase of software development. It covers capturing system requirements and applying design principles and architecture models that ensure maintainability and scalability.
Topics: Functional and non-functional requirements, requirement elicitation techniques including interviews, surveys and use cases, requirement specification and validation, SOLID principles, DRY and KISS principles, cohesion and coupling, modular design, refactoring strategies, architectural patterns including MVC, layered and microservices, system requirement and design documentation
Learning Outcome: - *Learning Outcome: Apply design principles and architecture models to create maintainable and scalable software solutions.*

No. of Hours: 12

Module 3: Practical Tools for Development and Quality Assurance
Scope of Module: This module introduces essential tools and techniques for writing efficient, testable, and reusable code. Students explore version control systems, reusable design patterns, and automated testing strategies.
Topics: Design patterns including Factory, Singleton, Observer and Strategy, advantages of design patterns in real-world applications, Git basics including initializing, cloning, committing and pushing repositories, branching and merging, resolving conflicts and using GitHub for collaboration, unit testing concepts, test-driven development including Red-Green-Refactor cycle, testing frameworks like JUnit and PyTest, test coverage analysis
Learning Outcome: - *Learning Outcome: Use design patterns, version control, and TDD practices to improve code quality and development efficiency.*

No. of Hours: 12

Module 4: DevOps Integration and Agile Project Management
Scope of Module: Students will learn how to automate software build and deployment processes using DevOps tools and manage Agile projects using tracking tools.
Topics: DevOps culture and principles, CI/CD concepts and benefits, setting up CI/CD pipelines using Jenkins or GitHub Actions, Infrastructure as Code tools and principles, Agile project management using Jira and Trello, sprint planning and backlog grooming, progress tracking using Kanban boards and velocity charts, team collaboration and documentation techniques
Learning Outcome: - *Learning Outcome: Integrate DevOps automation tools and Agile project management platforms to enhance software delivery efficiency.*

No. of Hours: 12

Module 5: Software Security, Quality, and Project Implementation
Scope of Module: This final module prepares students to deliver secure, high-quality software by integrating secure coding principles, evaluating software performance, and implementing a capstone mini project.
Topics: Secure coding principles and OWASP Top 10, input validation and secure authentication, software quality attributes including reliability, maintainability and usability, code quality metrics such as code coverage, defect density and cyclomatic complexity, software documentation including README, code comments and user manuals, project planning steps including defining scope, scheduling and risk management, preparing and presenting final deliverables, peer review and reflection
Learning Outcome: - *Learning Outcome: Apply quality and security practices to implement a complete mini software project with proper documentation and reporting.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic knowledge of programming (Java/Python recommended)
- Familiarity with object-oriented principles
- Understanding of software development lifecycle concepts

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for version control, CI/CD pipelines, and Agile project tools
- ✓ Group-based mini software projects
- ✓ Live coding sessions and design pattern workshops
- ✓ Sprint-based evaluations and peer reviews
- ✓ Practical demos using industry-standard tools

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Agile Software Development – University of Minnesota
2. Udacity: Agile Software Development
3. edX: DevOps Practices and Tools – Linux Foundation
4. GitHub Learning Lab: Intro to GitHub

Suggested Readings:

- Robert C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, Prentice Hall
- Erich Gamma et al., *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison-Wesley
- Gene Kim, Jez Humble, and Patrick Debois, *The DevOps Handbook*, IT Revolution
- Martin Fowler, *Refactoring: Improving the Design of Existing Code*, Addison-Wesley

Recommended Software/Tools:

8. **Version Control:** Git, GitHub
9. **Testing Tools:** JUnit, PyTest
10. **CI/CD:** Jenkins, GitHub Actions
11. **Agile Management Tools:** Jira, Trello
12. **Code Analysis:** SonarQube, Codacy
13. **Development Environments:** VS Code, IntelliJ IDEA, Eclipse
14. **Documentation:** Markdown, Doxygen, Swagger

Curriculum Development:

Sl.No	Identify and highlight in the module

1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	–	3	2	3	2	2
CO2	2	2	3	3	–	3	2	3	3	3
CO3	2	2	2	2	1	–	–	–	2	3
CO4	2	3	3	3	–	–	–	2	2	3
CO5	3	3	3	2	–	–	–	2	3	3
Articulation	2.2	2.4	2.6	2.6	1	3	2	2.5	2.4	2.8

Semester VI

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Course Title	Artificial Intelligence
Course Code	25VBT2E601
Semester	VI
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course offers an in-depth study of Artificial Intelligence concepts, search techniques, knowledge representation, uncertainty modeling, machine learning, neural networks, and reinforcement learning. It covers key principles and modern trends in AI with practical insights into building intelligent systems and decision-making models.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Comprehend the key concepts related to the AI field and its role in emerging trends and technology	L2
CO2	Identify the different AI techniques such as Search Methodologies, Reasoning, Problem Solving	L3
CO3	Implement a program in AI using Neural Networks and Activation Functions	L4
CO4	Design and implement appropriate AI solution techniques for problems	L5
CO5	Analyze the computational trade-offs involved in executing different AI models and principles	L4

Course Modules

No. of Hours: 24

Module 1: Foundations of Artificial Intelligence

Scope of Module: This module introduces AI, problem solving techniques, intelligent agents, and classical search strategies.
Topics: Current trends in AI, intelligent agents and environments, problem-solving agents, knowledge and reasoning in AI, forms of learning, problem formulation, uninformed and informed search strategies, heuristic functions, local search algorithms, optimization, nondeterministic and partial observation search
Learning Outcome*: Comprehend Artificial Intelligence and different terminologies and apply classical search techniques for problem solving*

No. of Hours: 24

Module 2: Logic and Knowledge Representation
Scope of Module: This module covers logical reasoning techniques and knowledge-based systems.
Topics: Adversarial search, game playing and alpha-beta pruning, logical agents and propositional logic, knowledge-based agents, theorem proving, model checking, first-order logic: syntax, semantics, forward and backward chaining, resolution, ontological engineering, default reasoning, category-based reasoning, event modeling.
Learning Outcome*: Apply logical reasoning and knowledge representation for AI-based decision systems*

No. of Hours: 24

Module 3: Reasoning Under Uncertainty
Scope of Module: This module explores probabilistic reasoning and handling uncertainty in AI systems.
Topics: Quantifying uncertainty, basic probability notation, joint distributions, Bayes' theorem, independence, probabilistic models, Bayesian networks, conditional distributions, first-order probabilistic models, acting under uncertainty, application of probabilistic reasoning in AI
Learning Outcome*: Use probabilistic reasoning to represent and analyze uncertain environments in AI applications*

No. of Hours: 24

Module 4: Learning Models and Neural Networks
Scope of Module: This module introduces machine learning approaches and neural network models.
Topics: Forms of learning, supervised learning, theory of learning, non-parametric models, SVM, ensemble learning,

neural network architecture, biological analogy, activation functions, gradient descent, CNNs, RNNs, backpropagation, model evaluation, hyperparameter tuning, network optimization, ANN-based applications
Learning Outcome: *Design and implement neural network-based models for predictive and classification tasks.*

No. of Hours: 24

Module 5: Reinforcement Learning and Intelligent Systems
Scope of Module: This module covers reinforcement learning, AI applications, and intelligent systems.
Topics: Introduction to reinforcement learning, passive vs active learning, generalization, policy search, real-time decision making, expert systems:(Jupyter and PyCharm) development stages, challenges, applications, swarm intelligence, evolutionary programming, AI in robotics, NLP, speech recognition, machine translation, structural object recognition, explainable AI.
Learning Outcome: *Apply reinforcement learning and develop intelligent system architectures for real-world scenarios.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:
- ➢ Familiarity with programming (preferably Python)
- ➢ Basic knowledge of discrete mathematics and logic
- ➢ Understanding of probability and linear algebra fundamentals

Pedagogy / Teaching Methodology:
- ✓ Conceptual explanation followed by practical coding exercises
- ✓ Hands-on implementation using Python (Jupyter, PyCharm)
- ✓ Lab sessions and quizzes for each module

✓ Use of simulations and visualizations for learning reinforcement
✓ Mini-projects and real-world AI case studies

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Artificial Intelligence by Stanford (CS221 – Lecture Notes)
   https://see.stanford.edu/Course/CS221
2. Elements of AI (University of Helsinki)
   https://www.elementsofai.com/
3. AI for Everyone by Andrew Ng (Coursera)
   https://www.coursera.org/learn/ai-for-everyone
4. Practical Deep Learning for Coders (fast.ai)
   https://course.fast.ai/

Suggested Readings:

- Stuart Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson
- Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press
- Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning*, MIT Press
- Sebastian Raschka, *Python Machine Learning*, Packt Publishing
- OpenAI and DeepMind Research Papers
- MIT OpenCourseWare: https://ocw.mit.edu
- KDnuggets and TowardsDataScience.com

Recommended Software/Tools (If applicable):

1. Python (Anaconda Distribution)
2. Jupyter Notebook and PyCharm
3. Scikit-learn, NumPy, Pandas, Matplotlib
4. TensorFlow and Keras
5. Google Colab for cloud-based experiments
6. Weka (for basic rule-based and probabilistic models)

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)

6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	1	2	1	3
CO2	1	3	3	2	2	2	1	2	1	3
CO3	3	–	3	3	3	2	1	2	2	3
CO4	2	3	3	3	3	2	1	2	2	3
CO5	3	3	1	3	3	2	2	3	3	3
Articulation	2.4	3	2.4	2.6	2.6	2.2	1.2	2.2	1.8	3

Course Title	Time Series Analysis
Course Code	25VBT2E602
Semester	VI
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course introduces the concepts, methods, and applications of Time Series Analysis in the context of data analytics. Students will explore patterns and structures in temporal data, learn forecasting techniques, understand model diagnostics, and apply statistical and machine learning approaches to real-world time-dependent datasets.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic concepts and components of time series data	L2
CO2	Apply techniques to visualize and decompose time series for trend and seasonality	L3
CO3	Build and evaluate forecasting models using classical methods	L4
CO4	Use statistical and machine learning techniques for time series prediction	L4
CO5	Analyze real-world time series datasets and draw meaningful conclusions	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Time Series and Components
Scope of Module: This module covers the foundations of time series data and introduces its key components, helping learners differentiate between types of time series and identify trends, cycles, and seasonality.

Topics: Definition and types of time series including univariate and multivariate, components of time series including trend, seasonal, cyclical and irregular components, additive and multiplicative models, importance of temporal order in forecasting, distinction between time series and cross-sectional data, graphical visualization using line plots and seasonal plots, real-life applications in finance, weather and sales analytics, stationarity and its importance
***Learning Outcome:* -** *Understand the basic concepts, structures, and components of time series data.*

No. of Hours: 24

Module 2: Visualization, Transformation, and Decomposition
Scope of Module: This module focuses on techniques for preparing and exploring time series data. It also covers methods for stabilizing variance and decomposing series into components.
Topics: Time plots using pandas and matplotlib, lag plots and autocorrelation plots, moving averages including simple and weighted, exponential smoothing and Holt's method, transformation techniques including logarithmic and square root transformations, differencing to achieve stationarity, additive and multiplicative decomposition models, decomposition using STL in Python, visualization of trend, seasonal and residual components
***Learning Outcome*: -** *Apply time series visualization and decomposition techniques to extract meaningful insights.*

No. of Hours: 24

Module 3: Autocorrelation and Classical Forecasting Models
Scope of Module: This module introduces key statistical models for forecasting time series data, including methods for identifying model structure and evaluating predictions.
Topics: Autocorrelation and partial autocorrelation functions, ACF and PACF plots and interpretation, identifying AR, MA, and ARMA models, autoregressive (AR) model estimation, moving average (MA) model formulation, ARMA combination model, ARIMA model construction including p, d, q identification, seasonal ARIMA (SARIMA) extension, model selection using AIC and BIC, residual *diagnostics and forecasting*
***Learning Outcome:* -** *Build and evaluate ARIMA-based time series models for forecasting applications.*

No. of Hours: 24

Module 4: Machine Learning for Time Series
Scope of Module: This module introduces modern machine learning techniques adapted for time series analysis, focusing on feature engineering, model training, and prediction.
Topics: Time-based train-test split, feature engineering including lag features and rolling statistics, supervised learning

with regression models, decision tree and random forest regression, evaluation metrics including MAE, RMSE and MAPE, importance of cross-validation for time series, introduction to ensemble models, visualizing model performance, strengths and limitations of machine learning approaches in temporal data
Learning Outcome: - *Use machine learning models to build predictive systems using time series datasets.*

No. of Hours: 24

Module 5: Case Studies and Advanced Topics
Scope of Module: This final module explores advanced forecasting methods and real-world applications of time series. It includes hands-on case studies from various domains.
Topics: Overview of LSTM and deep learning models for sequential data, sequence-to-sequence forecasting concepts, working with time series in Python using pandas and statsmodels, importing datasets and datetime indexing, resampling and frequency conversion, real-world case studies including sales forecasting, stock market analysis, and weather prediction, end-to-end project planning and reporting, interpreting and presenting results for decision making
Learning Outcome: - *Analyze real-world time series problems using advanced tools and complete project workflows.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- ➢ Basic knowledge of statistics and probability
- ➢ Familiarity with Python programming
- ➢ Understanding of regression and data visualization techniques

Pedagogy / Teaching Methodology:

- ✓ Concept-based teaching with real-world time series data

✓ Hands-on implementation using Python (pandas, statsmodels)
✓ Lab assignments and small projects
✓ In-class analysis using Jupyter Notebooks and Google Colab
✓ Quizzes and short assessments after each module

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Time Series Forecasting (Coursera – University of Colorado Boulder)
   https://www.coursera.org/learn/time-series-forecasting
2. Applied Time Series Analysis (LinkedIn Learning)
   https://www.linkedin.com/learning/applied-time-series-analysis
3. Time Series Analysis with Python (Datacamp)
   https://www.datacamp.com/courses/time-series-analysis-in-python
4. Forecasting Principles and Practice by Hyndman (Online Book)
   https://otexts.com/fpp3/

Suggested Readings:

- Chris Chatfield, *The Analysis of Time Series*, Chapman and Hall
- Rob J. Hyndman & George Athanasopoulos, *Forecasting: Principles and Practice*, OTexts
- James D. Hamilton, *Time Series Analysis*, Princeton University Press
- Practical Time Series Analysis by Aileen Nielsen, O'Reilly
- Hands-On Time Series Analysis with Python by B V Vishwas

Recommended Software/Tools (If applicable):

1. Python (Jupyter Notebook, Google Colab)
2. Pandas, NumPy, Statsmodels
3. Matplotlib, Seaborn
4. scikit-learn for ML models
5. TensorFlow/Keras for LSTM (if applicable)

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	–	3	2	2	1	2
CO2	2	3	2	3	–	2	2	2	2	3
CO3	2	2	3	2	1	–	–	1	2	3
CO4	2	3	3	3	–	–	–	2	2	3
CO5	3	3	3	2	–	–	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title	Data Mining Techniques
Course Code	25VBT2E603
Semester	VI
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course introduces the concepts, methodologies, and tools used in extracting meaningful patterns and knowledge from large data sets. Students will explore the data mining process including data preparation, classification, clustering, association rule mining, anomaly detection, and real-world applications with industry tools.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic concepts, tasks, and architecture of data mining systems	L2
CO2	Apply data preprocessing techniques for quality data input in mining tasks	L3
CO3	Implement classification and clustering algorithms for knowledge extraction	L4
CO4	Analyze association rules and pattern discovery techniques	L4
CO5	Evaluate data mining techniques in real-world domains like web, text, and business analytics	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Data Mining and Tasks
Scope of Module: This module introduces the fundamentals of data mining and explains the types of problems it solves, highlighting different approaches, system architecture, and real-world relevance.

Topics: Definition and scope of data mining, data mining vs database systems, knowledge discovery in databases (KDD) process, architecture of data mining systems, predictive and descriptive tasks, classification, clustering, association rule mining, anomaly detection, evaluation of patterns and models, real-life applications in finance, marketing and health analytics
***Learning Outcome**: Understand the core concepts, tasks, and scope of data mining and its relevance in various domains.*

No. of Hours: 24

Module 2: Data Preparation and Warehousing for Mining
Scope of Module: This module focuses on preparing data for analysis, covering data cleaning, transformation, and warehousing concepts needed for efficient and accurate mining.
Topics: Data cleaning techniques for missing and noisy data, data integration from multiple sources, data transformation including normalization and standardization, data reduction and dimensionality reduction, attribute selection and data discretization, introduction to data warehousing, OLAP operations including roll-up, drill-down and slice-and-dice, star and snowflake schemas, data cube design
***Learning Outcome:** Apply data preprocessing and warehousing strategies to prepare quality datasets for mining.*

No. of Hours: 24

Module 3: Classification Algorithms and Evaluation
Scope of Module: This module explores classification algorithms and model evaluation techniques used to predict categorical outcomes based on labeled training data.
Topics: Decision tree construction using ID3 and C4.5 algorithms, pruning strategies for decision trees, Naive Bayes classification, K-nearest neighbors (KNN) algorithm, confusion matrix, performance metrics including precision, recall, accuracy and F1-score, ROC curve analysis, model validation using cross-validation and holdout sets, comparison of classification techniques
***Learning Outcome**: Implement and evaluate classification models to extract meaningful patterns from data.*

No. of Hours: 24

Module 4: Association and Clustering Techniques
Scope of Module: This module covers unsupervised learning techniques including mining association rules and clustering data without predefined labels.
Topics: Market basket analysis, Apriori algorithm for frequent itemsets, support and confidence measures, FP-growth

algorithm, lift and conviction for rule interestingness, partition-based clustering using K-means, hierarchical clustering using dendrograms, distance metrics and similarity measures, density-based clustering with DBSCAN, cluster quality evaluation using silhouette score and intra-cluster distance
Learning Outcome: *Extract associations and natural groupings from data using rule mining and clustering techniques.*

No. of Hours: 24

Module 5: Advanced Topics and Real-World Applications
Scope of Module: This module explores advanced topics and tools in data mining including anomaly detection, web and text mining, and hands-on case studies from various industries.
Topics: Outlier detection using statistical and distance-based approaches, introduction to web and text mining, TF-IDF for text representation, mining unstructured and semi-structured data, overview of data mining tools including Weka, Orange and RapidMiner, Python libraries for mining including scikit-learn and pandas, business case studies on churn prediction, fraud detection and recommendation systems, mining workflow design and reporting
Learning Outcome: *Apply data mining tools and techniques to solve complex real-world problems across domains.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites:

- Basic knowledge of databases and SQL
- Familiarity with statistics and probability
- Introduction to Python programming and libraries like pandas

Pedagogy / Teaching Methodology:

✓ Concept-based teaching with real-world datasets
✓ Hands-on exercises using Python, Weka, and RapidMiner
✓ Lab-based assignments and tool walkthroughs
✓ Small projects in clustering, classification, and association rule mining
✓ Formative assessments after each module

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. Data Mining Specialization – University of Illinois (Coursera)
   https://www.coursera.org/specializations/data-mining
2. Practical Data Mining – FutureLearn
   https://www.futurelearn.com/courses/practical-data-mining
3. Data Mining with Weka – University of Waikato
   https://www.cs.waikato.ac.nz/ml/weka/mooc/
4. Machine Learning with Python – IBM (Coursera)
   https://www.coursera.org/learn/machine-learning-with-python

Suggested Readings:

- Jiawei Han, Micheline Kamber, *Data Mining: Concepts and Techniques*, Morgan Kaufmann
- Pang-Ning Tan, Michael Steinbach, *Introduction to Data Mining*, Pearson
- Mehmed Kantardzic, *Data Mining: Concepts, Models, Methods, and Algorithms*, Wiley
- Ian H. Witten, *Data Mining: Practical Machine Learning Tools and Techniques*, Elsevier
- Charu C. Aggarwal, *Data Mining: The Textbook*, Springer

Recommended Software/Tools (If applicable):

1. Weka
2. RapidMiner
3. Orange
4. Python (pandas, scikit-learn, matplotlib, seaborn)
5. Jupyter Notebooks / Google Colab

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)

6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	–	3	2	2	1	2
CO2	2	3	2	3	–	2	2	2	2	3
CO3	2	2	3	2	1	–	–	1	2	3
CO4	2	3	3	3	–	–	–	2	2	3
CO5	3	3	3	2	–	–	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title	R Programming
Course Code	25VBT2E604
Semester	VI
Credits	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course introduces the R programming language for data analysis, statistics, and visualization. It covers basic syntax, data types, control structures, data handling, graphical techniques, and statistical modeling, equipping learners with the programming and analytical skills to work with real-world data using R.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the fundamentals of R programming, syntax, and environment setup	L2
CO2	Write R programs using control structures, functions, and data structures	L3
CO3	Perform data manipulation, visualization, and basic statistical analysis using R	L3
CO4	Implement data analysis workflows using R packages and tools	L4
CO5	Apply R for solving real-world data science and analytics problems	L

Course Modules

No. of Hours: 24

Module 1: Basics of R Programming

Scope of Module: This module covers the basic syntax and foundational elements of R, including data types, expressions, and operators necessary for basic programming.
Topics: Introduction to R and RStudio environment, writing and executing R scripts, built-in functions and help features, R data types including numeric, character, logical and factor, declaring variables and constants, type conversion and coercion, arithmetic, relational and logical operators, expression evaluation and precedence rules

Learning Outcome: - Understand the core syntax, environment, and basic data handling features in R

No. of Hours: 24

Module 2: Control Structures, Functions, and Data Structures

Scope of Module:
This module covers control structures for decision-making and looping, as well as the creation and use of functions, vectors, lists, matrices, arrays, and data frames.

Topics:
Conditional statements including if, else and switch, looping using for, while and repeat, using break and next, creating and calling functions, function arguments and return values, scope and environments, vector operations and indexing, list creation and access, matrix construction and arithmetic, array handling and dimensional access, creating and modifying data frames, accessing rows and columns, factor levels and usage

Learning Outcome: - Use control structures, custom functions, and core data structures to write modular R programs

No. of Hours: 24

Module 3: File Handling and Data Manipulation

Scope of Module:
This module introduces data import and export, and manipulation using tidyverse packages to clean, transform, and summarize data.

Topics:
Reading and writing CSV, TXT and Excel files, using read.csv, read.table and write functions, handling file paths and encodings, using dplyr verbs including select, filter, arrange, mutate and summarise, using group_by and pipe operators, joining datasets, reshaping data with tidyr using spread and gather, handling missing data and NA values

Learning Outcome: - Read, clean and manipulate datasets using base R and tidyverse packages

No. of Hours: 24

Module 4: Data Visualization and Statistical Analysis

Scope of Module:
This module covers graphical techniques for data exploration and basic statistical techniques for inference and prediction.

Topics:
Introduction to ggplot2 and grammar of graphics, creating bar charts, histograms, boxplots and scatterplots, customizing aesthetics, themes and labels, descriptive statistics, probability distributions including normal, binomial and Poisson, hypothesis testing using t-test and chi-square, correlation and regression analysis, interpreting model output and assumptions

***Learning Outcome:* -** Create meaningful visualizations and perform basic statistical analyses using R.

No. of Hours: 24

Module 5: Advanced Topics and Real-world Applications

Scope of Module:
This module includes time series and project-based learning where students solve real-world problems and present insights using R.

Topics:
Working with date and time in R, time series object creation and visualization, simple moving averages and smoothing techniques, creating custom R scripts and sourcing external files, debugging with traceback and tryCatch, best coding practices and documentation, capstone project planning, selecting datasets and defining objectives, exploratory data analysis, reporting *and presenting results using R Markdown*

***Learning Outcome:* -** Apply R programming to solve real-world data problems through structured projects

Module	No of Pre Recordings
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites:
- ➢ Basic knowledge of programming concepts
- ➢ Understanding of data structures and logic
- ➢ Familiarity with statistics and data analysis

Pedagogy / Teaching Methodology:
- ✓ Hands-on R programming with real datasets
- ✓ Live demonstrations using RStudio
- ✓ Mini-projects and case studies for each module
- ✓ Formative quizzes and code reviews
- ✓ Use of R Markdown for reporting assignments

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. R Programming – Johns Hopkins University (Coursera)
   https://www.coursera.org/learn/r-programming
2. Introduction to R – DataCamp
   https://www.datacamp.com/courses/free-introduction-to-r
3. R Basics – edX (Harvard University)
   https://online-learning.harvard.edu/course/r-basics
4. Introduction to Data Science with R – Udacity
   https://www.udacity.com/course/intro-to-data-science--ud359

Suggested Readings:

- Garrett Grolemund, *Hands-On Programming with R*, O'Reilly
- Hadley Wickham, *R for Data Science*, O'Reilly
- Norman Matloff, *The Art of R Programming*, No Starch Press
- Tilman M. Davies, *The Book of R*, No Starch Press
- Michael J. Crawley, *The R Book*, Wiley

Recommended Software/Tools (If applicable):

1. R
2. RStudio
3. tidyverse
4. ggplot2
5. R Markdown

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	–	2	2	2	1	2
CO2	2	3	2	3	–	2	2	2	2	3
CO3	2	2	3	2	1	–	–	1	2	3

CO4	2	3	3	3	–	–	–	2	2	3
CO5	3	3	3	2	–	–	2	2	3	3

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ELECTIVE:

Cyber Security

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Semester-1

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBX0AE101	English	AECC	30	70	4
25VBT0C102	Fundamentals of Mathematics	CC	30	70	4
25VBT0C103	Problem Solving using C	CC	30	70	4
25VBT0C104	Computer Architecture	CC	30	70	4
26VBX0S105	Essentials of Generative AI	SEC	100	-	2
25VBT0L101	Problem Solving using C Lab	SEC	100	-	1
Total No of Credits					**19**

Semester-2

Course code	Course Name	Course category	CA	ESE	Credits
25VBX0AE205	Communicative English	AECC	30	70	4
25VBT0C201	Operating System	CC	30	70	4
25VBT0C202	Data Structures using C	CC	30	70	4
25VBT0C203	Relational Database Systems	CC	30	70	4
25VBT0L201	Data Structures using C Lab	SEC	100	-	1
25VBT0L202	Relational Database Systems Lab	SEC	100	-	1
Total No of Credits					**18**

Semester-3

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C301	Python Programming	CC	30	70	4
25VBT0C302	Design and Analysis of Algorithms	CC	30	70	4
25VBT0C303	Software Engineering	CC	30	70	4
25VBT0C304	Computer Networks	CC	30	70	4
25VBT0C305	Environmental, Social, and Governance (ESG) in IT	AECC	30	70	3
25VBT0L301	Python Programming Lab	SEC	100	-	1
25VBT0L302	Design and Analysis of Algorithms Lab	SEC	100	-	1
Total No of Credits					**21**

Semester-4

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C401	Web Technologies *	CC	30	70	4
25VBT0C402	Java Programming *	DSE	30	70	4
25VBT4E403	Network Security & Cryptography	DSE	30	70	4
25VBT4E404	Web Application Security	DSE	30	70	4
25VBT0C404	Quantitative Techniques	GE	30	70	3
25VBT0L401	Web Technologies Lab	SEC	100	-	1
25VBT0L402	Java Programming Lab	SEC	100	-	1
Total No of Credits					**21**

Semester-5

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBT0C501	Blockchain Technologies	CC	30	70	4
25VBT4E502	Machine Learning Techniques	DSE	30	70	4
25VBT4E503	Digital Forensics	DSE	30	70	4
25VBT4E504	Defensive Cyber Security Technologies	DSE	30	70	4
25VBT4E505	Cyber Threat Intelligence	DSE	30	70	4
25VBT0C503	Advanced Software Development Practices	SEC	30	70	2
Total No of Credits					**22**

Semester-6

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBT4E602	Cloud Security	DSE	30	70	4
25VBT4E603	Penetration Testing	DSE	30	70	4
25VBT4E604	Ethical Hacking	DSE	30	70	4
25VBT0P605	Project *	DSE			6
Total No of Credits					**22**

Legend

CC	Core Course

DSE	Discipline-Specific Elective
SEC	Skill Enhancement Courses
AECC	Ability Enhancement Compulsory Course
GE	Generic Elective

Detailed Syllabus

Semester I

Common Courses

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Course Title:	English
Course Code:	**25VBX0AE205**
Semester:	**I**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
Live Session	**12 hours**

Course Description:

This course introduces learners to literature, rhetorical practices, grammar, and academic writing. Through engagement with poetry, prose, drama, and structured writing tasks, students will gain foundational skills in critical reading, effective communication, and literary appreciation.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Examine literary texts in historical contexts and be sensitive to their social relevance	L4
CO2	Explain the process of communicating and interpreting human experiences from different cultures through literary representations	L2
CO3	Gain practical knowledge in the correct use of grammatical elements to express in English	L3
CO4	Appraise the art of rhetoric through speech and writing	L5
CO5	Develop higher order language skills, such as reading and writing, through texts centered on diverse themes and topics in literature	L6

Course Module

No. of Hours:24

Module 1: Foundations of Literature and Language
Scope of Module:

Explore how literature reflects language and meaning, and how rhetoric is constructed in influential speeches.
Topics: Literal and metaphorical meanings in literature, Shakespeare's Sonnet 18, Robert Frost's *Stopping by Woods on a Snowy Evening*, introduction to rhetoric, Aristotle's modes of appeal, discourse analysis, Martin Luther King Jr.'s *I Have a Dream* speech, oratory and audience connection, speeches of Brutus and Mark Antony.
Learning Outcome: *Comprehend concrete and abstract meanings of words and phrases, and discuss rhetorical construction of speeches.*

No. of Hours:24

Module 2: Poetic and Prose Expressions
Scope of Module: Analyze language symbolism, Indian English poetry, and the art of prose expression.
Topics: Symbolism in poetry, Blake's *The Tyger*, Hughes' *Hawk Roosting*, early Indian English poetry and themes, Sarojini Naidu's *In Salutation to the Eternal Peace*, Nissim Ezekiel's *The Professor*, prose as a distinct form, types and function of prose, Bertrand Russell's *In Praise of Idleness*.
Learning Outcome: *Explain poetic symbolism, and examine Indian and Western prose for theme and style.*

No. of Hours:24

Module 3: Grammar and Sentence Structuring
Scope of Module: Explore grammatical concepts, including sentence construction, reported speech, and paragraph writing.
Topics: Phrases, clauses, sentence types, components of a sentence, active and passive voice, conversion rules, reported speech, simple, compound, complex sentence structures, linkers, synthesis, transformation, paragraph structure and types, examples from literature.
Learning Outcome: *Demonstrate grammatical proficiency, including sentence synthesis and paragraph writing.*

No. of Hours:24

Module 4: Argumentation and Debate
Scope of Module: Develop structured argumentative and debating skills using classical and contemporary contexts.
Topics: Structure of argument (claim, reason, support, warrant), logical flow, Frederick Copleston vs Bertrand Russell radio debate, elements of a good case, defense and rebuttal strategies, importance of debate, analyzing contemporary topics.
Learning Outcome: *Develop an understanding of logical argumentation and apply strategies for debate*

No. of Hours:24

Module 5: Essay Writing and Text Performance
Scope of Module: Explore essay forms, dramatic theory, and literary performance in Western and Indian contexts.
Topics: Essay types – compare and contrast, cause and effect, Feynman's *The Value of Science*, Chesterton's *On Running After One's Hat*, Charles Lamb's *Dream Children: A Reverie*, dramatic theory by Aristotle and Bharata, Vijay Tendulkar's *Silence! The Court is in Session.*
Learning Outcome: *Appraise techniques for academic and personal essay writing, and analyze dramatic forms across cultures.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.

- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

7. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
8. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
9. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings:

Book

- Gupta, S. C. (2018). Comprehensive English Grammar & Composition. Arihant Prakashan

Online Articles, Journals, and Whitepapers

- British Council Learn English Articles, JSTOR Language and Literature Studies, Routledge Journals on Rhetoric and Composition

Web-based Resources

- Grammarly Handbook, Purdue OWL, YouTube Channels on Poetry in Performance, Project Gutenberg Literature Database

Recommended Software/Tools:

11. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
12. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
13. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
14. **Miro** – for mind-mapping essay structures.
15. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above-mentioned points.

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	2	3	1	1	2	1	1
CO3	1	1	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	3	2	1	1	1	2	1
Articulation	1	1	1.4	1.8	2	1	1	1.2	1.2	1

Note: The Articulation is indicative of how a particular course maps to a PO.

Articulation is calculated as:

$$= \frac{\text{Sum of CO Mappiung Levels for a perticular PO}}{\text{No.of COs that mapped to that PO}}$$

Example:1

$$Articulation\ of\ \boldsymbol{PO1} = \frac{(3+2+3+2+3)}{5} = 2.6$$

Example: 2

$$Articulation\ of\ \boldsymbol{PO7} = \frac{(1+1)}{2} = 1.0$$

Course Title:	Fundamentals of Mathematics
Course Code:	**25VBT0C102**
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces foundational mathematical concepts essential for problem-solving and application in computing and data analysis. It includes matrix algebra, calculus, vector algebra, and 3-D geometry to develop logical reasoning and analytical abilities among students.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Learn to carry out matrix operations, including inverses and determinants, and solve systems of equations using multiple methods.	L3
CO2	Demonstrate the idea of differentiation from first principles and work with derivatives as rates of change in mathematical models.	L3
CO3	Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions.	L4
CO4	Demonstrate vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.	L3
CO5	Apply matrix theory for solving systems of linear equations and compute eigenvalues and eigenvectors required for the matrix diagonalization process	L3

Course Modules

No. of Hours:24

Module 1: Matrices and Linear Algebra
Scope of Module: This module introduces students to matrix operations, properties of determinants, and methods for solving linear systems using algebraic and matrix techniques.
Topics: Types of matrices including row, column, diagonal, scalar, unit and zero matrices, algebra of matrices including addition, scalar multiplication and transpose, inverse of a matrix using elementary operations, definition and expansion of determinants up to 3x3, minors and cofactors, properties of determinants, adjoint and inverse of matrices, singular and non-singular matrices, consistency of linear systems, solving equations using Cramer's rule, matrix rank, echelon and normal form, solving linear systems using Gauss elimination, Gauss-Jordan, Gauss-Seidel and LU decomposition.
Learning Outcome: *Solve linear systems using matrix operations and analyze determinant-based consistency and inverse properties.*

No. of Hours:24

Module 2: Eigenvalues, Eigenvectors, and Vector Algebra
Scope of Module: This module explores the concepts of eigenvalues, eigenvectors, vector operations, and geometric representations of vectors in space.
Topics: Definition and computation of eigenvalues and eigenvectors, Rayleigh's power method for dominant eigenvalue, diagonalization of matrices, linear transformation and matrix reduction, types of vectors including unit, zero and position vectors, magnitude and direction of vectors, vector addition and scalar multiplication, dot product and its geometric meaning, projection of vectors, cross product and scalar triple product, area and volume calculation using vectors.
Learning Outcome: *Compute eigenvalues, eigenvectors, and apply vector operations in solving spatial problems and geometric modeling.*

No. of Hours:24

Module 3: Differential Calculus and Applications
Scope of Module: This module introduces the principles and rules of differentiation and applies them to various types of functions and curve-based problems.

Topics: Continuity of functions at a point and over intervals, derivatives of algebraic and trigonometric functions, exponential and logarithmic functions, derivatives of composite, inverse trigonometric and parametric functions, second-order derivatives, nth-order derivatives, and Leibnitz theorem, angle between curves and pedal equations, polar curve representations and applications.
Learning Outcome: *Apply differentiation techniques to model change, analyze polar curves, and solve advanced calculus problems.*

No. of Hours:24

Module 4: Integral Calculus and Vector Calculus
Scope of Module: This module focuses on integration methods, definite and indefinite integrals, and introductory vector calculus concepts.
Topics: Indefinite integrals using substitution, trigonometric identities, partial fractions and integration by parts, definite integrals and reduction formulae for powers of sine and cosine, vector function derivatives including velocity and acceleration, scalar and vector point functions, gradient, divergence, curl, Laplacian operators, solenoidal and irrotational vectors.
Learning Outcome: *Solve definite and indefinite integrals and apply differential vector calculus operators in applied mathematics.*

No. of Hours:24

Module 5: Three-Dimensional Geometry
Scope of Module: This module develops spatial reasoning through the study of 3D geometry including direction cosines, lines and planes.
Topics: Direction cosines and direction ratios, vector and cartesian equations of a straight line, angle between two lines, shortest distance between skew lines, vector and cartesian equations of planes, angle between two planes, coplanar lines and intersection of lines with planes.
Learning Outcome: *Analyze three-dimensional shapes using vector and cartesian methods and solve problems involving lines and planes in space.*

Module	**No. of Pre-Recordings**
1	10
2	12
3	10

4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic understanding of algebra and geometry from secondary education..

Pedagogy / Teaching Methodology:

- ✓ Conceptual and problem-based learning
- ✓ Interactive class exercises and proofs
- ✓ Assignments and quizzes using math software.

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Mathematics – I by Prof. Jitendra Kumar (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/111105038

6. Mathematics for Computer Science by MIT Open Courseware: https://ocw.mit.edu

Suggested Readings:

Book

- Applied Mathematics and Scientific Computing: International Conference on Advances in Mathematical Sciences, Vellore, India, December 2017 – Volume II (Trends in Mathematics), Springer, 2019

Online Articles, Journals, and Whitepapers

- Research articles from *SpringerLink*, *Mathematics Today*, and *Elsevier Journal of Mathematical Analysis*
- Whitepapers on matrix theory, calculus, and vector analysis from *AMS (American Mathematical Society)* and *SIAM (Society for Industrial and Applied Mathematics)*

Web-based Resources

- Khan Academy (topics: Calculus, Linear Algebra, Vectors, 3D Geometry
- MIT OpenCourseWare for Mathematics
- Interactive simulations and problem sets on Desmos, GeoGebra, and Brilliant.org.

Recommended Software/Tools (If applicable):

9. MATLAB/Octave
10. SageMath

11. Python (NumPy, Matplotlib)
12. GeoGebra for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	-	2	2	2	2	2
CO2	3	2	3	2	-	2	1	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.6	2.6	3	2.2	1	2	1.6	1.8	2.2	2.8

Course Title:	Problem Solving using C
Course Code:	25VBT0C103
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Session	**12 hours**

Course Description:
This course introduces students to the C programming language with an industry-focused approach. Emphasis is placed on problem-solving, structured programming, memory efficiency, and modular design. The course prepares students to handle real-world applications in embedded systems, system-level development, and performance-sensitive software solutions.

Course Outcomes(COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand and apply the core concepts of the C language including syntax, control flow, and data types.	L3
CO2	Develop modular and efficient code using functions, arrays, and structures.	L6
CO3	Manage memory effectively using pointers and dynamic memory allocation.	L3
CO4	Handle file operations and system-level programming tasks.	L3
CO5	Apply modern development tools, debugging practices, and implement mini-projects that solve real-world problems.	L6

Course Modules:

No. of Hours:24

Module 1: Programming Foundations and C Basics
Scope of Module: Introduce software concepts, basic C syntax, and structured programming methodology.

Topics: Role of programming in systems and embedded development, history and importance of C, variables, constants, keywords, data types, operators, input/output (printf, scanf, gets, puts), expressions, conditional statements (if, if-else, switch), looping (for, while, do-while), break, continue, goto, code documentation and commenting practices.
Learning Outcome :- *Implement basic control structures and understand the foundations of structured programming in C.*

No. of Hours:24

Module 2: Functions, Arrays and Strings
Scope of Module: Focus on modular programming and data handling through arrays and string operations.
Topics: Function declaration and definition, argument passing methods, recursion, return types, arrays (1D, 2D), basic algorithms (sorting, searching), string manipulation using standard functions, multidimensional string arrays, arrays in function arguments, memory usage with arrays.
Learning Outcome :- *Design modular programs using functions and implement logic-driven operations with arrays and strings.*

No. of Hours:24

Module 3: Structures, Unions, Pointers and Memory Management
Scope of Module: Introduce advanced C constructs for optimized data storage and dynamic memory operations.
Topics: Structures and nested structures, unions and memory overlap, arrays of structures, pointers: declaration, arithmetic, arrays with pointers, pointers to structures, dynamic memory (malloc, calloc, realloc, free), storage classes (auto, extern, static, register), pointer pitfalls and best practices.
Learning Outcome : *Apply pointer concepts and structured data storage to optimize program memory usage.*

No. of Hours:24

Module 4: File Systems, Command-Line Tools, and Build Automation
Scope of Module: Enable students to use persistent storage and build scalable projects using system-level tools.

Topics: Text and binary file handling (fopen, fclose, fread, fwrite, fprintf, fscanf), command-line argument usage, preprocessor directives (#define, #include, macros), header file creation, build tools (Makefile basics), version control systems (Git), compiler flags, debugging with gdb, introduction to CI/CD tools for C.
Learning Outcome: *Manage files, automate builds and integrate version control in a modern development pipeline.*

No. of Hours:24

Module 5: Industry Use Cases and Project-Based Application
Scope of Module: Apply knowledge in practical, time-bound projects aligned with industry-relevant themes.
Topics: Development of mini projects: menu-driven programs (e.g., ATM interface, student grade system), real-time input handling and validation, implementation of logging systems using file I/O, structuring code for modularity and readability, application testing using manual test cases, integration of Git for version tracking.
Learning Outcome: **-** *Design and deploy small-scale C projects using structured programming and version-controlled collaboration within limited timeframes.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Programming in C by Prof. Anupam Basu (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/106105085

Suggested Readings

Book

- Let Us C by Yashwant Kanetkar, 6th Edition, PBP Publication

Web-based Resources

- GeeksforGeeks – Advanced C tutorials
- OnlineGDB and HackerRank – Practice platforms
- GNU Compiler Collection (GCC) docs and POSIX C reference

Recommended Software/Tools (If applicable):

3. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	2	2	2	2
CO2	2	3	3	2	-	3	2	2	2	3
CO3	2	3	3	3	-	3	2	2	2	3
CO4	2	2	3	3	-	3	2	2	2	3
CO5	3	3	3	3	-	3	2	2	3	3

Articulation	2.4	2.6	2.8	2.6	1	2.8	2	2	2.2	2.8

Course Title:	Computer Architecture
Course Code:	25VBT0C104
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description

This course introduces students to the organization and architecture of computer systems. It covers internal structures, memory systems, I/O organization, instruction execution, and emerging processor technologies. The course develops analytical skills to evaluate hardware and architectural features in computing systems.

Course Outcomes(Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	To establish a strong foundation in principles and architectural concepts of computer systems.	L2
CO2	Gain insight on the functionality of different subsystems, such as the processor, input/output, and memory devices.	L3
CO3	Design and analyze simple arithmetic and logical units and their operations.	L3
CO4	Comprehend the concepts of parallel computing and hardware technologies.	L5
CO5	Develop insight into memory hierarchy and correlate with the concept of virtual and cache memory.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Structure and Instruction Set
Scope of Module: This module introduces basic components of computer systems, their instruction formats, and data representation.
Topics: Computer types, functional units, basic operational concepts, bus structures, instruction formats, number representation, arithmetic operations on signed and unsigned data, memory locations and addressing, memory read/write operations
Learning Outcome: *Develop insight on computer frameworks and identify the performance issues in computer systems*

No. of Hours:24

Module 2: Machine Instructions, I/O Systems, and Memory Organization
Scope of Module: This module explains instruction execution and system-level operations including input/output handling and memory management basics.
Topics: Addressing modes, assembly language instructions, input and output operations, subroutines, instruction encoding, accessing I/O devices, interrupt mechanism and hardware, direct memory access, standard I/O interfaces including PCI, SCSI and USB, basic memory organization including RAM, ROM, memory hierarchy principles, speed and cost trade-offs.
Learning Outcome: *Understand addressing techniques, memory operations, and standard interfaces for efficient I/O operations.*

No. of Hours:24

Module 3: Advanced Memory and Arithmetic Units
Scope of Module: This module introduces concepts of cache and virtual memory, logic gates and arithmetic units.
Topics: Cache memory organization and mapping techniques, replacement algorithms, performance optimization in cache, virtual memory and address translation, logic gates and flip flops, addition and subtraction of signed numbers, fast adder designs including carry look-ahead adder.
Learning Outcome: *Analyze the logic behind memory systems, understand arithmetic circuitry and apply memory design techniques.*

No. of Hours :24

Module 4: Instruction Processing and Parallel Architectures
Scope of Module: This module describes instruction execution cycles, control design, pipelining and modern parallel processing concepts.
Topics: Basic processing unit design, instruction execution steps, multiple bus organization, hardwired and microprogrammed control, pipelining basics, instruction hazards, data hazards, impact on instruction sets, parallel computer models including multiprocessors and multicomputers, PRAM and VLSI models.
Learning Outcome: *Analyze execution flow and design of control units, and explore the foundations of parallel computer architectures.*

No. of Hours :24

Module 5: Performance, Processor Technologies and Storage
Scope of Module: This module addresses performance metrics, advanced processor types, scalable performance and memory management techniques.
Topics: Performance metrics and speedup laws, program partitioning and scheduling, interconnection networks, CISC and RISC architectures, superscalar and VLIW processors, vector and symbolic processors, hierarchical and virtual memory technology, TLB, paging, segmentation, cache addressing modes, associative caches, SIMD processing, storage systems, I/O interfacing, RAID levels and performance reliability.
Learning Outcome: *Evaluate processor performance, understand advanced architecture models and memory storage strategies.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Computer Organization and Architecture by Prof. John Jose (IIT Guwahati) NPTEL: https://nptel.ac.in/courses/106103206

Suggested Readings

Book

- *Computer Organization and Architecture: Designing for Performance* by William Stallings, 10th Edition, Pearson.

Online Articles, Journals, and Whitepapers

- Research articles from *IEEE Xplore*, *ScienceDirect*, and *Journal of Parallel and Distributed Computing*
- Whitepapers on processor design, memory hierarchy, and instruction set architectures from *Intel*, *ARM*, and *ACM Computing Surveys*

Web-based Resources

- MIT OpenCourseWare – Computer System Organization and Architecture.
- Simulators and tools like EduMIPS64, Logisim, and Multi2Sim.

Recommended Software/Tools (If applicable):

3. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title:	**Essentials of Generative AI**
Course Code:	**26VBX0S105**
Semester:	**I**
Credits:	**2**
Course Type	**Skill Enhancement Course**
Learning Hours	60
Live Sessions	**12 hours**

Course Outcomes:

CO1: Understand Generative AI and LLMs in depth
CO2: Create text, image, and voice content using AI
CO3: Automate daily tasks and business workflows
CO4: Build AI agents that act independently
CO5: Design and deploy simple AI apps without coding

Course Modules

Module 1: Generative AI Prompt Engineering for Real Workflows

What is Generative AI and how it's transforming industries, Structure of an effective prompt: *Role → Task → Context → Output,* Common prompting mistakes and how to fix them, How large language models (LLMs) like ChatGPT, Claude, and Google AI Studio work, advanced prompting (few-shot, iterative, style-based), Using your own files in ChatGPT and Claude (RAG basics), Research and summarization using AI

Learning Outcome: Students will be able to understand how Generative AI works and master the art of prompting.

Module 2: Creative AI and Voice & Audio Creation

Understanding AI image generation, creating posters, campaign assets, and product visuals, building brand identity using Krea.ai, Generating realistic voiceovers using ElevenLabs, Script writing and tone control with ChatGPT & Claude, Integrating voice into short videos or podcasts ***Learning Outcome:*** Students will be able to use AI to generate visuals, voiceovers, and creative storytelling content.

Module 3: AI Automation & Productivity

Logic of triggers, actions, and workflows, setting up automation between apps (Gmail, Sheets, Drive), Connecting OpenAI to Make.com for intelligent automation, creating social media Management Workflow

and research automation flows, automating daily reports and reminders, building personal productivity dashboards, Integrating Claude and ChatGPT into existing workflows

Learning Outcome: Automate daily workflows and tasks using AI and no-code tools.

Module 4: Advanced AI Agents & Decision Flows

Introduction to n8n as a visual AI workflow builder, understanding nodes, triggers, and data passing, Using OpenAI node for smart responses and actions, designing multi-step reasoning workflows, Connecting Google Sheets, Slack, and other APIs, building autonomous agents that perform specific tasks

Learning Outcome: Students will be able to build AI agents that can think, decide, and act automatically.

Module 5: AI App Building & Deployment

Fundamentals of UI/UX for AI apps, structuring front-end and AI back-end flows, designing app logic using n8n and Make.com, integrating OpenAI and Claude APIs to your apps, handling user inputs and dynamic responses, using Google AI Studio to experiment with models, hosting and testing your AI app online, adding analytics and monitoring usage, final demo preparation and peer feedback

Learning Outcome: Students will be able to learn to design, connect, and deploy simple AI apps using no-code tools

Semester-II

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
Bengaluru - 560 004
P: +91 80 4343 1000

Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
P: +91 80 4343 0100

Course Title:	Communicative English
Course Code:	25VBX0AE205
Semester:	**II**
Credits:	**4**
Course Type	**AECC**
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course equips students with foundational and advanced communication techniques necessary for academic, personal, and professional success. Through practice-driven modules, students will develop their verbal, written, digital, and intercultural communication competence to become effective communicators.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Articulate the elements and processes involved in effective communication	L2
CO2	Analyze and differentiate between various forms of communication, recognizing their unique functions	L4
CO3	Apply diverse approaches to enhance listening and reading skills, leading to improved comprehension	L3
CO4	Demonstrate the ability to convey messages fluently and appropriately in diverse social and professional scenarios	L3
CO5	Employ advanced writing strategies to craft compelling and actionable written communication	L6

Course Modules

No. of Hours: 24

Module 1: Communication Foundations and Contexts
Scope of Module: Explore the process, types, and importance of communication with reference to global standards.
Topics: English as a global lingua franca, 21st-century communication needs, process and types of communication, workplace language skills, situational dialogues, formal and informal styles, communication barriers and management, verbal and non-verbal cues
Learning Outcome: *Explain the process and significance of effective communication in both workplace and societal contexts*

No. of Hours: 24

Module 2: Grammar, Reading, and Dialogue
Scope of Module: Build grammatical accuracy and comprehension through structured reading and dialogue practices
Topics: Essentials of good English (parts of speech, sentence structures), subject-verb agreement, discourse markers, reading strategies, textual understanding using *The English Teacher* by R.K. Narayan, direct and indirect dialogue, conversation control, dialogue in different scenarios, Einstein-Tagore discussion
Learning Outcome: *Apply grammar principles and reading skills for improved comprehension and communication*

No. of Hours:24

Module 3: Digital and Collaborative Communication
Scope of Module: Focus on the use of technology for learning, presenting, and collaborating in professional environments.
Topics: Online resources for language and research (Google Scholar, INFLIBNET, Project Gutenberg), writing essays and reports, persuasive and narrative writing, organizing reports, group presentations, public speaking, simulated interviews, using PPTs, ICT platforms, blogs, social media, email etiquette, virtual meeting tools

***Learning Outcome**: Utilize digital tools and collaborative strategies for professional communication and presentation*

No. of Hours:24

Module 4: Argumentation, Networking, and Global Communication
Scope of Module: Develop effective argumentation, negotiation, and multicultural communication skills.
Topics: Pillars of argument, logic structures, radio debate analysis, art of debate and rebuttal, negotiation principles, conflict resolution, difficult conversations, networking language and strategies, global communication etiquette, multicultural sensitivity, handling communication barriers
***Learning Outcome**: Demonstrate critical thinking, negotiation, and networking skills in global and multicultural communication settings*

No. of Hours:24

Module 5: Life Writing and Official Correspondence
Scope of Module: Explore reflective writing forms and develop professional written communication skills.
Topics: Official letter formats and styles, email writing (salutations, CC, BCC), resume and cover letters, types of life writing (memoirs, journals, biographies, testimonials), *The Diary of Anne Frank*, importance of life writing in reflecting social and personal history
***Learning Outcome**: Craft effective official communications and explore personal expression through reflective writing forms*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

7. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
8. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
9. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings

Book

- *Elements of Style* by William Strunk Jr. and E. B. White

Online Articles, Journals, and Whitepapers

- George Orwell's *Why I Write* (orwellfoundation.com)
- *The Sense of Style* by Steven Pinker
- Steven Earnshaw (Ed.). *The Handbook of Creative Writing*. Edinburgh University Press

Web-based Resources

- British Council Learn English, BBC Learning English, ELLLO, Purdue OWL Writing Lab, Grammarly Blog

Recommended Software/Tools:

11. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
12. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
13. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
14. **Miro** – for mind-mapping essay structures.
15. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global

2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	2	2	1	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	2	2	3	2
CO5	3	3	3	2	3	2	2	2	3	3
Articulation	2.2	2.2	2.6	1.8	2.2	2	2	2	2.2	2.4

Course Title:	Operating System
Course Code:	**25VBT0C201**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course provides an in-depth understanding of operating system concepts such as process management, memory organization, scheduling, file systems, I/O systems, and protection mechanisms. Through theoretical foundations and case studies (Linux), students will gain insight into how an OS functions as a system software and as a resource manager**.**

Course Outcomes (Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Gain insight into the basic operating system structure & concept of process management.	L2
CO2	Develop a strong foundation on process scheduling, process synchronization & concept of deadlock.	L3
CO3	Analyze and apply concepts related to process management, scheduling, and multithreaded programming.	L4
CO4	Evaluate various memory management strategies, such as paging and segmentation, and analyze the complexity and cost associated with virtual memory techniques	L5
CO5	Design and implement solutions for file systems, understand the structure and functioning of I/O systems and create strategies for security mechanisms and protection in operating systems.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Operating System
Scope of Module: Introduces the architecture, structures, and basic services of modern operating systems and their interactions with hardware.
Topics: Introduction to Operating Systems, Computer System Architecture, Types of Operating Systems, Operating System Structure, Operating System Operations, Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, OS Design & Implementation, Virtual Machines, OS Generation, System Boot
Learning Outcome: *Comprehend the fundamentals, structure, and services of operating systems.*

No. of Hours:24

Module 2: Process Management and Scheduling
Scope of Module: Focuses on process lifecycle, scheduling techniques, and multithreading concepts for efficient CPU management.
Topics: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication (IPC), Multithreaded Programming, Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling
Learning Outcome: Analyze and apply process management, scheduling algorithms, and multithreaded programming.

No. of Hours:24

Module 3: Synchronization and Deadlocks
Scope of Module: Examines concurrency issues in multi-process systems and methods to avoid synchronization and deadlock problems.
Topics: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Synchronization Problems, Monitors, Deadlock Introduction, System Model, Deadlock Characterization, Deadlock Handling Methods, Deadlock Prevention, Avoidance, Detection, Recovery
Learning Outcome: *Evaluate process synchronization mechanisms and methods to handle deadlocks in operating systems.*

No. of Hours:24

Module 4: Memory and Storage Management
Scope of Module: Explores how operating systems handle memory through allocation strategies and virtual memory mechanisms.
Topics: Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation, Virtual Memory Concepts, Virtual Address Space, Demand Paging, Copy-On-Write, Page Replacement Algorithms, Frame Allocation, Thrashing, Overview of Mass Storage, Disk Structure, Disk Scheduling, RAID Concepts
Learning Outcome: *Evaluate memory and storage management techniques including paging and virtual memory.*

No. of Hours:24

Module 5: File Systems, I/O, Protection and Case Study
Scope of Module: Describes file organization, I/O hardware-software interface, and protection strategies along with a case study on Linux.
Topics: File Concepts, Access Methods, Directory & Disk Structure, File Mounting & Sharing, File System Implementation, Directory Implementation, Allocation & Free-Space Management, Efficiency & Performance, I/O System Overview, Application I/O Interface, Kernel I/O Subsystem, STREAMS, Goals and Principles of Protection, Access Matrix, Access Control, Security Threats, Distributed Systems Overview, Case Study: Linux OS Design, Kernel Modules, Process & Memory Management, File Systems in Linux
Learning Outcome: *Design and assess file systems, I/O, protection mechanisms, and explore the Linux operating system.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12

5	10

Note: Min no of pre recordings 10**.**

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Operating System Fundamentals by Prof. Niket Kaushik (IIT Roorkee)
   NPTEL: https://nptel.ac.in/courses/106107191

Suggested Reading:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, *Operating System Concepts*, Wiley

Suggested Tools / Activities:

- Linux command line practice
- OS simulation tools (like LittleOS Book, Nachos, or PintOS – demonstration level)
- Process scheduling simulations (Gantt chart practice)
- Visualization of paging, segmentation, and memory management
- VirtualBox for exploring Linux file systems

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)

6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	1	2	1
CO2	3	3	3	3	3	1	–	1	2	1
CO3	3	3	3	3	3	1	–	1	2	2
CO4	3	2	3	3	3	1	1	1	2	3
CO5	3	1	1	3	3	2	1	1	1	1
Articulation	3	2.2	2.4	2.8	3	1.2	1	1	1.8	1.6

Course Title:	Data Structures using C
Course Code:	**25VBT0C202**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of data structures using the C programming language. It covers linear and non-linear structures, recursion, memory management, and algorithmic problem-solving through arrays, stacks, queues, linked lists, trees, and graphs. The course emphasizes practical implementation and performance analysis.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Comprehend fundamentals of Data Structures & its applications for solving real-world problems.	L2
CO2	Infer and develop applications of Linear Data Structures including stacks, queues, and lists.	L2
CO3	Interpret and apply Non-Linear Data Structures & their applications.	L3
CO4	Implement, analyze, and evaluate the searching algorithms	L5
CO5	Apply sorting algorithms to sort various types of data.	L3

Course Modules

No. of Hours:24

Module 1: Fundamentals of Data Structures & Pointers
Scope of Module: Introduces the concept and classification of data structures and deepens the understanding of pointers and memory management in C.
Topics: Introduction to Data Structures, Primitive and Non-Primitive Types, Linear vs Non-Linear Structures, Operations on Data Structures, Introduction to Algorithms, Characteristics & Elements of Algorithms, Pointer Basics, Pointer with Functions, Pass by Reference, Array of Pointers, Pointer to Arrays, Dynamic Memory Allocation, Structures and Unions, Self-referential Structures
Learning Outcome: *Understand the fundamental concepts of Data Structures and pointer-based memory operations.*

No. of Hours:24

Module 2: Arrays, Strings & Recursion
Scope of Module: Focuses on basic linear data representations and recursive algorithm strategies.
Topics: Linear Arrays: Representation, Traversing, Insertion, Deletion, Searching, Sorting, Dynamic Arrays, Multi-dimensional Arrays, String Concepts, String Operations, Pattern Matching Algorithms, Recursion: Direct and Indirect, Factorial, GCD, Fibonacci, Tower of Hanoi
Learning Outcome: *Apply array and string operations, and implement recursive solutions for mathematical and problem-solving tasks.*

No. of Hours:24

Module 3: Stacks and Queues
Scope of Module: Explores the stack and queue structures and their applications in computation.
Topics: Stack Definition, Operations, Array and Dynamic Representation, Polish & Reverse Polish Notations, Infix to Postfix Conversion, Postfix Evaluation, Queue Concepts: Operations, Array and Dynamic Representation, Circular Queue, Dequeue, and other types pf queues, Applications (e.g., Mazing Problem)
Learning Outcome: *Design and implement linear data structures using stacks and queues for solving expression and system-related problems.*

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No. of Hours:24

Module 4: Linked Lists and Trees
Scope of Module: Covers linked list variants and hierarchical data structures with traversal techniques.
Topics: Singly Linked List: Representation, Traversal, Insertion, Deletion, Doubly and Circular Linked Lists, Linked Stacks and Queues, Applications, Trees: Terminology, Binary Trees, Complete Binary Trees, Representation, Binary Tree Traversals (Inorder, Preorder, Postorder), Binary Search Trees: Insertion, Deletion, Searching, Expression Tree Evaluation
Learning Outcome: *Analyze and apply dynamic structures like linked lists and trees to manage and process data efficiently.*

No. of Hours:24

Module 5: Graphs, Sorting & Searching
Scope of Module: Focuses on non-linear graphs and foundational algorithms for data organization and retrieval.
Topics: Graphs: Directed, Undirected, Representation (Matrix, Adjacency List), BFS and DFS Traversals, Sorting Techniques: Bubble, Insertion, Selection, Quick, Heap Sort, Searching Algorithms: Linear, Binary, Interpolation, Jump Search
Learning Outcome: *Implement and analyze graph traversal, sorting, and searching algorithms based on performance and use cases.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Data Structures and Algorithms using C by Prof. Naveen Garg (IIT Delhi) NPTEL: https://nptel.ac.in/courses/106102064

Suggested Reading:

- Seymour Lipschutz, *Data Structures*, Schaum's Outlines
- Horowitz, Sahni, Anderson-Freed, *Fundamentals of Data Structures in C*
- Yashavant Kanetkar, *Data Structures Through C*
- NPTEL / GeeksforGeeks / HackerRank (Practice Problems)

Suggested Tools / Activities:

- Turbo C / GCC on Linux or Windows
- Implementing stacks, queues, trees in C
- Dry-run and trace recursion and sorting programs
- Mini-project: Student Record System, Expression Evaluation
- Practical lab with GDB (for pointer/stack memory visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	1	–	1	–	2
CO3	3	3	3	3	3	–	2	–	1	2
CO4	3	2	3	3	3	2	–	2	–	3
CO5	3	2	3	2	3	1	–	1	–	2
Articulation	3	2.6	2.8	2.4	2.6	1.3	2	1.3	1	2.2

Course Title:	Relational Database Systems
Course Code:	**25VBT0C203**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of relational database design, implementation, and management. Students will learn how to design databases using ER models, normalize schemas, write complex SQL queries, and understand transaction management and emerging trends like NoSQL and Big Data. Emphasis is placed on applying theoretical knowledge through hands-on practice.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic database concepts, architectures, and advantages over traditional file systems.	L2
CO2	Create and interpret ER/EER diagrams and convert them into relational schemas.	L6
CO3	Analyze database designs using normalization techniques for optimized performance and data integrity.	L4
CO4	Construct and execute SQL queries for database operations.	L5
CO5	Explore advanced databases and evaluate their applicability in different contexts.	L5

Course Modules

No. of Hours:24

Module 1: Database Fundamentals and Architecture
Scope of Module: Introduces students to databases, their characteristics, architecture, and the distinction between DBMS and traditional file systems.
Topics: Database Characteristics, File-Based Systems vs. DBMS, Types of Data Processing and Access Methods, Data Models Overview, DBMS vs. RDBMS, Database Applications, Schemas and Instances, Three-Schema Architecture, Data Independence, DDL, DML, DCL, TCL, Centralized vs. Client/Server Architecture, DBMS Classification
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data.*

No. of Hours: 24

Module 2: Data Modeling with ER/EER and Relational Design
Scope of Module: Focuses on designing data models using ER and EER diagrams and converting them into relational models.
Topics: Entity, Attributes, Relationships, ER Symbols, Weak Entities, Keys, Constraints, Advanced ER Concepts, UML-based EER Diagrams, ER-to-Relational Mapping, Subclasses, Superclasses,Specialization, Generalization, Relational Schema Design, Relational Model Concepts, Constraints, Update Operations, Transactions
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data. Design ER/EER diagrams and map them into normalized relational schemas.*

No. of Hours: 24

Module 3: SQL and Relational Algebra
Scope of Module: Covers data definition and manipulation in SQL and introduces relational algebra for query formulation.
Topics: SQL Data Types, DDL, DML, Constraints, Keys (Primary, Foreign, Alternate), INSERT, UPDATE, DELETE, SELECT Queries, Aggregate Functions, GROUP BY, HAVING, JOINs (Inner, Outer, Cross), Subqueries, Relational Algebra Operators, Unary & Binary Operations, Set Theory Operations, Grouping and Aggregation in Algebra
Learning Outcome: *Write efficient SQL queries and use relational algebra to express data operations.*

No. of Hours: 24

Module 4: Normalization, Transactions & Concurrency Control
Scope of Module: Deals with schema refinement, functional dependencies, transaction behaviour, and concurrency mechanisms.
Topics: Informal Design Guidelines, 1NF, 2NF, 3NF, BCNF, Multivalued Dependencies, 4NF, 5NF, Join Dependencies, ACID Properties, Transaction States, Serializability, Conflict & View Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols, Deadlock Detection & Prevention
Learning Outcome: *Normalize relational schemas and implement safe, concurrent transaction handling in DBMS.*

No. of Hours:24

Module 5: Database Recovery, NoSQL & Emerging Trends
Scope of Module: Explores recovery methods, non-relational databases, and current trends in the field.
Topics: Recovery Concepts, Types of Failures, Log-Based Recovery, Shadow Paging, ARIES Recovery Algorithm, Introduction to NoSQL, Types (Key-Value, Column, Document, Graph), Big Data & Hadoop Overview, Introduction to Data Warehousing and Data Mining, Database Security Concepts
Learning Outcome:*Explore database recovery techniques and evaluate modern database trends and technologies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

3. Database Management System by Prof. P. P. Chakrabarti (IIT Kharagpur) NPTEL: https://nptel.ac.in/courses/106105175

Suggested Reading:

- Ramez Elmasri & Shamkant Navathe, *Fundamentals of Database Systems*, Pearson
- Silberschatz, Korth, & Sudarshan, *Database System Concepts*, McGraw-Hill
- NPTEL Database Management Systems Modules
- Practice Resources: SQLZoo, LeetCode (SQL), DB-Fiddle

Suggested Tools / Activities:

- Use of MySQL / PostgreSQL / Oracle XE
- Lab practice: SQL query execution, ER diagram to schema mapping
- Projects: Library Management System, Online Store Schema Design
- Tools: DB Designer, SQL Workbench, pgAdmin, MongoDB Compass (for NoSQL demos)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	3	2	1
CO2	3	3	3	3	3	2	–	2	2	1
CO3	3	3	3	3	3	1	–	1	2	1
CO4	3	3	3	3	3	1	2	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1.5	1.6	2	1.4

Semester III

Common Courses

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
Bengaluru - 560 004
P: +91 80 4343 1000

Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
P: +91 80 4343 0100

Course Title:	Python Programming
Course Code:	25VBT0C301
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamental concepts of Python programming, covering syntax, data types, control structures, functions, and object-oriented principles. It also explores data structures, file handling, databases, web services, and networking. The course emphasizes problem-solving using Python and provides hands-on experience with real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic syntax, data types, and control structures in Python.	L2
CO2	Apply functions, modules, and object-oriented concepts to solve problems.	L3
CO3	Develop programs using file handling, exceptions, and standard libraries.	L3
CO4	Analyze and implement data structures such as lists, dictionaries, and tuples.	L4
CO5	Design real-world applications using Python frameworks and libraries.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Python and Basic Programming Concepts
Scope of Module: This module covers Python programming basics, syntax, variables, mathematical operations, and debugging techniques. It also introduces expressions, Boolean logic, and user input handling.

Topics: Introduction to programming concepts, Python as a programming language, writing and running Python scripts, variables and assignment statements, data types (integers, floats, and strings), arithmetic operations and expressions, Boolean expressions and logical operators, modulus operator and integer division, order of operations in expressions, working with user input and output, string operations and concatenation, naming conventions and keywords, writing meaningful comments in code, debugging techniques and best practices, common syntax errors and troubleshooting.
Learning Outcome: *Understand the fundamental concepts and terminology of Python programming while developing the ability to write and debug simple programs*.

No. of Hours: 24

Module 2: Functions, Iteration, and String Manipulation
Scope of Module: This module explores functions, control structures like loops, and handling string operations, enabling efficient program flow and data processing.
Topics: Function definitions and structure, function calls and return values, built-in functions in Python, parameters and arguments in functions, type conversion functions, recursive functions and base cases, iteration using while loops, iteration using for loops, using break and continue statements, nested loops and loop efficiency, string sequences and indexing, string slicing and concatenation, string immutability and methods, string formatting techniques, debugging functions and loops.
Learning Outcome: *Implement functions, loops, and string operations effectively for structured programming in Python.*

No. of Hours: 24

Module 3: Data Structures – Lists, Dictionaries, and Tuples
Scope of Module: This module covers essential Python data structures, including lists, dictionaries, and tuples, focusing on operations and efficient data handling.
Topics: Introduction to lists and their properties, list indexing and slicing, adding and removing list elements, list mutability and copying, iterating over lists using loops, list comprehensions and filtering, dictionary creation and key-value pairs, accessing and updating dictionary values, looping through dictionaries, dictionary operations and methods, introduction to tuples and immutability, tuple assignment and multiple return values, tuples as dictionary keys, comparing lists, dictionaries, and tuples, debugging common data structure issues.
Learning Outcome: *Analyze and manipulate Python's core data structures to store, retrieve, and* **process data effectively.**

No. of Hours: 24

Module 4: File Handling, Object-Oriented Programming, and Inheritance
Scope of Module: This module introduces file handling, object-oriented programming, and inheritance principles to

build reusable and structured code.
Topics: Reading and writing text files, handling different file formats, file paths and directory navigation, exception handling in file operations, object-oriented programming (OOP) concepts, defining classes and objects, attributes and instance methods, encapsulation and data hiding, mutability of objects and copying, understanding object lifecycles, inheritance and subclassing, overriding methods in subclasses, polymorphism and method resolution order, class diagrams and object hierarchies, debugging OOP-based programs.
Learning Outcome:Develop structured, reusable programs using file handling, OOP, and inheritance concepts in Python.

No. of Hours: 24

Module 5: Databases, Web Services, and Networking
Scope of Module: This module explores database management, web services, APIs, and network programming, enabling interaction with external data sources and networked systems.
Topics: Introduction to databases and SQL, creating and managing tables in SQL, writing and executing SQL queries, relational database modeling and normalization, handling multiple tables and relationships, constraints and data integrity, introduction to web services and APIs, understanding XML and JSON formats, parsing XML and JSON in Python, working with third-party APIs, introduction to networking concepts, sending and receiving data over networks, Python sockets for client-server communication, web scraping techniques using Python, debugging network and database programs.
Learning Outcome: *Develop proficiency in handling databases, web services, and networking concepts for real-world applications.*

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**
4	**12**
5	**11**

Note: Min no of pre recordings 10.

Prerequisites

- Basic understanding of programming logic and flowcharts
- Familiarity with any programming language (C/C++ preferred)
- Logical reasoning and problem-solving mindset

Pedagogy / Teaching Methodology

- ✓ Hands-on coding sessions in labs and online IDEs
- ✓ Mini-projects on text processing, games, or web apps
- ✓ Weekly coding challenges and debugging practice
- ✓ Group tasks involving script design or automation
- ✓ Integration with tools like Jupyter Notebooks, GitHub, and Colab

Certificate / Value Added Courses

9. Python for Everybody – Coursera (University of Michigan)
10. Google IT Automation with Python – Coursera
11. Introduction to Python – edX (Microsoft)
12. Automate the Boring Stuff with Python – Udemy

Suggested Readings

- Eric Matthes, *Python Crash Course*
- Charles Dierbach, *Introduction to Computer Science Using Python*
- Mark Lutz, *Learning Python*
- Al Sweigart, *Automate the Boring Stuff with Python*
- Guido van Rossum (online documentation): https://docs.python.org/3/

Recommended Software / Tools

7. **IDE/Editors:**
    a. Jupyter Notebook
    b. Visual Studio Code
    c. PyCharm (Community Edition)
    d. Thonny (for beginners)
8. **Online Platforms:**
    a. Google Colab
    b. Replit
    c. HackerRank / LeetCode (for Python practice)
9. **Libraries and Frameworks:**
    a. NumPy, Pandas (for data analysis)

b. Tkinter, PyQt (for GUI development)
c. Flask, Django (for web development)
d. Matplotlib, Seaborn (for data visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	-	1	1	1
CO2	3	3	3	3	3	2	1	1	1	1
CO3	2	3	2	2	3	2	1	1	2	-
CO4	3	3	2	2	2	2	1	2	1	1
CO5	2	3	3	3	3	3	1	1	1	1
Articulation	2.6	3	2.4	2.4	2.6	2.4	1	1.2	1.2	1

Course Title:	Design and Analysis of Algorithms
Course Code:	25VBT0C302
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course explores the fundamental principles and advanced techniques in algorithm design and analysis. Students will learn to develop computational solutions for problems like searching and sorting, apply divide-and-conquer, greedy, and dynamic programming techniques, and analyze algorithmic efficiency. The course will also cover space-time tradeoffs, iterative improvements, and approaches to solving NP-hard problems, providing industry-relevant problem-solving skills.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic algorithmic strategies and their time/space complexities.	L2
CO2	Apply divide and conquer, greedy, and dynamic programming paradigms to solve problems.	L3
CO3	Analyze algorithm efficiency using Big-O, Big-Ω, and Big-Θ notations.	L4
CO4	Evaluate and compare the performance of different algorithms.	L5
CO5	Design efficient algorithms for real-world problems using suitable techniques.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Algorithm Design and Analysis
Scope of Module:

This module introduces fundamental algorithm concepts, including problem-solving strategies, computational limits, and performance analysis. It covers basic searching, sorting techniques, and asymptotic notation for algorithm efficiency.
Topics: Definition and importance of algorithms, understanding problem complexity and computational constraints, importance of selecting appropriate data structures, algorithm design techniques, methods of specifying an algorithm, proving correctness of an algorithm, performance analysis and computational efficiency, space complexity and time complexity, asymptotic notations including Big-O, Omega, and Theta, mathematical analysis of recursive and non-recursive algorithms, selection sort and bubble sort fundamentals, sequential search and brute-force string matching, closest-pair problem using brute-force technique, convex hull problem using brute-force method, exhaustive search techniques.
Learning Outcome: *Understand the role of algorithms in problem-solving and analyze algorithm efficiency using mathematical models.*

No. of Hours: 24

Module 2: Divide and Conquer and Decrease and Conquer Approaches
Scope of Module: This module delves into the divide-and-conquer and decrease-and-conquer techniques, helping students analyze problems that can be solved by breaking them into smaller subproblems.
Topics: Introduction to divide-and-conquer strategy, recurrence equations and their significance, finding maximum and minimum elements, merge sort algorithm and analysis, quick sort algorithm and complexity, binary search and efficiency, binary tree traversals and their properties, multiplication of large integers using divide-and-conquer, Strassen's matrix multiplication algorithm, closest-pair problem using divide-and-conquer, convex hull problem via divide-and-conquer, insertion sort algorithm and its efficiency, depth-first search algorithm (DFS), breadth-first search algorithm (BFS), topological sorting and its applications.
Learning Outcome: *Analyze and implement divide-and-conquer and decrease-and-conquer techniques to optimize problem-solving.*

No. of Hours: 24

Module 3: Space-Time Tradeoffs, Greedy Approach, and Iterative Improvement
Scope of Module: This module focuses on space-time tradeoffs, string matching algorithms, and greedy techniques for optimization problems. Students will explore graph algorithms and iterative improvement techniques in optimization.

Topics: Introduction to space-time tradeoff principles, sorting by counting methods, input enhancement in string matching, Boyer-Moore algorithm for string matching, Horspool's algorithm and performance analysis, hashing fundamentals and applications, open hashing vs. closed hashing, Prim's algorithm for minimum spanning trees, Kruskal's algorithm using disjoint subsets, union-find method in Kruskal's algorithm, Dijkstra's algorithm for shortest path, Huffman tree construction and encoding, simplex method for linear programming, geometric interpretation of linear programming, maximum-flow problem and optimization strategies.
Learning Outcome: *Apply space-time tradeoffs, greedy techniques, and iterative improvement methods to solve optimization problems.*

No. of Hours: 24

Module 4: Transform and Conquer, Dynamic Programming, and Algorithmic Optimization
Scope of Module: This module covers algorithm transformation strategies, pre-sorting techniques, dynamic programming principles, and optimization algorithms used in shortest path problems and combinatorial optimization.
Topics: Introduction to transform and conquer approach, pre-sorting and its advantages, Gaussian elimination method, balanced search trees and their importance, heaps and heap sort algorithm, Horner's rule and its applications, binary exponentiation technique, problem reduction approach, overview of dynamic programming, computing binomial coefficients using dynamic programming, Warshall's algorithm for transitive closure, Floyd's algorithm for all-pairs shortest paths, principle of optimality in dynamic programming, optimal binary search trees, knapsack problem and memory functions.
Learning Outcome: *Design and implement dynamic programming solutions for combinatorial optimization problems.*

No. of Hours: 24

Module 5: Limitations of Algorithmic Power and Approximation Algorithms
Scope of Module: This module examines the theoretical limitations of algorithmic power, computational complexity classes, and approximation algorithms for NP-hard problems. It also introduces backtracking and branch-and-bound methods.

Topics: Introduction to lower-bound arguments, trivial lower bounds and problem complexity, information-theoretic arguments in complexity analysis, adversary arguments and decision trees, complexity classes: P, NP, and NP-complete problems, challenges in numerical algorithms, backtracking technique and its applications, N-Queens problem using backtracking, sum of subsets problem using backtracking, branch-and-bound method for optimization, knapsack problem using branch-and-bound, traveling salesperson problem and branch-and-bound, approximation algorithms for NP-hard problems, traveling salesman problem approximation techniques, knapsack problem approximation methods.
Learning Outcome: Analyze computational complexity, apply backtracking and branch-and-bound techniques, and develop approximation algorithms for NP-hard problems.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Knowledge of basic programming (C/C++/Python)
- Understanding of discrete mathematics
- Familiarity with data structures

Pedagogy

- ✓ Whiteboard algorithm walkthroughs
- ✓ Pseudocode-to-code transformation exercises
- ✓ Complexity analysis using real-world problems
- ✓ Case studies and project-based learning

Value Added Courses / Certificates

5. Algorithmic Toolbox – Coursera
6. Data Structures and Algorithms – Udacity

Suggested Readings

- Thomas H. Cormen et al., *Introduction to Algorithms*
- Jon Kleinberg & Éva Tardos, *Algorithm Design*
- Anany Levitin, *Introduction to the Design & Analysis of Algorithms*

Recommended Tools

5. Python/C++ IDEs (e.g., VS Code, Code::Blocks)
6. Online judges: HackerRank, LeetCode, Codeforces

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	3	3	3	2	3	2	-	1	2	3
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	2	2	1	1	1	1
CO4	1	1	2	1	3	2	1	1	1	2
CO5	1	2	2	3	2	2	1	2	2	2
Articulation	1.8	2.2	2.4	2	2.2	1.8	1	1.2	1.4	1.8

Course Title:	Software Engineering
Course Code:	25VBT0C303
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamentals of software engineering**,** including software development models, agile methodologies, requirements engineering, software design, testing, maintenance, and emerging trends**.** Students will explore industry-standard practices, software quality assurance, and modern development approaches such as DevOps, cloud computing, and AI-driven software engineering**.** By the end of the course, students will be equipped with the skills **to** design, develop, test, and maintain software systems efficiently**.**

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the phases of software development life cycle (SDLC).	L2
CO2	Apply appropriate process models for software projects.	L3
CO3	Analyze software requirements and specifications.	L4
CO4	Evaluate software design methodologies and testing techniques.	L5
CO5	Create documentation and design for real-world software applications.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Engineering
Scope of Module: This module introduces software engineering principles, software processes, and different software application domains.
Topics Covered: The nature of software, defining software, software application domains, the unique nature of web applications, software engineering and the software process, software engineering practice, software myths, a generic process model, defining a framework activity, identifying a task set, process assessment and improvement, prescriptive process models (waterfall, incremental, **evolutionary,** concurrent), specialized process models (component-based development, formal methods model, aspect-oriented development), the Unified Process and its phases, personal and team process models (PSP, TSP).
Learning Outcome: *Define software engineering principles, differentiate between software application domains, and describe various software process models.*

No. of Hours: 24

Module 2: Agile Development and Requirements Engineering
Scope of Module: This module explores agile methodologies and techniques for requirements gathering, analysis, and modeling.
Topics Covered: The concept of agility and its impact on the cost of change, agile process and principles, the politics of agile development, human factors in agility, extreme programming (XP) and its process, industrial XP, adaptive software development, Scrum framework, dynamic systems development method (DSDM), feature-driven development (FDD), lean software development, agile modeling, requirements engineering and stakeholders, developing use cases and UML models, requirements modeling for web applications.
Learning Outcome: *Explain agile methodologies, analyze software requirements, and apply modeling strategies for software specification.*

No. of Hours: 24

Module 3: Software Design and Architecture
Scope of Module: This module focuses on software design principles, architectural styles, and user interface design strategies.
Topics: The role of design in software engineering, the design process, software quality guidelines and attributes, evolution of software design, design concepts, the design model, software architecture, architectural genres and styles, component-level design, object-oriented view of components,

designing class-based components, user interface design, web application interface design, interface analysis and guidelines, interface design steps.
Learning Outcome: *Apply software design principles, develop architectural models, and implement user interface design guidelines.*

No. of Hours: 24

Module 4: Software Quality and Testing
Scope of Module: This module focuses on software quality assurance, verification, validation, and testing strategies.
Topics: Software quality and its dimensions, the software quality dilemma, achieving software quality through engineering methods, cost impact of software defects, review metrics and their use, software quality assurance (SQA) and its elements, SQA tasks, goals, and metrics, formal approaches to SQA, statistical software quality assurance, software reliability and availability, a strategic approach to software testing, verification and validation, unit testing, security testing, debugging and the debugging process.
Learning Outcome*: Analyze software quality assurance strategies and implement software testing techniques for defect prevention and validation.*

No. of Hours: 24

Module 5: Software Maintenance and Emerging Trends
Scope of Module: This module covers software maintenance techniques, risk management, and evolving trends in software engineering.
Topics: Software maintenance and evolution, legacy system maintenance, capability maturity models (CMM), software project risk management, risk mitigation strategies, software configuration management, change control, refactoring strategies, version control systems, release management, continuous integration and deployment (CI/CD), DevOps practices, cloud computing and microservices, AI in software development, future trends in software engineering.
Learning Outcome: *Evaluate software maintenance strategies, implement cost estimation models, and explore emerging trends in software engineering.*

Module	**No of Pre Recordings**
1	**10**

2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- Familiarity with basic programming
- Understanding of software applications

Pedagogy

- ✓ SDLC-based project development
- ✓ Use case modeling and UML design
- ✓ Agile and traditional model simulation
- ✓ Code review and testing labs

Value Added Courses / Certificates

5. Software Processes and Agile Practices – Coursera
6. Software Engineering Essentials – edX

Suggested Readings

- Ian Sommerville, *Software Engineering*
- Roger Pressman, *Software Engineering: A Practitioner's Approach*
- Pankaj Jalote, *An Integrated Approach to Software Engineering*

Recommended Tools

9. Visual Paradigm, StarUML (UML modeling)
10. GitHub (Version control)
11. JIRA (Agile project management)
12. Selenium, JUnit (Testing)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**

1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	-	1	1	1
CO2	2	3	2	3	2	1	1	1	1	1
CO3	2	2	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	2	-	1	3	2
CO5	1	1	1	1	3	2	2	3	2	1
Articulation	1.8	1.8	2	1.8	2.2	1.4	1.3	1.4	1.6	1.2

Course Title:	Computer Networks
Course Code:	25VBT0C304
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a comprehensive introduction to computer networks, covering fundamental networking principles, architectures, and protocols. Students will explore different network layers, their functionalities, and the mathematical calculations associated with data transmission. The course also introduces advanced networking concepts such as cloud computing, IoT, and network security.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand network architectures, protocols, and models.	L2
CO2	Apply network principles to configure and troubleshoot basic networks.	L3
CO3	Analyze different layers of the OSI and TCP/IP models.	L4
CO4	Evaluate network performance and security mechanisms.	L5
CO5	Design secure and scalable network infrastructures.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Computer Networks

Scope of Module: This module introduces fundamental networking concepts, network models, and physical layer functionalities. It provides an overview of computer networks, transmission media, and error detection mechanisms.
Topics: Overview of computer networks and their importance, Historical evolution of networking technologies, Network types and their applications (LAN, MAN, WAN), Network topologies and their impact on performance, The OSI reference model: layers and their functions, The TCP/IP model: comparison with OSI model, Analog and digital signals in networking, Transmission media: guided and unguided media, Signal encoding techniques and modulation schemes, Multiplexing techniques: FDM, TDM, and WDM, Spread spectrum techniques and their applications, Transmission errors: causes and effects, Error detection techniques: parity checks and checksums, Error correction mechanisms: Hamming code and CRC, Physical layer functions and performance metrics.
Learning Outcome: Explain the fundamental concepts of computer networks, transmission media, and error detection techniques

No. of Hours:24

Module 2: Data Link Layer and Medium Access Control
Scope of Module:
This module explores the data link layer, its role in error detection, flow control, and MAC protocols for wired and wireless networks.
Topics Covered:
Framing methods and techniques in data transmission, Flow control mechanisms: stop-and-wait and sliding window protocols, Error detection techniques: CRC, checksums, and parity bits, Error correction methods: Hamming code and ARQ techniques, Medium Access Control (MAC) protocols and their importance, CSMA/CD: collision detection and resolution, CSMA/CA: collision avoidance in wireless networks, Ethernet standards and frame structure, Token Ring: access method and frame structure, Wireless LAN standards: IEEE 802.11 and Wi-Fi, Bluetooth technology and applications, MAC addressing and its role in data link layer, LAN switching techniques: circuit switching vs. packet switching, Virtual LANs (VLANs) and their configurations, Data link layer security threats and mitigation techniques
Learning Outcome:*Describe data link layer functions, error detection techniques, and MAC protocols in wired and wireless networks.*

No. of Hours: 24

Module 3: Network Layer and Transport Layer

Scope of Module: This module covers network-layer functionalities, IP addressing, subnetting, and transport-layer protocols, including TCP and UDP.
Topics: Introduction to the network layer and its services, IP addressing schemes: IPv4 and IPv6, Subnetting techniques and IP address allocation, Routing algorithms: distance vector vs. link state, Static and dynamic routing protocols: RIP, OSPF, and BGP, ICMP protocol and error reporting in networks, IPv4 and IPv6 coexistence strategies, Address Resolution Protocol (ARP) and its working, Network Address Translation (NAT) and its applications, Transport layer functions and its role in networking, TCP and UDP: comparison and applications, Connection establishment and termination in TCP, Congestion control and flow control in TCP, Error detection and correction in transport layer, QoS mechanisms and performance optimization techniques
Learning Outcome: Analyze IP addressing, subnetting, and routing algorithms, and describe transport-layer services.

No. of Hours:24

Module 4: Network Security, Wireless & Multimedia Network
Scope of Module: This module covers network security principles, wireless communication fundamentals, and multimedia networking technologies.
Topics Covered: Network security threats and vulnerabilities, Cryptography basics: symmetric vs. asymmetric encryption, Authentication mechanisms and secure communication, Integrity and confidentiality mechanisms in networking, Wireless transmission fundamentals and radio communication, Cellular networks: architecture and mobile IP, IEEE 802.11 standard and wireless LAN protocols, Bluetooth technology: architecture and applications, Wireless security threats and mitigation techniques, Streaming and real-time communication protocols, Quality of Service (QoS) in multimedia networking, Voice over IP (VoIP) and its applications, Video conferencing protocols and challenges, Delay-sensitive traffic management in multimedia applications, Performance optimization for wireless and multimedia networks
Learning Outcome: Understand and apply multimedia networking protocols to ensure secure, efficient, and high-quality real-time communication over wireless and mobile networks.

No. of Hours: 24

Module 5: Advanced Networking and Emerging Technologies
Scope of Module: This module introduces advanced networking concepts such as network management, cloud computing, IoT, and blockchain.

Topics Covered: SNMP protocol and network monitoring techniques, Fault management and performance optimization in networks, Configuration management in enterprise networks, Distributed computing fundamentals and architectures, Client-server vs. peer-to-peer networking models, Distributed file systems and coordination algorithms, Cloud computing models: IaaS, PaaS, SaaS, Virtualization techniques and resource management, Cloud security challenges and privacy concerns, IoT architecture and components, Communication protocols for IoT applications, IoT security challenges and mitigation techniques, Software-Defined Networking (SDN) architecture and benefits, Network Function Virtualization (NFV) and its impact, Blockchain technology in networking and its applications.
Learning Outcome: Evaluate network management strategies, cloud computing models, and emerging technologies like IoT, SDN, and blockchain.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Basic computer system knowledge
- Understanding of binary arithmetic
- Familiarity with operating systems

Pedagogy

- ✓ Packet tracer simulations (Cisco)
- ✓ Layer-by-layer protocol analysis
- ✓ Wireshark labs and trace evaluations
- ✓ Network design mini-projects

Value Added Courses / Certificates

5. Computer Networking – Coursera (Stanford)
6. Cisco CCNA Introduction – NetAcad

Suggested Readings

- Andrew S. Tanenbaum, *Computer Networks*
- Behrouz A. Forouzan, *Data Communications and Networking*
- William Stallings, *Data and Computer Communications*

Recommended Tools

7. Cisco Packet Tracer
8. Wireshark
9. GNS3, NS2/NS3 simulators

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	-	1	1	1
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	3	1	-	2	2	1
CO4	1	2	2	3	2	2	1	2	2	1
CO5	1	1	1	1	1	1	2	1	3	3
Articulation	1.8	2	1.8	1.8	1.6	1.2	1.5	1.4	1.8	1.4

Course Title:	Environmental, Social, and Governance (ESG) in IT
Course Code:	25VBT0C305
Semester:	**III**
Credits:	**3**
Course Type	AECC
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth exploration of Environmental, Social, and Governance (ESG) principles and their critical application within the Information Technology (IT) sector. Students will examine how ESG factors influence IT operations, strategy, and policy-making, gaining insights into sustainable practices, ethical considerations, and effective governance in technology-driven environments. Through case studies and practical projects, learners will develop the skills necessary to integrate ESG considerations into IT frameworks, ensuring responsible and sustainable technological development.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand environmental principles and sustainability concepts.	L2
CO2	Identify the effects of human activities on ecosystems.	L3
CO3	Analyze environmental challenges and sustainability goals (SDGs).	L4
CO4	Evaluate policies and practices for sustainable development.	L5
CO5	Propose eco-friendly solutions for community or industry applications.	L6

Course Modules: **No. of Hours: 18**

Module 1: Introduction to ESG and Digital Responsibility
Scope of Module: This module lays the foundation of ESG principles and their relevance to the IT industry. It explores the global push toward sustainability, ethical tech development, and corporate responsibility.
Topics: Definition and Origin of ESG, Importance of ESG in IT, Sustainable Development Goals (SDGs) and IT alignment, Environmental Impact of Digital Technologies, Ethical Considerations in Tech Development, IT and Climate Change, ESG Ratings and Digital Business Performance, Role of IT Professionals in ESG, Green Certifications and IT Compliance, Digital Transformation and ESG Goals, Circular Economy in IT, Impact of Cloud and Data Centers on Environment, Tech Industry ESG Benchmarks, Digital Minimalism and Eco-design, Global ESG Reporting Frameworks.
Learning Outcome: *Understand ESG foundations, the importance of responsible tech, and the environmental impact of digital systems.*

No. of Hours: 18

Module 2: Environmental Sustainability in IT
Scope of Module: Focuses on sustainable computing, energy-efficient infrastructure, and green software engineering.
Topics: Green IT Practices, Energy-Efficient Hardware and Systems, Carbon Footprint of IT Operations, Sustainable Data Center Management, E-Waste Management and Recycling, Renewable Energy Use in Tech Firms, Virtualization and Cloud Sustainability, Lifecycle Assessment of IT Products, Power Management in Devices, Paperless Office and Digital Workflows, Sustainable Supply Chains in IT, Greener Coding Practices, Use of AI for Environmental Monitoring, IoT in Smart Environment Systems, IT and Climate Action Technologies.
Learning Outcome: *Evaluate IT strategies that promote environmental sustainability and carbon reduction.*

No. of Hours: 18

Module 3: Social Responsibility and Inclusion in Technology
Scope of Module: Covers how IT contributes to equity, digital literacy, accessibility, and ethical labor practices.
Topics: Digital Inclusion and Access to Technology, Gender Equality in Tech, Accessibility Standards (WCAG, ADA), Ethical Labor in Tech Supply Chains, Community Engagement through Technology, Corporate Social Responsibility (CSR) in IT, Digital Literacy and Education Programs, Tech for Good Initiatives, Bridging the Digital Divide, AI Bias and Fairness, Inclusive Design Principles, Social Impact Assessment in Tech Projects, Diversity in IT Workforce, Data for Social Good, Digital Safety and Well-being.
Learning Outcome: *Analyze IT's role in promoting social responsibility and inclusive technology design.*

No. of Hours:18

Module 4: Governance, Ethics, and Regulation in IT
Scope of Module: Discusses governance mechanisms, risk management, data ethics, and compliance in the IT context.
Topics: IT Governance Models, Data Privacy and Protection Laws (GDPR, PDP Bill India), Cyber Ethics and Accountability, Risk Management in Tech Projects, Regulatory Compliance in IT, Digital Rights Management, Transparent AI and Algorithm Auditing, Corporate Governance in IT Companies, Role of CIOs in ESG Governance, ESG Metrics and KPIs in Tech, Open Data and Public Interest, Whistleblowing Mechanisms in Tech Industry, IT Policy Frameworks, Blockchain for Governance Transparency, ESG Risks in IT Investments.
Learning Outcome: *Explore ethical governance practices, digital compliance, and risk management in IT.*

No. of Hours: 18

Module 5: ESG Implementation and Case Studies in IT
Scope of Module: Focuses on practical ESG integration into IT systems, success stories, frameworks, and tools.
Topics: ESG Strategy Development in Tech Organizations, Sustainability Reporting Tools (GRI, SASB), Role of CIOs and IT Managers in ESG, Measuring ESG Performance in IT Projects, ESG-Focused Software Development Lifecycle (SDLC), ESG Dashboards and Analytics, Green Procurement for IT Assets, Case Studies: Google, Microsoft, Infosys ESG Programs, IT in Disaster Response and Crisis Management, ESG Risk Mitigation Frameworks, ESG Investment in Tech Startups, ESG Certifications for IT Professionals, Open-source Tools for ESG Monitoring, ESG KPIs in Software Products, ESG Innovation Labs and Incubators.
Learning Outcome: *Apply ESG principles through frameworks, tools, and real-world tech case studies.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**

4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- General awareness of science and ecology
- Basic understanding of social issues

Pedagogy

- ✓ Eco-surveys and field visits
- ✓ Case studies on climate change and pollution
- ✓ Group discussions on policy impacts
- ✓ Sustainable campus or local community projects

Value Added Courses / Certificates

5. Sustainable Development Goals – edX
6. Introduction to Sustainability – Coursera

Suggested Readings

- Erach Bharucha, *Environmental Studies*
- R.Rajagopalan, *Environmental Studies from Crisis to Cure*
- UNEP Reports and SDG Guidelines

Recommended Tools

7. ArcGIS (for environment mapping)
8. SDG Tracker
9. OpenLCA (for life cycle assessment)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**

1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Concerns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	3	2	1	2
CO2	2	3	2	2	3	2	3	2	1	2
CO3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	2	3	2	3	3	3	2	3
CO5	1	2	3	3	3	3	3	3	3	3
Articulation	2	2.2	2.2	2.2	2.6	2.6	2.8	2.6	1.8	2.6

Semester IV

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Course Title:	**Web Technologies**
Course Code:	25VBT0C401
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to essential web development technologies, covering both front-end and back-end aspects. Students will learn to design, develop, and deploy interactive websites using HTML, CSS, JavaScript, and server-side scripting with PHP or Node.js, along with database integration. The course focuses on hands-on learning and equips students for careers in web development, UI/UX design, and full-stack engineering.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the structure and design principles of web applications.	L2
CO2	Develop interactive and responsive web pages using HTML, CSS, and JavaScript.	L3
CO3	Implement dynamic web applications using server-side scripting.	L3
CO4	Connect web applications with databases for data management.	L4
CO5	Deploy and manage complete web applications using modern web tools.	L5

Course Modules **No. of Hours: 24**

Module 1: Foundations of Web Technologies

Scope of Module: Covers the fundamentals of how the web works, including protocols, architecture, and core components.
Topics: Introduction to Internet and Web, Web Servers and Clients, HTTP and HTTPS Protocols, URL and URI Concepts, DNS and Hosting Basics, Static vs. Dynamic Websites, Web Browsers and Developer Tools, MIME Types and Web Content Types, TCP/IP and Sockets Overview, Browser Rendering Process, HTML Document Structure, Responsive Design Principles, Introduction to Web Accessibility (WCAG), Browser Compatibility Issues, Role of Web Standards (W3C).
Learning Outcome: - *Understand the core architecture and functioning of the web ecosystem.*

No. of Hours: 24

Module 2: Frontend Technologies – HTML, CSS, JavaScript
Scope of Module: Focuses on creating structured, styled, and interactive user interfaces using frontend technologies.
Topics: HTML5 Elements and Semantics, Forms and Validation, CSS3 Selectors and Properties, Responsive Design with Media Queries, CSS Frameworks (Bootstrap/Tailwind), Flexbox and Grid Layouts, Introduction to JavaScript Syntax, DOM Manipulation, Events and Event Handling, JavaScript Functions and Scope, Objects and Arrays, Form Validation with JavaScript, ES6 Features (Let, Const, Arrow Functions), Browser Storage (LocalStorage, SessionStorage), Introduction to AJAX and Fetch API.
Learning Outcome: - *Build responsive, accessible, and interactive front-end user interfaces.*

No. of Hours: 24

Module 3: Server-Side Programming and Backend Integration
Scope of Module: Introduces backend development and connecting frontend applications to databases and servers.
Topics: Introduction to Server-Side Scripting, Node.js and Express.js Basics, RESTful API Design, Routing and Middleware in Express, Working with JSON Data, Handling HTTP Requests and Responses, Templating Engines (EJS, Handlebars), Introduction to PHP (Optional), Error Handling in Server-Side Apps, Session Management and Cookies, Uploading and Handling Files, Working with Forms (POST, GET), Basic Authentication and Authorization, Connecting Frontend with Backend APIs, Building a Simple Full-Stack App.

***Learning Outcome: -** Create and connect server-side logic to client-side interfaces using web frameworks.*

No. of Hours: 24

Module 4: Databases and Web Integration
Scope of Module: Focuses on integrating databases into web applications and managing data using queries.
Topics: Relational Databases Overview (MySQL, PostgreSQL), NoSQL Databases (MongoDB), Database Design Basics, CRUD Operations in SQL, Mongoose with MongoDB in Node.js, Connecting Backend to Database, Query Parameters and Filtering, ORM Basics (Sequelize/Mongoose), Data Validation and Sanitization, Indexing and Performance Tuning, Managing Relationships and Joins, Authentication Data Storage, Environment Variables and DB Security, Transactions and Error Handling, Integrating Search in Web Applications.
***Learning Outcome: -** Design and connect databases to dynamic web applications for persistent storage.*

No. of Hours: 24

Module 5: Web Deployment, Security, and Modern Trends
Scope of Module: Covers web application deployment, security, DevOps integration, and modern web development trends.
Topics: Deployment on Platforms (Vercel, Netlify, Heroku), Git and GitHub for Version Control, Continuous Deployment Pipelines, Domain Registration and DNS Setup, SSL Certificates and HTTPS, Security Best Practices (XSS, CSRF, SQL Injection), HTTPS and Secure Headers, Content Delivery Networks (CDN), CORS Policy and Management, Progressive Web Apps (PWA), Introduction to Single Page Applications (React, Angular), WebSockets and Real-Time Communication, SEO Optimization for Web Apps, Lighthouse and Performance Auditing, Introduction to JAMstack Architecture.
***Learning Outcome: -** Deploy, secure, and optimize modern web applications using best practices.*

Module	No of Pre-Recordings
1	10
2	12

3	**10**
4	**12**
5	**10**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

➢ Basic understanding of programming concepts (e.g., loops, functions)
➢ Exposure to HTML or any markup language is beneficial
➢ Logical reasoning and analytical thinking

Pedagogy / Teaching Methodology:

✓ Hands-on coding with integrated browser tools
✓ Live problem-solving through lab exercises
✓ Real-world project-based learning
✓ Git-based version tracking and collaboration
✓ Assignments, quizzes, and mini-projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

9. Web Development by NPTEL (IIT Madras)
   https://nptel.ac.in/courses/106105084
10. Responsive Web Design by freeCodeCamp
    https://www.freecodecamp.org/learn
11. Full Stack Open 2024 by University of Helsinki
    https://fullstackopen.com/en/
12. HTML, CSS, and JS for Web Developers (Coursera)
    https://www.coursera.org/learn/html-css-javascript-for-web-developers

Suggested Readings:

- Jon Duckett, *HTML & CSS: Design and Build Websites*, Wiley
- Robin Nixon, *Learning PHP, MySQL & JavaScript*, O'Reilly
- Ethan Brown, *Web Development with Node and Express*, O'Reilly
- MDN Web Docs: https://developer.mozilla.org/
- W3Schools Reference: https://www.w3schools.com/

Recommended Software/Tools (If applicable):

15. Visual Studio Code
16. Node.js + npm
17. Postman for REST API testing
18. MongoDB Atlas and phpMyAdmin
19. Bootstrap, Tailwind CSS
20. Heroku / Netlify / Vercel for deployment
21. React / Angular (for SPA introduction)

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	2	3	2	–	–	2
CO2	3	3	3	2	3	3	3	–	1	3
CO3	3	3	3	3	3	3	2	1	1	3
CO4	3	3	2	3	3	3	3	–	1	3
CO5	3	3	3	3	3	3	3	2	2	3

Course Title:	Java Programming
Course Code:	25VBT0C402
Semester:	**IV**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces students to the fundamental principles of Object-Oriented Programming (OOP) using Java. It covers basic to advanced Java concepts including classes, objects, inheritance, polymorphism, exception handling, multithreading, and file I/O. The course emphasizes writing robust and efficient programs that solve real-world problems using Java's extensive features and libraries.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Develop a strong foundation in OOP concepts and core Java programming principles.	L2
CO2	Apply core Java constructs such as variables, loops, arrays, and control statements to develop simple applications.	L3
CO3	Apply exception handling techniques to manage runtime errors effectively.	L3
CO4	Develop multithreaded applications and implement synchronization mechanisms.	L4
CO5	Design and implement Java applications to solve real-world problems using complete Java concepts.	L5

Course Modules: **No. of Hours: 24**

Module 1: Object-Oriented Concepts and Java Fundamentals
Scope of Module: Covers the basic structure of object-oriented programming and introduces Java as an OOP language.
Topics: Introduction to the key principles of object-oriented programming including objects, classes, abstraction, encapsulation, inheritance, polymorphism, and abstract classes, Java programming

fundamentals, understanding bytecode, and the Java development kit (JDK), Java Runtime Environment (JRE), and Java Virtual Machine (JVM), primitive data types, literals, variables, type casting, operators, and shorthand assignments, control flow constructs including if-else, switch statements, and input reading, looping constructs like for, while, do-while, and enhanced for-loops with break, continue, and nesting techniques.
Learning Outcome: *Understand the fundamentals of Java and OOP principles, and apply control statements and loops in programs.*

No. of Hours: 24

Module 2: Classes, Objects, Methods, and Arrays
Scope of Module: Explores the core building blocks of Java programs including class design, object instantiation, and method usage.
Topics: Class fundamentals, object declaration, method definitions, constructors (default and parameterized), the use of this keyword, scanner class, garbage collection, and the finalize() method, constructor and method overloading, recursion, static and final keywords, and access control, inner and nested classes, array handling (one-dimensional and multi-dimensional arrays), alternative array declarations, enhanced for-loops, and array references, Java built-in functions for arrays and array-based problem-solving.
Learning Outcome: *Comprehend and implement class structures, object interaction, method overloading, and array operations.*

No. of Hours: 24

Module 3: Working with Strings, Inheritance, and Interfaces
Scope of Module: Focuses on handling string data, using inheritance to model hierarchies, and applying interfaces for abstraction.
Topics: String class, constructors, length property, string comparison, character extraction, string modification, case conversion, StringBuffer and StringBuilder for mutable strings, inheritance in depth, including member access, method overriding, super keyword usage, constructor chaining, abstract classes, dynamic method dispatch, the Object class, Interface concepts include creating and implementing interfaces, multiple inheritance using interfaces, extending interfaces, constants and variables in interfaces, distinguishing between interfaces and abstract classes.
Learning Outcome*: Implement inheritance and interfaces to build reusable and flexible code structures while managing string data effectively.*

No. of Hours: 24

Module 4: Exception Handling and Multithreading

Scope of Module: Introduces robust programming techniques using exception handling and explores process-based multitasking with threads.
Topics: Introduction to Java's exception handling model including try-catch-finally blocks, throw and throws keywords, exception hierarchy, multiple catch blocks, nested try statements, and handling subclass exceptions, custom exception creation, exception subclasses, chained exceptions, and exception handling with method overriding, multithreading fundamentals, the main thread, creating and managing threads using the Thread class and Runnable interface, thread priorities, lifecycle management, synchronization using methods and synchronized blocks.
Learning Outcome: *Design applications that handle runtime errors gracefully and manage concurrent execution using multithreading.*

No. of Hours: 24

Module 5: Java File I/O and Real-World Applications
Scope of Module: Covers input/output operations using Java I/O streams and applies learned concepts to build complete Java applications.
Topics: Introduction to Java I/O classes and interfaces, byte and character stream classes, stream hierarchy, text and binary file handling,file reading, writing, random access files, serialization and deserialization,Java-based applications combining all key concepts including classes, objects, inheritance, exception handling, file operations, and multithreading, use cases such as calculators, student record systems, file processors, and real-time data handling apps .
Learning Outcome: *Design complete Java programs incorporating object-oriented principles, exception handling, file operations, and multithreading..*

Module	**No of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**

5	**10**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs like Eclipse or IntelliJ
- ✓ Real-time code walkthroughs and live debugging
- ✓ Mini-projects like file processors, calculators, and student record systems
- ✓ Case studies based on real-world Java applications
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

5. Coursera: Java Programming and Software Engineering Fundamentals – Duke University
6. Oracle Java Tutorials
7. JetBrains Academy: Java Developer Track
8. Udacity: Java Programming Basics

Suggested Readings:

- Herbert Schildt, *Java: The Complete Reference*, McGraw Hill
- Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall
- Kathy Sierra and Bert Bates, *Head First Java*, O'Reilly Media
- Y. Daniel Liang, *Introduction to Java Programming and Data Structures*, Pearson

Recommended Software/Tools:

6. **Java Development Tools:** Eclipse, IntelliJ IDEA, NetBeans
7. **JDK Version:** Java SE 17 or latest LTS version
8. **Build Tools:** Maven, Gradle
9. **Version Control:** Git/GitHub
10. **Text Editors:** VS Code, Notepad++

CO-PO Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	–	2	–	–	1	–	2
CO2	2	3	3	–	3	–	–	1	1	2
CO3	2	3	3	2	3	–	1	–	–	2
CO4	2	3	3	2	3	2	2	1	–	2
CO5	1	2	3	3	3	3	2	2	2	3

Course Title:	Network Security & Cryptography
Course Code:	**25VBT4E403**
Semester:	**IV**
Credits:	**4**
Course Type	**DSE**
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces the foundational concepts of network security and cryptography tailored for undergraduate BCA students. It covers the basics of how information is secured over digital communication networks, emphasizing the importance of encryption, authentication, and secure protocols. Students will learn both theoretical and practical aspects of securing computer networks against common threats.

CO No.	Course Outcome	BTL
CO1	Understand the core principles of network security and its importance.	L2
CO2	Explain the types of security threats and mechanisms to prevent them.	L2
CO3	Apply basic encryption techniques and cryptographic algorithms.	L3
CO4	Analyze the use of authentication protocols and secure communication techniques.	L4
CO5	Implement simple security strategies and tools to safeguard networks.	L4

Course Modules

No. of Hours: 24

Module 1: Introduction to Network Security
Scope of Module: This module introduces the concept of network security, its goals, and why it's essential in the digital age. It also gives an overview of network threats and security services.
Topics: Importance of Network Security, Principles: Confidentiality, Integrity, Availability (CIA), Types of Network Attacks: Passive & Active, Common Threats: Malware, Phishing, Spoofing, Social Engineering, Security Services and Mechanisms, Network Vulnerabilities and Exploits, Introduction to Security Policies and Access Controls, Basics of Firewalls and Antivirus Software, Overview of Cybersecurity Terminology, Cyber Ethics and Cyber Laws (India & Global Perspective).
Learning Outcomes: *Understand the basic principles and importance of network security, types of threats, and the role of ethical and legal practices in protecting digital systems*

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No. of Hours: 24

Module 2: Basics of Cryptography
Scope of Module: Students will explore how cryptography helps protect information and the key techniques used to encrypt and decrypt data. The module emphasizes the difference between symmetric and asymmetric cryptography, common classical encryption techniques, and the importance of keys in secure communication.
Topics: Definition and Need for Cryptography, Objectives of Cryptography: Confidentiality, Integrity, Authentication, Non-repudiation, Symmetric vs. Asymmetric Encryption, Substitution and Transposition Ciphers, Classical Encryption Techniques: Caesar Cipher, Vigenère Cipher, Playfair Cipher, Introduction to RSA Algorithm, Concept of Keys: Public and Private, Key Distribution and Management (Basic Concepts), Block Ciphers vs Stream Ciphers.
Learning Outcome: Apply basic cryptographic techniques and differentiate between various encryption methods used to protect digital data.

No. of Hours: 24

Module 3: Message Integrity and Authentication
Scope of Module: This module focuses on ensuring that messages remain intact and are accessed only by authorized users. It introduces cryptographic hash functions, digital signatures, and authentication mechanisms essential for verifying data integrity and identity. **Topics:**
Hash Functions: MD5, SHA (SHA-1, SHA-256, Digital Signatures: Concepts, Applications, and Benefits, Public Key Infrastructure (PKI): Components and Functions, HMAC (Hash-based Message Authentication Code): Basic Concept, Authentication Protocols (e.g., CHAP, Kerberos – introductory overview), Password-Based Authentication and Challenges, Multi-Factor Authentication (MFA): Concept and Examples, CAPTCHA and OTP-based Authentication, Biometric Authentication, Real-World Applications: Email verification, E-commerce, Digital Certificates.
Learning Outcome: *Explain how data integrity and authentication are ensured using cryptographic methods and understand their real-world applications*

No. of Hours: 24

Module 4: Network Security Tools and Protocols
Scope of Module: This module introduces essential security protocols and tools that help secure network communications. It also provides hands-on awareness of basic tools used for monitoring and analyzing network traffic.

Topics: SSL/TLS and HTTPS: Purpose and How They Secure Communication, Secure Email Communication: PGP and S/MIME, VPN Basics: Concept, Use Cases, and Benefits, Firewalls: Types (Hardware/Software), Configuration Basics, Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS), Proxy Servers and Their Role in Security, Wireshark: Packet Sniffing and Basic Analysis (Demonstration), Antivirus & Anti-Malware Software Tools, Secure Web Browsing and Browser Security Settings.
Learning Outcome: *Identify common network security tools and explain the role of security protocols in protecting data during transmission.*

No. of Hours: 24

Module 5: Cybersecurity Best Practices & Case Studies
Scope of Module: This module aims to build cybersecurity awareness among students by teaching safe digital practices, ethical hacking fundamentals, and analyzing real-world attack scenarios. It encourages the application of simple tools and strategies for personal and organizational protection.
Topics: Safe Internet Practices & Password Security Guidelines, Strong Password Creation and Password Managers, Use of Antivirus and Anti-Malware Tools, Understanding Phishing Emails and Social Engineering Attacks, Introduction to Ethical Hacking: Concept and Scope, Introduction to Penetration Testing and Its Phases, Cyber Hygiene: Regular Updates, Backups, and Secure Configurations, Safe Use of Social Media and Public Wi-Fi.
Learning Outcome: *Adopt cybersecurity best practices, understand the ethical and legal context, and evaluate case studies to develop preventive approaches*

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Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of computer networks
- Familiarity with operating systems
- Introductory understanding of programming and IT infrastructure

Pedagogy / Teaching Methodology:

- ✓ Concept explanation through real-world scenarios and cyber threat models
- ✓ Demonstrations using Wireshark, OpenSSL, VPN tools, and firewalls
- ✓ Hands-on cryptography exercises (e.g., Caesar Cipher, RSA)
- ✓ Security configuration tasks and basic penetration testing labs
- ✓ Case studies and interactive quizzes on contemporary threats

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Cisco: Introduction to Cybersecurity
2. Coursera: Network Security & Database Vulnerabilities – NYU
3. Khan Academy: Internet Safety and Security
4. Cybrary: Cryptography and Network Security Courses

Suggested Readings:

- William Stallings, *Cryptography and Network Security*, Pearson
- Behrouz A. Forouzan, *Cryptography and Network Security*, McGraw-Hill
- Atul Kahate, *Cryptography and Network Security*, Tata McGraw-Hill
- Charlie Kaufman et al., *Network Security: Private Communication in a Public World*, Pearson

Recommended Software/Tools:

1. **Network Analysis Tools:** Wireshark, Nmap
2. **Cryptography Tools:** CrypTool, OpenSSL
3. **Security Tools:** Antivirus (e.g., Bitdefender, Avast), Firewall configuration tools
4. **Simulation Platforms:** Cisco Packet Tracer, VirtualBox (for secure labs)
5. **Protocols:** SSL/TLS, HTTPS, PGP, VPN configuration tools

Lab/Practice Exercises and Use Cases:

- Encryption/decryption practice with classical ciphers (Caesar, Vigenère)
- Hash value generation using MD5/SHA tools
- Digital signature verification using PKI demos
- Packet sniffing and basic traffic analysis with Wireshark
- Role-play scenarios simulating phishing/social engineering
- Capstone activity: design a basic secure network plan for a small business

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	–	–	2	2	–	–	1
CO2	3	3	2	–	2	2	3	–	–	1
CO3	3	2	3	2	3	–	2	–	–	1
CO4	3	3	2	2	3	1	3	–	–	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3	2.6	2.2	2	2.75	1.75	2.6	1	2	1.2

Course Title:	Web Application Security
Course Code:	**25VBT4E404**
Semester:	**IV**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to the fundamentals of securing web applications. Students will learn the most common vulnerabilities affecting websites and web applications, how attackers exploit them, and the methods used to prevent such threats. Practical aspects of securing front-end and back-end components will be emphasized using real-world examples and hands-on tools.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the principles of web application security and common attack vectors.	L2
CO2	Identify and analyze web vulnerabilities using tools and testing techniques.	L3
CO3	Apply security practices in front-end and back-end development.	L3
CO4	Demonstrate secure coding practices to prevent common attacks.	L4
CO5	Evaluate real-world web attacks and apply mitigation strategies.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Web Application Security
Scope of Module: Covers the architecture of web applications, the nature of threats, and the importance of implementing security in the development cycle.
Topics: Web application architecture (Client, Server, DB), HTTP vs HTTPS, Web security goals, Attack surfaces in web applications, OWASP Top 10 overview, CIA triad in web security, Basics of input validation and output encoding, Introduction to threat modeling, Role of front-end and back-end security, Web browser security basics.
Learning Outcome: Understand how web applications function and the need for securing each layer.

No. of Hours: 24

Module 2: Common Web Vulnerabilities
Scope of Module: Delves into the most common vulnerabilities affecting web applications and how attackers exploit them.
Topics: SQL Injection (SQLi), Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Broken Authentication and Session Management, Security misconfigurations, Directory traversal, Insecure file uploads, Insecure deserialization, XML External Entity (XXE) attack, Command injection.
Learning Outcome: *Recognize key web application vulnerabilities and understand their impact*

No. of Hours: 24

Module 3: Secure Coding Practices
Scope of Module: Teaches students how to avoid security flaws through safe coding practices in both front-end and server-side development. It emphasizes practical strategies for writing robust and secure code in web applications.
Topics: Input validation and sanitization, Output escaping, Secure session handling, Secure cookie attributes, CSRF token implementation, Using HTTPS and security headers, Avoiding insecure dependencies, Error handling and logging securely, Password hashing (bcrypt), Avoiding hardcoded secrets, Role-based access control (RBAC), Secure database queries using prepared statements, Secure file upload and download handling, Avoiding client-side security misconfigurations, Common pitfalls in JavaScript security
Learning Outcome: *Implement secure coding practices to defend against common web application exploits, enhance code resilience, and follow security standards in development.*

No. of Hours: 24

Module 5: Cybersecurity Best Practices and Case Studies
Scope of Module: Covers real-world examples, preventive strategies, and practical approaches to maintaining web application security.
Topics: Safe internet practices, Password policies and 2FA, Use of CAPTCHAs, Secure API practices, Rate limiting and throttling, Web Application Firewall (WAF), Security in deployment (DevSecOps basics), Case studies on Facebook breach, Zomato breach, Indian Aadhaar leak, Introduction to bug bounty programs, Cyber laws overview (India).
Learning Outcome: *Analyze real-world attacks and recommend strategies to prevent them.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre-recordings.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of HTML, JavaScript, and web development
- Familiarity with client-server architecture
- Understanding of HTTP/HTTPS and basic networking

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs with vulnerability testing (e.g., XSS, SQLi)
- ✓ Code audits and secure code refactoring exercises
- ✓ Case study-based discussions of real-world breaches
- ✓ Security tool usage (Burp Suite, OWASP ZAP)
- ✓ Quizzes, code reviews, and capstone mini-projects

Certificate / Value Added Courses Recommended (Free Resource Links):

- PortSwigger Web Security Academy
- OWASP Top 10 Web Application Security Risks
- Coursera: Web Application Security Testing
- Hacker101 (by HackerOne)

Suggested Readings:

- Dafydd Stuttard & Marcus Pinto, *The Web Application Hacker's Handbook*, Wiley
- Bryan Sullivan & Vincent Liu, *Web Application Security: A Beginner's Guide*, McGraw Hill
- OWASP Official Guides and Cheat Sheets
- Michal Zalewski, *The Tangled Web: A Guide to Securing Modern Web Applications*, No Starch Press

Recommended Software/Tools:

1. **Vulnerability Testing:** Burp Suite, OWASP ZAP, Nikto
2. **Security Analysis:** Browser DevTools, HTTP Toolkit
3. **Coding & Testing:** Postman, VS Code, GitHub
4. **Authentication/Authorization:** OAuth, JWT, reCAPTCHA

5. **Environments:** Docker, Localhost, XAMPP/LAMP stack

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	–	2	2	3	–	–	2
CO2	3	3	3	2	-	2	3	–	1	2
CO3	3	2	2	2	3	–	2	–	–	2
CO4	3	3	3	2	3	1	3	–	–	1
CO5	3	3	3	2	2	2	3	1	1	3
Articulation	3	2.8	2.6	2	2.5	1.75	2.8	1	1	2

Course Title:	**Quantitative Techniques**
Course Code:	**25VBT0C404**
Semester:	**IV**
Credits:	**3**
Course Type	GE
Learning Hours	90
Live Sessions	**12 hours**

Course Description:

This course aims to equip students with the mathematical and statistical tools required for decision-making and problem-solving in computer applications and business scenarios. It covers topics such as linear programming, probability, statistics, correlation, regression, and queuing theory. These quantitative techniques are essential for data analysis, operations research, and software modeling.

Course Outcomes (COs):

CO	Course Outcome	BTL
CO1	Understand the fundamentals of quantitative methods and their applications in computer science.	L2
CO2	Solve optimization problems using linear programming and graphical methods.	L3
CO3	Apply concepts of probability and distributions in real-life decision-making.	L3
CO4	Analyze data using correlation, regression, and index numbers.	L4
CO5	Demonstrate the use of queuing theory and statistical decision-making tools.	L5

Course Modules **No. of Hours: 18**

Module 1: Linear Algebra and Equations
Scope of Module: Covers matrix operations, system of linear equations, and their computational applications.

Topics:
Types of Matrices, Matrix Operations, Determinants and Properties, Inverse of a Matrix, Solving Linear Equations (Cramer's Rule, Matrix Inversion), Gauss Elimination Method, Rank of a Matrix, Eigenvalues and Eigenvectors, Applications in Computer Graphics, Linear Dependence and Independence, Linear Transformation, Diagonalization, Vector Spaces, Basis and Dimension, Applications in Data Science.
Learning Outcome: - *Use matrix algebra to solve linear systems and perform transformations in computing.*

No. of Hours: 18

Module 2: Descriptive Statistics
Scope of Module:
Focuses on summarizing and interpreting data using various statistical measures.
Topics:
Types of Data, Data Collection Methods, Frequency Distribution, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Variance, Standard Deviation), Skewness and Kurtosis, Percentiles and Quartiles, Data Visualization (Histograms, Pie Charts, Box Plots), Cross-tabulation and Contingency Tables, Correlation Analysis, Covariance, Scatter Plots, Use of Excel/SPSS for Data Analysis, Real-life Data Interpretation.
Learning Outcome: - *Analyze and describe data using statistical measures and visualizations.*

No. of Hours: 18

Module 3: Linear Programming and Optimization
Scope of Module:
Explores techniques for modeling and solving optimization problems using LPP.
Topics:
Introduction to Linear Programming, Formulating LPPs, Graphical Method, Simplex Method, Duality in LPP, Sensitivity Analysis, Transportation Problem, Assignment Problem, Degeneracy and Unbalanced Problems, Maximization and Minimization Models, Profit and Cost Optimization, Integer Programming, Decision Variables and Constraints, Real-world Applications, Use of Solver Tools in Excel.
Learning Outcome: - *Formulate and solve optimization problems using linear programming techniques.*

No. of Hours: 18

Module 4: Probability and Distributions
Scope of Module:
Introduces probability concepts and probability distributions for quantitative reasoning.
Topics:
Basic Probability Rules, Conditional Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Expected Value and Variance, Binomial Distribution, Poisson Distribution, Normal Distribution, Central Limit Theorem, Applications in Risk Analysis, Z-scores and Standardization,

Probability Trees, Joint and Marginal Probabilities, Monte Carlo Simulations, Statistical Applications in IT.
Learning Outcome: - *Apply probability and distributions to evaluate uncertain events and risks.*

No. of Hours: 18

Module 5: Decision Theory and Forecasting
Scope of Module: Focuses on decision-making techniques and forecasting tools for business applications.
Topics: Decision-Making Under Certainty, Uncertainty, and Risk, Payoff Tables and Decision Trees, Expected Monetary Value, Maximax, Maximin, Minimax Regret, Forecasting Techniques (Moving Average, Exponential Smoothing), Time Series Analysis, Trend and Seasonality Detection, Regression Models, Index Numbers, Error Analysis (MAD, MSE), Use of Forecasting in Business and IT, Software Tools for Decision Analysis.
Learning Outcome: *Implement decision analysis and forecasting models for planning and problem-solving.*

Module	**No of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum no of pre-recordings.

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)

4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning
- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

9. Coursera: Statistics with Excel
   https://www.coursera.org/learn/basic-statistics-excel
10. edX: Data Science: Probability
    https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
11. MIT OpenCourseWare: Introduction to Probability and Statistics
    https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings:

- Richard I. Levin & David S. Rubin, Statistics for Management, Pearson
- S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House
- Taha H. A., Operations Research: An Introduction, Pearson
- Vohra N.D., Quantitative Techniques in Management, Tata McGraw-Hill
- Online articles from JSTOR, ScienceDirect, and SpringerLink for research-based insights

Recommended Software/Tools (If applicable):

7. Microsoft Excel (with Solver add-in)
8. SPSS for statistical analysis

9. R or Python (NumPy, SciPy, Pandas, Statsmodels)
4. Tableau or Power BI for data visualization

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	–	2	–	–	–	–
CO2	3	3	3	2	–	3	–	–	–	–
CO3	3	3	3	2	–	2	–	–	–	–
CO4	3	3	3	3	2	2	–	–	–	–
CO5	3	3	3	3	2	3	–	–	–	–

Semester V

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Centre for Distance & Online Education
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Course Title:	Block chain Technologies
Course Code:	**25VBT0C501**
Semester:	**V**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces the foundational and advanced aspects of blockchain technology. Students will explore block chain architecture, cryptographic techniques, smart contracts, and application platforms. They will also evaluate block chain's impact on security, privacy, business ecosystems, and societal implications. The course emphasizes practical skills through development environments and case studies.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of blockchain technology.	L2
CO2	Explore various blockchain platforms and their applications.	L3
CO3	Develop skills to design and implement blockchain-based solutions.	L4
CO4	Analyze the security and privacy aspects of blockchain.	L4
CO5	Assess the impact of blockchain technology on business and society.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Blockchain Technology
Scope of Module: Introduces the basics, architecture, and cryptographic foundation required for understanding blockchain systems.
Topics: Introduction to Blockchain Technology, History and Evolution of Blockchain, Types of Blockchains: Public, Private, Consortium, Applications of Blockchain Technology, Components of Blockchain: Blocks, Chains, Nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Smart Contracts and Their Execution, Blockchain Forks, Basic Cryptographic

Concepts: Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Cryptographic Algorithms Used in Blockchain
Learning Outcome: - *Gain foundational understanding of blockchain principles, architecture, and cryptography.*

No. of Hours: 24

Module 2: Blockchain Platforms and Development
Scope of Module: Focuses on blockchain ecosystems and hands-on development using Ethereum and other platforms.
Topics: Bitcoin and Ethereum: Structure and Functionality, Hyperledger Fabric, Ripple, Corda and Other Blockchain Platforms, Setting Up Blockchain Development Environment, Writing Smart Contracts in Solidity, Deploying Smart Contracts on Ethereum, Decentralized Applications (DApps), Detailed Study of Smart Contracts, Smart Contract Development and Testing, Real World Use Cases of Smart Contracts
Learning Outcome: - *Explore and implement blockchain-based solutions using various platforms and tools.*

No. of Hours: 24

Module 3: Blockchain Security, Privacy and Compliance
Scope of Module: Analyzes the threats and solutions related to blockchain security, privacy regulations, and standards.
Topics: Security Issues in Blockchain, Attacks on Blockchain: 51% Attack, Sybil Attack, Privacy Solutions in Blockchain, Regulatory and Legal Implications, Data Privacy Laws and Regulations, Blockchain's Role in Ensuring Data Privacy, Case Studies on Privacy Issues in Blockchain, Overview of Popular Cryptocurrencies, Cryptocurrency Mining and Transactions, Regulatory Aspects of Cryptocurrencies, International Standards for Blockchain Technology, Frameworks and Protocols for Blockchain Development, Compliance and Best Practices
Learning Outcome: - *Evaluate security vulnerabilities, privacy frameworks, and compliance in blockchain systems.*

No. of Hours: 24

Module 4: Blockchain Applications in Industry and Society
Scope of MoNote: Min No of pre recordings.

dule: Explores how blockchain is transforming industries and provides real-world use cases across various domains.
Topics: Blockchain in Financial Services: Cryptocurrencies, Payment Systems, Supply Chain Management, Healthcare and Identity Management, Government and Public Services, Impact of Blockchain on Business Models, Case Studies in Finance, Supply Chain and Healthcare, Blockchain for Enterprise Solutions, Emerging Research Areas in Blockchain, Potential Future Applications, Ethical and Societal Implications
Learning Outcome: - *Assess real-world blockchain use cases, societal impacts, and business transformation through blockchain.*

No. of Hours: 24

Module 5: Advanced Blockchain Integration and Emerging Trends
Scope of Module: Covers the integration of blockchain with other technologies and future innovations.
Topics: Interoperability and Scalability in Blockchain, Blockchain and the Internet of Things (IoT), Blockchain and Artificial Intelligence (AI), Future Trends and Innovations in Blockchain, Integrating Blockchain with Cloud Platforms, Use Cases of Blockchain in Cloud Computing, Advantages and Challenges
Learning Outcome: - *Analyze the integration of blockchain with emerging technologies and its future direction.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min No of pre recordings.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic understanding of cryptography and networking
- Familiarity with distributed systems
- Programming experience (preferably in JavaScript, Python, or Solidity)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for smart contract development using Solidity
- ✓ Simulations and projects involving blockchain platforms like Ethereum and Hyperledger
- ✓ Case study discussions on real-world blockchain implementations
- ✓ Group activities on blockchain architecture and DApp design
- ✓ Evaluation through mini-projects, quizzes, and practical assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

9. Coursera: Blockchain Specialization – University at Buffalo & SUNY
10. IBM Blockchain Foundation Developer Course
11. edX: Blockchain Fundamentals – UC Berkeley
12. Blockchain Council: Free Blockchain Courses

Suggested Readings:

- Arvind Narayanan et al., *Bitcoin and Cryptocurrency Technologies*, Princeton University Press
- Melanie Swan, *Blockchain: Blueprint for a New Economy*, O'Reilly
- Imran Bashir, *Mastering Blockchain*, Packt Publishing
- Don Tapscott & Alex Tapscott, *Blockchain Revolution*, Penguin

Recommended Software/Tools:

7. **Smart Contract Development:** Remix IDE, Truffle, Hardhat
8. **Blockchain Platforms:** Ethereum, Hyperledger Fabric, Corda
9. **Languages:** Solidity, JavaScript, Go
10. **Testing and Deployment:** Ganache, MetaMask, Infura
11. **Development Environments:** Visual Studio Code, Docker
12. **Version Control:** Git/GitHub

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	–	1	1	2
CO2	2	–	2	2	–	3	2	–	1	2
CO3	2	3	–	2	–	2	2	2	–	2
CO4	2	3	2	–	2	–	3	2	1	2
CO5	1	2	1	2	1	3	–	2	2	–
Articulation	2	2.5	1.5	1.75	1.6	2.5	2.3	1.75	1.25	2

Course Title:	Machine Learning Techniques
Course Code:	**25VBT4E502**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to the fundamental concepts, techniques, and applications of machine learning. It focuses on practical understanding and implementation of algorithms that allow computers to learn from data and make decisions. Through hands-on examples and projects, students will learn supervised, unsupervised, and basic reinforcement learning methods suitable for real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the foundational principles and workflow of machine learning.	L2
CO2	Differentiate between supervised and unsupervised learning techniques.	L3
CO3	Apply machine learning algorithms like regression, classification, and clustering.	L3
CO4	Evaluate model performance using appropriate metrics and validation methods.	L4
CO5	Implement real-world problem-solving using machine learning libraries and tools.	L5

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Course Modules

No. of Hours: 24

Module 1: Introduction to Machine Learning
Scope of Module: This module introduces the core concepts and workflow of machine learning, including the types of learning and the role of data in predictive systems.
Topics: Definition of Machine Learning, History and evolution, Types of machine learning: supervised, unsupervised, reinforcement learning, Applications of ML in daily life, ML workflow: data preprocessing, model building, evaluation, Basic concepts of data: features, labels, attributes, noise, Overview of tools: Python, Scikit-learn, Pandas, Jupyter
Learning Outcome: *Understand what machine learning is, its types, and how it is applied in real-world scenarios.*

No of hours:24

Module 2: Data Preprocessing and Feature Engineering
Scope of Module: Covers essential steps to prepare data for machine learning models, including cleaning, transforming, handling noise, and engineering meaningful features to improve model performance.
Topics: Handling missing data, Encoding categorical variables (Label Encoding, One-Hot Encoding), Feature scaling (standardization, normalization), Feature selection and dimensionality reduction, Introduction to Principal Component Analysis (PCA), Train-test split, Cross-validation techniques, Detecting and removing outliers, Binning and discretization, Data transformation (log, box-cox), Handling imbalanced datasets (SMOTE introduction), Correlation analysis, Feature importance using decision trees
Learning Outcome: *Prepare and transform raw, noisy, or incomplete data into structured and relevant input for machine learning algorithms, enabling better model accuracy and generalization.*

No. of Hours: 24

Module 3: Supervised Learning Algorithms
Scope of the Module: Focuses on learning from labeled data using various classification and regression techniques.
Topics: Linear regression, Logistic regression, k-Nearest Neighbors (kNN), Decision Trees, Random Forests, Support Vector Machines (SVM), Model evaluation: accuracy, precision, recall, F1 score, confusion matrix
Learning Outcome: *Implement and evaluate key supervised learning models for classification and regression problems*

No. of Hours: 24

Module 4: Unsupervised Learning and Clustering
Scope of the Module: Introduces students to learning patterns from unlabeled data using clustering, dimensionality reduction, and association analysis techniques. Emphasis is placed on pattern discovery and understanding hidden structures in data.
Topics: Clustering: k-Means, Hierarchical clustering, Introduction to DBSCAN, Choosing the right number of clusters (Elbow method, Silhouette score), Distance metrics (Euclidean, Manhattan), Applications of

clustering (customer segmentation, document grouping), Dimensionality reduction using PCA and t-SNE (intro), Visualization with PCA and t-SNE, Introduction to association rule mining (Apriori algorithm), Support, confidence, and lift in rule mining, Anomaly detection basics, Real-world applications of unsupervised learning (e.g., fraud detection, recommendation systems)
Learning Outcome: *Apply unsupervised learning techniques to discover hidden patterns, visualize data, and make sense of complex datasets without labels.*

No. of Hours:24

Module 5: Model Tuning and Real-World Applications
Scope of Module: Covers advanced techniques like model tuning and shows practical applications of ML in industry use cases.
Topics: Model overfitting and underfitting, Hyperparameter tuning (Grid Search, Randomized Search), Introduction to ensemble learning, Introduction to neural networks (basics only), Case studies: Email spam detection, House price prediction, Fraud detection, Introduction to ML ethics and bias, Final project guidance
Learning Outcome: *Optimize and fine-tune ML models and evaluate their performance on practical problems.*

Module	**No of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min No Of pre-recordings:10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of Python programming
- Familiarity with statistics and linear algebra
- Understanding of data structures and algorithms

Pedagogy / Teaching Methodology:

- ✓ Python-based implementation in Jupyter Notebooks
- ✓ Case studies and mini-projects using Scikit-learn and Pandas
- ✓ Group assignments on dataset preprocessing and model evaluation
- ✓ Use of public datasets from Kaggle/UCI ML Repository
- ✓ Regular quizzes and concept visualizations

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Machine Learning by Andrew Ng – Stanford University
2. Google's Machine Learning Crash Course

3. Fast.ai: Practical Deep Learning for Coders
4. Kaggle Learn: Intro to Machine Learning

Suggested Readings:

- Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly
- Tom Mitchell, *Machine Learning*, McGraw Hill
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning*, Springer
- Chris Bishop, *Pattern Recognition and Machine Learning*, Springer

Recommended Software/Tools:

1. **Programming Language:** Python
2. **Libraries:** Scikit-learn, Pandas, NumPy, Matplotlib, Seaborn
3. **Platforms:** Jupyter Notebook, Google Colab
4. **Additional Tools:** TensorFlow/Keras (for neural network basics), MLflow (optional for model tracking)

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	–	–	–	–	2
CO3	3	3	3	2	3	–	–	–	2	2
CO4	3	3	3	2	3	–	–	–	2	3
CO5	3	3	3	2	3	2	–	1	2	3
Articulation	3	3	2.8	2	2.6	2	-	1	2	2.4

Course Title:	Digital Forensics
Course Code:	**25VBT4E503**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces the core principles and practices of digital forensics, tailored for undergraduate BCA students. It emphasizes techniques for identifying, collecting, preserving, and analysing digital evidence. The course also covers forensic tools, legal considerations, and real-world investigative case studies to develop students' capabilities in handling cybercrime investigations and digital data breaches.

Course Outcomes (COs):
Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of digital forensics and its role in cybercrime investigation.	L2
CO2	Identify and explain methods for evidence acquisition, preservation, and analysis from digital devices.	L3
CO3	Use forensic tools to examine file systems, deleted data, and email artifacts.	L4
CO4	Analyze network and mobile device data for forensic purposes.	L4
CO5	Apply ethical, legal, and procedural standards in digital forensics investigations.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Digital Forensics
Scope of Module:
This module introduces the field of digital forensics, its relevance in today's cybercrime landscape, and the overall investigative process. It focuses on the foundational knowledge required to understand how digital evidence is identified, handled, and utilized in investigations.
Topics: Digital Forensics, History and Evolution, Types of Cybercrimes (Phishing, Hacking, Identity Theft,

Cyberstalking), Phases of Digital Investigation (Identification, Preservation, Analysis, Reporting), Digital Evidence and Its Characteristics, The Role of Forensic Analysts, Chain of Custody and Documentation, Categories of Digital Evidence (Text, Image, Audio, Video, Metadata), Basics of File Systems (FAT, NTFS, ext3), Types of Devices Involved in Digital Crime (PCs, USBs, Mobile Devices, Cloud), Digital Crime Scene Basics, Introduction to Anti-forensics Techniques (Data Hiding, Steganography, Encryption), Introduction to ISO/IEC Standards in Forensics
Learning Outcome: *Understand the fundamentals of digital forensics, stages of investigation, and the nature and handling of digital evidence in real-world scenarios.*

No. of Hours: 24

Module 2: Evidence Acquisition and Preservation
Scope of Module: Focuses on proper methods for identifying, acquiring, and preserving digital evidence without tampering or violating legal procedures. The module also emphasizes maintaining the integrity and admissibility of evidence in legal proceedings.
Topics: Evidence Acquisition Principles, Live vs Dead Acquisition, Disk Imaging Techniques (Bit-by-bit copy, Logical Imaging), Write Blockers and Their Role, Hashing and Verification (MD5, SHA-1, SHA-256), Evidence Collection from Volatile and Non-Volatile Memory, Memory Dumping Basics (RAM Acquisition), Legal Considerations during Evidence Handling, Chain of Custody Documentation, Tools for Acquisition (FTK Imager, EnCase, dd command), BIOS/UEFI Acquisition Considerations, Acquiring Evidence from External Devices (USB, HDD, SD cards), Time Synchronization and Time Stamps, Challenges in Remote Evidence Collection, Guidelines from NIST and Digital Evidence Best Practices.
Learning Outcome: *Apply standard and legally sound procedures for acquiring and preserving digital evidence from various devices while ensuring forensic soundness and maintaining admissibility in court.*

No. of Hours: 24

Module 3: File Systems and Data Recovery
Scope of Module:
Covers the structure of file systems and methods to retrieve lost or hidden data through forensic tools. Emphasis is placed on understanding how data is stored, modified, deleted, and recovered from storage media.
Topics: File System Forensics (FAT, NTFS, ext3, ext4), File Metadata Analysis (MAC Times), File Signature and Header Recovery, Deleted File Recovery, Slack Space and Free Space Analysis, Hidden and Encrypted Files, Fragmented File Recovery, File Allocation Table and Master File Table (MFT), Volume Shadow Copy Analysis, File Recovery from USB/External Drives, Forensic Imaging Tools (FTK Imager, Autopsy, Sleuth Kit), Keyword Searching and Data Carving, Analyzing File Timestamps and System Logs, Hexadecimal and Binary View of Files, Case Study: Recovering Evidence from a Corrupted Disk.
Learning Outcome: *Perform structured forensic analysis of various file systems and effectively recover deleted, hidden, or fragmented data using forensic tools.*

No. of Hours: 24

Module 4: Network and Email Forensics
Scope of Module:
Explores the investigation of network traffic and email communications to detect suspicious or malicious activity.
Topics: Network Forensics Overview, Capturing and Analyzing Network Traffic using Wireshark, Packet Analysis Techniques, Identifying IP, MAC, Port Activity, Firewall and Router Log Analysis, Email Forensics (Header Analysis, Spoofing Detection), Attachments and Phishing Email Investigation
Learning Outcome: *Analyze network traffic and emails to extract forensic evidence related to cyberattacks or data breaches.*

No. of Hours: 24

Module 5: Mobile and Cloud Forensics with Legal Framework
Scope of Module:
Covers forensic analysis of smartphones and cloud environments, along with the legal framework governing digital investigations.
Topics: Mobile Device Forensics Overview, SIM and SD Card Forensics, Analyzing Mobile App Data, Mobile Backup and Sync Artifacts, Cloud Storage Investigation Basics (Google Drive, Dropbox), Introduction to Forensic Tools (Cellebrite, Oxygen), Indian IT Act 2000 and Amendments, Legal and Ethical Responsibilities, Cybercrime Case Studies and Courtroom Evidence Presentation
Learning Outcome: *Conduct basic forensic investigations on mobile/cloud systems and understand legal boundaries and responsibilities.*

Module	**No of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of operating systems and file systems
- Familiarity with computer networks
- Introductory understanding of cybersecurity and legal frameworks

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using forensic tools like FTK Imager, Autopsy, and Wireshark
- ✓ Simulated cybercrime investigation scenarios
- ✓ Real-world case study discussions
- ✓ Documentation and chain of custody exercises
- ✓ Practical evidence acquisition and reporting projects

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Digital Forensics – University of Maryland

2. Cybrary: Digital Forensics Fundamentals
3. OpenLearn: Digital Forensics
4. NIST Guidelines on Digital Evidence

Suggested Readings:

- Nelson, Phillips, Enfinger, and Steuart, *Guide to Computer Forensics and Investigations*, Cengage
- Bill Nelson, *Digital Forensics Workbook*, Cengage
- Eoghan Casey, *Digital Evidence and Computer Crime*, Academic Press
- NIST Special Publications on Digital Evidence Handling

Recommended Software/Tools:

1. **Forensic Tools:** FTK Imager, Autopsy, Sleuth Kit, EnCase (demo), Cellebrite (demo)
2. **Network Analysis:** Wireshark
3. **Imaging & Acquisition:** dd command, Write blockers
4. **Log & Email Analysis:** MxToolbox, Outlook PST tools
5. **Mobile & Cloud Tools:** Oxygen Forensics, ADB (Android Debug Bridge), Google Takeout

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	3	1	–	2
CO2	3	3	3	2	2	2	3	–	–	2
CO3	3	3	3	2	3	–	2	–	–	2
CO4	3	3	3	2	3	–	2	–	–	2
CO5	3	3	2	1	2	3	3	1	–	3

Articulation	**3**	**3**	**2.6**	**1.8**	**2.4**	**2.3**	**2.6**	**1**	**-**	**2.2**

Course Title:	Defensive Cyber Security Technologies
Course Code:	**25VBT4E504**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course provides an in-depth exploration of defensive cyber security technologies, focusing on strategies and tools essential for protecting digital assets against cyber threats. Students will gain practical knowledge of implementing and managing security measures to safeguard networks, systems, and data. Emphasis is placed on real-world applications, preparing students for critical roles in cybersecurity defense within the industry.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of defensive cybersecurity and the importance of protecting information assets.	L2
CO2	Implement and manage firewalls, intrusion detection/prevention systems, and other perimeter defense mechanisms.	L3
CO3	Apply encryption techniques to ensure data confidentiality and integrity.	L3
CO4	Develop skills in monitoring, detecting, and responding to security incidents using SIEM tools.	L4
CO5	Evaluate and mitigate vulnerabilities through regular assessments and the application of security patches.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Cyber Defense
Scope of Module:
Introduces basic security concepts, types of threats, and foundational strategies in defending IT infrastructure.

Topics: Overview of Cybersecurity Threat Landscape, Types of Cyber Attacks (Malware, Phishing, Ransomware), CIA Triad and Security Principles, Threat Modeling Basics, Risk Assessment and Management, Cyber Kill Chain, Defense-in-Depth Strategy, Zero Trust Architecture, Role of Firewalls and VPNs, Security Policies and Procedures, Vulnerability Assessment Lifecycle, Penetration Testing Overview, Importance of Patch Management, Human Factors and Social Engineering Defense, Overview of Security Standards (ISO 27001, NIST).
Learning Outcome: *Understand key cyber threats and foundational defensive strategies.*

No. of Hours: 24

Module 2: Network and Infrastructure Defense
Scope of Module: Focuses on securing networks, firewalls, segmentation, and monitoring network traffic for anomalies.
Topics: Network Security Fundamentals, Perimeter Defense with Firewalls, IDS and IPS Systems, Network Segmentation and Micro segmentation, Secure Network Protocols (SSL, TLS, IPsec), Configuration Hardening, DNS Security Techniques, Network Behaviour Analysis Tools, Honeypots and Deception Technologies, Secure Remote Access, VPN Technologies and Protocols, Wi-Fi Security (WPA3, EAP), Zero Trust Network Access (ZTNA), Cloud Network Defense, Best Practices for Network Monitoring.
Learning Outcome: *Implement network-level security controls and monitor traffic for threats.*

No. of Hours: 24

Module 3: Endpoint, Application, and Data Protection
Scope of Module:
Covers protection of devices, applications, and sensitive data from unauthorized access and tampering.
Topics: Endpoint Security Solutions (EDR/XDR), Secure Boot and Trusted Computing, OS Hardening Techniques, Antivirus and Anti-malware Tools, Application Whitelisting and Control, Secure SDLC and DevSecOps, Web Application Firewalls (WAF), OWASP Top 10 and Mitigation Strategies, Secure Authentication (MFA, Passwordless), Data Loss Prevention (DLP), Disk and File Encryption (BitLocker, VeraCrypt), Secure Cloud Storage Practices, Mobile Device Security, Role of IAM (Identity and Access Management), Database Security Techniques.
Learning Outcome: *Secure endpoints, applications, and data using defensive strategies and tools.*

No. of Hours: 24

Module 4: Threat Detection and Incident Response
Scope of Module: Introduces methods and tools used for detecting threats and managing incidents in real-time.

Topics: Security Information and Event Management (SIEM), Log Collection and Correlation, SOC Operations and Monitoring, Threat Hunting Techniques, Indicators of Compromise (IOCs), Threat Intelligence Platforms, Behavioral Analytics and Anomaly Detection, Real-Time Alerting Systems, Incident Response Lifecycle, Role of SOAR Tools, Containment and Eradication Procedures, Chain of Custody and Evidence Handling, Incident Communication and Reporting, Red vs. Blue Team Exercises, Post-Incident Review and Lessons Learned.
Learning Outcome: *Detect, investigate, and respond to cybersecurity incidents effectively*

No. of Hours: 24

Module 5: Modern Defensive Tools and Emerging Trends
Scope of Module:
Focuses on current tools and technologies in defense, with exposure to automation, AI, and emerging challenges.
Topics: AI and ML in Cybersecurity Defense, Automated Response Tools (SOAR), MITRE ATT&CK Framework, Cyber Threat Emulation Tools (Cuckoo Sandbox, Metasploit), Container Security (Docker, Kubernetes), Cloud Security Posture Management (CSPM), Zero-Day Threat Detection, Security Automation and Orchestration, Role of Blockchain in Cyber Defense, Quantum-Safe Cryptography Overview, Digital Forensics Basics, SIEM Tools: Splunk, ELK Stack, Secure Configuration Management Tools (Ansible, Chef), Cybersecurity Regulations and Compliance (IT Act, GDPR), Career Roles in Defensive Cybersecurity.
Learning Outcome: *Apply emerging technologies and tools in proactive cyber defense strategies.*

Module	**No of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min No of Pre recordings:10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic understanding of networking and operating systems
- Familiarity with cybersecurity principles
- Basic experience with system administration or scripting is beneficial

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs and simulations with firewalls, IDS/IPS, and SIEM tools
- ✓ Case-based analysis of real cyber incidents
- ✓ Live demonstrations of endpoint protection and secure configurations
- ✓ Use of open-source and enterprise security tools
- ✓ Group projects and industry-focused assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

1. Coursera: Cybersecurity Specialization – University of Maryland
2. Cybrary: Defensive Security Engineer Learning Path
3. IBM: Introduction to Cybersecurity Tools & Cyber Attacks
4. MITRE ATT&CK Navigator

Suggested Readings:

- William Stallings, *Network Security Essentials: Applications and Standards*, Pearson
- Mark Ciampa, *Security+ Guide to Network Security Fundamentals*, Cengage
- Bruce Schneier, *Applied Cryptography*, Wiley
- NIST Special Publications: 800-53, 800-61, 800-171

Recommended Software/Tools:

1. **Perimeter Defense:** pfSense, Cisco ASA, Snort, Suricata
2. **SIEM Platforms:** Splunk, ELK Stack, OSSIM
3. **Endpoint Security:** CrowdStrike, Windows Defender, Symantec
4. **Threat Detection/Response:** Wireshark, Cuckoo Sandbox, MITRE ATT&CK Navigator
5. **Security Automation:** Ansible, Chef, SOAR tools
6. **Cloud Security:** AWS Security Hub, CSPM tools

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	-	3	3	1
CO2	3	3	2	2	2	2	2	3	3	1
CO3	3	2	3	2	3	2	2	2	1	1

CO4	3	3	2	2	3	1	2	2	1	1
CO5	3	3	3	2	3	2	2	2	2	2

Course Title:	Cyber Threat Intelligence
Course Code:	**25VBT4E505**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course provides an in-depth understanding of cyber threat intelligence (CTI) and its role in modern cybersecurity. It covers threat identification, analysis techniques, attack vectors, and proactive defense mechanisms. Students will explore real-world cyber threats and learn to apply intelligence-driven security strategies for risk mitigation.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamentals of Cyber Threat Intelligence and its significance in cybersecurity.	L2
CO2	Analyze various cyber threats, attack methods, and adversary tactics.	L3
CO3	Apply intelligence-gathering techniques for threat detection and risk assessment.	L4
CO4	Evaluate cyber threat intelligence frameworks and models for security implementation.	L4
CO5	Develop strategies for mitigating cyber threats and enhancing organizational security posture.	L5

Course Modules **No. of Hours: 24**

Module 1: Introduction to Cyber Threat Intelligence
Scope of Module: This module introduces the fundamentals of cyber threat intelligence, its role in cybersecurity, and how intelligence can be used to predict and prevent attacks.

Topics: Definition and importance of Cyber Threat Intelligence in modern cybersecurity: Threat Intelligence Lifecycle: Planning, Collection, Processing, Analysis, Dissemination, Feedback; Types of Threat Intelligence: Strategic, Tactical, Operational, Technical; Role of CTI in cybersecurity operations : proactive defense, incident response; Intelligence sources: Open-Source Intelligence, Human Intelligence, Machine Intelligence; Cyber threat landscape: Emerging trends and real-world examples.
Learning Outcome: *Understand the role of Cyber Threat Intelligence in cybersecurity and recognize different intelligence sources*.

No. of Hours: 24

Module 2: Cyber Threat Actors and Attack Vectors
Scope of Module: This module focuses on identifying cyber threat actors, their motivations, and the common attack techniques they use.
Topics: Cyber threat actors: Nation-state attackers, hacktivists, cybercriminals, insider threats; Common attack vectors: Phishing, malware, ransomware, DDoS, zero-day exploits; Cyber Kill Chain model and MITRE ATT&CK framework for attack analysis; Case studies of major cyber attacks; Threat hunting techniques and Indicators of Compromise; Practical exercise: Analyzing phishing emails or mapping IoCs to ATT&CK.
Learning Outcome: *Analyze cyber threat actors and their attack methodologies for proactive threat detection.*

No. of Hours: 24

Module 3: Threat Intelligence Collection and Analysis
Scope of Module: This module covers various intelligence-gathering techniques and frameworks used for threat analysis.
Topics: Data collection techniques for CTI: passive/active, ethical/legal considerations; Threat intelligence feeds and platforms: SIEMs, TIPs, commercial/community feeds; Threat data normalization and correlation methods; Open-Source Intelligence (OSINT) tools: Maltego, Shodan, SpiderFoot; STIX (Structured Threat Information eXpression) and TAXII (Trusted Automated Exchange) standards; Threat intelligence sharing and collaboration: MISP, ISACs.
Learning Outcome: *Apply intelligence collection techniques to gather and analyze cyber threats effectively.*

No. of Hours: 24

Module 4: Threat Intelligence Frameworks and Defense Mechanisms

Scope of Module: This module explores popular threat intelligence frameworks and proactive security measures used to mitigate threats.
Topics: Threat intelligence frameworks: MITRE ATT&CK, Diamond Model, Cyber Kill Chain; Role of CTI in incident response and digital forensics; AI and machine learning applications in threat detection/analysis; SIEM integration and automated threat response playbooks; Cyber defense strategies: Proactive hunting, deception technologies; SOC (Security Operations Center) workflows and CTI automation.
Learning Outcome: *Evaluate different frameworks and tools for implementing intelligence-driven security measures.*

No. of Hours: 24

Module 5: Case Studies and Best Practices in Threat Intelligence
Scope of Module: This module highlights real-world case studies and best practices for cyber threat intelligence implementation.
Topics: Case studies: Log4j vulnerability, SolarWinds supply-chain attack, ransomware campaigns; Implementing CTI programs: Stakeholder alignment, tool selection, ROI metrics; Compliance and regulations: GDPR, NIST CSF, ISO 27001; Ethical considerations in CTI: privacy, attribution, sharing boundaries; Future trends: IoT/OT threats, AI-driven adversaries, threat intelligence as a service.
Learning Outcome: *Analyze real-world cases and adopt best practices for implementing threat intelligence in cybersecurity.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings: 10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of cybersecurity principles
- Familiarity with common cyber attacks and network fundamentals
- Understanding of system architecture and security tools

Pedagogy / Teaching Methodology:

- ✓ Hands-on threat analysis labs using OSINT tools and ATT&CK Navigator
- ✓ Case study presentations and group projects
- ✓ Intelligence feed simulation and threat mapping exercises
- ✓ SIEM and TIP platform demonstrations
- ✓ Assignments on STIX/TAXII data interpretation and incident tracking

Certificate / Value Added Courses Recommended (Free Resource Links):

1. MITRE ATT&CK Training
2. Coursera: Cyber Threat Intelligence by NYU
3. IBM: Introduction to Threat Intelligence

4. Recorded Future Learning Portal

Suggested Readings:

- Henry Dalziel, *Cyber Threat Intelligence*, Syngress
- Scott J. Roberts and Rebekah Brown, *The Threat Intelligence Handbook*, O'Reilly
- Sherri Davidoff, *Data Breaches: Crisis and Opportunity*, Addison-Wesley
- NIST SP 800-150: *Guide to Cyber Threat Information Sharing*

Recommended Software/Tools:

1. **OSINT Tools:** Maltego, Shodan, SpiderFoot
2. **Threat Intelligence Platforms (TIPs):** MISP, ThreatConnect
3. **SIEM Tools:** Splunk, ELK Stack
4. **Frameworks:** MITRE ATT&CK, STIX/TAXII, Cyber Kill Chain
5. **Automation:** SOAR, Ansible playbooks for response
6. **Threat Feeds:** AlienVault OTX, Recorded Future (community)

CO-PO Mapping

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2

Articulation	3	2.6	2.2	2	2.2	1.75	2.6	1	2	1.2

Course Title:	Advanced Software Development Practices
Course Code:	**25VBT0C503**
Semester:	**V**
Credits:	**2**
Course Type	**SEC**
Learning Hours	60
Live Sessions	**12 hours**

Course Description

This course introduces advanced principles, methodologies, and tools essential for modern software development. Emphasizing Agile methodologies, clean coding practices, scalable architecture, DevOps integration, quality assurance, and security, it equips learners with industry-ready skills to design, develop, and manage robust software systems.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Apply software development principles to design scalable and maintainable applications.	L3
CO2	Analyze software design patterns and architecture to solve real-world problems.	L4
CO3	Employ modern tools and practices such as version control, CI/CD, and testing in the development process.	L4
CO4	Demonstrate team collaboration, documentation, and agile methodologies in software projects.	L3
CO5	Evaluate software quality attributes including performance, security, and usability.	L5

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Course Modules

No. of Hours: 12

Module 1: Foundations of Modern Software Development
Scope of Module: This module introduces the evolution of software development practices and explores traditional and modern software life cycle models. It also emphasizes Agile methodologies, focusing on the Scrum framework and real-world team roles.
Topics: History and evolution of software development, software development methodologies including

Waterfall, Iterative, Spiral and V-Model, Agile manifesto and principles, introduction to Scrum including roles, ceremonies and artifacts, product backlog, sprint planning and burndown charts, comparison between Agile and traditional models, case study on Scrum in practice
***Learning Outcome**: Explain the evolution of software development practices and their implementation using traditional SDLC models and Agile methodologies.*

No. of Hours: 12

Module 2: Designing Scalable and Maintainable Software
Scope of Module: This module focuses on the planning and design phase of software development. It covers capturing system requirements and applying design principles and architecture models that ensure maintainability and scalability.
Topics: Functional and non-functional requirements, requirement elicitation techniques including interviews, surveys and use cases, requirement specification and validation, SOLID principles, DRY and KISS principles, cohesion and coupling, modular design, refactoring strategies, architectural patterns including MVC, layered and microservices, system requirement and design documentation
***Learning Outcome**:Apply design principles and architecture models to create maintainable and scalable software solutions.*

No. of Hours: 12

Module 3: Practical Tools for Development and Quality Assurance
Scope of Module: This module introduces essential tools and techniques for writing efficient, testable, and reusable code. Students explore version control systems, reusable design patterns, and automated testing strategies.
Topics: Design patterns including Factory, Singleton, Observer and Strategy, advantages of design patterns in real-world applications, Git basics including initializing, cloning, committing and pushing repositories, branching and merging, resolving conflicts and using GitHub for collaboration, unit testing concepts, test-driven development including Red-Green-Refactor cycle, testing frameworks like JUnit and PyTest, test coverage analysis
***Learning Outcome**: Use design patterns, version control, and TDD practices to improve code quality and development efficiency.*

No. of Hours: 12

Module 4: DevOps Integration and Agile Project Management

Scope of Module: Students will learn how to automate software build and deployment processes using DevOps tools and manage Agile projects using tracking tools.
Topics: DevOps culture and principles, CI/CD concepts and benefits, setting up CI/CD pipelines using Jenkins or GitHub Actions, Infrastructure as Code tools and principles, Agile project management using Jira and Trello, sprint planning and backlog grooming, progress tracking using Kanban boards and velocity charts, team collaboration and documentation techniques
Learning Outcome: *Integrate DevOps automation tools and Agile project management platforms to enhance software delivery efficiency.*

No. of Hours: 12

Module 5: Software Security, Quality, and Project Implementation
Scope of Module:
This final module prepares students to deliver secure, high-quality software by integrating secure coding principles, evaluating software performance, and implementing a capstone mini project.
Topics: Secure coding principles and OWASP Top 10, input validation and secure authentication, software quality attributes including reliability, maintainability and usability, code quality metrics such as code coverage, defect density and cyclomatic complexity, software documentation including README, code comments and user manuals, project planning steps including defining scope, scheduling and risk management, preparing and presenting final deliverables, peer review and reflection
Learning Outcome: *Apply quality and security practices to implement a complete mini software project with proper documentation and reporting.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of programming (Java/Python recommended)
- Familiarity with object-oriented principles
- Understanding of software development lifecycle concepts

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for version control, CI/CD pipelines, and Agile project tools
- ✓ Group-based mini software projects
- ✓ Live coding sessions and design pattern workshops
- ✓ Practical demos using industry-standard tools

Certificate / Value Added Courses Recommended (Free Resource Links):

5. Coursera: Agile Software Development – University of Minnesota
6. Udacity: Agile Software Development
7. edX: DevOps Practices and Tools – Linux Foundation
8. GitHub Learning Lab: Intro to GitHub

Suggested Readings:

- Robert C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, Prentice Hall
- Erich Gamma et al., *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison-Wesley
- Gene Kim, Jez Humble, and Patrick Debois, *The DevOps Handbook*, IT Revolution
- Martin Fowler, *Refactoring: Improving the Design of Existing Code*, Addison-Wesley

Recommended Software/Tools:

15. **Version Control:** Git, GitHub
16. **Testing Tools:** JUnit, PyTest
17. **CI/CD:** Jenkins, GitHub Actions
18. **Agile Management Tools:** Jira, Trello
19. **Code Analysis:** SonarQube, Codacy
20. **Development Environments:** VS Code, IntelliJ IDEA, Eclipse
21. **Documentation:** Markdown, Doxygen, Swagger

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	-	3	2	3	2	2
CO2	2	2	3	3	-	3	2	3	3	3
CO3	2	2	2	2	1	-	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1	3	2	2	2.6	2.8

Semester VI

Course Title:	Vulnerability Analysis
Course Code:	**25VBT4E601**
Semester:	**VI**
Credits:	**120**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course provides an in-depth understanding of vulnerability analysis in cybersecurity. It covers the identification, assessment, and mitigation of security vulnerabilities in IT systems, networks, and applications. Students will learn vulnerability scanning techniques, exploit analysis, and secure coding practices to prevent security breaches.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamentals of vulnerability analysis and its significance in cybersecurity.	L2
CO2	Identify and classify different types of vulnerabilities in software, networks, and systems.	L3
CO3	Apply various vulnerability scanning tools and techniques for threat assessment.	L4
CO4	Evaluate mitigation strategies and security best practices for vulnerability management.	L5
CO5	Develop secure coding practices to minimize security flaws in applications.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Vulnerability Analysis
Scope of Module: This module introduces the fundamentals of vulnerability analysis and its role in cybersecurity risk management.

Topics: Definition and core principles of vulnerability analysis, Importance in modern cybersecurity frameworks, Software vulnerabilities: OWASP Top 10 overview, Network vulnerabilities: protocols and misconfigurations, Hardware vulnerabilities: firmware and physical security, Human factors: social engineering and misconfigurations, Vulnerability vs. threat vs. risk: comparative analysis, Security vulnerability lifecycle stages, CVE/NVD/Exploit-DB: structure and practical usage, Ethical considerations in vulnerability disclosure.
Learning Outcome: *Understand the key concepts of vulnerability analysis and differentiate vulnerabilities from threats and risks.*

No. of Hours: 24

Module 2: Vulnerability Assessment and Exploit Analysis
Scope of Module:
This module covers various vulnerability assessment techniques and exploit analysis methods.
Topics:
Manual assessment techniques and methodologies, Automated scanning approaches and limitations, Nessus: configuration and scan types, OpenVAS: setup and practical scanning, Web application vulnerabilities: SQLi, XSS, CSRF; Network-level vulnerabilities: MITM, ARP spoofing, DNS poisoning techniques and prevention, Zero-day exploit characteristics and analysis, Case study: Log4j vulnerability deep dive, Exploit database analysis and interpretation
Learning Outcome:
Identify security vulnerabilities using different scanning techniques and analyze exploit mechanisms.

No. of Hours: 24

Module 3: Vulnerability Scanning Tools and Techniques
Scope of Module: This module focuses on practical vulnerability scanning methods using industry-standard tools.
Topics: Commercial vs. open-source scanner comparison, Burp Suite: intercepting proxies and scanning OWASP ZAP: automated scanning features, Nmap: advanced network scanning techniques, Metasploit framework for vulnerability verification, SAST tools and static code analysis, DAST tools and dynamic testing approaches, Penetration testing vs. vulnerability scanning, CVSS scoring and risk prioritization, Effective vulnerability reporting formats.
Learning Outcome: *Apply vulnerability scanning tools to identify security weaknesses effectively.*

No. of Hours: 24

Module 4: Vulnerability Mitigation and Secure Coding Practices
Scope of Module: This module explores mitigation strategies and secure coding methodologies to prevent vulnerabilities.

Topics: Patch management systems and strategies, Firewall configuration for vulnerability protection, IDS/IPS systems and their role in mitigation, Input validation and sanitization techniques, Secure authentication implementation, Parameterized queries and prepared statements, Secure SDLC integration practices, Cryptographic controls for data protection, Risk-based vulnerability management, Secure coding labs: practical implementation
Learning Outcome: *Evaluate different mitigation strategies and apply secure coding techniques for software development.*

No. of Hours: 24

Module 5: Compliance, Regulations, and Best Practices
Scope of Module: This module covers compliance requirements and best practices for vulnerability management.
Topics: ISO 27001 controls for vulnerability management, NIST SP 800-115 technical guide, GDPR requirements for vulnerability handling, MITRE ATT&CK framework application, NIST Cybersecurity Framework implementation, Incident response and vulnerability correlation, Bug bounty programs and responsible disclosure, Emerging trends in vulnerability management, AI/ML applications in vulnerability detection, Future challenges in cybersecurity vulnerabilities
Learning Outcome:*Analyze compliance requirements and implement best practices in vulnerability management..*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of computer networks and web technologies
- Familiarity with cybersecurity principles and operating systems
- Programming experience is advantageous (e.g., Python, Java)

Pedagogy / Teaching Methodology:

- ✓ Hands-on vulnerability scanning labs using tools like Nessus, Burp Suite, and OpenVAS
- ✓ Secure coding workshops and SDLC integration exercises
- ✓ Real-world vulnerability case studies (e.g., Log4j)
- ✓ Tool demonstrations and threat model walkthroughs
- ✓ Industry-standard compliance alignment with NIST and ISO frameworks

Certificate / Value Added Courses Recommended (Free Resource Links):

- OWASP: Secure Coding Practices
- Cybrary: Vulnerability Management

- Coursera: Cybersecurity Specialization – University of Maryland
- NIST: SP 800-115 – Technical Guide to Security Testing and Assessment

Suggested Readings:

- Kim, C. and Solomon, M., *Fundamentals of Information Systems Security*, Jones & Bartlett
- Stuttard, D. and Pinto, M., *The Web Application Hacker's Handbook*, Wiley
- NIST SP 800 Series (115, 30, 53)
- OWASP Top 10 Security Risks Documentation

Recommended Software/Tools:

1. **Scanning Tools:** Nessus, OpenVAS, Nmap, Burp Suite, OWASP ZAP
2. **Exploitation Tools:** Metasploit Framework
3. **Code Analysis Tools:** SonarQube, Fortify, Checkmarx
4. **Vulnerability Databases:** CVE, NVD, Exploit-DB
5. **Security Assessment Standards:** CVSS, OWASP Testing Guide

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3	2.6	2.2	2	2.75	1.75	2.6	1	2	1.2

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Course Title:	Cloud Security
Course Code:	**25VBT4E602**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description

This course introduces core security concepts in cloud computing. It provides learners with knowledge and practical insights on securing cloud environments, covering threats, technologies, legal considerations, access control, identity management, encryption, and auditing in public, private, and hybrid cloud models.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamentals of cloud computing and cloud security requirements.	L2
CO2	Identify potential vulnerabilities and attacks in cloud infrastructure and services.	L3
CO3	Apply authentication, encryption, and identity management techniques in cloud settings.	L4
CO4	Analyze compliance, legal, and regulatory frameworks associated with cloud usage.	L4
CO5	Evaluate risk management and security monitoring tools in cloud environments.	L5

Course Modules

No. of Hours: 24

Module 1: Cloud Computing and Security Foundations

Scope of Module: This module introduces cloud computing and its service models while emphasizing the principles and challenges of cloud security.
Topics: Definition and characteristics of cloud computing, service models including IaaS, PaaS and SaaS, deployment models such as public, private, hybrid and community cloud, shared responsibility model, security triad (confidentiality, integrity, availability), threats and vulnerabilities in cloud computing, cloud-specific risks including multitenancy and virtualization exposure, need for security in distributed computing environments.
Learning Outcome: *Understand cloud computing models and the fundamental principles and challenges of securing them*

No. of Hours: 24

Module 2: Cloud Threats, Attacks, and Risk Management
Scope of Module:
This module explores the types of threats and attacks in cloud systems and introduces frameworks and techniques to assess and manage risks.
Topics: Cloud-specific threats including data breaches, account hijacking and DDoS attacks, insecure APIs and misconfigurations, malicious insiders, threat modeling in the cloud, risk management lifecycle, qualitative and quantitative risk assessment, impact and likelihood matrix, mitigation and risk response planning, case studies of real-world cloud attacks.
Learning Outcome: *Identify key threats to cloud environments and apply risk assessment methodologies to mitigate them*

No. of Hours: 24

Module 3: Identity, Access Management, and Encryption
Scope of Module:
This module focuses on mechanisms for ensuring that only authorized users can access cloud resources and that data remains confidential and secure.
Topics: Authentication vs authorization, role-based and attribute-based access control models, multi-factor authentication (MFA), single sign-on (SSO), identity federation and identity-as-a-service (IDaaS), cryptographic techniques in cloud security, symmetric and asymmetric encryption, TLS and SSL protocols, key management systems, data-in-transit and data-at-rest protection.
Learning Outcome: *Apply access control models and cryptographic solutions to secure identities and data in cloud environments*

No. of Hours: 24

Module 4: Cloud Compliance, Governance, and Legal Aspects

Scope of Module: This module introduces compliance standards and regulations governing cloud operations, along with privacy and legal obligations.
Topics: Cloud security governance and policies, regulatory frameworks including GDPR, HIPAA, ISO/IEC 27001, PCI-DSS, legal concerns such as data sovereignty and jurisdiction, cloud service level agreements (SLAs), vendor management and auditing responsibilities, business continuity planning and disaster recovery requirements, auditing tools and reports.
Learning Outcome: *Analyze cloud security compliance requirements and evaluate their impact on business and legal operations.*

No. of Hours: 24

Module 5: Security Operations, Monitoring, and Incident Response
Scope of Module:
The final module emphasizes operational controls and monitoring techniques to ensure security is maintained throughout the cloud system lifecycle.
Topics: Cloud Security Operations Center (CSOC), log monitoring and audit trails, security information and event management (SIEM), intrusion detection and prevention systems (IDPS), vulnerability scanning and penetration testing, incident detection and response workflow, real-time alerting and threat intelligence, automation in cloud security monitoring, cloud-native tools such as AWS GuardDuty, Azure Security Center and Google Cloud Security Command Center.
Learning Outcome*: Implement security monitoring, incident detection and response practices in a cloud operations setting.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Understanding of basic networking and security principles
- Familiarity with virtualization and cloud computing basics
- Experience with Linux/Windows system administration is beneficial

Pedagogy / Teaching Methodology:

- Hands-on labs using AWS, Azure, or GCP security tools
- Case studies of cloud breaches and industry responses
- Simulations of access control and encryption in cloud environments
- Log monitoring and incident response walkthroughs
- Presentations on compliance frameworks and regulatory alignment

Certificate / Value Added Courses Recommended (Free Resource Links):

- AWS Security Fundamentals
- Google Cloud: Security in Google Cloud Specialization
- Microsoft Learn: Azure Security Engineer Learning Path
- CSA (Cloud Security Alliance) Resources

Suggested Readings:

- Vic (J.R.) Winkler, *Securing the Cloud: Cloud Computer Security Techniques and Tactics*, Syngress
- Ronald Krutz and Russell Dean Vines, *Cloud Security: A Comprehensive Guide*, Wiley
- Tim Mather et al., *Cloud Security and Privacy*, O'Reilly
- NIST SP 800-144: *Guidelines on Security and Privacy in Public Cloud Computing*

Recommended Software/Tools:

- **Cloud Providers:** AWS, Azure, Google Cloud
- **Security Tools:** AWS GuardDuty, Azure Security Center, Google Cloud SCC
- **Monitoring & Logging:** SIEM (Splunk, ELK Stack), CloudTrail, CloudWatch
- **Compliance Auditing:** CloudMapper, ScoutSuite, Prisma Cloud
- **Encryption & IAM:** KMS (Key Management Service), IAM Roles/Policies

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title:	Penetration Testing
Course Code:	**25VBT4E603**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course provides a comprehensive understanding of penetration testing, covering methodologies, tools, and ethical considerations. Students will learn vulnerability assessment, exploitation techniques, and security best practices through hands-on exercises. The curriculum includes network and web application security, privilege escalation, and cloud penetration testing. By the end of the course, students will be able to conduct professional security assessments and generate detailed reports.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of penetration testing and ethical hacking.	L2
CO2	Explore different penetration testing methodologies and frameworks.	L3
CO3	Develop skills for identifying, exploiting, and mitigating vulnerabilities.	L4
CO4	Analyze security assessment tools and techniques used in penetration testing.	L4
CO5	Evaluate real-world penetration testing scenarios and reporting mechanisms.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Penetration Testing
Scope of Module: This module introduces the fundamental concepts of penetration testing, differentiates it from ethical hacking, and explores various methodologies. It also covers information gathering techniques essential for identifying vulnerabilities.
Topics: Definition and importance of penetration testing, difference between penetration testing and ethical hacking, penetration testing process, types of penetration testing, legal and ethical considerations, OWASP Testing Guide, PTES (Penetration Testing Execution Standard), NIST Penetration Testing Guidelines, black box, white box, and gray box testing, scope and rules of

engagement, active and passive reconnaissance, Whois and Nslookup, social engineering and OSINT, scanning for open ports and services, identifying attack surface.
Learning Outcome: *Understand the fundamental concepts, methodologies, and ethical considerations of penetration testing.*

No. of Hours: 24

Module 2: Scanning, Enumeration, and Vulnerability Analysis
Scope of Module: This module focuses on scanning and enumeration techniques used to identify vulnerabilities in network and system infrastructures. It also explores various vulnerability assessment tools and methodologies.
Topics: Introduction to network scanning, using Nmap and other scanning tools, identifying services and versions, user and system enumeration techniques, banner grabbing and fingerprinting, understanding vulnerabilities, vulnerability scanners (Nessus and OpenVAS), identifying common vulnerabilities, manual vs. automated vulnerability assessment, interpreting vulnerability reports, introduction to exploitation, buffer overflow, exploiting web application vulnerabilities, exploiting network and system vulnerabilities, using Metasploit Framework.
Learning Outcome: *Develop skills in scanning, enumerating, and analyzing vulnerabilities using industry-standard tools.*

No. of Hours: 24

Module 3: Exploitation and Web Application Security
Scope of Module:
This module dives into various exploitation techniques and web application security threats, with a focus on identifying, exploiting, and mitigating vulnerabilities in applications and networks.
Topics: Common web vulnerabilities (OWASP Top 10), SQL injection, cross-site scripting (XSS), cross-site request forgery (CSRF), insecure authentication and session management, security misconfigurations, testing network infrastructure, sniffing and man-in-the-middle (MITM) attacks, wireless network penetration testing, DNS and ARP poisoning, firewall and IDS/IPS evasion techniques, mobile application security assessment, Android and iOS app testing, IoT security vulnerabilities, testing embedded systems.
Learning Outcome: *Gain hands-on experience in exploiting and securing web applications and networks.*

No. of Hours: 24

Module 4: Advanced Penetration Testing Techniques **Scope of Module:**
This module covers privilege escalation, post-exploitation techniques, wireless and cloud penetration testing, and their security implications.
Topics: Understanding privilege escalation, exploiting weak permissions, maintaining access (backdoors and rootkits), data exfiltration techniques, clearing tracks and log tampering, wireless

security testing tools, cracking Wi-Fi passwords and encryption, cloud security threats, penetration testing in AWS, penetration testing in Azure, penetration testing in GCP, securing cloud applications and data, phishing attacks and techniques, impersonation and pretexting, social engineering countermeasures. ***Learning Outcome:*** Analyze advanced penetration testing techniques and their impact on system security.

Module 5: Reporting, Compliance, and Real-World Scenarios
Scope of Module:
This module emphasizes the importance of documentation, compliance requirements, and case studies in penetration testing. It prepares students to perform security assessments professionally.
Topics: Writing a penetration testing report, summarizing findings and risk analysis, recommendations and remediation steps, executive summary vs. technical report, compliance requirements (ISO, PCI-DSS, GDPR), overview of penetration testing tools, Burp Suite, Wireshark, Nikto, scripting for automated testing (Python and Bash), automating vulnerability scanning, writing custom exploits, successful penetration testing engagements, case study on data breaches, ethical and legal issues in penetration testing.
Learning Outcome*: Evaluate penetration testing reports, compliance standards, and industry practices.*

Module	No of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of networking and cybersecurity
- Familiarity with Linux and command-line tools
- Exposure to programming/scripting languages (e.g., Python, Bash)

Pedagogy / Teaching Methodology:

- ✓ Live demonstrations and hands-on labs with Kali Linux, Metasploit, and Burp Suite
- ✓ Real-world simulations (web app exploits, Wi-Fi hacking, phishing)
- ✓ Case-based learning and walkthroughs of actual cyber-attacks
- ✓ Tool-based vulnerability scanning, exploitation, and report writing
- ✓ Practical assignments and a capstone pentesting project

Certificate / Value Added Courses Recommended (Free Resource Links):

1. TryHackMe: Beginner to Offensive Security
2. Hack The Box Academy
3. OWASP Web Security Testing Guide

4. Offensive Security: PWK (Intro to Penetration Testing)

Suggested Readings:

- Georgia Weidman, *Penetration Testing: A Hands-On Introduction to Hacking*, No Starch Press
- Wil Allsopp, *Advanced Penetration Testing*, Wiley
- Kim Crawley, *The Pentester Blueprint*, Wiley
- OWASP Testing Guide v4 and PTES documentation

Recommended Software/Tools:

1. **Operating Environment:** Kali Linux, Parrot OS
2. **Tools:** Nmap, Metasploit, Burp Suite, Wireshark, Nikto, OpenVAS
3. **Web Exploitation:** OWASP ZAP, SQLMap, XSSer
4. **Reporting & Automation:** CherryTree, Dradis, Python/Bash scripts
5. **Cloud Testing:** AWS CLI, ScoutSuite, Prowler

CO - PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	1	-	2	1	3	2	1	2
CO2	1	3	2	2	3	-	2	2	2	2
CO3	2	2	3	3	3	2	3	1	2	2
CO4	1	3	2	3	3	2	3	2	1	2

CO5	1	2	2	2	2	3	3	3	2	3
Articulation	1.4	2.6	2	2.5	2.6	2	2.8	2	1.6	2.4

Course Title:	Ethical Hacking
Course Code:	**25VBT4E604**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course provides a comprehensive understanding of ethical hacking principles, methodologies, and tools. It covers various hacking techniques used by security professionals to test and secure systems against cyber threats. Students will explore penetration testing, vulnerability assessment, and countermeasures to mitigate security risks.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamentals of ethical hacking and its role in cybersecurity.	L2
CO2	Identify and analyze different hacking techniques and attack vectors.	L3
CO3	Apply penetration testing methodologies to assess system vulnerabilities.	L4
CO4	Evaluate security measures and countermeasures to mitigate cyber threats.	L5
CO5	Implement ethical hacking tools and techniques in a controlled environment.	L5

Course Modules

No. of Hours: 24

Module 1: Introduction to Ethical Hacking
Scope of Module: This module introduces the ethical aspects of hacking and the importance of ethical hacking in cybersecurity.
Topics: Definition and scope of ethical hacking, Evolution of hacking and cybersecurity landscape, White hat vs black hat vs gray hat hackers, Legal frameworks and compliance standards, Ethical hacking certifications and career paths, Reconnaissance phase techniques and tools, Scanning methodologies overview, Gaining access and maintaining persistence, Covering tracks and reporting, Case studies of ethical hacking engagements.

Learning Outcome: *Understand the role of ethical hacking in cybersecurity and recognize different hacker categories.*

No. of Hours: 24

Module 2: Reconnaissance and Footprinting
Scope of Module: This module focuses on information-gathering techniques used to identify potential security weaknesses.
Topics:
Passive information gathering techniques, Active reconnaissance methods, WHOIS lookup and DNS enumeration, Network mapping using traceroute, Social engineering tactics, Google hacking and advanced search operators, Open-source intelligence (OSINT) tools, Email header analysis Metadata extraction from documents, Competitive intelligence gathering
Learning Outcome:
Perform reconnaissance and footprinting to gather intelligence on target systems.

No. of Hours: 24

Module 3: Scanning and Enumeration
Scope of Module: This module covers scanning techniques used to identify system vulnerabilities.
Topics: Network scanning with Nmap, Port scanning techniques and stealth methods, Service version detection, Vulnerability scanning with Nessus/OpenVAS, Banner grabbing techniques, SNMP enumeration methods, LDAP and Active Directory enumeration, NetBIOS and SMB enumeration SMTP and DNS enumeration, Firewall and IDS evasion techniques.
Learning Outcome: *Apply scanning and enumeration techniques to detect security flaws in networks.*

No. of Hours: 24

Module 4: System Hacking and Exploitation Techniques **Scope of Module:**
This module explores hacking techniques used to exploit system vulnerabilities.
Topics:
Password cracking methodologies, Rainbow table attacks, Privilege escalation techniques, Rootkit detection and analysis, Metasploit framework usage, Custom payload creation, Antivirus evasion techniques, Man-in-the-middle attacks, ARP spoofing and DNS poisoning, Post-exploitation techniques.
Learning Outcome: *Analyze and exploit system vulnerabilities using ethical hacking techniques.*

No. of Hours: 24

Module 5: Web Application Hacking and Security

Scope of Module: This module focuses on identifying and mitigating web application vulnerabilities.
Topics: OWASP Top 10 vulnerabilities, SQL injection advanced techniques, Blind SQL injection methods, Cross-site scripting (XSS) variants, CSRF attack vectors, Session hijacking techniques, Burp Suite for web app testing, OWASP ZAP for vulnerability scanning, Web service security testing, Secure coding countermeasures.
Learning Outcome: *Identify and mitigate security vulnerabilities in web applications.*

Module	No of Pre-Recordings
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Prerequisites:

- Basic knowledge of computer networks and operating systems
- Familiarity with cybersecurity concepts
- Introduction to programming/scripting (Python or Bash preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using Kali Linux, Metasploit, Nmap, and Burp Suite
- ✓ Real-time demonstrations of scanning, exploitation, and mitigation
- ✓ Case study discussions on ethical hacking engagements
- ✓ Group projects focused on simulated penetration tests
- ✓ Regular quizzes and tool-based assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

1. TryHackMe: Pre-Security and Offensive Security Paths
2. EC-Council CEH Learning Resources
3. Hack The Box Academy
4. Cybrary: Ethical Hacking Training
5. OWASP Top 10 Project

Suggested Readings:

- Georgia Weidman, *Penetration Testing: A Hands-On Introduction to Hacking*, No Starch Press
- Kevin Mitnick, *The Art of Invisibility*
- EC-Council, *Certified Ethical Hacker (CEH) Official Study Guide*
- OWASP Web Security Testing Guide

Recommended Software/Tools:

1. **Operating Systems:** Kali Linux, Parrot OS

2. **Tools:** Nmap, Wireshark, Burp Suite, OWASP ZAP, Metasploit, Nikto, OpenVAS
3. **Languages/Scripts:** Bash, Python
4. **Frameworks:** OWASP Top 10, PTES (Penetration Testing Execution Standard)

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3	2.6	2.2	2	2.75	1.75	2.6	1	2	1.2

ELECTIVE:

Artificial Intelligence

Elective: Artificial Intelligence

Semester-1

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBX0AE101	English	AECC	30	70	4
25VBT0C102	Fundamentals of Mathematics	CC	30	70	4
25VBT0C103	Problem Solving using C	CC	30	70	4
25VBT0C104	Computer Architecture	CC	30	70	4
26VBX0S105	Essentials of Generative AI	SEC	30	70	2
25VBT0L101	Problem Solving using C Lab	SEC	100	-	1
Total No of Credits					**19**

Semester-2

Course code	Course Name	Course category	CA	ESE	Credits
25VBX0AE205	Communicative English	AECC	30	70	4
25VBT0C201	Operating System	CC	30	70	4
25VBT0C202	Data Structures using C *	CC	30	70	4
25VBT0C203	Relational Database Systems *	CC	30	70	4
25VBT0L201	Data Structures using C Lab	SEC	100	-	1
25VBT0L202	Relational Database Systems Lab	SEC	100	-	1
Total No of Credits					**18**

Semester-3

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C301	Python Programming *	CC	30	70	4
25VBT0C302	Design and Analysis of Algorithms *	CC	30	70	4
25VBT0C303	Software Engineering	CC	30	70	4
25VBT0C304	Computer Networks	CC	30	70	4

25VBT0C305	Environmental, Social, and Governance (ESG) in IT	AECC	30	70	3
25VBT0L301	Python Programming Lab	SEC	100	-	1
25VBT0L302	Design and Analysis of Algorithms Lab	SEC	100	-	1
Total No of Credits					**21**

Semester-4

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C401	Web Technologies *	CC	30	70	4
25VBT0C402	Java Programming *	DSE	30	70	4
25VBT5E403	Probability and Statistics	DSE	30	70	4
25VBT5E404	Introduction to Artificial Intelligence	DSE	30	70	4
25VBT0C404	Quantitative Techniques	GE	30	70	3
25VBT0L401	Web Technologies Lab	SEC	100	-	1
25VBT0L402	Java Programming Lab	SEC	100	-	1
Total No of Credits					**21**

Semester-5

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C501	Block Chain Technologies	CC	30	70	4
25VBT5E502	Introduction to Machine Learning	DSE	30	70	4
25VBT5E503	Data Visualization	DSE	30	70	4
25VBT5E504	Data Mining and predictive modelling	DSE	30	70	4
25VBT5E505	Deep Learning	DSE	30	70	4
25VBT0C503	Advanced Software Development Practices	SEC	30	70	2
Total No of Credits					**22**

Semester-6

Course code	Course Name	Course category	CA	ESE	Credits
25VBT5E601	AI Ethics and governance	DSE	30	70	4
25VBT5E602	Data Analytics with R	DSE	30	70	4
25VBT5E603	Natural Language Processing	DSE	30	70	4
25VBT5E604	Computer Vision	DSE	30	70	4
25VBT0P605	Project *	Thesis			6
Total No of Credits					**22**

Semester I

Courses

Course Title:	English
Course Code:	**25VBX0AE101**
Semester:	**I**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course introduces learners to literature, rhetorical practices, grammar, and academic writing. Through engagement with poetry, prose, drama, and structured writing tasks, students will gain foundational skills in critical reading, effective communication, and literary appreciation.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Examine literary texts in historical contexts and be sensitive to their social relevance	L4
CO2	Explain the process of communicating and interpreting human experiences from different cultures through literary representations	L2
CO3	Gain practical knowledge in the correct use of grammatical elements to express in English	L3
CO4	Appraise the art of rhetoric through speech and writing	L5
CO5	Develop higher order language skills, such as reading and writing, through texts centered on diverse themes and topics in literature	L6

Course Module

No. of Hours:24

Module 1: Foundations of Literature and Language
Scope of Module: *Explore how literature reflects language and meaning, and how rhetoric is constructed in influential speeches.*
Topics: Literal and metaphorical meanings in literature, Shakespeare's Sonnet 18, Robert Frost's *Stopping by Woods on a Snowy Evening*, introduction to rhetoric, Aristotle's modes of appeal, discourse analysis, Martin Luther King Jr.'s *I Have a Dream* speech, oratory and audience connection, speeches of Brutus and Mark Antony.
Learning Outcome: *Comprehend concrete and abstract meanings of words and phrases, and discuss rhetorical construction of speeches.*

No. of Hours:24

Module 2: Poetic and Prose Expressions
Scope of Module: Analyze language symbolism, Indian English poetry, and the art of prose expression.
Topics: Symbolism in poetry, Blake's *The Tyger*, Hughes' *Hawk Roosting*, early Indian English poetry and themes, Sarojini Naidu's *In Salutation to the Eternal Peace*, Nissim Ezekiel's *The Professor*, prose as a distinct form, types and function of prose, Bertrand Russell's *In Praise of Idleness*.
Learning Outcome: *Explain poetic symbolism, and examine Indian and Western prose for theme and style.*

No. of Hours:24

Module 3: Grammar and Sentence Structuring
Scope of Module: Explore grammatical concepts, including sentence construction, reported speech, and paragraph writing.
Topics: Phrases, clauses, sentence types, components of a sentence, active and passive voice,

conversion rules, reported speech, simple, compound, complex sentence structures, linkers, synthesis, transformation, paragraph structure and types, examples from literature.
Learning Outcome: *Demonstrate grammatical proficiency, including sentence synthesis and paragraph writing.*

No. of Hours:24

Module 4: Argumentation and Debate
Scope of Module: Develop structured argumentative and debating skills using classical and contemporary contexts.
Topics: Structure of argument (claim, reason, support, warrant), logical flow, Frederick Copleston vs Bertrand Russell radio debate, elements of a good case, defense and rebuttal strategies, importance of debate, analyzing contemporary topics.
Learning Outcome: *Develop an understanding of logical argumentation and apply strategies for debate*

No. of Hours:24

Module 5: Essay Writing and Text Performance
Scope of Module: Explore essay forms, dramatic theory, and literary performance in Western and Indian contexts.
Topics: Essay types – compare and contrast, cause and effect, Feynman's *The Value of Science*, Chesterton's *On Running After One's Hat*, Charles Lamb's *Dream Children: A Reverie*, dramatic theory by Aristotle and Bharata, Vijay Tendulkar's *Silence! The Court is in Session*.
Learning Outcome: *Appraise techniques for academic and personal essay writing, and analyze dramatic forms across cultures.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

10. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
11. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
12. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings:

Book

- Gupta, S. C. (2018). Comprehensive English Grammar & Composition. Arihant Prakashan

Online Articles, Journals, and Whitepapers

- British Council Learn English Articles, JSTOR Language and Literature Studies, Routledge Journals on Rhetoric and Composition

Web-based Resources

- Grammarly Handbook, Purdue OWL, YouTube Channels on Poetry in Performance, Project Gutenberg Literature Database

Recommended Software/Tools:

16. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
17. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
18. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
19. **Miro** – for mind-mapping essay structures.
20. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and highlight in the module

1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	2	3	1	1	2	1	1
CO3	1	1	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	3	2	1	1	1	2	1
Articulation	1	1	1.4	1.8	2	1	1	1.2	1.2	1

Note: The Articulation is indicative of how a particular course maps to a PO.

Articulation is calculated as:

$$= \frac{\text{Sum of CO Mappiung Levels for a perticular PO}}{\text{No.of COs that mapped to that PO}}$$

Example:1

$$Articulation\ of\ \boldsymbol{PO1} = \frac{(3+2+3+2+3)}{5} = 2.6$$

Example: 2

$$Articulation\ of\ \boldsymbol{PO7} = \frac{(1+1)}{2} = 1.0$$

Course Title:	Fundamentals of Mathematics
Course Code:	**25VBT0C102**
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces foundational mathematical concepts essential for problem-solving and application in computing and data analysis. It includes matrix algebra, calculus, vector algebra, and 3-D geometry to develop logical reasoning and analytical abilities among students.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Learn to carry out matrix operations, including inverses and determinants, and solve systems of equations using multiple methods.	L3
CO2	Demonstrate the idea of differentiation from first principles and work with derivatives as rates of change in mathematical models.	L3
CO3	Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions.	L4
CO4	Demonstrate vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.	L3
CO5	Apply matrix theory for solving systems of linear equations and compute eigenvalues and eigenvectors required for the matrix diagonalization process	L3

Course Modules

No. of Hours:24

Module 1: Matrices and Linear Algebra
Scope of Module: This module introduces students to matrix operations, properties of determinants, and methods for solving linear systems using algebraic and matrix techniques.
Topics: Types of matrices including row, column, diagonal, scalar, unit and zero matrices, algebra of matrices including addition, scalar multiplication and transpose, inverse of a matrix using elementary operations, definition and expansion of determinants up to 3x3, minors and cofactors, properties of determinants, adjoint and inverse of matrices, singular and non-singular matrices, consistency of linear systems, solving equations using Cramer's rule, matrix rank, echelon and normal form, solving linear systems using Gauss elimination, Gauss-Jordan, Gauss-Seidel and LU decomposition.
Learning Outcome: *Solve linear systems using matrix operations and analyze determinant-based consistency and inverse properties.*

No. of Hours:24

Module 2: Eigenvalues, Eigenvectors, and Vector Algebra
Scope of Module: This module explores the concepts of eigenvalues, eigenvectors, vector operations, and geometric representations of vectors in space.
Topics: Definition and computation of eigenvalues and eigenvectors, Rayleigh's power method for dominant eigenvalue, diagonalization of matrices, linear transformation and matrix reduction, types of vectors including unit, zero and position vectors, magnitude and direction of vectors, vector addition and scalar multiplication, dot product and its geometric meaning, projection of vectors, cross product and scalar triple product, area and volume calculation using vectors.
Learning Outcome: *Compute eigenvalues, eigenvectors, and apply vector operations in solving spatial problems and geometric modeling.*

No. of Hours:24

Module 3: Differential Calculus and Applications
Scope of Module: This module introduces the principles and rules of differentiation and applies them to various types of functions and curve-based problems.
Topics: Continuity of functions at a point and over intervals, derivatives of algebraic and trigonometric functions, exponential and logarithmic functions, derivatives of composite, inverse trigonometric and

parametric functions, second-order derivatives, nth-order derivatives, and Leibnitz theorem, angle between curves and pedal equations, polar curve representations and applications.
Learning Outcome: *Apply differentiation techniques to model change, analyze polar curves, and solve advanced calculus problems.*

No. of Hours:24

Module 4: Integral Calculus and Vector Calculus
Scope of Module: This module focuses on integration methods, definite and indefinite integrals, and introductory vector calculus concepts.
Topics: Indefinite integrals using substitution, trigonometric identities, partial fractions and integration by parts, definite integrals and reduction formulae for powers of sine and cosine, vector function derivatives including velocity and acceleration, scalar and vector point functions, gradient, divergence, curl, Laplacian operators, solenoidal and irrotational vectors.
Learning Outcome: *Solve definite and indefinite integrals and apply differential vector calculus operators in applied mathematics.*

No. of Hours:24

Module 5: Three-Dimensional Geometry
Scope of Module: This module develops spatial reasoning through the study of 3D geometry including direction cosines, lines and planes.
Topics: Direction cosines and direction ratios, vector and cartesian equations of a straight line, angle between two lines, shortest distance between skew lines, vector and cartesian equations of planes, angle between two planes, coplanar lines and intersection of lines with planes.
Learning Outcome: *Analyze three-dimensional shapes using vector and cartesian methods and solve problems involving lines and planes in space.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic understanding of algebra and geometry from secondary education..

Pedagogy / Teaching Methodology:

- ✓ Conceptual and problem-based learning
- ✓ Interactive class exercises and proofs
- ✓ Assignments and quizzes using math software.

Certificate / Value Added Courses Recommended (with Free Resource Links):

7. Mathematics – I by Prof. Jitendra Kumar (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/111105038

8. Mathematics for Computer Science by MIT Open Courseware: https://ocw.mit.edu

Suggested Readings:

Book

- Applied Mathematics and Scientific Computing: International Conference on Advances in Mathematical Sciences, Vellore, India, December 2017 – Volume II (Trends in Mathematics), Springer, 2019

Online Articles, Journals, and Whitepapers

- Research articles from *SpringerLink*, *Mathematics Today*, and *Elsevier Journal of Mathematical Analysis*
- Whitepapers on matrix theory, calculus, and vector analysis from *AMS (American Mathematical Society)* and *SIAM (Society for Industrial and Applied Mathematics)*

Web-based Resources

- Khan Academy (topics: Calculus, Linear Algebra, Vectors, 3D Geometry
- MIT OpenCourseWare for Mathematics
- Interactive simulations and problem sets on Desmos, GeoGebra, and Brilliant.org.

Recommended Software/Tools (If applicable):

13. MATLAB/Octave
14. SageMath
15. Python (NumPy, Matplotlib)

16. GeoGebra for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	-	2	2	2	2	2
CO2	3	2	3	2	-	2	1	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.6	2.6	3	2.2	1	2	1.6	1.8	2.2	2.8

Course Title:	Problem Solving using C
Course Code:	**25VBT0C103**
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:
This course introduces students to the C programming language with an industry-focused approach. Emphasis is placed on problem-solving, structured programming, memory efficiency, and modular design. The course prepares students to handle real-world applications in embedded systems, system-level development, and performance-sensitive software solutions.

Course Outcomes(COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand and apply the core concepts of the C language including syntax, control flow, and data types.	L3
CO2	Develop modular and efficient code using functions, arrays, and structures.	L6
CO3	Manage memory effectively using pointers and dynamic memory allocation.	L3
CO4	Handle file operations and system-level programming tasks.	L3
CO5	Apply modern development tools, debugging practices, and implement mini-projects that solve real-world problems.	L6

Course Modules:

No. of Hours:24

Module 1: Programming Foundations and C Basics
Scope of Module: Introduce software concepts, basic C syntax, and structured programming methodology.

Topics: Role of programming in systems and embedded development, history and importance of C, variables, constants, keywords, data types, operators, input/output (printf, scanf, gets, puts), expressions, conditional statements (if, if-else, switch), looping (for, while, do-while), break, continue, goto, code documentation and commenting practices.
Learning Outcome :- *Implement basic control structures and understand the foundations of structured programming in C.*

No. of Hours:24

Module 2: Functions, Arrays and Strings
Scope of Module: Focus on modular programming and data handling through arrays and string operations.
Topics: Function declaration and definition, argument passing methods, recursion, return types, arrays (1D, 2D), basic algorithms (sorting, searching), string manipulation using standard functions, multidimensional string arrays, arrays in function arguments, memory usage with arrays.
Learning Outcome :- *Design modular programs using functions and implement logic-driven operations with arrays and strings.*

No. of Hours:24

Module 3: Structures, Unions, Pointers and Memory Management
Scope of Module: Introduce advanced C constructs for optimized data storage and dynamic memory operations.
Topics: Structures and nested structures, unions and memory overlap, arrays of structures, pointers: declaration, arithmetic, arrays with pointers, pointers to structures, dynamic memory (malloc, calloc, realloc, free), storage classes (auto, extern, static, register), pointer pitfalls and best practices.
Learning Outcome : *Apply pointer concepts and structured data storage to optimize program memory usage.*

No. of Hours:24

Module 4: File Systems, Command-Line Tools, and Build Automation
Scope of Module: Enable students to use persistent storage and build scalable projects using system-level tools.

Topics: Text and binary file handling (fopen, fclose, fread, fwrite, fprintf, fscanf), command-line argument usage, preprocessor directives (#define, #include, macros), header file creation, build tools (Makefile basics), version control systems (Git), compiler flags, debugging with gdb, introduction to CI/CD tools for C.
Learning Outcome: *Manage files, automate builds and integrate version control in a modern development pipeline.*

No. of Hours:24

Module 5: Industry Use Cases and Project-Based Application
Scope of Module: Apply knowledge in practical, time-bound projects aligned with industry-relevant themes.
Topics: Development of mini projects: menu-driven programs (e.g., ATM interface, student grade system), real-time input handling and validation, implementation of logging systems using file I/O, structuring code for modularity and readability, application testing using manual test cases, integration of Git for version tracking.
Learning Outcome: **-** *Design and deploy small-scale C projects using structured programming and version-controlled collaboration within limited timeframes.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

4. Programming in C by Prof. Anupam Basu (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/106105085

Suggested Readings

Book

- Let Us C by Yashwant Kanetkar, 6th Edition, PBP Publication

Web-based Resources

- GeeksforGeeks – Advanced C tutorials
- OnlineGDB and HackerRank – Practice platforms
- GNU Compiler Collection (GCC) docs and POSIX C reference

Recommended Software/Tools (If applicable):

4. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	2	2	2	2
CO2	2	3	3	2	-	3	2	2	2	3

CO3	2	3	3	3	-	3	2	2	2	3
CO4	2	2	3	3	-	3	2	2	2	3
CO5	3	3	3	3	-	3	2	2	3	3
Articulation	2.4	2.6	2.8	2.6	1	2.8	2	2	2.2	2.8

Course Title:	Computer Architecture
Course Code:	**25VBT0C104**
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description

This course introduces students to the organization and architecture of computer systems. It covers internal structures, memory systems, I/O organization, instruction execution, and emerging processor technologies. The course develops analytical skills to evaluate hardware and architectural features in computing systems.

Course Outcomes(Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	To establish a strong foundation in principles and architectural concepts of computer systems.	L2
CO2	Gain insight on the functionality of different subsystems, such as the processor, input/output, and memory devices.	L3
CO3	Design and analyze simple arithmetic and logical units and their operations	L3
CO4	Comprehend the concepts of parallel computing and hardware technologies	L5
CO5	Develop insight into memory hierarchy and correlate with the concept of virtual and cache memory	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Structure and Instruction Set
Scope of Module: This module introduces basic components of computer systems, their instruction formats, and data representation.
Topics: Computer types, functional units, basic operational concepts, bus structures, instruction formats, number representation, arithmetic operations on signed and unsigned data, memory locations and addressing, memory read/write operations
Learning Outcome: *Develop insight on computer framework and identify the performance issues in computer systems*

No. of Hours :24

Module 2: Machine Instructions, I/O Systems, and Memory Organization
Scope of Module: This module explains instruction execution and system-level operations including input/output handling and memory management basics.
Topics: Addressing modes, assembly language instructions, input and output operations, subroutines, instruction encoding, accessing I/O devices, interrupt mechanism and hardware, direct memory access, standard I/O interfaces including PCI, SCSI and USB, basic memory organization including RAM, ROM, memory hierarchy principles, speed and cost trade-offs.
Learning Outcome: *Understand addressing techniques, memory operations, and standard interfaces for efficient I/O operations.*

No. of Hours :24

Module 3: Advanced Memory and Arithmetic Units
Scope of Module: This module introduces concepts of cache and virtual memory, logic gates and arithmetic units.
Topics: Cache memory organization and mapping techniques, replacement algorithms, performance optimization in cache, virtual memory and address translation, logic gates and flip flops, addition and subtraction of signed numbers, fast adder designs including carry look-ahead adder.
Learning Outcome: *Analyze the logic behind memory systems, understand arithmetic circuitry and apply memory design techniques.*

No. of Hours :24

Module 4: Instruction Processing and Parallel Architectures
Scope of Module: This module describes instruction execution cycles, control design, pipelining and modern parallel processing concepts.

Topics: Basic processing unit design, instruction execution steps, multiple bus organization, hardwired and microprogrammed control, pipelining basics, instruction hazards, data hazards, impact on instruction sets, parallel computer models including multiprocessors and multicomputers, PRAM and VLSI models.
Learning Outcome: *Analyze execution flow and design of control units, and explore the foundations of parallel computer architectures.*

No. of Hours :24

Module 5: Performance, Processor Technologies and Storage
Scope of Module: This module addresses performance metrics, advanced processor types, scalable performance and memory management techniques.
Topics: Performance metrics and speedup laws, program partitioning and scheduling, interconnection networks, CISC and RISC architectures, superscalar and VLIW processors, vector and symbolic processors, hierarchical and virtual memory technology, TLB, paging, segmentation, cache addressing modes, associative caches, SIMD processing, storage systems, I/O interfacing, RAID levels and performance reliability.
Learning Outcome: *Evaluate processor performance, understand advanced architecture models and memory storage strategies.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

4. Computer Organization and Architecture by Prof. John Jose (IIT Guwahati) NPTEL: https://nptel.ac.in/courses/106103206

Suggested Readings

Book

- *Computer Organization and Architecture: Designing for Performance* by William Stallings, 10th Edition, Pearson.

Online Articles, Journals, and Whitepapers

- Research articles from *IEEE Xplore*, *ScienceDirect*, and *Journal of Parallel and Distributed Computing*
- Whitepapers on processor design, memory hierarchy, and instruction set architectures from *Intel*, *ARM*, and *ACM Computing Surveys*

Web-based Resources

- MIT OpenCourseWare – Computer System Organization and Architecture.
- Simulators and tools like EduMIPS64, Logisim, and Multi2Sim.

Recommended Software/Tools (If applicable):

4. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

Course Title:	**Essentials of Generative AI**
Course Code:	**26VBX0S105**
Semester:	**I**
Credits:	**2**
Course Type	**Skill Enhancement Course**
Learning Hours	60
Live Sessions	**12 hours**

Course Outcomes:

CO1: Understand Generative AI and LLMs in depth
CO2: Create text, image, and voice content using AI
CO3: Automate daily tasks and business workflows
CO4: Build AI agents that act independently
CO5: Design and deploy simple AI apps without coding

Course Modules

Module 1: Generative AI Prompt Engineering for Real Workflows

What is Generative AI and how it's transforming industries, Structure of an effective prompt: *Role → Task → Context → Output,* Common prompting mistakes and how to fix them, How large language models (LLMs) like ChatGPT, Claude, and Google AI Studio work, advanced prompting (few-shot, iterative, style-based), Using your own files in ChatGPT and Claude (RAG basics), Research and summarization using AI

Learning Outcome: Students will be able to understand how Generative AI works and master the art of prompting.

Module 2: Creative AI and Voice & Audio Creation

Understanding AI image generation, creating posters, campaign assets, and product visuals, building brand identity using Krea.ai, Generating realistic voiceovers using ElevenLabs, Script writing and tone control with ChatGPT & Claude, Integrating voice into short videos or podcasts ***Learning Outcome:*** Students will be able to use AI to generate visuals, voiceovers, and creative storytelling content.

Module 3: AI Automation & Productivity

Logic of triggers, actions, and workflows, setting up automation between apps (Gmail, Sheets, Drive), Connecting OpenAI to Make.com for intelligent automation, creating social media Management Workflow

and research automation flows, automating daily reports and reminders, building personal productivity dashboards, Integrating Claude and ChatGPT into existing workflows

Learning Outcome: Automate daily workflows and tasks using AI and no-code tools.

Module 4: Advanced AI Agents & Decision Flows

Introduction to n8n as a visual AI workflow builder, understanding nodes, triggers, and data passing, Using OpenAI node for smart responses and actions, designing multi-step reasoning workflows, Connecting Google Sheets, Slack, and other APIs, building autonomous agents that perform specific tasks

Learning Outcome: Students will be able to build AI agents that can think, decide, and act automatically.

Module 5: AI App Building & Deployment

Fundamentals of UI/UX for AI apps, structuring front-end and AI back-end flows, designing app logic using n8n and Make.com, integrating OpenAI and Claude APIs to your apps, handling user inputs and dynamic responses, using Google AI Studio to experiment with models, hosting and testing your AI app online, adding analytics and monitoring usage, final demo preparation and peer feedback

Learning Outcome: Students will be able to learn to design, connect, and deploy simple AI apps using no-code tools

Semester-II

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
Bengaluru - 560 004
P: +91 80 4343 1000

Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
P: +91 80 4343 0100

Course Title:	Communicative English
Course Code:	**25VBX0AE205**
Semester:	**II**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course equips students with foundational and advanced communication techniques necessary for academic, personal, and professional success. Through practice-driven modules, students will develop their verbal, written, digital, and intercultural communication competence to become effective communicators.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Articulate the elements and processes involved in effective communication	L2
CO2	Analyze and differentiate between various forms of communication, recognizing their unique functions	L4
CO3	Apply diverse approaches to enhance listening and reading skills, leading to improved comprehension	L3
CO4	Demonstrate the ability to convey messages fluently and appropriately in diverse social and professional scenarios	L3
CO5	Employ advanced writing strategies to craft compelling and actionable written communication	L6

Course Modules

No. of Hours: 24

Module 1: Communication Foundations and Contexts
Scope of Module: Explore the process, types, and importance of communication with reference to global standards.
Topics: English as a global lingua franca, 21st-century communication needs, process and types of communication, workplace language skills, situational dialogues, formal and informal styles, communication barriers and management, verbal and non-verbal cues
Learning Outcome: *Explain the process and significance of effective communication in both workplace and societal contexts*

No. of Hours: 24

Module 2: Grammar, Reading, and Dialogue
Scope of Module: Build grammatical accuracy and comprehension through structured reading and dialogue practices
Topics: Essentials of good English (parts of speech, sentence structures), subject-verb agreement, discourse markers, reading strategies, textual understanding using *The English Teacher* by R.K. Narayan, direct and indirect dialogue, conversation control, dialogue in different scenarios, Einstein-Tagore discussion
Learning Outcome: *Apply grammar principles and reading skills for improved comprehension and communication*

No. of Hours:24

Module 3: Digital and Collaborative Communication
Scope of Module: Focus on the use of technology for learning, presenting, and collaborating in professional environments.
Topics: Online resources for language and research (Google Scholar, INFLIBNET, Project Gutenberg), writing essays and reports, persuasive and narrative writing, organizing reports, group presentations, public speaking, simulated interviews, using PPTs, ICT platforms, blogs, social media, email etiquette, virtual meeting tools
Learning Outcome: *Utilize digital tools and collaborative strategies for professional communication and presentation*

No. of Hours:24

Module 4: Argumentation, Networking, and Global Communication
Scope of Module: Develop effective argumentation, negotiation, and multicultural communication skills.
Topics: Pillars of argument, logic structures, radio debate analysis, art of debate and rebuttal, negotiation principles, conflict resolution, difficult conversations, networking language and strategies, global communication etiquette, multicultural sensitivity, handling communication barriers
Learning Outcome: *Demonstrate critical thinking, negotiation, and networking skills in global and multicultural communication settings*

No. of Hours:24

Module 5: Life Writing and Official Correspondence
Scope of Module: Explore reflective writing forms and develop professional written communication skills.
Topics: Official letter formats and styles, email writing (salutations, CC, BCC), resume and cover letters, types of life writing (memoirs, journals, biographies, testimonials), *The Diary of Anne Frank*, importance of life writing in reflecting social and personal history
Learning Outcome: *Craft effective official communications and explore personal expression through reflective writing forms*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

10. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
11. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
12. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings

Book

- *Elements of Style* by William Strunk Jr. and E. B. White

Online Articles, Journals, and Whitepapers

- George Orwell's *Why I Write* (orwellfoundation.com)
- *The Sense of Style* by Steven Pinker
- Steven Earnshaw (Ed.). *The Handbook of Creative Writing*. Edinburgh University Press

Web-based Resources

- British Council Learn English, BBC Learning English, ELLLO, Purdue OWL Writing Lab, Grammarly Blog

Recommended Software/Tools:

16. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
17. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
18. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
19. **Miro** – for mind-mapping essay structures.
20. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development

3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	2	2	1	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	2	2	3	2
CO5	3	3	3	2	3	2	2	2	3	3
Articulation	2.2	2.2	2.6	1.8	2.2	2	2	2	2.2	2.4

Course Title:	Operating System
Course Code:	**25VBT0C201**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course provides an in-depth understanding of operating system concepts such as process management, memory organization, scheduling, file systems, I/O systems, and protection mechanisms. Through theoretical foundations and case studies (Linux), students will gain insight into how an OS functions as a system software and as a resource manager**.**

Course Outcomes (Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Gain insight into the basic operating system structure & concept of process management.	L2
CO2	Develop a strong foundation on process scheduling, process synchronization & concept of deadlock.	L3
CO3	Analyze and apply concepts related to process management, scheduling, and multithreaded programming.	L4
CO4	Evaluate various memory management strategies, such as paging and segmentation, and analyze the complexity and cost associated with virtual memory techniques	L5
CO5	Design and implement solutions for file systems, understand the structure and functioning of I/O systems and create strategies for security mechanisms and protection in operating systems.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Operating System
Scope of Module: Introduces the architecture, structures, and basic services of modern operating systems and their interactions with hardware.
Topics: Introduction to Operating Systems, Computer System Architecture, Types of Operating Systems, Operating System Structure, Operating System Operations, Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, OS Design & Implementation, Virtual Machines, OS Generation, System Boot
Learning Outcome: *Comprehend the fundamentals, structure, and services of operating systems.*

No. of Hours:24

Module 2: Process Management and Scheduling
Scope of Module: Focuses on process lifecycle, scheduling techniques, and multithreading concepts for efficient CPU management.
Topics: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication (IPC), Multithreaded Programming, Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling
Learning Outcome: Analyze and apply process management, scheduling algorithms, and multithreaded programming.

No. of Hours:24

Module 3: Synchronization and Deadlocks
Scope of Module: Examines concurrency issues in multi-process systems and methods to avoid synchronization and deadlock problems.
Topics: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Synchronization Problems, Monitors, Deadlock Introduction, System Model, Deadlock Characterization, Deadlock Handling Methods, Deadlock Prevention, Avoidance, Detection, Recovery
Learning Outcome: *Evaluate process synchronization mechanisms and methods to handle deadlocks in operating systems.*

No. of Hours:24

Module 4: Memory and Storage Management

Scope of Module: Explores how operating systems handle memory through allocation strategies and virtual memory mechanisms.
Topics: Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation, Virtual Memory Concepts, Virtual Address Space, Demand Paging, Copy-On-Write, Page Replacement Algorithms, Frame Allocation, Thrashing, Overview of Mass Storage, Disk Structure, Disk Scheduling, RAID Concepts
Learning Outcome: *Evaluate memory and storage management techniques including paging and virtual memory.*

No. of Hours:24

Module 5: File Systems, I/O, Protection and Case Study
Scope of Module: Describes file organization, I/O hardware-software interface, and protection strategies along with a case study on Linux.
Topics: File Concepts, Access Methods, Directory & Disk Structure, File Mounting & Sharing, File System Implementation, Directory Implementation, Allocation & Free-Space Management, Efficiency & Performance, I/O System Overview, Application I/O Interface, Kernel I/O Subsystem, STREAMS, Goals and Principles of Protection, Access Matrix, Access Control, Security Threats, Distributed Systems Overview, Case Study: Linux OS Design, Kernel Modules, Process & Memory Management, File Systems in Linux
Learning Outcome: *Design and assess file systems, I/O, protection mechanisms, and explore the Linux operating system.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

4. Operating System Fundamentals by Prof. Niket Kaushik (IIT Roorkee)
NPTEL: https://nptel.ac.in/courses/106107191

Suggested Reading:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, *Operating System Concepts*, Wiley

Suggested Tools / Activities:

- Linux command line practice
- OS simulation tools (like LittleOS Book, Nachos, or PintOS – demonstration level)
- Process scheduling simulations (Gantt chart practice)
- Visualization of paging, segmentation, and memory management
- VirtualBox for exploring Linux file systems

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	1	2	1
CO2	3	3	3	3	3	1	–	1	2	1
CO3	3	3	3	3	3	1	–	1	2	2
CO4	3	2	3	3	3	1	1	1	2	3
CO5	3	1	1	3	3	2	1	1	1	1
Articulation	3	2.2	2.4	2.8	3	1.2	1	1	1.8	1.6

Course Title:	Data Structures using C
Course Code:	**25VBT0C202**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of data structures using the C programming language. It covers linear and non-linear structures, recursion, memory management, and algorithmic problem-solving through arrays, stacks, queues, linked lists, trees, and graphs. The course emphasizes practical implementation and performance analysis.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Comprehend fundamentals of Data Structures & its applications for solving real-world problems.	L2
CO2	Infer and develop applications of Linear Data Structures including stacks, queues, and lists.	L2
CO3	Interpret and apply Non-Linear Data Structures & their applications.	L3
CO4	Implement, analyze, and evaluate the searching algorithms	L5
CO5	Apply sorting algorithms to sort various types of data.	L3

Course Modules

No. of Hours:24

Module 1: Fundamentals of Data Structures & Pointers

Scope of Module: Introduces the concept and classification of data structures and deepens the understanding of pointers and memory management in C.
Topics: Introduction to Data Structures, Primitive and Non-Primitive Types, Linear vs Non-Linear Structures, Operations on Data Structures, Introduction to Algorithms, Characteristics & Elements of Algorithms, Pointer Basics, Pointer with Functions, Pass by Reference, Array of Pointers, Pointer to Arrays, Dynamic Memory Allocation, Structures and Unions, Self-referential Structures
Learning Outcome: *Understand the fundamental concepts of Data Structures and pointer-based memory operations.*

No. of Hours:24

Module 2: Arrays, Strings & Recursion
Scope of Module: Focuses on basic linear data representations and recursive algorithm strategies.
Topics: Linear Arrays: Representation, Traversing, Insertion, Deletion, Searching, Sorting, Dynamic Arrays, Multi-dimensional Arrays, String Concepts, String Operations, Pattern Matching Algorithms, Recursion: Direct and Indirect, Factorial, GCD, Fibonacci, Tower of Hanoi
Learning Outcome: *Apply array and string operations, and implement recursive solutions for mathematical and problem-solving tasks.*

No. of Hours:24

Module 3: Stacks and Queues
Scope of Module: Explores the stack and queue structures and their applications in computation.
Topics: Stack Definition, Operations, Array and Dynamic Representation, Polish & Reverse Polish Notations, Infix to Postfix Conversion, Postfix Evaluation, Queue Concepts: Operations, Array and Dynamic Representation, Circular Queue, Dequeue, and other types pf queues, Applications (e.g., Mazing Problem)
Learning Outcome: *Design and implement linear data structures using stacks and queues for solving expression and system-related problems.*

No. of Hours:24

Module 4: Linked Lists and Trees
Scope of Module: Covers linked list variants and hierarchical data structures with traversal techniques.

Topics: Singly Linked List: Representation, Traversal, Insertion, Deletion, Doubly and Circular Linked Lists, Linked Stacks and Queues, Applications, Trees: Terminology, Binary Trees, Complete Binary Trees, Representation, Binary Tree Traversals (Inorder, Preorder, Postorder), Binary Search Trees: Insertion, Deletion, Searching, Expression Tree Evaluation
Learning Outcome: *Analyze and apply dynamic structures like linked lists and trees to manage and process data efficiently.*

No. of Hours:24

Module 5: Graphs, Sorting & Searching
Scope of Module: Focuses on non-linear graphs and foundational algorithms for data organization and retrieval.
Topics: Graphs: Directed, Undirected, Representation (Matrix, Adjacency List), BFS and DFS Traversals, Sorting Techniques: Bubble, Insertion, Selection, Quick, Heap Sort, Searching Algorithms: Linear, Binary, Interpolation, Jump Search
Learning Outcome: *Implement and analyze graph traversal, sorting, and searching algorithms based on performance and use cases.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

4. Data Structures and Algorithms using C by Prof. Naveen Garg (IIT Delhi) NPTEL: https://nptel.ac.in/courses/106102064

Suggested Reading:

- Seymour Lipschutz, *Data Structures*, Schaum's Outlines
- Horowitz, Sahni, Anderson-Freed, *Fundamentals of Data Structures in C*
- Yashavant Kanetkar, *Data Structures Through C*
- NPTEL / GeeksforGeeks / HackerRank (Practice Problems)

Suggested Tools / Activities:

- Turbo C / GCC on Linux or Windows
- Implementing stacks, queues, trees in C
- Dry-run and trace recursion and sorting programs
- Mini-project: Student Record System, Expression Evaluation
- Practical lab with GDB (for pointer/stack memory visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	1	–	1	–	2
CO3	3	3	3	3	3	–	2	–	1	2
CO4	3	2	3	3	3	2	–	2	–	3
CO5	3	2	3	2	3	1	–	1	–	2
Articulation	3	2.6	2.8	2.4	2.6	1.3	2	1.3	1	2.2

Course Title:	Relational Database Systems
Course Code:	**25VBT0C203**
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of relational database design, implementation, and management. Students will learn how to design databases using ER models, normalize schemas, write complex SQL queries, and understand transaction management and emerging trends like NoSQL and Big Data. Emphasis is placed on applying theoretical knowledge through hands-on practice.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic database concepts, architectures, and advantages over traditional file systems.	L2
CO2	Create and interpret ER/EER diagrams and convert them into relational schemas.	L6
CO3	Analyze database designs using normalization techniques for optimized performance and data integrity.	L4
CO4	Construct and execute SQL queries for database operations.	L5
CO5	Explore advanced databases and evaluate their applicability in different contexts.	L5

Course Modules

No. of Hours:24

Module 1: Database Fundamentals and Architecture
Scope of Module: Introduces students to databases, their characteristics, architecture, and the distinction between DBMS and traditional file systems.
Topics: Database Characteristics, File-Based Systems vs. DBMS, Types of Data Processing and Access Methods, Data Models Overview, DBMS vs. RDBMS, Database Applications, Schemas and Instances, Three-Schema Architecture, Data Independence, DDL, DML, DCL, TCL, Centralized vs. Client/Server Architecture, DBMS Classification
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data.*

No. of Hours: 24

Module 2: Data Modeling with ER/EER and Relational Design
Scope of Module: Focuses on designing data models using ER and EER diagrams and converting them into relational models.
Topics: Entity, Attributes, Relationships, ER Symbols, Weak Entities, Keys, Constraints, Advanced ER Concepts, UML-based EER Diagrams, ER-to-Relational Mapping, Subclasses, Superclasses,Specialization, Generalization, Relational Schema Design, Relational Model Concepts, Constraints, Update Operations, Transactions
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data. Design ER/EER diagrams and map them into normalized relational schemas.*

No. of Hours: 24

Module 3: SQL and Relational Algebra
Scope of Module: Covers data definition and manipulation in SQL and introduces relational algebra for query formulation.
Topics: SQL Data Types, DDL, DML, Constraints, Keys (Primary, Foreign, Alternate), INSERT, UPDATE, DELETE, SELECT Queries, Aggregate Functions, GROUP BY, HAVING, JOINs (Inner, Outer, Cross), Subqueries, Relational Algebra Operators, Unary & Binary Operations, Set Theory Operations, Grouping and Aggregation in Algebra
Learning Outcome: *Write efficient SQL queries and use relational algebra to express data operations.*

No. of Hours: 24

Module 4: Normalization, Transactions & Concurrency Control
Scope of Module: Deals with schema refinement, functional dependencies, transaction behaviour, and concurrency mechanisms.
Topics: Informal Design Guidelines, 1NF, 2NF, 3NF, BCNF, Multivalued Dependencies, 4NF, 5NF, Join Dependencies, ACID Properties, Transaction States, Serializability, Conflict & View Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols, Deadlock Detection & Prevention
Learning Outcome: *Normalize relational schemas and implement safe, concurrent transaction handling in DBMS.*

No. of Hours:24

Module 5: Database Recovery, NoSQL & Emerging Trends
Scope of Module: Explores recovery methods, non-relational databases, and current trends in the field.
Topics: Recovery Concepts, Types of Failures, Log-Based Recovery, Shadow Paging, ARIES Recovery Algorithm, Introduction to NoSQL, Types (Key-Value, Column, Document, Graph), Big Data & Hadoop Overview, Introduction to Data Warehousing and Data Mining, Database Security Concepts
Learning Outcome:*Explore database recovery techniques and evaluate modern database trends and technologies.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

4. Database Management System by Prof. P. P. Chakrabarti (IIT Kharagpur) NPTEL: https://nptel.ac.in/courses/106105175

Suggested Reading:

- Ramez Elmasri & Shamkant Navathe, *Fundamentals of Database Systems*, Pearson
- Silberschatz, Korth, & Sudarshan, *Database System Concepts*, McGraw-Hill
- NPTEL Database Management Systems Modules
- Practice Resources: SQLZoo, LeetCode (SQL), DB-Fiddle

Suggested Tools / Activities:

- Use of MySQL / PostgreSQL / Oracle XE
- Lab practice: SQL query execution, ER diagram to schema mapping
- Projects: Library Management System, Online Store Schema Design
- Tools: DB Designer, SQL Workbench, pgAdmin, MongoDB Compass (for NoSQL demos)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	3	2	1
CO2	3	3	3	3	3	2	–	2	2	1
CO3	3	3	3	3	3	1	–	1	2	1
CO4	3	3	3	3	3	1	2	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1.5	1.6	2	1.4

Semester III

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Course Title:	Python Programming
Course Code:	25VBT0C301
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamental concepts of Python programming, covering syntax, data types, control structures, functions, and object-oriented principles. It also explores data structures, file handling, databases, web services, and networking. The course emphasizes problem-solving using Python and provides hands-on experience with real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic syntax, data types, and control structures in Python.	L2
CO2	Apply functions, modules, and object-oriented concepts to solve problems.	L3
CO3	Develop programs using file handling, exceptions, and standard libraries.	L3
CO4	Analyze and implement data structures such as lists, dictionaries, and tuples.	L4
CO5	Design real-world applications using Python frameworks and libraries.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Python and Basic Programming Concepts

Scope of Module: This module covers Python programming basics, syntax, variables, mathematical operations, and debugging techniques. It also introduces expressions, Boolean logic, and user input handling.
Topics: Introduction to programming concepts, Python as a programming language, writing and running Python scripts, variables and assignment statements, data types (integers, floats, and strings), arithmetic operations and expressions, Boolean expressions and logical operators, modulus operator and integer division, order of operations in expressions, working with user input and output, string operations and concatenation, naming conventions and keywords, writing meaningful comments in code, debugging techniques and best practices, common syntax errors and troubleshooting.
Learning Outcome: *Understand the fundamental concepts and terminology of Python programming while developing the ability to write and debug simple programs.*

No. of Hours: 24

Module 2: Functions, Iteration, and String Manipulation
Scope of Module: This module explores functions, control structures like loops, and handling string operations, enabling efficient program flow and data processing.
Topics: Function definitions and structure, function calls and return values, built-in functions in Python, parameters and arguments in functions, type conversion functions, recursive functions and base cases, iteration using while loops, iteration using for loops, using break and continue statements, nested loops and loop efficiency, string sequences and indexing, string slicing and concatenation, string immutability and methods, string formatting techniques, debugging functions and loops.
Learning Outcome: *Implement functions, loops, and string operations effectively for structured programming in Python.*

No. of Hours: 24

Module 3: Data Structures – Lists, Dictionaries, and Tuples
Scope of Module: This module covers essential Python data structures, including lists, dictionaries, and tuples, focusing on operations and efficient data handling.
Topics: Introduction to lists and their properties, list indexing and slicing, adding and removing list elements, list mutability and copying, iterating over lists using loops, list comprehensions and filtering, dictionary creation and key-value pairs, accessing and updating dictionary values, looping through dictionaries, dictionary operations and methods, introduction to tuples and immutability, tuple assignment and multiple return values, tuples as dictionary keys, comparing lists, dictionaries, and tuples, debugging common data structure issues.
Learning Outcome**:** *Analyze and manipulate Python's core data structures to store, retrieve, and*

process data effectively.

No. of Hours: 24

Module 4: File Handling, Object-Oriented Programming, and Inheritance
Scope of Module: This module introduces file handling, object-oriented programming, and inheritance principles to build reusable and structured code.
Topics: Reading and writing text files, handling different file formats, file paths and directory navigation, exception handling in file operations, object-oriented programming (OOP) concepts, defining classes and objects, attributes and instance methods, encapsulation and data hiding, mutability of objects and copying, understanding object lifecycles, inheritance and subclassing, overriding methods in subclasses, polymorphism and method resolution order, class diagrams and object hierarchies, debugging OOP-based programs.
Learning Outcome:Develop structured, reusable programs using file handling, OOP, and inheritance concepts in Python.

No. of Hours: 24

Module 5: Databases, Web Services, and Networking
Scope of Module: This module explores database management, web services, APIs, and network programming, enabling interaction with external data sources and networked systems.
Topics: Introduction to databases and SQL, creating and managing tables in SQL, writing and executing SQL queries, relational database modeling and normalization, handling multiple tables and relationships, constraints and data integrity, introduction to web services and APIs, understanding XML and JSON formats, parsing XML and JSON in Python, working with third-party APIs, introduction to networking concepts, sending and receiving data over networks, Python sockets for client-server communication, web scraping techniques using Python, debugging network and database programs.
Learning Outcome: *Develop proficiency in handling databases, web services, and networking concepts for real-world applications.*

Module	No of Pre Recordings
1	10

2	**11**
3	**12**
4	**12**
5	**11**

Note: Min no of pre recordings 10.

Prerequisites

- Basic understanding of programming logic and flowcharts
- Familiarity with any programming language (C/C++ preferred)
- Logical reasoning and problem-solving mindset

Pedagogy / Teaching Methodology

- ✓ Hands-on coding sessions in labs and online IDEs
- ✓ Mini-projects on text processing, games, or web apps
- ✓ Weekly coding challenges and debugging practice
- ✓ Group tasks involving script design or automation
- ✓ Integration with tools like Jupyter Notebooks, GitHub, and Colab

Certificate / Value Added Courses

13. Python for Everybody – Coursera (University of Michigan)
14. Google IT Automation with Python – Coursera
15. Introduction to Python – edX (Microsoft)
16. Automate the Boring Stuff with Python – Udemy

Suggested Readings

- Eric Matthes, *Python Crash Course*
- Charles Dierbach, *Introduction to Computer Science Using Python*
- Mark Lutz, *Learning Python*
- Al Sweigart, *Automate the Boring Stuff with Python*
- Guido van Rossum (online documentation): https://docs.python.org/3/

Recommended Software / Tools

10. **IDE/Editors:**
    a. Jupyter Notebook

   b. Visual Studio Code
   c. PyCharm (Community Edition)
   d. Thonny (for beginners)
11. **Online Platforms:**
   a. Google Colab
   b. Replit
   c. HackerRank / LeetCode (for Python practice)
12. **Libraries and Frameworks:**
   a. NumPy, Pandas (for data analysis)
   b. Tkinter, PyQt (for GUI development)
   c. Flask, Django (for web development)
   d. Matplotlib, Seaborn (for data visualization)

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	3	-	1	1	1
CO2	3	3	3	3	3	2	1	1	1	1
CO3	2	3	2	2	3	2	1	1	2	-

CO	3	3	2	2	2	2	1	2	1	1
CO	2	3	3	3	3	3	1	1	1	1
Articulation	2.6	3	2.4	2.4	2.6	2.4	1	1.2	1.2	1

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Course Title:	Design and Analysis of Algorithms
Course Code:	25VBT0C302
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course explores the fundamental principles and advanced techniques in algorithm design and analysis. Students will learn to develop computational solutions for problems like searching and sorting, apply divide-and-conquer, greedy, and dynamic programming techniques, and analyze algorithmic efficiency. The course will also cover space-time tradeoffs, iterative improvements, and approaches to solving NP-hard problems, providing industry-relevant problem-solving skills.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic algorithmic strategies and their time/space complexities.	L2
CO2	Apply divide and conquer, greedy, and dynamic programming paradigms to solve problems.	L3
CO3	Analyze algorithm efficiency using Big-O, Big-Ω, and Big-Θ notations.	L4
CO4	Evaluate and compare the performance of different algorithms.	L5
CO5	Design efficient algorithms for real-world problems using suitable techniques.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Algorithm Design and Analysis
Scope of Module:

This module introduces fundamental algorithm concepts, including problem-solving strategies, computational limits, and performance analysis. It covers basic searching, sorting techniques, and asymptotic notation for algorithm efficiency.
Topics: Definition and importance of algorithms, understanding problem complexity and computational constraints, importance of selecting appropriate data structures, algorithm design techniques, methods of specifying an algorithm, proving correctness of an algorithm, performance analysis and computational efficiency, space complexity and time complexity, asymptotic notations including Big-O, Omega, and Theta, mathematical analysis of recursive and non-recursive algorithms, selection sort and bubble sort fundamentals, sequential search and brute-force string matching, closest-pair problem using brute-force technique, convex hull problem using brute-force method, exhaustive search techniques.
Learning Outcome*: Understand the role of algorithms in problem-solving and analyze algorithm efficiency using mathematical models.*

No. of Hours: 24

Module 2: Divide and Conquer and Decrease and Conquer Approaches
Scope of Module: This module delves into the divide-and-conquer and decrease-and-conquer techniques, helping students analyze problems that can be solved by breaking them into smaller subproblems.
Topics: **I**ntroduction to divide-and-conquer strategy, recurrence equations and their significance, finding maximum and minimum elements, merge sort algorithm and analysis, quick sort algorithm and complexity, binary search and efficiency, binary tree traversals and their properties, multiplication of large integers using divide-and-conquer, Strassen's matrix multiplication algorithm, closest-pair problem using divide-and-conquer, convex hull problem via divide-and-conquer, insertion sort algorithm and its efficiency, depth-first search algorithm (DFS), breadth-first search algorithm (BFS), topological sorting and its applications.
Learning Outcome*: Analyze and implement divide-and-conquer and decrease-and-conquer techniques to optimize problem-solving.*

No. of Hours: 24

Module 3: Space-Time Tradeoffs, Greedy Approach, and Iterative Improvement
Scope of Module: This module focuses on space-time tradeoffs, string matching algorithms, and greedy techniques for optimization problems. Students will explore graph algorithms and iterative improvement techniques in optimization.

Topics: Introduction to space-time tradeoff principles, sorting by counting methods, input enhancement in string matching, Boyer-Moore algorithm for string matching, Horspool's algorithm and performance analysis, hashing fundamentals and applications, open hashing vs. closed hashing, Prim's algorithm for minimum spanning trees, Kruskal's algorithm using disjoint subsets, union-find method in Kruskal's algorithm, Dijkstra's algorithm for shortest path, Huffman tree construction and encoding, simplex method for linear programming, geometric interpretation of linear programming, maximum-flow problem and optimization strategies.
Learning Outcome: *Apply space-time tradeoffs, greedy techniques, and iterative improvement methods to solve optimization problems.*

No. of Hours: 24

Module 4: Transform and Conquer, Dynamic Programming, and Algorithmic Optimization
Scope of Module: This module covers algorithm transformation strategies, pre-sorting techniques, dynamic programming principles, and optimization algorithms used in shortest path problems and combinatorial optimization.
Topics: Introduction to transform and conquer approach, pre-sorting and its advantages, Gaussian elimination method, balanced search trees and their importance, heaps and heap sort algorithm, Horner's rule and its applications, binary exponentiation technique, problem reduction approach, overview of dynamic programming, computing binomial coefficients using dynamic programming, Warshall's algorithm for transitive closure, Floyd's algorithm for all-pairs shortest paths, principle of optimality in dynamic programming, optimal binary search trees, knapsack problem and memory functions.
Learning Outcome: *Design and implement dynamic programming solutions for combinatorial optimization problems.*

No. of Hours: 24

Module 5: Limitations of Algorithmic Power and Approximation Algorithms
Scope of Module: This module examines the theoretical limitations of algorithmic power, computational complexity classes, and approximation algorithms for NP-hard problems. It also introduces backtracking and branch-and-bound methods.

Topics: Introduction to lower-bound arguments, trivial lower bounds and problem complexity, information-theoretic arguments in complexity analysis, adversary arguments and decision trees, complexity classes: P, NP, and NP-complete problems, challenges in numerical algorithms, backtracking technique and its applications, N-Queens problem using backtracking, sum of subsets problem using backtracking, branch-and-bound method for optimization, knapsack problem using branch-and-bound, traveling salesperson problem and branch-and-bound, approximation algorithms for NP-hard problems, traveling salesman problem approximation techniques, knapsack problem approximation methods.
Learning Outcome: Analyze computational complexity, apply backtracking and branch-and-bound techniques, and develop approximation algorithms for NP-hard problems.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Knowledge of basic programming (C/C++/Python)
- Understanding of discrete mathematics
- Familiarity with data structures

Pedagogy

- ✓ Whiteboard algorithm walkthroughs
- ✓ Pseudocode-to-code transformation exercises
- ✓ Complexity analysis using real-world problems
- ✓ Case studies and project-based learning

Value Added Courses / Certificates

7. Algorithmic Toolbox – Coursera
8. Data Structures and Algorithms – Udacity

Suggested Readings

- Thomas H. Cormen et al., *Introduction to Algorithms*
- Jon Kleinberg & Éva Tardos, *Algorithm Design*
- Anany Levitin, *Introduction to the Design & Analysis of Algorithms*

Recommended Tools

7. Python/C++ IDEs (e.g., VS Code, Code::Blocks)
8. Online judges: HackerRank, LeetCode, Codeforces

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	-	1	2	3
CO2	2	3	2	2	1	1	-	1	1	1

CO3	2	2	3	2	2	2	1	1	1	1
CO4	1	1	2	1	3	2	1	1	1	2
CO5	1	2	2	3	2	2	1	2	2	2
Articulation	1.8	2.2	2.4	2	2.2	1.8	1	1.2	1.4	1.8

Course Title:	Software Engineering
Course Code:	25VBT0C303
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamentals of software engineering, including software development models, agile methodologies, requirements engineering, software design, testing, maintenance, and emerging trends. Students will explore industry-standard practices, software quality assurance, and modern development approaches such as DevOps, cloud computing, and AI-driven software engineering. By the end of the course, students will be equipped with the skills **to** design, develop, test, and maintain software systems efficiently.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the phases of software development life cycle (SDLC).	L2
CO2	Apply appropriate process models for software projects.	L3
CO3	Analyze software requirements and specifications.	L4
CO4	Evaluate software design methodologies and testing techniques.	L5
CO5	Create documentation and design for real-world software applications.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Engineering

Scope of Module: This module introduces software engineering principles, software processes, and different software application domains.
Topics Covered: The nature of software, defining software, software application domains, the unique nature of web applications, software engineering and the software process, software engineering practice, software myths, a generic process model, defining a framework activity, identifying a task set, process assessment and improvement, prescriptive process models (waterfall, incremental, **evolutionary,** concurrent), specialized process models (component-based development, formal methods model, aspect-oriented development), the Unified Process and its phases, personal and team process models (PSP, TSP).
Learning Outcome: *Define software engineering principles, differentiate between software application domains, and describe various software process models.*

No. of Hours: 24

Module 2: Agile Development and Requirements Engineering
Scope of Module: This module explores agile methodologies and techniques for requirements gathering, analysis, and modeling.
Topics Covered: The concept of agility and its impact on the cost of change, agile process and principles, the politics of agile development, human factors in agility, extreme programming (XP) and its process, industrial XP, adaptive software development, Scrum framework, dynamic systems development method (DSDM), feature-driven development (FDD), lean software development, agile modeling, requirements engineering and stakeholders, developing use cases and UML models, requirements modeling for web applications.
Learning Outcome: *Explain agile methodologies, analyze software requirements, and apply modeling strategies for software specification.*

No. of Hours: 24

Module 3: Software Design and Architecture
Scope of Module: This module focuses on software design principles, architectural styles, and user interface design strategies.
Topics: The role of design in software engineering, the design process, software quality guidelines and attributes, evolution of software design, design concepts, the design model, software architecture, architectural genres and styles, component-level design, object-oriented view of components, designing class-based components, user interface design, web application interface design, interface analysis and guidelines, interface design steps.
Learning Outcome: *Apply software design principles, develop architectural models, and implement user interface design guidelines.*

No. of Hours: 24

Module 4: Software Quality and Testing
Scope of Module: This module focuses on software quality assurance, verification, validation, and testing strategies.
Topics: Software quality and its dimensions, the software quality dilemma, achieving software quality through engineering methods, cost impact of software defects, review metrics and their use, software quality assurance (SQA) and its elements, SQA tasks, goals, and metrics, formal approaches to SQA, statistical software quality assurance, software reliability and availability, a strategic approach to software testing, verification and validation, unit testing, security testing, debugging and the debugging process.
Learning Outcome*: Analyze software quality assurance strategies and implement software testing techniques for defect prevention and validation.*

No. of Hours: 24

Module 5: Software Maintenance and Emerging Trends
Scope of Module: This module covers software maintenance techniques, risk management, and evolving trends in software engineering.
Topics: Software maintenance and evolution, legacy system maintenance, capability maturity models (CMM), software project risk management, risk mitigation strategies, software configuration management, change control, refactoring strategies, version control systems, release management, continuous integration and deployment (CI/CD), DevOps practices, cloud computing and microservices, AI in software development, future trends in software engineering.
Learning Outcome: *Evaluate software maintenance strategies, implement cost estimation models, and explore emerging trends in software engineering.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12

5	**10**

Note: Min no of pre recordings 10.

Prerequisites

- Familiarity with basic programming
- Understanding of software applications

Pedagogy

- ✓ SDLC-based project development
- ✓ Use case modeling and UML design
- ✓ Agile and traditional model simulation
- ✓ Code review and testing labs

Value Added Courses / Certificates

7. Software Processes and Agile Practices – Coursera
8. Software Engineering Essentials – edX

Suggested Readings

- Ian Sommerville, *Software Engineering*
- Roger Pressman, *Software Engineering: A Practitioner's Approach*
- Pankaj Jalote, *An Integrated Approach to Software Engineering*

Recommended Tools

13. Visual Paradigm, StarUML (UML modeling)
14. GitHub (Version control)
15. JIRA (Agile project management)
16. Selenium, JUnit (Testing)**Curriculum Development:**

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)

4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Consersns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.**CO - PO Mapping Table**

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	-	1	1	1
CO2	2	3	2	3	2	1	1	1	1	1
CO3	2	2	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	2	-	1	3	2
CO5	1	1	1	1	3	2	2	3	2	1
Articulation	1.8	1.8	2	1.8	2.2	1.4	1.3	1.4	1.6	1.2

Course Title:	Computer Networks
Course Code:	25VBT0C304
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description: This course provides a comprehensive introduction to computer networks, covering fundamental networking principles, architectures, and protocols. Students will explore different network layers, their functionalities, and the mathematical calculations associated with data transmission. The course also introduces advanced networking concepts such as cloud computing, IoT, and network security.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand network architectures, protocols, and models.	L2
CO2	Apply network principles to configure and troubleshoot basic networks.	L3
CO3	Analyze different layers of the OSI and TCP/IP models.	L4
CO4	Evaluate network performance and security mechanisms.	L5
CO5	Design secure and scalable network infrastructures.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Networks
Scope of Module: This module introduces fundamental networking concepts, network models, and physical layer functionalities. It provides an overview of computer networks, transmission media, and error detection mechanisms.

Topics:Overview of computer networks and their importance, Historical evolution of networking technologies, Network types and their applications (LAN, MAN, WAN), Network topologies and their impact on performance, The OSI reference model: layers and their functions, The TCP/IP model: comparison with OSI model, Analog and digital signals in networking, Transmission media: guided and unguided media, Signal encoding techniques and modulation schemes, Multiplexing techniques: FDM, TDM, and WDM, Spread spectrum techniques and their applications, Transmission errors: causes and effects, Error detection techniques: parity checks and checksums, Error correction mechanisms: Hamming code and CRC, Physical layer functions and performance metrics.
Learning Outcome: Explain the fundamental concepts of computer networks, transmission media, and error detection techniques

No. of Hours:24

Module 2: Data Link Layer and Medium Access Control
Scope of Module:
This module explores the data link layer, its role in error detection, flow control, and MAC protocols for wired and wireless networks.
Topics Covered:
Framing methods and techniques in data transmission, Flow control mechanisms: stop-and-wait and sliding window protocols, Error detection techniques: CRC, checksums, and parity bits, Error correction methods: Hamming code and ARQ techniques, Medium Access Control (MAC) protocols and their importance, CSMA/CD: collision detection and resolution, CSMA/CA: collision avoidance in wireless networks, Ethernet standards and frame structure, Token Ring: access method and frame structure, Wireless LAN standards: IEEE 802.11 and Wi-Fi, Bluetooth technology and applications, MAC addressing and its role in data link layer, LAN switching techniques: circuit switching vs. packet switching, Virtual LANs (VLANs) and their configurations, Data link layer security threats and mitigation techniques
Learning Outcome:*Describe data link layer functions, error detection techniques, and MAC protocols in wired and wireless networks.*

No. of Hours: 24

Module 3: Network Layer and Transport Layer
Scope of Module: This module covers network-layer functionalities, IP addressing, subnetting, and transport-layer protocols, including TCP and UDP.

Topics: Introduction to the network layer and its services, IP addressing schemes: IPv4 and IPv6, Subnetting techniques and IP address allocation, Routing algorithms: distance vector vs. link state, Static and dynamic routing protocols: RIP, OSPF, and BGP, ICMP protocol and error reporting in networks, IPv4 and IPv6 coexistence strategies, Address Resolution Protocol (ARP) and its working, Network Address Translation (NAT) and its applications, Transport layer functions and its role in networking, TCP and UDP: comparison and applications, Connection establishment and termination in TCP, Congestion control and flow control in TCP, Error detection and correction in transport layer, QoS mechanisms and performance optimization techniques
Learning Outcome: Analyze IP addressing, subnetting, and routing algorithms, and describe transport-layer services.

No. of Hours:24

Module 4: Network Security, Wireless & Multimedia Network
Scope of Module: This module covers network security principles, wireless communication fundamentals, and multimedia networking technologies.
Topics Covered: Network security threats and vulnerabilities, Cryptography basics: symmetric vs. asymmetric encryption, Authentication mechanisms and secure communication, Integrity and confidentiality mechanisms in networking, Wireless transmission fundamentals and radio communication, Cellular networks: architecture and mobile IP, IEEE 802.11 standard and wireless LAN protocols, Bluetooth technology: architecture and applications, Wireless security threats and mitigation techniques, Streaming and real-time communication protocols, Quality of Service (QoS) in multimedia networking, Voice over IP (VoIP) and its applications, Video conferencing protocols and challenges, Delay-sensitive traffic management in multimedia applications, Performance optimization for wireless and multimedia networks
Learning Outcome: Understand and apply multimedia networking protocols to ensure secure, efficient, and high-quality real-time communication over wireless and mobile networks.

No. of Hours: 24

Module 5: Advanced Networking and Emerging Technologies
Scope of Module: This module introduces advanced networking concepts such as network management, cloud computing, IoT, and blockchain.

Topics Covered:
SNMP protocol and network monitoring techniques, Fault management and performance optimization in networks, Configuration management in enterprise networks, Distributed computing fundamentals and architectures, Client-server vs. peer-to-peer networking models, Distributed file systems and coordination algorithms, Cloud computing models: IaaS, PaaS, SaaS, Virtualization techniques and resource management, Cloud security challenges and privacy concerns, IoT architecture and components, Communication protocols for IoT applications, IoT security challenges and mitigation techniques, Software-Defined Networking (SDN) architecture and benefits, Network Function Virtualization (NFV) and its impact, Blockchain technology in networking and its applications

Learning Outcome: Evaluate network management strategies, cloud computing models, and emerging technologies like IoT, SDN, and blockchain.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Basic computer system knowledge
- Understanding of binary arithmetic
- Familiarity with operating systems

Pedagogy

- ✓ Packet tracer simulations (Cisco)
- ✓ Layer-by-layer protocol analysis
- ✓ Wireshark labs and trace evaluations
- ✓ Network design mini-projects

Value Added Courses / Certificates

7. Computer Networking – Coursera (Stanford)
8. Cisco CCNA Introduction – NetAcad

Suggested Readings

- Andrew S. Tanenbaum, *Computer Networks*
- Behrouz A. Forouzan, *Data Communications and Networking*
- William Stallings, *Data and Computer Communications*

Recommended Tools

10. Cisco Packet Tracer
11. Wireshark
12. GNS3, NS2/NS3 simulators

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	-	1	1	1
CO2	2	3	2	2	1	1	-	1	1	1

CO3	2	2	3	2	3	1	-	2	2	1
CO4	1	2	2	3	2	2	1	2	2	1
CO5	1	1	1	1	1	1	2	1	3	3
Articulation	1.8	2	1.8	1.8	1.6	1.2	1.5	1.4	1.8	1.4

Course Title:	Environmental, Social, and Governance (ESG) in IT
Course Code:	25VBT0C305
Semester:	**III**
Credits:	**3**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth exploration of Environmental, Social, and Governance (ESG) principles and their critical application within the Information Technology (IT) sector. Students will examine how ESG factors influence IT operations, strategy, and policy-making, gaining insights into sustainable practices, ethical considerations, and effective governance in technology-driven environments. Through case studies and practical projects, learners will develop the skills necessary to integrate ESG considerations into IT frameworks, ensuring responsible and sustainable technological development.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand environmental principles and sustainability concepts.	L2
CO2	Identify the effects of human activities on ecosystems.	L3
CO3	Analyze environmental challenges and sustainability goals (SDGs).	L4
CO4	Evaluate policies and practices for sustainable development.	L5
CO5	Propose eco-friendly solutions for community or industry applications.	L6

Course Modules: **No. of Hours: 18**

Module 1: Introduction to ESG and Digital Responsibility
Scope of Module: This module lays the foundation of ESG principles and their relevance to the IT industry. It explores the global push toward sustainability, ethical tech development, and corporate responsibility.
Topics: Definition and Origin of ESG, Importance of ESG in IT, Sustainable Development Goals (SDGs) and IT alignment, Environmental Impact of Digital Technologies, Ethical Considerations in Tech Development, IT and Climate Change, ESG Ratings and Digital Business Performance, Role of IT Professionals in ESG, Green Certifications and IT Compliance, Digital Transformation and ESG Goals, Circular Economy in IT, Impact of Cloud and Data Centers on Environment, Tech Industry ESG Benchmarks, Digital Minimalism and Eco-design, Global ESG Reporting Frameworks.
Learning Outcome: *Understand ESG foundations, the importance of responsible tech, and the environmental impact of digital systems.*

No. of Hours: 18

Module 2: Environmental Sustainability in IT
Scope of Module: Focuses on sustainable computing, energy-efficient infrastructure, and green software engineering.
Topics: Green IT Practices, Energy-Efficient Hardware and Systems, Carbon Footprint of IT Operations, Sustainable Data Center Management, E-Waste Management and Recycling, Renewable Energy Use in Tech Firms, Virtualization and Cloud Sustainability, Lifecycle Assessment of IT Products, Power Management in Devices, Paperless Office and Digital Workflows, Sustainable Supply Chains in IT, Greener Coding Practices, Use of AI for Environmental Monitoring, IoT in Smart Environment Systems, IT and Climate Action Technologies.
Learning Outcome: *Evaluate IT strategies that promote environmental sustainability and carbon reduction.*

No. of Hours: 18

Module 3: Social Responsibility and Inclusion in Technology
Scope of Module: Covers how IT contributes to equity, digital literacy, accessibility, and ethical labor practices.
Topics: Digital Inclusion and Access to Technology, Gender Equality in Tech, Accessibility Standards (WCAG, ADA), Ethical Labor in Tech Supply Chains, Community Engagement through Technology, Corporate Social Responsibility (CSR) in IT, Digital Literacy and Education Programs, Tech for Good Initiatives, Bridging the Digital Divide, AI Bias and Fairness, Inclusive Design Principles, Social Impact Assessment in Tech Projects, Diversity in IT Workforce, Data for Social Good, Digital Safety and Well-being.
Learning Outcome: *Analyze IT's role in promoting social responsibility and inclusive technology design.*

No. of Hours:18

Module 4: Governance, Ethics, and Regulation in IT

Scope of Module: Discusses governance mechanisms, risk management, data ethics, and compliance in the IT context.
Topics: IT Governance Models, Data Privacy and Protection Laws (GDPR, PDP Bill India), Cyber Ethics and Accountability, Risk Management in Tech Projects, Regulatory Compliance in IT, Digital Rights Management, Transparent AI and Algorithm Auditing, Corporate Governance in IT Companies, Role of CIOs in ESG Governance, ESG Metrics and KPIs in Tech, Open Data and Public Interest, Whistleblowing Mechanisms in Tech Industry, IT Policy Frameworks, Blockchain for Governance Transparency, ESG Risks in IT Investments.
Learning Outcome: *Explore ethical governance practices, digital compliance, and risk management in IT.*

No. of Hours: 18

Module 5: ESG Implementation and Case Studies in IT
Scope of Module: Focuses on practical ESG integration into IT systems, success stories, frameworks, and tools.
Topics: ESG Strategy Development in Tech Organizations, Sustainability Reporting Tools (GRI, SASB), Role of CIOs and IT Managers in ESG, Measuring ESG Performance in IT Projects, ESG-Focused Software Development Lifecycle (SDLC), ESG Dashboards and Analytics, Green Procurement for IT Assets, Case Studies: Google, Microsoft, Infosys ESG Programs, IT in Disaster Response and Crisis Management, ESG Risk Mitigation Frameworks, ESG Investment in Tech Startups, ESG Certifications for IT Professionals, Open-source Tools for ESG Monitoring, ESG KPIs in Software Products, ESG Innovation Labs and Incubators.
Learning Outcome: *Apply ESG principles through frameworks, tools, and real-world tech case studies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Suggested Readings:

Prerequisites

- General awareness of science and ecology
- Basic understanding of social issues

Pedagogy

- ✓ Eco-surveys and field visits
- ✓ Case studies on climate change and pollution
- ✓ Group discussions on policy impacts
- ✓ Sustainable campus or local community projects

Value Added Courses / Certificates

7. Sustainable Development Goals – edX
8. Introduction to Sustainability – Coursera

Suggested Readings

- Erach Bharucha, *Environmental Studies*
- R.Rajagopalan, *Environmental Studies from Crisis to Cure*
- UNEP Reports and SDG Guidelines

Recommended Tools

10. ArcGIS (for environment mapping)
11. SDG Tracker
12. OpenLCA (for life cycle assessment)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Concerns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	3	2	1	2
CO2	2	3	2	2	3	2	3	2	1	2
CO3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	2	3	2	3	3	3	2	3
CO5	1	2	3	3	3	3	3	3	3	3
Articulation	2	2.2	2.2	2.2	2.6	2.6	2.8	2.6	1.8	2.6

Course Title:	**Web Technologies**
Course Code:	**25VBT0C401**
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description: This course introduces students to essential web development technologies, covering both front-end and back-end aspects. Students will learn to design, develop, and deploy interactive websites using HTML, CSS, JavaScript, and server-side scripting with PHP or Node.js, along with database integration. The course focuses on hands-on learning and equips students for careers in web development, UI/UX design, and full-stack engineering.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the structure and design principles of web applications.	L2
CO2	Develop interactive and responsive web pages using HTML, CSS, and JavaScript.	L3
CO3	Implement dynamic web applications using server-side scripting.	L3
CO4	Connect web applications with databases for data management.	L4
CO5	Deploy and manage complete web applications using modern web tools.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Web Technologies
Scope of Module: Covers the fundamentals of how the web works, including protocols, architecture, and core components.

Topics: Introduction to Internet and Web, Web Servers and Clients, HTTP and HTTPS Protocols, URL and URI Concepts, DNS and Hosting Basics, Static vs. Dynamic Websites, Web Browsers and Developer Tools, MIME Types and Web Content Types, TCP/IP and Sockets Overview, Browser Rendering Process, HTML Document Structure, Responsive Design Principles, Introduction to Web Accessibility (WCAG), Browser Compatibility Issues, Role of Web Standards (W3C).
Learning Outcome: *Understand the core architecture and functioning of the web ecosystem.*

No. of Hours: 24

Module 3: Server-Side Programming and Backend Integration
Scope of Module: Introduces backend development and connecting frontend applications to databases and servers.
Topics: Introduction to Server-Side Scripting, Node.js and Express.js Basics, RESTful API Design, Routing and Middleware in Express, Working with JSON Data, Handling HTTP Requests and Responses, Templating Engines (EJS, Handlebars), Introduction to PHP (Optional), Error Handling in Server-Side Apps, Session Management and Cookies, Uploading and Handling Files, Working with Forms (POST, GET), Basic Authentication and Authorization, Connecting Frontend with Backend APIs, Building a Simple Full-Stack App.
Learning Outcome: *Create and connect server-side logic to client-side interfaces using web frameworks.*

No. of Hours:24

Module 4: Databases and Web Integration
Scope of Module: Focuses on integrating databases into web applications and managing data using queries.
Topics: Relational Databases Overview (MySQL, PostgreSQL), NoSQL Databases (MongoDB), Database Design Basics, CRUD Operations in SQL, Mongoose with MongoDB in Node.js, Connecting Backend to Database, Query Parameters and Filtering, ORM Basics (Sequelize/Mongoose), Data Validation and Sanitization, Indexing and Performance Tuning, Managing Relationships and Joins, Authentication Data Storage, Environment Variables and DB Security, Transactions and Error Handling, Integrating Search in Web Applications.
Learning Outcome: *Design and connect databases to dynamic web applications for persistent storage.*

No. of Hours:24

Module 5: Web Deployment, Security, and Modern Trends

Scope of Module: Covers web application deployment, security, DevOps integration, and modern web development trends.
Topics: Deployment on Platforms (Vercel, Netlify, Heroku), Git and GitHub for Version Control, Continuous Deployment Pipelines, Domain Registration and DNS Setup, SSL Certificates and HTTPS, Security Best Practices (XSS, CSRF, SQL Injection), HTTPS and Secure Headers, Content Delivery Networks (CDN), CORS Policy and Management, Progressive Web Apps (PWA), Introduction to Single Page Applications (React, Angular), WebSockets and Real-Time Communication, SEO Optimization for Web Apps, Lighthouse and Performance Auditing, Introduction to JAMstack Architecture.
Learning Outcome: *Deploy, secure, and optimize modern web applications using best practices*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- ➢ Basic understanding of programming concepts (e.g., loops, functions)
- ➢ Exposure to HTML or any markup language is beneficial
- ➢ Logical reasoning and analytical thinking

Pedagogy / Teaching Methodology:

- ✓ Hands-on coding with integrated browser tools
- ✓ Live problem-solving through lab exercises
- ✓ Real-world project-based learning
- ✓ Git-based version tracking and collaboration
- ✓ Assignments, quizzes, and mini-projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

13. Web Development by NPTEL (IIT Madras)
    https://nptel.ac.in/courses/106105084
14. Responsive Web Design by freeCodeCamp
    https://www.freecodecamp.org/learn
15. Full Stack Open 2024 by University of Helsinki
    https://fullstackopen.com/en/
16. HTML, CSS, and JS for Web Developers (Coursera)
    https://www.coursera.org/learn/html-css-javascript-for-web-developers

Suggested Readings

Books:

- Web Technologies – *Uttam K. Roy*
- Learning Web Design – *Jennifer Niederst Robbins*
- Eloquent JavaScript – *Marijn Haverbeke*

Online Resources:

- https://developer.mozilla.org
- https://www.w3schools.com
- https://nodejs.org

Recommended Software/Tools:

1. Visual Studio Code / Sublime Text
2. Google Chrome Developer Tools
3. XAMPP / WAMP (for PHP & MySQL)
4. Node.js and npm
5. Git and GitHub
6. Bootstrap, jQuery

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development

3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	2	3	2	–	–	2
CO2	3	3	3	2	3	3	3	–	1	3
CO3	3	3	3	3	3	3	2	1	1	3
CO4	3	3	2	3	3	3	3	–	1	3
CO5	3	3	3	3	3	3	3	2	2	3
Articulation	3	2.8	2.6	2.75	2.8	3	2.6	1.5	1.25	2.8

Course Title:	Java Programming *
Course Code:	**25VBT0C402**
Semester:	**IV**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces students to the fundamental principles of Object-Oriented Programming (OOP) using Java. It covers basic to advanced Java concepts including classes, objects, inheritance, polymorphism, exception handling, multithreading, and file I/O. The course emphasizes writing robust and efficient programs that solve real-world problems using Java's extensive features and libraries.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Develop a strong foundation in OOP concepts and core Java programming principles.	L2
CO2	Apply core Java constructs such as variables, loops, arrays, and control statements to develop simple applications.	L3
CO3	Apply exception handling techniques to manage runtime errors effectively.	L3
CO4	Develop multithreaded applications and implement synchronization mechanisms.	L4
CO5	Design and implement Java applications to solve real-world problems using complete Java concepts.	L5

Course Modules

No. of Hours : 24

Module 1: Object-Oriented Concepts and Java Fundamentals
Scope of Module: Covers the basic structure of object-oriented programming and introduces Java as an OOP language.

Topics:
Introduction to the key principles of object-oriented programming including objects, classes,abstraction,encapsulation, inheritance,polymorphism, and abstract classes, Java programming fundamentals, understanding bytecode, and the Java development kit (JDK), Java Runtime Environment (JRE), and Java Virtual Machine (JVM), primitive data types, literals, variables, typecasting, operators, and shorthand assignments, control flow constructs including if-else, switch statements, and input reading, looping constructs like for, while, do-while,and enhanced for-loops with break, continue, and nesting techniques.
Learning Outcome: *Understand the fundamentals of Java and OOP principles, and apply control statements and loops in programs.*

No. of Hours : 24

Module 2: Classes, Objects, Methods, and Arrays
Scope of Module: Explores the core building blocks of Java programs including class design, object instantiation, and method usage.
Topics: Class fundamentals, object declaration, method definitions, constructors (default and parameterized), the use of this keyword, scanner class, garbage collection, and the finalize() method, constructor and method overloading, recursion, static and final keywords, and access control, inner and nested classes, array handling(one-dimensional and multi-dimensional arrays), alternative array declarations, enhanced for-loops, and array references, Java built-in functions for arrays and array-based problem-solving.
Learning Outcome: *Comprehend and implement class structures, object interaction, method overloading, and array operations***.**

No. of Hours : 24

Module 3: Working with Strings, Inheritance, and Interfaces
Scope of Module: Focuses on handling string data, using inheritance to model hierarchies, and applying interfaces for abstraction.
Topics: String class, constructors, length property, string comparison, character extraction, string modification, case conversion, StringBuffer and StringBuilder formutable strings, inheritance in depth, including member access, method overriding, super keyword usage, constructor chaining, abstract classes, dynamic method dispatch, the Object class, Interface concepts include creating and implementing interfaces, multiple inheritance using interfaces, extending interfaces, constants and variables in interfaces, distinguishing between interfaces and abstract classes.
Learning Outcome*: Implement inheritance and interfaces to build reusable and flexible code structures while managing string data effectively.*

No. of Hours : 24

Module 4: Exception Handling and Multithreading
Scope of Module: Introduces robust programming techniques using exception handling and explores process-based multitasking with threads
Topics: Introduction to Java's exception handling model including try-catch-finally blocks, throw and throws keywords, exception hierarchy, multiple catch blocks, nested try statements, and handling subclass exceptions, custom exception creation, exception subclasses, chained exceptions, and exception handling with method overriding, multithreading fundamentals, the main thread, creating and managing threads using the Thread class and Runnable interface, thread priorities, lifecycle management, synchronization using methods and synchronized blocks.
Learning Outcome: *Design applications that handle runtime errors gracefully and manage concurrent execution using multithreading.*

No. of Hours : 24

Module 5: Java File I/O and Real-World Applications
Scope of Module: Covers input/output operations using Java I/O streams and applies learned concepts to build complete Java applications.
Topics: Introduction to JavaI/O classes and interfaces, byte and character stream classes, stream hierarchy, text and binaryfile handling,file reading, writing, random access files, serialization and deserialization,Java-based applications combining all key concepts including classes, objects, inheritance, exception handling, file operations, and multithreading, use cases such as calculators, student record systems, file processors, and real-time data handling apps .
Learning Outcome: *Design complete Java programs incorporating object-oriented principles, exception handling, file operations, and multithreading*

Module	**No of Pre Recordings**
1	**10**
2	**12**

3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs like Eclipse or IntelliJ
- ✓ Real-time code walkthroughs and live debugging
- ✓ Mini-projects like file processors, calculators, and student record systems
- ✓ Case studies based on real-world Java applications
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

9. Coursera: Java Programming and Software Engineering Fundamentals – Duke University
10. Oracle Java Tutorials
11. JetBrains Academy: Java Developer Track
12. Udacity: Java Programming Basics

Suggested Readings

Books:

- Herbert Schildt, *Java: The Complete Reference*, McGraw Hill
- Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall

- Kathy Sierra and Bert Bates, *Head First Java*, O'Reilly Media
- Y. Daniel Liang, *Introduction to Java Programming and Data Structures*, Pearson

Online Resources:

- **https://docs.oracle.com/javase/**
- **https://www.javatpoint.com**
- **https://www.geeksforgeeks.org/java**

Recommended Software/Tools:

11. **Java Development Tools:** Eclipse, IntelliJ IDEA, NetBeans
12. **JDK Version:** Java SE 17 or latest LTS version
13. **Build Tools:** Maven, Gradle
14. **Version Control:** Git/GitHub
15. **Text Editors:** VS Code, Notepad++

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

C	P	P	P	P	P	P	P	P	P	PO

O\PO	O1	O2	O3	O4	O5	O6	O7	O8	O9	10
CO1	3	3	3	–	2	–	–	1	–	2
CO2	2	3	3	–	3	–	–	1	1	2
CO3	2	3	3	2	3	–	1	–	–	2
CO4	2	3	3	2	3	2	2	1	–	2
CO5	1	2	3	3	3	3	2	2	2	3
Articulation	2	2.8	3	2.3	2.8	2.5	1.6	1.25	1.5	2.2

Course Title:	**Probability and Statistics**
Course Code:	**25VBT5E403**
Semester:	**IV**
Credits:	**4**
Course Type	**DSE**
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course offers a foundational and comprehensive understanding of probability theory and statistical analysis, critical for data-driven decision-making, research, and scientific exploration. Students will learn how to describe data, model random phenomena, analyze statistical patterns, perform estimation, and test hypotheses using real-world datasets.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand the foundational principles of probability and its applications.	L2
CO2	Analyze and apply discrete and continuous probability distributions.	L3
CO3	Examine the relationship between multiple variables using joint and conditional distributions.	L4
CO4	Conduct statistical estimation using sampling distributions and apply confidence interval techniques.	L4
CO5	Perform hypothesis testing to draw inferences and support decision-making.	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Probability
Scope of Module: This module establishes the theoretical foundation of probability with practical problem-solving and real-world use cases.

Topics: Random experiments, outcomes, and sample space; Events: simple, compound, mutually exclusive, exhaustive; Classical, empirical, and axiomatic approaches to probability; Addition and multiplication laws of probability; Conditional probability and independence of events; Bayes' Theorem and applications in medical testing, spam filtering, fraud detection; Basic counting techniques: rule of product, permutations, combinations; Venn diagrams and probability trees for visualization, Real-life problems involving multi-step experiments.
Learning Outcome: *Apply foundational probability concepts, including conditional probability and Bayes' theorem, to analyze and interpret real-life uncertain events.*

No. of Hours: 24

Module 2: Random Variables and Probability Distributions
Scope of Module: This module focuses on the mathematical modeling of uncertainty using random variables and commonly used probability distributions.
Topics: Definition and classification of random variables (discrete vs continuous); Probability mass function (PMF), probability density function (PDF), and cumulative distribution function (CDF); Expected value (mean), variance, standard deviation, skewness and kurtosis of distributions; Properties of expectation and variance (linearity, independence); Key discrete distributions: Binomial, Poisson, Geometric, Hypergeometric; Key continuous distributions: Uniform, Normal, Exponential, Gamma; Moment generating functions and their use in deriving moments; Applications of distributions in quality control, reliability engineering, queuing models.
Learning Outcome: *Use appropriate probability distributions to model and analyze discrete and continuous random variables in practical contexts.*

No. of Hours: 24

Module 3: Joint, Marginal and Conditional Distributions
Scope of Module: This module builds skills in handling more than one random variable and understanding their interactions.
Topics: Joint probability distribution for discrete and continuous variables; Marginal distributions and the Law of Total Probability; Conditional distributions and conditional expectation; Independence of random variables and covariance; Correlation coefficient and interpretation; Linear combinations of random variables; Bivariate Normal Distribution; Practical examples: joint demand modeling, weather data correlation, stock market variables.
Learning Outcome: *Model and interpret relationships between multiple random variables using joint, marginal, and conditional distributions.*

No. of Hours: 24

Module 4: Sampling Distributions and Estimation
Scope of Module: This module introduces inferential statistics through the use of sampling distributions and parameter estimation
Topics: Concepts of population and sample; Types of sampling: simple random, stratified, systematic, cluster; Sampling distribution of sample mean, sample proportion, and sample variance; Central Limit Theorem and its implications; Point estimation: methods of moments, maximum likelihood estimation; Properties of estimators: unbiasedness, consistency, efficiency; Confidence intervals for mean (known/unknown variance), proportion, and variance; Applications in business, healthcare, political polling, and industrial processes.
Learning Outcome: *Understand sampling theory and perform estimation of population parameters using real-world sample data.*

No. of Hours: 24

Module 5: Hypothesis Testing and Statistical Inference
Scope of Module: This module focuses on inferential decision-making using statistical tests and real-life data applications.
Topics: Hypothesis testing framework: null and alternative hypotheses; Type I and Type II errors, significance level, power of a test; One-tailed and two-tailed tests; z-test and t-test for single sample and two-sample comparisons; Paired sample tests; Chi-square tests for independence and goodness-of-fit Analysis of Variance (ANOVA – one-way); Introduction to p-value and confidence level interpretation Case studies: marketing research, quality control, clinical trials, consumer behavior.
Learning Outcome: *Use hypothesis testing techniques to draw meaningful conclusions from sample data and support strategic decisions.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**

5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning
- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

12. NPTEL: Probability and Statistics
    https://nptel.ac.in/courses/111105090
13. Coursera: Statistics with Excel
    https://www.coursera.org/learn/basic-statistics-excel
14. edX: Data Science: Probability
    https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
15. MIT OpenCourseWare: Introduction to Probability and Statistics
    https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings

Books:

- Sheldon Ross – *Introduction to Probability and Statistics for Engineers and Scientists*
- Douglas C. Montgomery, George C. Runger – *Applied Statistics and Probability for Engineers*
- Robert V. Hogg, Elliot Tanis – *Probability and Statistical Inference*
- William Mendenhall – *Introduction to Probability and Statistics*

Recommended Tools & Platforms

1. R (base, ggplot2, dplyr, caret)

2. Python (NumPy, SciPy, statsmodels)
3. Minitab / SPSS for statistical modeling
4. Graphing calculators and statistical software (e.g., Minitab)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	**3.0**	**2.6**	**2.2**	**2.0**	**2.75**	**1.75**	**2.6**	**1.0**	**2.0**	**1.2**

Course Title:	**Introduction to Artificial Intelligence**
Course Code:	**25VBT5E404**
Semester:	**IV**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a foundational overview of Artificial Intelligence (AI), emphasizing intelligent agents, problem-solving, knowledge representation, reasoning, and basic machine learning. Students will learn core AI concepts, explore real-world applications, and gain practical insight into building simple intelligent systems.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand the foundations of Artificial Intelligence and its real-world applications	L2
CO2	Apply problem-solving techniques using search strategies and game playing	L3
CO3	Use knowledge representation and reasoning approaches in AI systems.	L4
CO4	Implement basic machine learning models for intelligent behavior.	L5
CO5	Evaluate ethical implications and future trends in Artificial Intelligence.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Artificial Intelligence
Scope of Module: This module introduces AI definitions, types, applications, and agent-based modeling frameworks.
Topics: History and evolution of Artificial Intelligence; Definitions and goals of AI; Branches of AI: symbolic, statistical, sub-symbolic; Types of AI: narrow, general, and super AI; Intelligent agents: structure,

environments, rationality; PEAS model and task environment types; Agent types: simple reflex, model-based, goal-based, utility-based; Applications of AI in healthcare, finance, robotics, and education; AI research challenges and current landscape.
Learning Outcome: *Understand what AI is, its scope, and how intelligent agents operate in diverse environments.*

No. of Hours: 24

Module 2: Problem Solving and Search Techniques
Scope of Module: This module covers AI search algorithms for problem-solving and planning, including adversarial strategies.
Topics: Problem formulation and state-space representation; Uninformed search strategies: Breadth-First Search (BFS), Depth-First Search (DFS), Uniform Cost Search; Informed search strategies: Greedy Best-First Search, A* Search; Heuristics and evaluation functions; Local search: Hill Climbing, Simulated Annealing; Constraint Satisfaction Problems (CSPs); Game playing: Minimax algorithm, Alpha-Beta Pruning; Applications: puzzle solvers, path planning, strategic decision-making **.**
Learning Outcome: *Apply informed and uninformed search algorithms for solving AI problems and two-player games.*

No. of Hours: 24

Module 3: Knowledge Representation and Reasoning
Scope of Module: This module explains how knowledge can be represented symbolically and how reasoning can be performed using logic.
Topics: Knowledge representation methods: propositional and predicate logic; Inference rules: Modus Ponens, resolution, forward and backward chaining; Unification and substitution; Semantic networks, frames, ontologies; Production systems and rule-based expert systems; Handling uncertainty: probabilistic reasoning and fuzzy logic basics; Non-monotonic reasoning and default logic; Applications: expert systems, chatbots, diagnostic reasoning**.**
Learning Outcome: *Use formal logic and representation schemes to enable AI systems to reason with knowledge.*

No. of Hours: 24

Module 4: Basics of Machine Learning in AI
Scope of Module: This module introduces core concepts of machine learning and its role in artificial intelligence.
Topics: Learning types: supervised, unsupervised, reinforcement; Basic algorithms: Decision Trees, k-

Nearest Neighbors, Naive Bayes; Model evaluation: accuracy, precision, recall, F1-score; Overfitting, underfitting, and model generalization; Introduction to neural networks and deep learning; Applications of ML in speech recognition, image classification, and recommendation systems. Hands-on tools: Scikit-learn, Weka, TensorFlow.
Learning Outcome: *Implement basic machine learning models to perform intelligent classification and decision-making tasks.*

No. of Hours: 24

Module 5: AI Applications, Ethics, and Future Trends
Scope of Module: This module discusses how AI is transforming industries and raises critical questions on ethics, risks, and governance.
Topics: Real-world AI applications: autonomous vehicles, virtual assistants, recommendation engines, fraud detection; Ethical concerns in AI: bias, fairness, transparency, accountability; Risks of AI: surveillance, deepfakes, job automation, adversarial AI; Explainability and responsible AI frameworks; AI and law: GDPR, AI Act, AI governance; Trends in AI: cognitive computing, AGI, neuromorphic computing; Sustainable and inclusive AI for society**.**
Learning Outcome: *Analyze AI's impact on society and evaluate ethical frameworks guiding responsible AI development.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Strong understanding of Python programming, statistics, and data structures.

Pedagogy / Teaching Methodology:

- ✓ Project-based learning with datasets from real-world domains
- ✓ Lab-based exercises using Jupyter and Google Colab

- ✓ Mini case studies and research paper reviews
- ✓ Tool walkthroughs and guided deployment

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. NPTEL: Probability and Statistics
   https://nptel.ac.in/courses/111105090
2. edX: Data Science: Probability
   https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home

Suggested Readings

Books:

- *Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach*
- *Elaine Rich, Kevin Knight – Artificial Intelligence*
- *Nils Nilsson – The Quest for Artificial Intelligence*
- *George Luger – Artificial Intelligence: Structures and Strategies for Complex Problem Solving*

Recommended Tools & Platforms

1. R (base, ggplot2, dplyr, caret)
2. Python (NumPy, SciPy, statsmodels)
3. Minitab / SPSS for statistical modeling
4. Graphing calculators and statistical software (e.g., Minitab)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	**3.0**	**2.6**	**2.2**	**2.0**	**2.75**	**1.75**	**2.6**	**1.0**	**2.0**	**1.2**

Course Title:	Quantitative Techniques
Course Code:	**25VBT0C404**
Semester:	**IV**
Credits:	**4**
Course Type	GE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course aims to equip students with the mathematical and statistical tools required for decision-making and problem-solving in computer applications and business scenarios. It covers topics such as linear programming, probability, statistics, correlation, regression, and queuing theory. These quantitative techniques are essential for data analysis, operations research, and software modeling.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the fundamentals of quantitative methods and their applications in computer science.	L2
CO2	Solve optimization problems using linear programming and graphical methods.	L3
CO3	Apply concepts of probability and distributions in real-life decision-making.	L3
CO4	Analyze data using correlation, regression, and index numbers.	L4
CO5	Demonstrate the use of queuing theory and statistical decision-making tools.	L5

Course Modules

No. of Hours: 24

Module 1: Linear Algebra and Equations
Scope of Module: Covers matrix operations, system of linear equations, and their computational applications.
Topics: Types of Matrices, Matrix Operations, Determinants and Properties, Inverse of a Matrix, Solving Linear Equations (Cramer's Rule, Matrix Inversion), Gauss Elimination Method, Rank of a Matrix,

Eigenvalues and Eigenvectors, Applications in Computer Graphics, Linear Dependence and Independence, Linear Transformation, Diagonalization, Vector Spaces, Basis and Dimension, Applications in Data Science.
Learning Outcome: *Use matrix algebra to solve linear systems and perform transformations in computing.*

No. of Hours: 24

Module 2: Descriptive Statistics
Scope of Module: Focuses on summarizing and interpreting data using various statistical measures.
Topics: Types of Data, Data Collection Methods, Frequency Distribution, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Variance, Standard Deviation), Skewness and Kurtosis, Percentiles and Quartiles, Data Visualization (Histograms, Pie Charts, Box Plots), Cross-tabulation and Contingency Tables, Correlation Analysis, Covariance, Scatter Plots, Use of Excel/SPSS for Data Analysis, Real-life Data Interpretation.
Learning Outcome: *Analyze and describe data using statistical measures and visualizations.*

No. of Hours: 24

Module 3: Linear Programming and Optimization
Scope of Module: Explores techniques for modeling and solving optimization problems using LPP.
Topics: Introduction to Linear Programming, Formulating LPPs, Graphical Method, Simplex Method, Duality in LPP, Sensitivity Analysis, Transportation Problem, Assignment Problem, Degeneracy and Unbalanced Problems, Maximization and Minimization Models, Profit and Cost Optimization, Integer Programming, Decision Variables and Constraints, Real-world Applications, Use of Solver Tools in Excel.
Learning Outcome: *Formulate and solve optimization problems using linear programming techniques.*

No. of Hours: 24

Module 4: Probability and Distributions
Scope of Module: Introduces probability concepts and probability distributions for quantitative reasoning.
Topics: Basic Probability Rules, Conditional Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Expected Value and Variance, Binomial Distribution, Poisson Distribution, Normal Distribution, Central Limit Theorem, Applications in Risk Analysis, Z-scores and Standardization,

Probability Trees, Joint and Marginal Probabilities, Monte Carlo Simulations, Statistical Applications in IT.
Learning Outcome: *Apply probability and distributions to evaluate uncertain events and risks.*

No. of Hours: 24

Module 5: Decision Theory and Forecasting
Scope of Module: Focuses on decision-making techniques and forecasting tools for business applications.
Topics: Decision-Making Under Certainty, Uncertainty, and Risk, Payoff Tables and Decision Trees, Expected Monetary Value, Maximax, Maximin, Minimax Regret, Forecasting Techniques (Moving Average, Exponential Smoothing), Time Series Analysis, Trend and Seasonality Detection, Regression Models, Index Numbers, Error Analysis (MAD, MSE), Use of Forecasting in Business and IT, Software Tools for Decision Analysis.
Learning Outcome: *Implement decision analysis and forecasting models for planning and problem-solving.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning

- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. NPTEL: Probability and Statistics
   https://nptel.ac.in/courses/111105090
2. Coursera: Statistics with Excel
   https://www.coursera.org/learn/basic-statistics-excel
3. edX: Data Science: Probability
   https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
4. MIT OpenCourseWare: Introduction to Probability and Statistics
   https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings:

- Richard I. Levin & David S. Rubin, Statistics for Management, Pearson
- S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House
- Taha H. A., Operations Research: An Introduction, Pearson
- Vohra N.D., Quantitative Techniques in Management, Tata McGraw-Hill
- Online articles from JSTOR, ScienceDirect, and SpringerLink for research-based insights

Recommended Software/Tools (If applicable):

10. Microsoft Excel (with Solver add-in)
11. SPSS for statistical analysis
12. R or Python (NumPy, SciPy, Pandas, Statsmodels)
13. Tableau or Power BI for data visualization

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	2	3	2	2
CO2	3	2	3	3	2	3	2	3	3	2
CO3	3	2	2	2	2	-	1	1	1	2
CO4	2	3	3	3	2	1	1	2	2	3
CO5	3	3	3	2	2	-	1	2	3	2
Articulation	**2.8**	**2.6**	**2.6**	**2.6**	**2.0**	**2.0**	**1.4**	**2.2**	**2.2**	**2.2**

Semester V

Course Title:	**Block Chain Technologies**
Course Code:	**25VBT0C501**
Semester:	**V**
Credits:	**4**
Course Type	**Core Course**
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the foundational and advanced aspects of blockchain technology. Students will explore blockchain architecture, cryptographic techniques, smart contracts, and application platforms. They will also evaluate blockchain's impact on security, privacy, business ecosystems, and societal implications. The course emphasizes practical skills through development environments and case studies.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of blockchain technology.	L2
CO2	Explore various blockchain platforms and their applications.	L3
CO3	Develop skills to design and implement blockchain-based solutions.	L4
CO4	Analyze the security and privacy aspects of blockchain.	L4
CO5	Assess the impact of blockchain technology on business and society.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Blockchain Technology
Scope of Module: Introduces the basics, architecture, and cryptographic foundation required for understanding blockchain systems.
Topics: Introduction to Blockchain Technology, History and Evolution of Blockchain, Types of Blockchains: Public, Private, Consortium, Applications of Blockchain Technology, Components of Blockchain: Blocks, Chains, Nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Smart Contracts and Their Execution, Blockchain Forks, Basic Cryptographic

Concepts: Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Cryptographic Algorithms Used in Blockchain.
Learning Outcome: *Gain foundational understanding of blockchain principles, architecture, and cryptography.*

No. of Hours: 24

Module 2: Blockchain Platforms and Development
Scope of Module: Focuses on blockchain ecosystems and hands-on development using Ethereum and other platforms.
Topics: Bitcoin and Ethereum: Structure and Functionality, Hyperledger Fabric, Ripple, Corda and Other Blockchain Platforms, Setting Up Blockchain Development Environment, Writing Smart Contracts in Solidity, Deploying Smart Contracts on Ethereum, Decentralized Applications (DApps), Detailed Study of Smart Contracts, Smart Contract Development and Testing, Real World Use Cases of Smart Contracts.
Learning Outcome: *Explore and implement blockchain-based solutions using various platforms and tools.*

No. of Hours: 24

Module 3: Blockchain Security, Privacy and Compliance
Scope of Module: Analyzes the threats and solutions related to blockchain security, privacy regulations, and standards.
Topics: Security Issues in Blockchain, Attacks on Blockchain: 51% Attack, Sybil Attack, Privacy Solutions in Blockchain, Regulatory and Legal Implications, Data Privacy Laws and Regulations, Blockchain's Role in Ensuring Data Privacy, Case Studies on Privacy Issues in Blockchain, Overview of Popular Cryptocurrencies, Cryptocurrency Mining and Transactions, Regulatory Aspects of Cryptocurrencies, International Standards for Blockchain Technology, Frameworks and Protocols for Blockchain Development, Compliance and Best Practices.
Learning Outcome: *Evaluate security vulnerabilities, privacy frameworks, and compliance in blockchain systems.*

No. of Hours: 24

Module 4: Blockchain Applications in Industry and Society
Scope of Module: Explores how blockchain is transforming industries and provides real-world use cases across various domains.

Topics:
Blockchain in Financial Services: Cryptocurrencies, Payment Systems, Supply Chain Management, Healthcare and Identity Management, Government and Public Services, Impact of Blockchain on Business Models, Case Studies in Finance, Supply Chain and Healthcare, Blockchain for Enterprise Solutions, Emerging Research Areas in Blockchain, Potential Future Applications, Ethical and Societal Implications

Learning Outcome: *Assess real-world blockchain use cases, societal impacts, and business transformation through blockchain.*

No. of Hours: 24

Module 5: Advanced Blockchain Integration and Emerging Trends

Scope of Module:
Covers the integration of blockchain with other technologies and future innovations.

Topics:
Interoperability and Scalability in Blockchain, Blockchain and the Internet of Things (IoT), Blockchain and Artificial Intelligence (AI), Future Trends and Innovations in Blockchain, Integrating Blockchain with Cloud Platforms, Use Cases of Blockchain in Cloud Computing, Advantages and Challenges.

Learning Outcome: *Analyze the integration of blockchain with emerging technologies and its future direction.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

Blockchain Technology by **Prof. Sandeep Shukla** (IIT Kanpur)
NPTEL Link: https://nptel.ac.in/courses/106104220

Suggested Readings:

- Antonopoulos, Andreas M. *Mastering Bitcoin: Unlocking Digital Cryptocurrencies*, O'Reilly Media, Inc., 2017. ISBN 13: 9781491954386
- Mougayar, William. *The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology*, Wiley, 2016. ISBN 13: 9781119300311

Recommended Software/Tools (If applicable):

Ethereum (Remix IDE),Ganache, MetaMask, Truffle Suite

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	2	3	2	2
CO2	3	2	3	3	2	3	2	3	3	2
CO3	3	2	2	2	2	-	1	1	1	2
CO4	2	3	3	3	2	1	1	2	2	3

CO5	3	3	3	2	2	-	1	2	3	2
Articulation	**2.4**	**2.6**	**2.8**	**2.6**	**1.0**	**2.8**	**2.0**	**2.0**	**2.2**	**2.8**

Course Title:	Introduction to Machine Learning
Course Code:	**25VBT5E502**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a hands-on and theoretical introduction to machine learning, covering key algorithms and techniques for classification, regression, clustering, dimensionality reduction, and model evaluation. Students will develop practical machine learning skills using Python-based tools and apply them to real-world data problems.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the basic concepts, workflow, and types of machine learning.	L2
CO2	Apply supervised learning algorithms for classification and regression tasks.	L3
CO3	Implement unsupervised learning methods including clustering and dimensionality reduction.	L5
CO4	Evaluate and optimize machine learning models using performance metrics.	L5
CO5	Explore real-world applications of machine learning and understand current trends.	L3

Course Modules

No. of Hours : 24

Module 1: Introduction to Machine Learning
Scope of Module: This module introduces the foundations, types, and phases of machine learning and data preprocessing techniques.

Topics: Definition and history of machine learning; Types of machine learning: supervised, unsupervised, semi-supervised, reinforcement; ML vs AI vs Deep Learning; Typical ML workflow: data collection, preprocessing, model training, evaluation, deployment; Features, labels, training and testing datasets; Bias-variance tradeoff and overfitting vs underfitting; Data preprocessing: handling missing values, encoding categorical data, feature scaling; Introduction to Python libraries: Scikit-learn, Pandas, NumPy, Matplotlib.
Learning Outcome: *Understand the machine learning lifecycle and prepare data for machine learning tasks.*

No. of Hours : 24

Module 2: Supervised Learning – Classification
Scope of Module: This module explores common classification algorithms and model performance evaluation techniques.
Topics: Binary and multiclass classification problems; k-Nearest Neighbors (k-NN) algorithm; Decision Trees and Random Forests; Naïve Bayes classifier and applications; Support Vector Machines (SVMs); Performance metrics: confusion matrix, accuracy, precision, recall, F1-score; ROC curve and AUC Cross-validation and model tuning; Use cases: email spam detection, customer segmentation, disease classification.
Learning Outcome: *Apply classification algorithms and evaluate their performance on structured datasets.*

No. of Hours : 24

Module 3: Supervised Learning – Regression
Scope of Module: This module focuses on predicting continuous outcomes using regression models.
Topics: Simple linear regression and multiple linear regression; Polynomial regression and regularization techniques: Ridge, Lasso; Assumptions of linear regression and residual analysis; Decision Tree and Random Forest regression; Support Vector Regression; Evaluation metrics: Mean Absolute Error, Mean Squared Error, R-squared; Practical applications: stock price prediction, house price forecasting, sales estimation.
Learning Outcome*: Implement regression techniques to model and forecast continuous-valued data.*

No. of Hours : 24

Module 4: Unsupervised Learning and Dimensionality Reduction
Scope of Module: This module introduces algorithms for discovering patterns and reducing data complexity without labels.
Topics: Clustering: k-Means algorithm and elbow method; Hierarchical clustering and dendrograms; DBSCAN and density-based clustering; Dimensionality reduction: Principal Component Analysis; Feature selection vs feature extraction; Applications in customer segmentation, anomaly detection, recommender systems; Visualizing high-dimensional data.
Learning Outcome: *Use clustering and PCA techniques to extract insights from unlabeled data.*

No. of Hours : 24

Module 5: Model Evaluation, Applications, and Trends
Scope of Module: This module discusses model optimization, real-world applications, and recent developments in ML.
Topics: Model generalization and selection; Hyperparameter tuning with grid search and random search Pipeline construction and automation; Use cases of ML in healthcare, finance, e-commerce, social media, and robotics; Introduction to AutoML and ML Ops; Challenges in ML: data bias, interpretability, model fairness; Trends: explainable AI (XAI), tiny ML, federated learning; Ethical and societal implications of ML.
Learning Outcome: *Optimize ML models and evaluate their performance in real-world applications while understanding emerging trends.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Real-time code walkthroughs and live debugging
- ✓ Mini-projects like file processors, calculators, and student record systems
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

Google Machine Learning Crash Course: https://developers.google.com/machine-learning/crash-course

Suggested Readings

Books:

- Tom Mitchell – *Machine Learning*
- Aurélien Géron – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*
- Ethem Alpaydin – *Introduction to Machine Learning*

Online Resources:

- Scikit-learn Documentation: https://scikit-learn.org
- Kaggle Tutorials: https://www.kaggle.com/learn
- MIT OpenCourseWare: https://ocw.mit.edu

Recommended Software/Tools:

1. Python (Scikit-learn, Pandas, NumPy, Matplotlib, Seaborn)
2. Jupyter Notebook
3. Google Colab
4. Weka (for GUI-based ML exploration)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3.0	2.6	2.2	2.0	2.75	1.75	2.6	1.0	2.0	1.2

Course Title:	**Data Visualization**
Course Code:	**25VBT5E503**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course aims to equip students with the knowledge and skills to represent complex datasets visually. It emphasizes the use of visualization tools and techniques to extract, analyze, and communicate data-driven insights effectively.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the principles and importance of data visualization.	L2
CO2	Apply design principles to create effective visual representations of data.	L3
CO3	Use data visualization tools like Tableau, Power BI, and Python libraries.	L3
CO4	Analyze datasets and build interactive dashboards for data storytelling.	L4
CO5	Evaluate and critique visualizations for clarity, efficiency, and impact.	L5

Course Modules

No. of Hours : 24

Module 1: Fundamentals of Data Visualization
Scope of Module: Covers basic concepts, history, and the importance of visualization in decision-making.

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Topics: Definition and Purpose of Data Visualization, History and Evolution of Visualization, Benefits of Visual Communication, Types of Data (Categorical, Numerical, Temporal, Spatial), Introduction to Exploratory vs Explanatory Visualization, Data Types and Levels of Measurement, Characteristics of Effective Visuals, Data-ink Ratio and Chartjunk, Understanding Audience Needs, Choosing the Right Chart Type, Introduction to Visualization Tools, Common Pitfalls in Visualization, Storytelling with Data, Role of Color and Perception, Ethical Considerations in Data Representation.
Learning Outcome: *Understand the fundamentals and design principles of data visualization.*

No. of Hours : 24

Module 2: Visual Design Principles and Charting Techniques
Scope of Module: Focuses on design elements, chart types, and aesthetics in creating visualizations.
Topics: Gestalt Principles in Visualization, Pre-attentive Attributes, Chart Selection Guidelines, Bar Charts, Line Charts, Pie Charts, Histograms, Boxplots, Scatter Plots, Heatmaps, Bullet Graphs, Treemaps, Choropleth Maps, Infographics Basics, Color Theory in Visualization, Use of Typography and Layout, Dashboard Design Principles
Learning Outcome: *Apply visual design concepts to create meaningful and accurate charts.*

No. of Hours : 24

Module 3: Data Processing and Visualization using Python
Scope of Module: Hands-on creation of visualizations using Python libraries for different datasets.
Topics: Data Import and Cleaning with Pandas, Exploratory Data Analysis (EDA), Matplotlib Basics and Plot Customization, Seaborn for Statistical Plots, Plotly for Interactive Visualization, Working with Time Series Data, Multi-Plot Layouts, Annotating Charts, Visualizing Missing Data, Correlation Heatmaps, Pairplots and Facets, Geographic Visualizations with Folium, Word Clouds for Text Data, Saving and Sharing Visuals, Best Practices in Python Visualization.
Learning Outcome*: Create diverse data visualizations using Python libraries..*

No. of Hours : 24

Module 4: Interactive Dashboards with Tableau and Power BI

Scope of Module: Covers the use of popular business intelligence tools for interactive analytics.
Topics: Tableau Environment Overview, Data Connection and Preparation in Tableau, Dimensions and Measures, Calculated Fields and Parameters, Filters and Sorting, Building Dashboards in Tableau, Storytelling and Navigation, Introduction to Power BI Interface, Power Query Editor, DAX Functions and Measures, Building Reports and Visuals in Power BI, Slicers and Filters, Publishing and Sharing Dashboards, Comparing Tableau and Power BI, Real-time Dashboard Design.
Learning Outcome: *Design interactive dashboards using Tableau and Power BI.*

No. of Hours : 24

Module 5: Advanced Topics and Applications in Data Visualization
Scope of Module: Explores specialized visualization methods and domain-specific applications.
Topics: Visualizing Networks and Graphs, Visual Analytics in Business Intelligence, Data Journalism and Narrative Visualization, Visualizing Survey Data, Visualizing Big Data, Real-Time Data Visualization, Dashboards for KPIs and Metrics, Accessibility in Visualization, Mobile-Responsive Visualizations, A/B Testing and Data Interpretation, Visualizing Machine Learning Outputs, Data Storyboarding, Evaluation and Critique of Visualizations, Industry Use Cases, Recent Trends and Tools in Visualization.
Learning Outcome: *Implement advanced visualization techniques for real-world applications.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

Data Visualization by **Prof. Arun K. Pujari** (University of Hyderabad)
NPTEL Link: https://nptel.ac.in/courses/106104224

Suggested Readings

Books:

- Storytelling with Data – Cole Nussbaumer Knaflic
- The Visual Display of Quantitative Information – Edward R. Tufte
- Data Visualization: A Practical Introduction – Kieran Healy
- Interactive Data Visualization for the Web – Scott Murray

Online Resources:

- https://www.tableau.com
- https://powerbi.microsoft.com
- https://seaborn.pydata.org
- https://plotly.com

Recommended Software/Tools:

1. Tableau
2. PowerBi

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	1	3	2	1
CO2	3	3	3	3	3	2	1	2	2	1
CO3	3	3	3	3	3	1	1	1	2	1
CO4	3	3	3	3	3	1	1	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3.0	2.8	2.8	2.8	3.0	1.4	1.0	1.6	2.0	1.4

Course Title:	Data Mining and Predictive Modelling
Course Code:	**25VBT5E504**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to essential techniques in data mining and predictive analytics. It covers data preprocessing, pattern discovery, classification, regression, clustering, and model interpretation. The course emphasizes real-world applications, hands-on implementation, and evaluation of predictive models.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the fundamentals of data mining and the data preparation process.	L2
CO2	Apply classification and regression algorithms for predictive modeling.	L3
CO3	Discover patterns and perform association rule mining.	L3
CO4	Analyze and cluster datasets to uncover hidden structures..	L4
CO5	Evaluate model performance and interpret predictive results for decision-making.	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to Data Mining and Preprocessing
Scope of Module: This module introduces the concept of data mining, its role in knowledge discovery, and preprocessing techniques required for quality data analysis.

Topics:
Definition and objectives of data mining; KDD process and CRISP-DM methodology; Types of data: structured, unstructured, semi-structured; Data quality and cleaning methods; Handling missing data, outlier detection, and noise; Data integration and transformation; Normalization and discretization; Feature engineering and selection; Tools for data mining: WEKA, RapidMiner, Python libraries: pandas, sklearn.
Learning Outcome: *Prepare and transform raw data into a clean and suitable format for data mining processes.*

No. of Hours : 24

Module 2: Classification and Predictive Modelling
Scope of Module: This module focuses on building predictive models using classification techniques and evaluating their performance.
Topics: Classification tasks and decision boundaries; Algorithms: Decision Trees, Random Forests, Naïve Bayes, k-Nearest Neighbors; Support Vector Machines (SVM) and logistic regression; Evaluation metrics: accuracy, precision, recall, F1-score, ROC curve; Confusion matrix and cross-validation techniques; Bias-variance tradeoff in classification models; Practical use cases: fraud detection, customer churn, sentiment analysis.
Learning Outcome: *Develop and evaluate classification models to predict categorical outcomes.*

No. of Hours : 24

Module 3: Regression and Predictive Analytics
Scope of Module: This module covers regression techniques for continuous outcome prediction and forecasting.
Topics: Linear regression and multiple linear regression; Polynomial regression and curve fitting Regularization: Ridge and Lasso regression; Evaluation metrics: RMSE, MAE, R-squared; Model assumptions and residual analysis; Ensemble regression methods: Gradient Boosting, Random Forest Regression; Case studies: demand forecasting, price prediction, risk scoring.
Learning Outcome*: Apply regression-based predictive models to forecast numerical values and trends.*

No. of Hours : 24

Module 4: Association Rule Mining and Pattern Discovery
Scope of Module: This module introduces algorithms to discover hidden patterns and associations within large datasets.
Topics: Market basket analysis and frequent itemsets; Apriori algorithm and candidate generation; FP-Growth algorithm for scalable pattern mining; Support, confidence, and lift measures; Rule pruning and interestingness; Applications in retail analytics, recommendation systems, healthcare; Sequence pattern mining and web usage mining.
Learning Outcome: *Generate actionable business insights using association rules and pattern discovery techniques.*

No. of Hours : 24

Module 5: Clustering and Model Interpretation
Scope of Module: This module covers unsupervised clustering techniques and focuses on model interpretability and deployment.
Topics: Clustering concepts and similarity measures; k-Means and k-Medoids clustering; Hierarchical clustering: agglomerative and divisive; DBSCAN and density-based clustering; Cluster validation: silhouette score, Davies-Bouldin index; Interpreting predictive models using SHAP, LIME, feature importance; Model deployment and integration into business workflows; Challenges: overfitting, imbalanced data, scalability, fairness.
Learning Outcome: *Perform clustering analysis and interpret model behavior to support data-driven decisions.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12

5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Real-time code walkthroughs and live debugging
- ✓ Case studies based on real-world applications
- ✓ Weekly coding challenges and quizzes
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

- ✓ **Data Mining** by **Prof. Pabitra Mitra (IIT Kharagpur)**
  NPTEL Link: https://nptel.ac.in/courses/106105174

Suggested Readings

Books:

- Jiawei Han, Micheline Kamber – *Data Mining: Concepts and Techniques*
- Trevor Hastie, Robert Tibshirani – *The Elements of Statistical Learning*
- Galit Shmueli – *Data Mining for Business Analytics*
- Pang-Ning Tan – *Introduction to Data Mining*

Online Resources:

- UCI Machine Learning Repository: https://archive.ics.uci.edu/ml
- Kaggle: https://www.kaggle.com
- Scikit-learn Documentation: https://scikit-learn.org
- Google Cloud ML Tools: https://cloud.google.com/products/ai

Recommended Software/Tools:

1. Python (Scikit-learn, pandas, NumPy, Matplotlib, Seaborn)
2. RapidMiner and WEKA
3. Jupyter Notebook and Google Colab
4. Tableau or Power BI for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**-**	**2**	**2**	**3**	**-**	**-**	**1**
CO3	**3**	**2**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**3**	**1**	**3**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**1**	**2**	**2**
Articulation	**3.0**	**2.6**	**2.2**	**2.0**	**2.7**	**1.7**	**2.6**	**1.0**	**2.0**	**1.2**

					5	5				

Course Title:	Deep Learning
Course Code:	**25VBT5E505**
Semester:	**V**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth introduction to deep learning techniques and their applications in artificial intelligence. Students will learn about neural networks, optimization techniques, and advanced deep learning architectures such as CNNs, RNNs, and transformers. The course also includes hands-on experience with deep learning frameworks like TensorFlow and PyTorch.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the fundamentals of deep learning and artificial neural networks.	L2
CO2	Apply optimization techniques for training deep neural networks effectively.	L3
CO3	Implement convolutional and recurrent neural networks for AI applications.	L5
CO4	Evaluate deep learning models for various AI tasks such as computer vision and NLP.	L5
CO5	Explore emerging deep learning trends, including transformers and generative models.	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to Deep Learning
Scope of Module: This module introduces deep learning concepts, its applications, and differences from traditional machine learning.

Topics:
Overview of Artificial Intelligence, Machine Learning, and Deep Learning, Structure and Working of Artificial Neural Networks (ANN), Perceptron Model and Activation Functions, Feedforward and Backpropagation Algorithms, Overview of Deep Learning Frameworks: TensorFlow, PyTorch.
Learning Outcome: *Understand the fundamentals of deep learning and artificial neural networks.*

No. of Hours : 24

Module 2: Optimization Techniques for Deep Learning
Scope of Module: This module explores optimization strategies used for training deep neural networks.
Topics: Loss Functions and Optimization Strategies, Gradient Descent Variants: SGD, Adam, RMSProp; Regularization Techniques: Dropout, Batch Normalization, L2 Regularization; Vanishing and Exploding Gradients Problem, Hyperparameter Tuning and Model Evaluation.
Learning Outcome: *Apply optimization techniques for training deep learning models efficiently.*

No. of Hours : 24

Module 3: Convolutional Neural Networks for Computer Vision
Scope of Module: This module covers deep learning approaches for image classification and object detection.
Topics: Introduction to CNNs and Their Architecture, Convolutional Layers, Pooling, and Fully Connected Layers, Image Classification Using CNNs, Pretrained Models: VGG, ResNet, Inception, Object Detection and Image Segmentation.
Learning Outcome: *Implement CNNs for AI applications in computer vision*

No. of Hours : 24

Module 4: Recurrent Neural Networks and Sequence Learning
Scope of Module: This module focuses on deep learning for sequential data analysis, including NLP applications.

Topics: Introduction to Recurrent Neural Networks, Long Short-Term Memory and Gated Recurrent Units, Applications in Natural Language Processing, Text Generation and Sentiment Analysis, Speech Recognition and Machine Translation, Challenges in Long-Term Dependencies.
Learning Outcome: *Implement RNN-based models for AI tasks involving sequential data.*

No. of Hours : 24

Module 5: Advanced Deep Learning Models
Scope of Module: This module covers modern deep learning advancements, including transformer models.
Topics: Introduction to Transformer Models: BERT, GPT; Attention Mechanism and Self-Attention; Generative Adversarial Networks and Variational Autoencoders for Data Generation; Reinforcement Learning with Deep Learning; Ethical Considerations in AI and Bias in Deep Learning.
Learning Outcome: *Explore advanced deep learning architectures and their AI applications.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Real-time code walkthroughs and live debugging
- ✓ Case studies based on real-world applications
- ✓ Weekly coding challenges and quizzes
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

- ✓ **Deep Learning** by **Prof. C. V. Jawahar (IIIT Hyderabad)**
  NPTEL Link: https://nptel.ac.in/courses/117105084

Suggested Readings

Books:

- Ian Goodfellow, Yoshua Bengio, Aaron Courville – *Deep Learning*
- Aurélien Géron – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*
- François Chollet – *Deep Learning with Python*
- Sebastian Raschka – *Python Machine Learning*

Online Resources:

- Deep Learning with TensorFlow: https://www.tensorflow.org
- Deep Learning with PyTorch: https://pytorch.org
- AI Ethics Guidelines: https://ai.google/research

Recommended Software/Tools:

1. **Deep Learning Libraries** (TensorFlow, PyTorch, Keras)
2. **NLP Libraries** (Hugging Face Transformers, NLTK, spaCy)
3. **Data Processing** (OpenCV, Pandas, NumPy)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global

2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**-**	**2**	**2**	**3**	**-**	**-**	**1**
CO3	**3**	**2**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**3**	**1**	**3**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**1**	**2**	**2**
Articulation	**3.0**	**2.6**	**2.2**	**2.0**	**2.75**	**1.75**	**2.6**	**1.0**	**2.0**	**1.2**

Course Title:	Advanced Software Development Practices
Course Code:	**25VBT0C503**
Semester:	**V**
Credits:	**2**
Course Type	Skill Enhancement Course
Learning Hours	60
Live Sessions	**12 hours**

Course Description:

This course introduces advanced principles, methodologies, and tools essential for modern software development. Emphasizing Agile methodologies, clean coding practices, scalable architecture, DevOps integration, quality assurance, and security, it equips learners with industry-ready skills to design, develop, and manage robust software systems.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	**Course Outcome**	**BTL**
CO1	Apply software development principles to design scalable and maintainable applications.	L3
CO2	Analyze software design patterns and architecture to solve real-world problems.	L4
CO3	Employ modern tools and practices such as version control, CI/CD, and testing in the development process.	L4
CO4	Demonstrate team collaboration, documentation, and agile methodologies in software projects.	L3
CO5	Evaluate software quality attributes including performance, security, and usability.	L5

Course Modules

No. of Hours : 12

Module 1: Foundations of Modern Software Development
Scope of Module: This module introduces the evolution of software development practices and explores traditional and modern software life cycle models. It also emphasizes Agile methodologies, focusing on the Scrum framework and real-world team roles.

Topics: History and evolution of software development, software development methodologies including Waterfall, Iterative, Spiral and V-Model, Agile manifesto and principles, introduction to Scrum including roles, ceremonies and artifacts, product backlog, sprint planning and burndown charts, comparison between Agile and traditional models, case study on Scrum in practice.
Learning Outcome: *Explain the evolution of software development practices and their implementation using traditional SDLC models and Agile methodologies.*

No. of Hours : 12

Module 2: Designing Scalable and Maintainable Software
Scope of Module: This module focuses on the planning and design phase of software development. It covers capturing system requirements and applying design principles and architecture models that ensure maintainability and scalability.
Topics: Functional and non-functional requirements, requirement elicitation techniques including interviews, surveys and use cases, requirement specification and validation, SOLID principles, DRY and KISS principles, cohesion and coupling, modular design, refactoring strategies, architectural patterns including MVC, layered and microservices, system requirement and design documentation.
Learning Outcome: *Apply design principles and architecture models to create maintainable and scalable software solutions.*

No. of Hours : 12

Module 3: Practical Tools for Development and Quality Assurance
Scope of Module: This module introduces essential tools and techniques for writing efficient, testable, and reusable code. Students explore version control systems, reusable design patterns, and automated testing strategies.
Topics: Design patterns including Factory, Singleton, Observer and Strategy, advantages of design patterns in real-world applications, Git basics including initializing, cloning, committing and pushing repositories, branching and merging, resolving conflicts and using GitHub for collaboration, unit testing concepts, test-driven development including Red-Green-Refactor cycle, testing frameworks like JUnit and PyTest, test coverage analysis.
Learning Outcome*: Use design patterns, version control, and TDD practices to improve code quality and development efficiency.*

No. of Hours : 12

Module 4: DevOps Integration and Agile Project Management
Scope of Module: Students will learn how to automate software build and deployment processes using DevOps tools and manage Agile projects using tracking tools.
Topics: DevOps culture and principles, CI/CD concepts and benefits, setting up CI/CD pipelines using Jenkins or GitHub Actions, Infrastructure as Code tools and principles, Agile project management using Jira and Trello, sprint planning and backlog grooming, progress tracking using Kanban boards and velocity charts, team collaboration and documentation techniques.
Learning Outcome *Integrate DevOps automation tools and Agile project management platforms to enhance software delivery efficiency*.

No. of Hours : 12

Module 5: Software Security, Quality, and Project Implementation
Scope of Module: This final module prepares students to deliver secure, high-quality software by integrating secure coding principles, evaluating software performance, and implementing a capstone mini project.
Topics: Secure coding principles and OWASP Top 10, input validation and secure authentication, software quality attributes including reliability, maintainability and usability, code quality metrics such as code coverage, defect density and cyclomatic complexity, software documentation including README, code comments and user manuals, project planning steps including defining scope, scheduling and risk management, preparing and presenting final deliverables, peer review and reflection.
Learning Outcome: *Apply quality and security practices to implement a complete mini software project with proper documentation and reporting.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of programming (Java/Python recommended)
- Familiarity with object-oriented principles
- Understanding of software development lifecycle concepts

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for version control, CI/CD pipelines, and Agile project tools
- ✓ Group-based mini software projects
- ✓ Live coding sessions and design pattern workshops
- ✓ Sprint-based evaluations and peer reviews
- ✓ Practical demos using industry-standard tools

Certificate / Value Added Courses Recommended (Free Resource Links):

9. Coursera: Agile Software Development – University of Minnesota
10. Udacity: Agile Software Development
11. edX: DevOps Practices and Tools – Linux Foundation
12. GitHub Learning Lab: Intro to GitHub

Suggested Readings:

- Robert C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, Prentice Hall
- Erich Gamma et al., *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison-Wesley
- Gene Kim, Jez Humble, and Patrick Debois, *The DevOps Handbook*, IT Revolution
- Martin Fowler, *Refactoring: Improving the Design of Existing Code*, Addison-Wesley

Recommended Software/Tools:

22. **Version Control:** Git, GitHub
23. **Testing Tools:** JUnit, PyTest
24. **CI/CD:** Jenkins, GitHub Actions
25. **Agile Management Tools:** Jira, Trello
26. **Code Analysis:** SonarQube, Codacy
27. **Development Environments:** VS Code, IntelliJ IDEA, Eclipse
28. **Documentation:** Markdown, Doxygen, Swagger

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	3	2	3	2	2
CO2	2	2	3	3	2	3	2	3	3	3
CO3	2	2	2	2	1	2	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1.67	2.67	2.0	2.5	2.4	2.8

Semester VI

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Course Title:	AI Ethics and governance
Course Code:	**25VBT5E601**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course explores the ethical, societal, and governance implications of Artificial Intelligence (AI) in the modern world. It addresses algorithmic fairness, transparency, accountability, privacy, bias mitigation, and the creation of trustworthy AI systems. Students will engage with current frameworks, case studies, and policy discussions to understand and shape responsible AI deployment.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand ethical principles and challenges associated with AI development and deployment.	L2
CO2	Analyze social, legal, and human rights implications of AI technologies.	L4
CO3	Identify bias, discrimination, and fairness issues in AI models and data.	L4
CO4	Explore frameworks, standards, and governance mechanisms for responsible AI.	L5
CO5	Evaluate case studies and apply ethical reasoning to real-world AI applications.	L5

Course Modules

No. of Hours : 24

Module 1: Foundations of AI Ethics
Scope of Module: This module introduces ethical theories and the foundational issues surrounding Artificial Intelligence.

Topics: Need for ethics in Artificial Intelligence; Moral and philosophical foundations: utilitarianism, deontology, virtue ethics; AI vs Human decision-making; Autonomy, agency, and moral status of intelligent systems; Transparency, accountability, and responsibility; Ethical dilemmas in automation, autonomous vehicles, and surveillance; Global perspectives and cultural values in ethical AI.
Learning Outcome: *Understand core ethical theories and apply them to conceptualize dilemmas posed by AI systems.*

No. of Hours : 24

Module 2: Fairness, Bias, and Discrimination in AI
Scope of Module: This module focuses on algorithmic bias and its societal consequences, along with methods to assess and mitigate unfairness.
Topics: Sources of bias in data and machine learning models; Discrimination and disparate impact; Metrics of fairness: equal opportunity, demographic parity, equalized odds; Bias mitigation techniques: pre-processing, in-processing, and post-processing methods; Case studies: biased hiring systems, facial recognition, healthcare access; Intersectionality and vulnerable populations; Legal implications and anti-discrimination laws in AI contexts.
Learning Outcome: *Identify and address fairness issues in data-driven AI systems using ethical and legal lenses.*

No. of Hours : 24

Module 3: Privacy, Security, and Data Ethics
Scope of Module: This module explores the ethical concerns and legal frameworks associated with data usage in AI
Topics: Data privacy and ownership in AI systems; Consent, transparency, and data protection principles; Data anonymization, de-identification, and re-identification risks; Security risks in AI: adversarial attacks, model inversion, data poisoning; Privacy-by-design and differential privacy; Laws and regulations: GDPR, CCPA, India's Data Protection Bill; Trade-offs between personalization and privacy.
Learning Outcome: *Understand privacy and security risks of AI systems and the need for ethical data governance.*

No. of Hours : 24

Module 4: Governance Frameworks and Responsible AI

Scope of Module:
This module introduces frameworks, standards, and international initiatives guiding the responsible governance of AI.

Topics:
OECD Principles on AI, UNESCO AI ethics recommendations; Responsible AI principles: fairness, accountability, transparency, explainability (FATE); AI governance models: centralized vs decentralized oversight; Human-in-the-loop and human-on-the-loop frameworks; AI auditability, documentation: Model Cards, Data Sheets; National AI policies and ethical charters: EU AI Act, India's National Strategy on AI, Corporate responsibility and AI governance in industry.

Learning Outcome: *Analyze AI governance frameworks and apply responsible AI principles to real-world scenarios.*

No. of Hours : 24

Module 5: Case Studies, Policy, and Future Challenges

Scope of Module:
This module applies ethical reasoning to real-world case studies and discusses policy-making and future ethical challenges in AI.

Topics:
High-profile case studies: COMPAS recidivism scoring, Deepfakes, Cambridge Analytica, ChatGPT; Ethics in predictive policing, social scoring systems, autonomous weapons; Ethical audits and policy interventions; Role of multidisciplinary teams in ethical AI development; Emerging issues: generative AI, synthetic media, digital humans, AI sentience; Futures thinking: AI and labor, environmental impact, global equity; Building ethical cultures and codes of conduct in AI research and practice.

Learning Outcome: *Apply ethical reasoning and policy frameworks to evaluate AI systems in real-world contexts.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Case studies based on real-world applications
- ✓ Weekly coding challenges and quizzes
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

- ✓ **Ethics in AI and Data Science** by **Prof. N. M. Anoop Krishnan (IIT Madras)**
NPTEL Link: https://nptel.ac.in/courses/110106148

Suggested Readings

Books:

- Virginia Dignum – *Responsible Artificial Intelligence*
- Cathy O'Neil – *Weapons of Math Destruction*
- Shoshana Zuboff – *The Age of Surveillance Capitalism*
- Nick Bostrom – *Superintelligence: Paths, Dangers, Strategies*

Online Resources:

- AI Ethics Guidelines Global Inventory: https://algorithmwatch.org
- OECD AI Principles: https://oecd.ai
- AI Now Institute Reports: https://ainowinstitute.org
- Stanford HAI: https://hai.stanford.edu

Recommended Software/Tools:

1. Fairness and Explainability Libraries (AI Fairness 360, LIME, SHAP)
2. Privacy-preserving ML Frameworks (TensorFlow Privacy, PySyft)
3. Model Documentation Templates (Model Cards, Datasheets for Datasets)
4. Policy simulation platforms (The Moral Machine, AI Policy Simulator)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	3	3	-	-	2
CO2	3	3	2	-	2	3	3	-	-	2
CO3	3	2	3	2	3	3	3	-	-	2
CO4	3	3	2	2	3	2	3	-	-	2
CO5	3	3	3	2	3	3	3	1	2	2
Articulation	3.0	2.6	2.2	2.0	2.75	2.8	3.0	1.0	2.0	2.0

Course Title:	Data Analytics with R
Course Code:	**25VBT5E602**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a practical and conceptual introduction to data analytics using the R programming language. It covers data handling, transformation, visualization, and statistical analysis, leading to advanced techniques in predictive modeling and reporting. Students will gain hands-on experience in R and develop skills to analyze, interpret, and present data effectively.

Course Outcomes (COs):

Upon successful completion of this course, learners will be able to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the basics of R programming and data structures for analytics	L2
CO2	Perform data cleaning, transformation, and visualization using R packages	L3
CO3	Apply descriptive and inferential statistical techniques on real-world data.	L5
CO4	Build predictive models using regression and classification techniques in R	L5
CO5	Create reproducible analytical reports and dashboards for communication.	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to R for Data Analytics
Scope of Module: This module introduces R as a statistical programming language, focusing on its core syntax, environment, and data handling.

Topics:
Installing and setting up R and RStudio; Understanding R syntax, variables, and data types; Vectors, matrices, lists, data frames, and factors; Control structures: loops, conditionals, and functions; Working with built-in datasets and importing data from CSV, Excel, and databases. Reading and writing files; Exploratory Data Analysis (EDA) using summary statistics and structure functions; Use of base R vs tidyverse packages for data analysis.
Learning Outcome: *Use R programming for basic data operations and explore structured datasets effectively.*

No. of Hours : 24

Module 2: Data Cleaning, Transformation, and Visualization
Scope of Module: This module covers data wrangling and visualization techniques using the tidyverse ecosystem in R.
Topics: Handling missing data, duplicates, and data type inconsistencies; Data filtering, sorting, grouping, and summarizing with dplyr; Data reshaping using tidyr: pivot_longer, pivot_wider, separate, unite; Merging datasets using join functions; Data visualization using ggplot2: bar charts, histograms, boxplots, scatter plots, line graphs; Adding themes, labels, color schemes, and facets; Customizing plots for reporting and storytelling; Use of patchwork and plotly for interactive and combined visualizations.
Learning Outcome: *Clean, reshape, and visualize data using powerful R packages for analytic storytelling.*

No. of Hours : 24

Module 3: Descriptive and Inferential Statistics in R
Scope of Module: This module focuses on the application of statistical methods for data understanding and decision-making.
Topics: Descriptive statistics: measures of central tendency, variability, and distribution; Probability distributions: normal, binomial, Poisson, and t-distribution; Hypothesis testing: z-test, t-test, chi-square test, ANOVA; Correlation and covariance analysis; Confidence intervals and sampling distributions; Using functions like t.test(), chisq.test(), aov(), cor(), prop.test(); Real-world applications in survey analysis, quality control, and experimentation.
Learning Outcome*: Perform statistical analysis and hypothesis testing to draw valid inferences from data.*

No. of Hours : 24

Module 4: Predictive Modelling with R

Scope of Module: This module covers regression and classification techniques using R for predictive analytics.
Topics: Simple and multiple linear regression using lm(); Model diagnostics: residuals, multicollinearity, assumptions checking; Logistic regression for binary classification; Decision trees and random forests using rpart, caret, and randomForest; Model evaluation metrics: MAE, RMSE, R^2, accuracy, precision, recall, ROC curve; Cross-validation and train-test split with caret; Use cases in business forecasting, customer churn, and healthcare analytics.
Learning Outcome: *Build and evaluate predictive models for both continuous and categorical outcomes using R.*

No. of Hours : 24

Module 5: Reproducible Reporting and Dashboarding in R
Scope of Module: This module introduces techniques for reporting and presenting data-driven insights using R Markdown and Shiny apps.
Topics: Introduction to R Markdown and knitr for dynamic reporting; Creating HTML, PDF, and Word reports; Embedding code, visualizations, and tables into reproducible documents; Introduction to Shiny for interactive dashboards; Building UI and server components in Shiny; Reactive programming and widget integration; Publishing dashboards with RStudio Connect or Shinyapps.io; Design considerations for analytical storytelling and stakeholder communication.
Learning Outcome: *Design reproducible reports and interactive dashboards to communicate data insights effectively.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Real-time code walkthroughs and live debugging
- ✓ Case studies based on real-world applications
- ✓ Weekly coding challenges and quizzes
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

- ✓ **Data Analytics with R** by **Prof. Shalabh (IIT Kanpur)**
  NPTEL Link: https://nptel.ac.in/courses/111104100

Suggested Readings

Books:

- Hadley Wickham & Garrett Grolemund – *R for Data Science*
- Norman Matloff – *The Art of R Programming*
- Garrett Grolemund – *Hands-On Programming with R*
- Maria Keller – *Data Analytics Using R*

Online Resources:

- RStudio Education: https://education.rstudio.com
- Tidyverse Documentation: https://www.tidyverse.org
- CRAN Task Views: https://cran.r-project.org
- Kaggle R Tutorials: https://www.kaggle.com/learn/r

Recommended Software/Tools:

1. R and RStudio IDE
2. Tidyverse packages (dplyr, tidyr, ggplot2, readr, stringr)
3. Caret, rpart, randomForest, plotly

4. R Markdown, Shiny, Flexdashboard

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3.0	2.6	2.2	2.0	2.75	1.75	2.6	1.0	2.0	1.2

Course Title:	Natural Language Processing
Course Code:	**25VBT5E603**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a comprehensive introduction to the field of Natural Language Processing (NLP). Students will learn how to process and analyze human language using computational techniques, covering fundamental linguistic concepts, preprocessing, syntactic and semantic analysis, sentiment mining, and real-world applications using modern NLP tools.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand fundamental concepts of Natural Language Processing and linguistic structure.	L2
CO2	Apply syntactic and semantic processing techniques to analyze natural language.	L4
CO3	Implement text preprocessing, vectorization, and basic NLP pipelines.	L4
CO4	Develop applications using NLP libraries and evaluate model performance.	L5
CO5	Analyze real-world NLP challenges in multilingual and domain-specific contexts.	L5

Course Modules

No. of Hours : 24

Module 1: Fundamentals of Natural Language and Processing
Scope of Module: This module introduces the field of NLP and its applications. It covers the basics of natural language, linguistic structure, and how machines interpret language for information extraction and understanding.

Topics:
Definition and scope of NLP, importance of NLP in modern applications, natural language vs formal language, structure of language and linguistic levels, morphology and word structure, parts of speech and their categories, syntactic structure and parse trees, semantics and meaning representation, pragmatics and context, challenges in language ambiguity and polysemy, types of NLP systems including rule-based, statistical and hybrid approaches.
Learning Outcome: *Understand the basics of human language and the scope of Natural Language Processing.*

No. of Hours : 24

Module 2: Text Processing and Feature Representation
Scope of Module: This module covers the techniques required to prepare text for analysis. It also introduces how to convert textual data into numerical form using feature extraction techniques.
Topics: Tokenization methods including whitespace and regex-based, sentence segmentation and paragraph chunking, stop word removal and its impact on NLP tasks, stemming and lemmatization using NLTK and spaCy, text normalization including case folding and punctuation removal, regular expressions for information extraction, bag-of-words model, vectorization techniques using CountVectorizer and TF-IDF, sparse and dense matrix representations, cosine similarity for measuring document distance, visualizing term frequency distributions using word clouds.
Learning Outcome: *Apply text preprocessing and feature extraction techniques to convert raw text into usable inputs for NLP tasks.*

No. of Hours : 24

Module 3: Syntactic and Semantic Analysis
Scope of Module: This module explores how grammatical structures and meaning are captured in NLP. It introduces syntactic parsing techniques and semantic concepts for analyzing sentence structures and relationships.
Topics: Syntax and parse trees, phrase structure grammars and CFGs, constituency parsing vs dependency parsing, parsing tools in NLTK and spaCy, ambiguity in parsing and disambiguation techniques, named entity recognition and entity classification, introduction to WordNet and lexical databases, word sense disambiguation using Lesk algorithm, semantic similarity and relatedness, semantic role labeling and predicate-argument structure, applications of syntactic and semantic analysis in translation and question answering.
Learning Outcome: *Analyze the structure and meaning of text using parsing and semantic interpretation techniques.*

No. of Hours : 24

Module 4: Text Classification and Sentiment Analysis
Scope of Module: This module introduces the use of machine learning algorithms in NLP. It covers classification models used for sentiment analysis, spam detection, and topic categorization**.**
Topics: Overview of text classification tasks, labeled datasets and supervised learning, text vectorization using TF-IDF and word embeddings, Naive Bayes classifier for sentiment analysis, support vector machines for text classification, training and testing splits for model evaluation, performance metrics including accuracy, precision, recall, F1-score and ROC curve, confusion matrix interpretation, sentiment lexicons including AFINN and VADER, polarity and subjectivity analysis, building pipelines with scikit-learn and evaluating model output.
Learning Outcome: *Build and evaluate text classification and sentiment analysis models using machine learning techniques.*

No. of Hours : 24

Module 5: Real-world NLP Applications and Challenges
Scope of Module: The final module addresses the complexities of working with multilingual and domain-specific language. It concludes with modern tools and libraries used in practical NLP development.
Topics: Challenges in processing Indian languages including tokenization and transliteration, Unicode handling and script conversion, case studies on Hindi and Tamil NLP applications, introduction to word embeddings including Word2Vec and GloVe, n-gram language models and their limitations, introduction to deep learning in NLP, overview of transformer-based models such as BERT, implementation using Hugging Face Transformers, real-world applications in chatbots, question answering, text summarization, speech recognition and translation.
Learning Outcome: *Apply NLP tools and techniques to real-world multilingual and domain-specific problems.*

Module	**No of Pre Recordings**
1	**10**
2	**12**
3	**10**

4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Case studies based on real-world applications
- ✓ Weekly coding challenges and quizzes
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

Natural Language Processing by **Prof. Pawan Goyal (IIT Kharagpur)** □

NPTEL Link: https://nptel.ac.in/courses/106105158

Suggested Readings

Books:

- Speech and Language Processing by Daniel Jurafsky and James H. Martin, Pearson, 2021
- Online resources from NLP-progress, NLTK book, spaCy documentation, Hugging Face tutorials
- Research articles from ACL Anthology and Journal of Natural Language Engineering

Recommended Software/Tools:

NLTK, spaCy, scikit-learn, pandas, Hugging Face Transformers, Google Colab)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules

1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1.0	2.5	2.0	1.8	2.0	2.8

Course Title:	Computer Vision
Course Code:	**25VBT5E604**
Semester:	**VI**
Credits:	**4**
Course Type	DSE
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces fundamental concepts and techniques of Computer Vision (CV), focusing on how machines interpret and analyze visual data. It explores image processing, feature extraction, object detection, image segmentation, and deep learning techniques for vision applications. Students will gain hands-on experience using OpenCV, TensorFlow, and PyTorch to build AI-driven computer vision applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	**Course Outcome**	**BTL**
CO1	Understand the fundamental principles and applications of computer vision.	L2
CO2	Apply image processing and feature extraction techniques for visual data analysis.	L3
CO3	Implement deep learning-based computer vision models using CNNs.	L3
CO4	Evaluate various computer vision tasks such as object detection and segmentation.	L4
CO5	Explore advanced topics in computer vision, including generative models and vision transformers.	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to Computer Vision
Scope of Module: This module provides an introduction to computer vision concepts, applications, and challenges.
Topics: Overview of Computer Vision and Its Applications; Types of images and visual tasks in CV: classification, detection, segmentation; Image Representation: Pixels, Color Spaces (RGB, HSV,

Grayscale), and Image Formats :JPEG, PNG; Introduction to OpenCV and setting up the environment; Basic Image Manipulation: Resizing, Cropping, Color Channel Separation; Edge Detection Techniques: Sobel, Prewitt, and Canny; Image Thresholding: Global, Adaptive, and Otsu's Method; Basic Filtering Techniques: Box, Gaussian, Median Filtering. Image Smoothing and Noise Reduction; Practical Exercises: Image reading, manipulation, and visualization with OpenCV.
Learning Outcome: *Understand the fundamental principles and applications of computer vision.*

No. of Hours : 24

Module 2: Image Processing and Feature Extraction
Scope of Module: This module explores various image processing techniques for feature extraction.
Topics: Histogram Analysis: Histograms, Equalization, Contrast Stretching; Morphological Operations: Dilation, Erosion, Opening, Closing, Hit-or-Miss; Edge Enhancement and Sharpening Filters; Feature Detection: Corners (Harris, Shi-Tomasi), Blobs (DoG), FAST; Feature Descriptors: SIFT, SURF, ORB, BRIEF Feature Matching: Brute-Force, FLANN, and Ratio Test; Line Detection using Hough Transform; Circle Detection with Parametric Hough; Keypoint Matching and Homography Estimation; Hands-on Tasks: Feature matching and transformation alignment.
Learning Outcome: *Apply image processing and feature extraction techniques for visual data analysis.*

No. of Hours : 24

Module 3: Deep Learning for Computer Vision
Scope of Module: This module focuses on deep learning models for image classification and recognition.
Topics: Overview of Deep Learning and Its Importance in Vision Tasks; Introduction to CNNs: Concepts of Convolution, Stride, Padding, and Receptive Field; CNN Architecture: Convolutional Layers, Pooling Layers, Fully Connected Layers; Activation Functions: ReLU, Sigmoid, Softmax; Popular Pretrained CNNs: VGG16/19, ResNet, MobileNet, Inception; Transfer Learning: Feature Extraction vs Fine-tuning; Image Classification with CNNs using TensorFlow/Keras or PyTorch; Loss Functions and Optimizers: Cross Entropy, SGD, Adam; Data Augmentation Techniques: Rotation, Scaling, Flipping, Brightness; Training CNNs on Custom Datasets.
Learning Outcome*: Implement deep learning-based computer vision models using CNNs.*

No. of Hours : 24

Module 4: Object Detection and Image Segmentation
Scope of Module: This module covers advanced vision tasks such as object detection and segmentation.
Topics: Overview of Object Detection Tasks and Challenges; Traditional Object Detection: Sliding Window, Selective Search; Modern Object Detectors: YOLOv3/YOLOv5, SSD, Faster R-CNN; Understanding Anchor Boxes, IOU, NMS: Non-Max Suppression; Object Tracking Overview: introduction to Deep SORT, Kalman Filters; Introduction to Image Segmentation: Semantic vs Instance; Architectures: U-Net, Mask R-CNN, and their use in medical imaging; Metrics for Detection and Segmentation: mAP, Pixel Accuracy, IoU; Applications: Crowd Counting, Face Detection, Lane Detection; Mini-project: Build an end-to-end object detector using a pretrained YOLO model.
Learning Outcome: *Evaluate various computer vision tasks such as object detection and segmentation.*

No. of Hours : 24

Module 5: Advanced Topics in Computer Vision
Scope of Module: This module covers cutting-edge advancements in computer vision research and applications.
Topics: Vision Transformers: Architecture and Comparison with CNNs; Self-Attention Mechanism and Patch Embeddings in ViT; Generative Adversarial Networks: Architecture, DCGAN, Pix2Pix; 3D Computer Vision: Stereo Vision, Depth Estimation, Point Clouds; Facial Recognition Techniques: Eigenfaces, LBPH, DeepFace; Emotion Recognition and Expression Analysis; Ethical Issues: Surveillance, Deepfakes, Bias in Facial Recognition; Privacy Considerations in CV Applications; Introduction to Zero-shot and Few-shot Learning in Vision; Overview of Research Trends: Diffusion Models, NeRF, Explainable CV.
Learning Outcome: *Explore advanced topics in computer vision, including generative models and vision transformers.*

Module	**No of Pre Recordings**
1	**10**
2	**12**

3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs
- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

Computer Vision by **Prof. Jayanta Mukhopadhyay (IIT Kharagpur)**
NPTEL Link: https://nptel.ac.in/courses/106105216

Suggested Readings

Books:

- Richard Szeliski – Computer Vision: Algorithms and Applications
- David A. Forsyth & Jean Ponce – Computer Vision: A Modern Approach
- Adrian Rosebrock – Deep Learning for Computer Vision with Python
- Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning

Online Resources:

- OpenCV Documentation: https://opencv.org
- Deep Learning for CV (TensorFlow & PyTorch): https://www.tensorflow.org, https://pytorch.org
- CV Research Papers: https://arxiv.org

Recommended Software/Tools:

1. **Image Processing** (OpenCV, PIL, NumPy)
2. **Deep Learning for Vision** (TensorFlow, PyTorch, Keras)
3. **Object Detection Models** (YOLO, SSD, Faster R-CNN)
4. **Data Augmentation** (Albumentations, imgaug)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2	2	-	-	1
CO2	3	3	2	-	2	2	3	-	-	1
CO3	3	2	3	2	3	-	2	-	-	1
CO4	3	3	2	2	3	1	3	-	-	1
CO5	3	3	3	2	3	2	3	1	2	2
Articulation	3.0	2.6	2.2	2.0	2.75	1.75	2.6	1.0	2.0	1.2

ELECTIVE:

Cloud Computing

www.jainuniversity.ac.in

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Elective: Cloud Computing

Semester-1

Course Code	Course Name	Course Category	CA	ESE	Credits
25VBX0AE101	English	AECC	30	70	4
25VBT0C102	Fundamentals of Mathematics	CC	30	70	4
25VBT0C103	Problem Solving using C	CC	30	70	4
25VBT0C104	Computer Architecture	CC	30	70	4
26VBX0S105	Essentials of Generative AI	SEC	30	70	2
25VBT0L101	Problem Solving using C Lab	SEC	100	-	1
Total No of Credits					19

Semester-2

Course code	Course Name	Course category	CA	ESE	Credits
25VBX0AE205	Communicative English	AECC	30	70	4
25VBT0C201	Operating System	CC	30	70	4
25VBT0C202	Data Structures using C	CC	30	70	4
25VBT0C203	Relational Database Systems	CC	30	70	4
25VBT0L201	Data Structures using C Lab	SEC	100	-	1
25VBT0L202	Relational Database Systems Lab	SEC	100	-	1
Total No of Credits					18

Semester-3

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C301	Python Programming	CC	30	70	4
25VBT0C302	Design and Analysis of Algorithms	CC	30	70	4
25VBT0C303	Software Engineering	CC	30	70	4
25VBT0C304	Computer Networks	CC	30	70	4
25VBT0C305	Environmental, Social, and Governance (ESG) in IT	AECC	30	70	3
25VBT0L301	Python Programming Lab	SEC	100	-	1
25VBT0L302	Design and Analysis of Algorithms Lab	SEC	100	-	1

Total No of Credits	21

Semester-4

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C401	Web Technologies	CC	30	70	4
25VBT0C402	Java Programming	DSE	30	70	4
25VBT3E403	Containers and Microservices	DSE	30	70	4
25VBT3E404	AWS Cloud Computing Essentials	DSE	30	70	4
25VBT0C404	Quantitative Techniques	GE	30	70	3
25VBT0L401	Web Technologies Lab	SEC	100	-	1
25VBT0L402	Java Programming Lab	SEC	100	-	1
Total No of Credits					21

Semester-5

Course code	Course Name	Course category	CA	ESE	Credits
25VBT0C501	Block Chain Technologies	CC	30	70	4
25VBT3E502	Cloud Infrastructure and Services	DSE	30	70	4
25VBT3E503	DevOps Fundamentals	DSE	30	70	4
25VBT3E504	Cloud Managed Services	DSE	30	70	4
25VBT3E505	Google Cloud Platform Essentials	DSE	30	70	4
25VBT0C503	Advanced Software Development Practices	SEC	30	70	2
Total No of Credits					22

Semester-6

Course code	Course Name	Course category	CA	ESE	Credits
25VBT3E601	Cloud Application Development	DSE	30	70	4
25VBT3E602	Azure Fundamentals	DSE	30	70	4
25VBT3E603	Cloud Security	DSE	30	70	4

25VBT3E604	Internet of Things with Cloud	DSE	30	70	4
25VBT0P605	Project	Thesis			6
Total No of Credits					22
Overall Program Credits					123

Legend

CC	Core Course
DSE	Discipline Specific Elective
SEC	Skill Enhancement Courses
AECC	Ability Enhancement Compulsory Course
GE	Generic Elective

CENTRE FOR DISTANCE AND ONLINE EDUCATION

ONLINE

Detailed Syllabus

Corporate Office
91/2, Dr. A N Krishna Rao Road V V Puram,
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Centre for Distance & Online Education
319, 25th Main, 17th Cross,
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Semester I

Common Courses

Course Title:	English
Course Code:	25VBX0AE101
Semester:	**I**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course introduces learners to literature, rhetorical practices, grammar, and academic writing. Through engagement with poetry, prose, drama, and structured writing tasks, students will gain foundational skills in critical reading, effective communication, and literary appreciation.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Examine literary texts in historical contexts and be sensitive to their social relevance	L4
CO2	Explain the process of communicating and interpreting human experiences from different cultures through literary representations	L2
CO3	Gain practical knowledge in the correct use of grammatical elements to express in English	L3
CO4	Appraise the art of rhetoric through speech and writing	L5
CO5	Develop higher order language skills, such as reading and writing, through texts centered on diverse themes and topics in literature	L6

Course Module

No. of Hours:24

Module 1: Foundations of Literature and Language
Scope of Module: *Explore how literature reflects language and meaning, and how rhetoric is constructed in influential speeches.*
Topics: Literal and metaphorical meanings in literature, Shakespeare's Sonnet 18, Robert Frost's *Stopping by Woods on a Snowy Evening*, introduction to rhetoric, Aristotle's modes of appeal, discourse analysis, Martin Luther King Jr.'s *I Have a Dream* speech, oratory and audience connection, speeches of Brutus and Mark Antony.
Learning Outcome: *Comprehend concrete and abstract meanings of words and phrases, and discuss rhetorical construction of speeches.*

No. of Hours:24

Module 2: Poetic and Prose Expressions
Scope of Module: Analyze language symbolism, Indian English poetry, and the art of prose expression.
Topics: Symbolism in poetry, Blake's *The Tyger*, Hughes' *Hawk Roosting*, early Indian English poetry and themes, Sarojini Naidu's *In Salutation to the Eternal Peace*, Nissim Ezekiel's *The Professor*, prose as a distinct form, types and function of prose, Bertrand Russell's *In Praise of Idleness*.
Learning Outcome: *Explain poetic symbolism, and examine Indian and Western prose for theme and style.*

No. of Hours:24

Module 3: Grammar and Sentence Structuring
Scope of Module: Explore grammatical concepts, including sentence construction, reported speech, and paragraph writing.

Topics: Phrases, clauses, sentence types, components of a sentence, active and passive voice, conversion rules, reported speech, simple, compound, complex sentence structures, linkers, synthesis, transformation, paragraph structure and types, examples from literature.
Learning Outcome: *Demonstrate grammatical proficiency, including sentence synthesis and paragraph writing.*

No. of Hours:24

Module 4: Argumentation and Debate
Scope of Module: Develop structured argumentative and debating skills using classical and contemporary contexts.
Topics: Structure of argument (claim, reason, support, warrant), logical flow, Frederick Copleston vs Bertrand Russell radio debate, elements of a good case, defense and rebuttal strategies, importance of debate, analyzing contemporary topics.
Learning Outcome: *Develop an understanding of logical argumentation and apply strategies for debate*

No. of Hours:24

Module 5: Essay Writing and Text Performance
Scope of Module: Explore essay forms, dramatic theory, and literary performance in Western and Indian contexts.
Topics: Essay types – compare and contrast, cause and effect, Feynman's *The Value of Science*, Chesterton's *On Running After One's Hat*, Charles Lamb's *Dream Children: A Reverie*, dramatic theory by Aristotle and Bharata, Vijay Tendulkar's *Silence! The Court is in Session.*
Learning Outcome: *Appraise techniques for academic and personal essay writing, and analyze dramatic forms across cultures.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

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Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):
- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:
- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

13. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
14. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
15. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings:

Book
- Gupta, S. C. (2018). Comprehensive English Grammar & Composition. Arihant Prakashan

Online Articles, Journals, and Whitepapers
- British Council Learn English Articles, JSTOR Language and Literature Studies, Routledge Journals on Rhetoric and Composition

Web-based Resources
- Grammarly Handbook, Purdue OWL, YouTube Channels on Poetry in Performance, Project Gutenberg Literature Database

Recommended Software/Tools:

21. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
22. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
23. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
24. **Miro** – for mind-mapping essay structures.
25. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development
3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	2	3	1	1	2	1	1
CO3	1	1	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	3	2	1	1	1	2	1
Articulation	1	1	1.4	1.8	2	1	1	1.2	1.2	1

Note: The Articulation is indicative of how a particular course maps to a PO.

Articulation is calculated as:

$$= \frac{\text{Sum of CO Mappiung Levels for a perticular PO}}{\text{No.of COs that mapped to that PO}}$$

Example:1

$$Articulation\ of\ \boldsymbol{PO1} = \frac{(3+2+3+2+3)}{5} = 2.6$$

Example: 2

$$Articulation\ of\ \boldsymbol{PO7} = \frac{(1+1)}{2} = 1.0$$

Course Title:	Fundamentals of Mathematics
Course Code:	25VBT0C102
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces foundational mathematical concepts essential for problem-solving and application in computing and data analysis. It includes matrix algebra, calculus, vector algebra, and 3-D geometry to develop logical reasoning and analytical abilities among students.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Learn to carry out matrix operations, including inverses and determinants, and solve systems of equations using multiple methods.	L3
CO2	Demonstrate the idea of differentiation from first principles and work with derivatives as rates of change in mathematical models.	L3
CO3	Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions.	L4
CO4	Demonstrate vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.	L3
CO5	Apply matrix theory for solving systems of linear equations and compute eigenvalues and eigenvectors required for the matrix diagonalization process	L3

Course Modules

No. of Hours:24

Module 1: Matrices and Linear Algebra
Scope of Module: This module introduces students to matrix operations, properties of determinants, and methods for solving linear systems using algebraic and matrix techniques.
Topics: Types of matrices including row, column, diagonal, scalar, unit and zero matrices, algebra of matrices including addition, scalar multiplication and transpose, inverse of a matrix using elementary operations, definition and expansion of determinants up to 3x3, minors and cofactors, properties of determinants, adjoint and inverse of matrices, singular and non-singular matrices, consistency of linear systems, solving equations using Cramer's rule, matrix rank, echelon and normal form, solving linear systems using Gauss elimination, Gauss-Jordan, Gauss-Seidel and LU decomposition.
Learning Outcome: *Solve linear systems using matrix operations and analyze determinant-based consistency and inverse properties.*

No. of Hours:24

Module 2: Eigenvalues, Eigenvectors, and Vector Algebra
Scope of Module: This module explores the concepts of eigenvalues, eigenvectors, vector operations, and geometric representations of vectors in space.
Topics: Definition and computation of eigenvalues and eigenvectors, Rayleigh's power method for dominant eigenvalue, diagonalization of matrices, linear transformation and matrix reduction, types of vectors including unit, zero and position vectors, magnitude and direction of vectors, vector addition and scalar multiplication, dot product and its geometric meaning, projection of vectors, cross product and scalar triple product, area and volume calculation using vectors.
Learning Outcome: *Compute eigenvalues, eigenvectors, and apply vector operations in solving spatial problems and geometric modeling.*

No. of Hours:24

Module 3: Differential Calculus and Applications
Scope of Module: This module introduces the principles and rules of differentiation and applies them to various types of functions and curve-based problems.
Topics: Continuity of functions at a point and over intervals, derivatives of algebraic and trigonometric functions, exponential and logarithmic functions, derivatives of composite, inverse trigonometric and parametric functions, second-order derivatives, nth-order derivatives, and Leibnitz theorem, angle between curves and pedal equations, polar curve representations and applications.

Learning Outcome: *Apply differentiation techniques to model change, analyze polar curves, and solve advanced calculus problems.*

No. of Hours:24

Module 4: Integral Calculus and Vector Calculus
Scope of Module: This module focuses on integration methods, definite and indefinite integrals, and introductory vector calculus concepts.
Topics: Indefinite integrals using substitution, trigonometric identities, partial fractions and integration by parts, definite integrals and reduction formulae for powers of sine and cosine, vector function derivatives including velocity and acceleration, scalar and vector point functions, gradient, divergence, curl, Laplacian operators, solenoidal and irrotational vectors.
Learning Outcome: *Solve definite and indefinite integrals and apply differential vector calculus operators in applied mathematics.*

No. of Hours:24

Module 5: Three-Dimensional Geometry
Scope of Module: This module develops spatial reasoning through the study of 3D geometry including direction cosines, lines and planes.
Topics: Direction cosines and direction ratios, vector and cartesian equations of a straight line, angle between two lines, shortest distance between skew lines, vector and cartesian equations of planes, angle between two planes, coplanar lines and intersection of lines with planes.
Learning Outcome: *Analyze three-dimensional shapes using vector and cartesian methods and solve problems involving lines and planes in space.*

Module	**No. of Pre-Recordings**
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic understanding of algebra and geometry from secondary education..

Pedagogy / Teaching Methodology:

- ✓ Conceptual and problem-based learning
- ✓ Interactive class exercises and proofs
- ✓ Assignments and quizzes using math software.

Certificate / Value Added Courses Recommended (with Free Resource Links):

9. Mathematics – I by Prof. Jitendra Kumar (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/111105038

10. Mathematics for Computer Science by MIT Open Courseware: https://ocw.mit.edu

Suggested Readings:

Book

- Applied Mathematics and Scientific Computing: International Conference on Advances in Mathematical Sciences, Vellore, India, December 2017 – Volume II (Trends in Mathematics), Springer, 2019

Online Articles, Journals, and Whitepapers

- Research articles from *SpringerLink*, *Mathematics Today*, and *Elsevier Journal of Mathematical Analysis*
- Whitepapers on matrix theory, calculus, and vector analysis from *AMS (American Mathematical Society)* and *SIAM (Society for Industrial and Applied Mathematics)*

Web-based Resources

- Khan Academy (topics: Calculus, Linear Algebra, Vectors, 3D Geometry
- MIT OpenCourseWare for Mathematics
- Interactive simulations and problem sets on Desmos, GeoGebra, and Brilliant.org.

Recommended Software/Tools (If applicable):

17. MATLAB/Octave
18. SageMath
19. Python (NumPy, Matplotlib)
20. GeoGebra for visualization

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	-	2	2	2	2	2
CO2	3	2	3	2	-	2	1	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.6	2.6	3	2.2	1	2	1.6	1.8	2.2	2.8

Course Title:	Problem Solving using C
Course Code:	25VBT0C103
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:
This course introduces students to the C programming language with an industry-focused approach. Emphasis is placed on problem-solving, structured programming, memory efficiency, and modular design. The course prepares students to handle real-world applications in embedded systems, system-level development, and performance-sensitive software solutions.

Course Outcomes(COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand and apply the core concepts of the C language including syntax, control flow, and data types.	L3
CO2	Develop modular and efficient code using functions, arrays, and structures.	L6
CO3	Manage memory effectively using pointers and dynamic memory allocation.	L3
CO4	Handle file operations and system-level programming tasks.	L3
CO5	Apply modern development tools, debugging practices, and implement mini-projects that solve real-world problems.	L6

Course Modules:

No. of Hours:24

Module 1: Programming Foundations and C Basics
Scope of Module: Introduce software concepts, basic C syntax, and structured programming methodology.

Topics: Role of programming in systems and embedded development, history and importance of C, variables, constants, keywords, data types, operators, input/output (printf, scanf, gets, puts), expressions, conditional statements (if, if-else, switch), looping (for, while, do-while), break, continue, goto, code documentation and commenting practices.
Learning Outcome :- *Implement basic control structures and understand the foundations of structured programming in C.*

No. of Hours:24

Module 2: Functions, Arrays and Strings
Scope of Module: Focus on modular programming and data handling through arrays and string operations.
Topics: Function declaration and definition, argument passing methods, recursion, return types, arrays (1D, 2D), basic algorithms (sorting, searching), string manipulation using standard functions, multidimensional string arrays, arrays in function arguments, memory usage with arrays.
Learning Outcome :- *Design modular programs using functions and implement logic-driven operations with arrays and strings.*

No. of Hours:24

Module 3: Structures, Unions, Pointers and Memory Management
Scope of Module: Introduce advanced C constructs for optimized data storage and dynamic memory operations.
Topics: Structures and nested structures, unions and memory overlap, arrays of structures, pointers: declaration, arithmetic, arrays with pointers, pointers to structures, dynamic memory (malloc, calloc, realloc, free), storage classes (auto, extern, static, register), pointer pitfalls and best practices.
Learning Outcome : *Apply pointer concepts and structured data storage to optimize program memory usage.*

No. of Hours:24

Module 4: File Systems, Command-Line Tools, and Build Automation
Scope of Module: Enable students to use persistent storage and build scalable projects using system-level tools.

Topics: Text and binary file handling (fopen, fclose, fread, fwrite, fprintf, fscanf), command-line argument usage, preprocessor directives (#define, #include, macros), header file creation, build tools (Makefile basics), version control systems (Git), compiler flags, debugging with gdb, introduction to CI/CD tools for C.
***Learning Outcome**: Manage files, automate builds and integrate version control in a modern development pipeline.*

No. of Hours:24

Module 5: Industry Use Cases and Project-Based Application
Scope of Module: Apply knowledge in practical, time-bound projects aligned with industry-relevant themes.
Topics: Development of mini projects: menu-driven programs (e.g., ATM interface, student grade system), real-time input handling and validation, implementation of logging systems using file I/O, structuring code for modularity and readability, application testing using manual test cases, integration of Git for version tracking.
***Learning Outcome*: -** *Design and deploy small-scale C projects using structured programming and version-controlled collaboration within limited timeframes.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Programming in C by Prof. Anupam Basu (IIT Kharagpur)NPTEL: https://nptel.ac.in/courses/106105085

Suggested Readings

Book

- Let Us C by Yashwant Kanetkar, 6th Edition, PBP Publication

Web-based Resources

- GeeksforGeeks – Advanced C tutorials
- OnlineGDB and HackerRank – Practice platforms
- GNU Compiler Collection (GCC) docs and POSIX C reference

Recommended Software/Tools (If applicable):

5. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	2	2	2	2	2
CO2	2	3	3	2	-	3	2	2	2	3

CO3	2	3	3	3	-	3	2	2	2	3
CO4	2	2	3	3	-	3	2	2	2	3
CO5	3	3	3	3	-	3	2	2	3	3
Articulation	2.4	2.6	2.8	2.6	1	2.8	2	2	2.2	2.8

Course Title:	Computer Architecture
Course Code:	25VBT0C104
Semester:	**I**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description

This course introduces students to the organization and architecture of computer systems. It covers internal structures, memory systems, I/O organization, instruction execution, and emerging processor technologies. The course develops analytical skills to evaluate hardware and architectural features in computing systems.

Course Outcomes(Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	To establish a strong foundation in principles and architectural concepts of computer systems.	L2
CO2	Gain insight on the functionality of different subsystems, such as the processor, input/output, and memory devices.	L3
CO3	Design and analyze simple arithmetic and logical units and their operations	L3
CO4	Comprehend the concepts of parallel computing and hardware technologies	L5
CO5	Develop insight into memory hierarchy and correlate with the concept of virtual and cache memory	L5

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Computer Structure and Instruction Set

Scope of Module: This module introduces basic components of computer systems, their instruction formats, and data representation.
Topics: Computer types, functional units, basic operational concepts, bus structures, instruction formats, number representation, arithmetic operations on signed and unsigned data, memory locations and addressing, memory read/write operations
Learning Outcome: *Develop insight on computer framework and identify the performance issues in computer systems*

No. of Hours :24

Module 2: Machine Instructions, I/O Systems, and Memory Organization
Scope of Module: This module explains instruction execution and system-level operations including input/output handling and memory management basics.
Topics: Addressing modes, assembly language instructions, input and output operations, subroutines, instruction encoding, accessing I/O devices, interrupt mechanism and hardware, direct memory access, standard I/O interfaces including PCI, SCSI and USB, basic memory organization including RAM, ROM, memory hierarchy principles, speed and cost trade-offs.
Learning Outcome: *Understand addressing techniques, memory operations, and standard interfaces for efficient I/O operations.*

No. of Hours :24

Module 3: Advanced Memory and Arithmetic Units
Scope of Module: This module introduces concepts of cache and virtual memory, logic gates and arithmetic units.
Topics: Cache memory organization and mapping techniques, replacement algorithms, performance optimization in cache, virtual memory and address translation, logic gates and flip flops, addition and subtraction of signed numbers, fast adder designs including carry look-ahead adder.
Learning Outcome: *Analyze the logic behind memory systems, understand arithmetic circuitry and apply memory design techniques.*

No. of Hours :24

Module 4: Instruction Processing and Parallel Architectures
Scope of Module: This module describes instruction execution cycles, control design, pipelining and modern parallel processing concepts.

Topics: Basic processing unit design, instruction execution steps, multiple bus organization, hardwired and microprogrammed control, pipelining basics, instruction hazards, data hazards, impact on instruction sets, parallel computer models including multiprocessors and multicomputers, PRAM and VLSI models.
Learning Outcome: *Analyze execution flow and design of control units, and explore the foundations of parallel computer architectures.*

No. of Hours :24

Module 5: Performance, Processor Technologies and Storage
Scope of Module: This module addresses performance metrics, advanced processor types, scalable performance and memory management techniques.
Topics: Performance metrics and speedup laws, program partitioning and scheduling, interconnection networks, CISC and RISC architectures, superscalar and VLIW processors, vector and symbolic processors, hierarchical and virtual memory technology, TLB, paging, segmentation, cache addressing modes, associative caches, SIMD processing, storage systems, I/O interfacing, RAID levels and performance reliability.
Learning Outcome: *Evaluate processor performance, understand advanced architecture models and memory storage strategies.*

Module	No. of Pre-Recordings
1	10
2	12
3	10
4	12
5	10

Note: Minimum number of pre-recordings is 10.

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Computer Organization and Architecture by Prof. John Jose (IIT Guwahati) NPTEL: https://nptel.ac.in/courses/106103206

Suggested Readings

Book

- *Computer Organization and Architecture: Designing for Performance* by William Stallings, 10th Edition, Pearson.

Online Articles, Journals, and Whitepapers

- Research articles from *IEEE Xplore*, *ScienceDirect*, and *Journal of Parallel and Distributed Computing*
- Whitepapers on processor design, memory hierarchy, and instruction set architectures from *Intel*, *ARM*, and *ACM Computing Surveys*

Web-based Resources

- MIT OpenCourseWare – Computer System Organization and Architecture.
- Simulators and tools like EduMIPS64, Logisim, and Multi2Sim.

Recommended Software/Tools (If applicable):

5. GCC Compiler, Visual Studio Code, Linux Terminal, C IDEs

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	2	1.8	2	2.8

ourse Title:	**Essentials of Generative AI**
Course Code:	**26VBX0S105**
Semester:	**I**
Credits:	**2**
Course Type	**Skill Enhancement Course**
Learning Hours	60
Live Sessions	**12 hours**

Course Outcomes:

CO1: Understand Generative AI and LLMs in depth
CO2: Create text, image, and voice content using AI
CO3: Automate daily tasks and business workflows
CO4: Build AI agents that act independently
CO5: Design and deploy simple AI apps without coding

Course Modules

Module 1: Generative AI Prompt Engineering for Real Workflows

What is Generative AI and how it's transforming industries, Structure of an effective prompt: *Role → Task → Context → Output,* Common prompting mistakes and how to fix them, How large language models (LLMs) like ChatGPT, Claude, and Google AI Studio work, advanced prompting (few-shot, iterative, style-based), Using your own files in ChatGPT and Claude (RAG basics), Research and summarization using AI

Learning Outcome: Students will be able to understand how Generative AI works and master the art of prompting.

Module 2: Creative AI and Voice & Audio Creation

Understanding AI image generation, creating posters, campaign assets, and product visuals, building brand identity using Krea.ai, Generating realistic voiceovers using ElevenLabs, Script writing and tone control with ChatGPT & Claude, Integrating voice into short videos or podcasts ***Learning Outcome:*** Students will be able to use AI to generate visuals, voiceovers, and creative storytelling content.

Module 3: AI Automation & Productivity

Logic of triggers, actions, and workflows, setting up automation between apps (Gmail, Sheets, Drive), Connecting OpenAI to Make.com for intelligent automation, creating social media Management Workflow

and research automation flows, automating daily reports and reminders, building personal productivity dashboards, Integrating Claude and ChatGPT into existing workflows

Learning Outcome: Automate daily workflows and tasks using AI and no-code tools.

Module 4: Advanced AI Agents & Decision Flows

Introduction to n8n as a visual AI workflow builder, understanding nodes, triggers, and data passing, Using OpenAI node for smart responses and actions, designing multi-step reasoning workflows, Connecting Google Sheets, Slack, and other APIs, building autonomous agents that perform specific tasks

Learning Outcome: Students will be able to build AI agents that can think, decide, and act automatically.

Module 5: AI App Building & Deployment

Fundamentals of UI/UX for AI apps, structuring front-end and AI back-end flows, designing app logic using n8n and Make.com, integrating OpenAI and Claude APIs to your apps, handling user inputs and dynamic responses, using Google AI Studio to experiment with models, hosting and testing your AI app online, adding analytics and monitoring usage, final demo preparation and peer feedback

Learning Outcome: Students will be able to learn to design, connect, and deploy simple AI apps using no-code tools

Semester-II

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Centre for Distance & Online Education
319, 25th Main, 17th Cross,
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Course Title:	Communicative English
Course Code:	25VBX0AE205
Semester:	**II**
Credits:	**4**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	120
	12 hours

Course Description:

This course equips students with foundational and advanced communication techniques necessary for academic, personal, and professional success. Through practice-driven modules, students will develop their verbal, written, digital, and intercultural communication competence to become effective communicators.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Articulate the elements and processes involved in effective communication	L2
CO2	Analyze and differentiate between various forms of communication, recognizing their unique functions	L4
CO3	Apply diverse approaches to enhance listening and reading skills, leading to improved comprehension	L3
CO4	Demonstrate the ability to convey messages fluently and appropriately in diverse social and professional scenarios	L3
CO5	Employ advanced writing strategies to craft compelling and actionable written communication	L6

Course Modules

No. of Hours: 24

Module 1: Communication Foundations and Contexts
Scope of Module: Explore the process, types, and importance of communication with reference to global standards.
Topics: English as a global lingua franca, 21st-century communication needs, process and types of communication, workplace language skills, situational dialogues, formal and informal styles, communication barriers and management, verbal and non-verbal cues
Learning Outcome: *Explain the process and significance of effective communication in both workplace and societal contexts*

No. of Hours: 24

Module 2: Grammar, Reading, and Dialogue
Scope of Module: Build grammatical accuracy and comprehension through structured reading and dialogue practices
Topics: Essentials of good English (parts of speech, sentence structures), subject-verb agreement, discourse markers, reading strategies, textual understanding using *The English Teacher* by R.K. Narayan, direct and indirect dialogue, conversation control, dialogue in different scenarios, Einstein-Tagore discussion
Learning Outcome: *Apply grammar principles and reading skills for improved comprehension and communication*

No. of Hours:24

Module 3: Digital and Collaborative Communication
Scope of Module: Focus on the use of technology for learning, presenting, and collaborating in professional environments.
Topics: Online resources for language and research (Google Scholar, INFLIBNET, Project Gutenberg), writing essays and reports, persuasive and narrative writing, organizing reports, group presentations, public speaking, simulated interviews, using PPTs, ICT platforms, blogs, social media, email etiquette, virtual meeting tools
Learning Outcome: *Utilize digital tools and collaborative strategies for professional communication and presentation*

No. of Hours:24

Module 4: Argumentation, Networking, and Global Communication

Scope of Module: Develop effective argumentation, negotiation, and multicultural communication skills.
Topics: Pillars of argument, logic structures, radio debate analysis, art of debate and rebuttal, negotiation principles, conflict resolution, difficult conversations, networking language and strategies, global communication etiquette, multicultural sensitivity, handling communication barriers
Learning Outcome: *Demonstrate critical thinking, negotiation, and networking skills in global and multicultural communication settings*

No. of Hours:24

Module 5: Life Writing and Official Correspondence
Scope of Module: Explore reflective writing forms and develop professional written communication skills.
Topics: Official letter formats and styles, email writing (salutations, CC, BCC), resume and cover letters, types of life writing (memoirs, journals, biographies, testimonials), *The Diary of Anne Frank*, importance of life writing in reflecting social and personal history
Learning Outcome: *Craft effective official communications and explore personal expression through reflective writing forms*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites (If Any):

- Basic proficiency in English (reading, writing, speaking).
- Familiarity with high school-level grammar and literary concepts.

Pedagogy / Teaching Methodology:

- ✓ **Close reading and textual analysis** of poems, essays, and speeches.
- ✓ **Audio-visual aids** such as videos of dramatic performances and famous speeches.
- ✓ **Group discussions** to encourage collaborative learning.

Certificate / Value-Added Courses Recommended (with Free Resource Links):

13. *Grammar and Punctuation* – Coursera (University of California, Irvine): https://www.coursera.org/learn/grammar-punctuation
14. *English Grammar and Essay Writing* – edX (BerkeleyX): https://www.edx.org/course/english-grammar-and-essay-writing
15. *Public Speaking* – edX (University of Washington): https://www.edx.org/course/public-speaking

Suggested Readings

Book

- *Elements of Style* by William Strunk Jr. and E. B. White

Online Articles, Journals, and Whitepapers

- George Orwell's *Why I Write* (orwellfoundation.com)
- *The Sense of Style* by Steven Pinker
- Steven Earnshaw (Ed.). *The Handbook of Creative Writing*. Edinburgh University Press

Web-based Resources

- British Council Learn English, BBC Learning English, ELLLO, Purdue OWL Writing Lab, Grammarly Blog

Recommended Software/Tools:

21. **Grammarly** or **ProWritingAid** – for grammar correction and style improvement.
22. **Jamboard** or **Padlet** – for brainstorming and organizing debate ideas.
23. **Speech analysis apps** – to evaluate clarity, pitch, and delivery.
24. **Miro** – for mind-mapping essay structures.
25. **VoiceThread** or **Flipgrid** – for recording and reviewing speech or performance assignments.

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	1	1	2	2	2	1	2
CO2	2	2	2	2	3	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	2	2	3	2
CO5	3	3	3	2	3	2	2	2	3	3
Articulation	2.2	2.2	2.6	1.8	2.2	2	2	2	2.2	2.4

Course Title:	Operating System
Course Code:	25VBT0C201
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course provides an in-depth understanding of operating system concepts such as process management, memory organization, scheduling, file systems, I/O systems, and protection mechanisms. Through theoretical foundations and case studies (Linux), students will gain insight into how an OS functions as a system software and as a resource manager**.**

Course Outcomes (Cos)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Gain insight into the basic operating system structure & concept of process management.	L2
CO2	Develop a strong foundation on process scheduling, process synchronization & concept of deadlock.	L3
CO3	Analyze and apply concepts related to process management, scheduling, and multithreaded programming.	L4
CO4	Evaluate various memory management strategies, such as paging and segmentation, and analyze the complexity and cost associated with virtual memory techniques	L5
CO5	Design and implement solutions for file systems, understand the structure and functioning of I/O systems and create strategies for security mechanisms and protection in operating systems.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Operating System
Scope of Module: Introduces the architecture, structures, and basic services of modern operating systems and their interactions with hardware.
Topics: Introduction to Operating Systems, Computer System Architecture, Types of Operating Systems, Operating System Structure, Operating System Operations, Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, OS Design & Implementation, Virtual Machines, OS Generation, System Boot
Learning Outcome: *Comprehend the fundamentals, structure, and services of operating systems.*

No. of Hours:24

Module 2: Process Management and Scheduling
Scope of Module: Focuses on process lifecycle, scheduling techniques, and multithreading concepts for efficient CPU management.
Topics: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication (IPC), Multithreaded Programming, Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling
Learning Outcome: Analyze and apply process management, scheduling algorithms, and multithreaded programming.

No. of Hours:24

Module 3: Synchronization and Deadlocks
Scope of Module: Examines concurrency issues in multi-process systems and methods to avoid synchronization and deadlock problems.
Topics: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Synchronization Problems, Monitors, Deadlock Introduction, System Model, Deadlock Characterization, Deadlock Handling Methods, Deadlock Prevention, Avoidance, Detection, Recovery

Learning Outcome: *Evaluate process synchronization mechanisms and methods to handle deadlocks in operating systems.*

No. of Hours:24

Module 4: Memory and Storage Management
Scope of Module: Explores how operating systems handle memory through allocation strategies and virtual memory mechanisms.
Topics: Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation, Virtual Memory Concepts, Virtual Address Space, Demand Paging, Copy-On-Write, Page Replacement Algorithms, Frame Allocation, Thrashing, Overview of Mass Storage, Disk Structure, Disk Scheduling, RAID Concepts
Learning Outcome: *Evaluate memory and storage management techniques including paging and virtual memory.*

No. of Hours:24

Module 5: File Systems, I/O, Protection and Case Study
Scope of Module: Describes file organization, I/O hardware-software interface, and protection strategies along with a case study on Linux.
Topics: File Concepts, Access Methods, Directory & Disk Structure, File Mounting & Sharing, File System Implementation, Directory Implementation, Allocation & Free-Space Management, Efficiency & Performance, I/O System Overview, Application I/O Interface, Kernel I/O Subsystem, STREAMS, Goals and Principles of Protection, Access Matrix, Access Control, Security Threats, Distributed Systems Overview, Case Study: Linux OS Design, Kernel Modules, Process & Memory Management, File Systems in Linux
Learning Outcome: *Design and assess file systems, I/O, protection mechanisms, and explore the Linux operating system.*

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**

4	**12**
5	**10**

Note: Min no of pre recordings 10**.**

Prerequisites (If Any):

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Operating System Fundamentals by Prof. Niket Kaushik (IIT Roorkee)
NPTEL: https://nptel.ac.in/courses/106107191

Suggested Reading:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, *Operating System Concepts*, Wiley

Suggested Tools / Activities:

- Linux command line practice
- OS simulation tools (like LittleOS Book, Nachos, or PintOS – demonstration level)
- Process scheduling simulations (Gantt chart practice)
- Visualization of paging, segmentation, and memory management
- VirtualBox for exploring Linux file systems

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	1	2	1
CO2	3	3	3	3	3	1	–	1	2	1
CO3	3	3	3	3	3	1	–	1	2	2
CO4	3	2	3	3	3	1	1	1	2	3
CO5	3	1	1	3	3	2	1	1	1	1
Articulation	3	2.2	2.4	2.8	3	1.2	1	1	1.8	1.6

Course Title:	Data Structures using C
Course Code:	25VBT0C202
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of data structures using the C programming language. It covers linear and non-linear structures, recursion, memory management, and algorithmic problem-solving through arrays, stacks, queues, linked lists, trees, and graphs. The course emphasizes practical implementation and performance analysis.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Comprehend fundamentals of Data Structures & its applications for solving real-world problems.	L2
CO2	Infer and develop applications of Linear Data Structures including stacks, queues, and lists.	L2
CO3	Interpret and apply Non-Linear Data Structures & their applications.	L3
CO4	Implement, analyze, and evaluate the searching algorithms	L5
CO5	Apply sorting algorithms to sort various types of data.	L3

Course Modules

No. of Hours:24

Module 1: Fundamentals of Data Structures & Pointers
Scope of Module:

Introduces the concept and classification of data structures and deepens the understanding of pointers and memory management in C.
Topics: Introduction to Data Structures, Primitive and Non-Primitive Types, Linear vs Non-Linear Structures, Operations on Data Structures, Introduction to Algorithms, Characteristics & Elements of Algorithms, Pointer Basics, Pointer with Functions, Pass by Reference, Array of Pointers, Pointer to Arrays, Dynamic Memory Allocation, Structures and Unions, Self-referential Structures
Learning Outcome: *Understand the fundamental concepts of Data Structures and pointer-based memory operations.*

No. of Hours:24

Module 2: Arrays, Strings & Recursion
Scope of Module: Focuses on basic linear data representations and recursive algorithm strategies.
Topics: Linear Arrays: Representation, Traversing, Insertion, Deletion, Searching, Sorting, Dynamic Arrays, Multi-dimensional Arrays, String Concepts, String Operations, Pattern Matching Algorithms, Recursion: Direct and Indirect, Factorial, GCD, Fibonacci, Tower of Hanoi
Learning Outcome: *Apply array and string operations, and implement recursive solutions for mathematical and problem-solving tasks.*

No. of Hours:24

Module 3: Stacks and Queues
Scope of Module: Explores the stack and queue structures and their applications in computation.
Topics: Stack Definition, Operations, Array and Dynamic Representation, Polish & Reverse Polish Notations, Infix to Postfix Conversion, Postfix Evaluation, Queue Concepts: Operations, Array and Dynamic Representation, Circular Queue, Dequeue, and other types pf queues, Applications (e.g., Mazing Problem)
Learning Outcome**:** *Design and implement linear data structures using stacks and queues for solving expression and system-related problems.*

No. of Hours:24

Module 4: Linked Lists and Trees
Scope of Module: Covers linked list variants and hierarchical data structures with traversal techniques.
Topics: Singly Linked List: Representation, Traversal, Insertion, Deletion, Doubly and Circular Linked Lists, Linked Stacks and Queues, Applications, Trees: Terminology, Binary Trees, Complete Binary Trees,

Representation, Binary Tree Traversals (Inorder, Preorder, Postorder), Binary Search Trees: Insertion, Deletion, Searching, Expression Tree Evaluation
Learning Outcome: *Analyze and apply dynamic structures like linked lists and trees to manage and process data efficiently.*

No. of Hours:24

Module 5: Graphs, Sorting & Searching
Scope of Module: Focuses on non-linear graphs and foundational algorithms for data organization and retrieval.
Topics: Graphs: Directed, Undirected, Representation (Matrix, Adjacency List), BFS and DFS Traversals, Sorting Techniques: Bubble, Insertion, Selection, Quick, Heap Sort, Searching Algorithms: Linear, Binary, Interpolation, Jump Search
Learning Outcome: *Implement and analyze graph traversal, sorting, and searching algorithms based on performance and use cases.*

Module	No of Pre Recordings
1	10
2	11
3	12
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- ✓ Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Data Structures and Algorithms using C by Prof. Naveen Garg (IIT Delhi) NPTEL: https://nptel.ac.in/courses/106102064

Suggested Reading:

- Seymour Lipschutz, *Data Structures*, Schaum's Outlines
- Horowitz, Sahni, Anderson-Freed, *Fundamentals of Data Structures in C*
- Yashavant Kanetkar, *Data Structures Through C*
- NPTEL / GeeksforGeeks / HackerRank (Practice Problems)

Suggested Tools / Activities:

- Turbo C / GCC on Linux or Windows
- Implementing stacks, queues, trees in C
- Dry-run and trace recursion and sorting programs
- Mini-project: Student Record System, Expression Evaluation
- Practical lab with GDB (for pointer/stack memory visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	–	–	–	–	2
CO2	3	3	3	2	2	1	–	1	–	2

CO3	3	3	3	3	3	–	2	–	1	2
CO4	3	2	3	3	3	2	–	2	–	3
CO5	3	2	3	2	3	1	–	1	–	2
Articulation	3	2.6	2.8	2.4	2.6	1.3	2	1.3	1	2.2

Course Title:	Relational Database Systems
Course Code:	25VBT0C203
Semester:	**II**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
	12 hours

Course Description:

This course introduces the fundamental concepts of relational database design, implementation, and management. Students will learn how to design databases using ER models, normalize schemas, write complex SQL queries, and understand transaction management and emerging trends like NoSQL and Big Data. Emphasis is placed on applying theoretical knowledge through hands-on practice.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand basic database concepts, architectures, and advantages over traditional file systems.	L2
CO2	Create and interpret ER/EER diagrams and convert them into relational schemas.	L6
CO3	Analyze database designs using normalization techniques for optimized performance and data integrity.	L4
CO4	Construct and execute SQL queries for database operations.	L5
CO5	Explore advanced databases and evaluate their applicability in different contexts.	L5

Course Modules

No. of Hours:24

Module 1: Database Fundamentals and Architecture
Scope of Module: Introduces students to databases, their characteristics, architecture, and the distinction between DBMS and traditional file systems.
Topics: Database Characteristics, File-Based Systems vs. DBMS, Types of Data Processing and Access Methods, Data Models Overview, DBMS vs. RDBMS, Database Applications, Schemas and Instances, Three-Schema Architecture, Data Independence, DDL, DML, DCL, TCL, Centralized vs. Client/Server Architecture, DBMS Classification
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data.*

No. of Hours: 24

Module 2: Data Modeling with ER/EER and Relational Design
Scope of Module: Focuses on designing data models using ER and EER diagrams and converting them into relational models.
Topics: Entity, Attributes, Relationships, ER Symbols, Weak Entities, Keys, Constraints, Advanced ER Concepts, UML-based EER Diagrams, ER-to-Relational Mapping, Subclasses, Superclasses,Specialization, Generalization, Relational Schema Design, Relational Model Concepts, Constraints, Update Operations, Transactions
Learning Outcome: *Understand database fundamentals and architectures for managing large-scale data. Design ER/EER diagrams and map them into normalized relational schemas.*

No. of Hours: 24

Module 3: SQL and Relational Algebra
Scope of Module: Covers data definition and manipulation in SQL and introduces relational algebra for query formulation.
Topics: SQL Data Types, DDL, DML, Constraints, Keys (Primary, Foreign, Alternate), INSERT, UPDATE, DELETE, SELECT Queries, Aggregate Functions, GROUP BY, HAVING, JOINs (Inner, Outer, Cross), Subqueries,

Relational Algebra Operators, Unary & Binary Operations, Set Theory Operations, Grouping and Aggregation in Algebra
Learning Outcome: *Write efficient SQL queries and use relational algebra to express data operations.*

No. of Hours: 24

Module 4: Normalization, Transactions & Concurrency Control
Scope of Module: Deals with schema refinement, functional dependencies, transaction behaviour, and concurrency mechanisms.
Topics: Informal Design Guidelines, 1NF, 2NF, 3NF, BCNF, Multivalued Dependencies, 4NF, 5NF, Join Dependencies, ACID Properties, Transaction States, Serializability, Conflict & View Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols, Deadlock Detection & Prevention
Learning Outcome: *Normalize relational schemas and implement safe, concurrent transaction handling in DBMS.*

No. of Hours:24

Module 5: Database Recovery, NoSQL & Emerging Trends
Scope of Module: Explores recovery methods, non-relational databases, and current trends in the field.
Topics: Recovery Concepts, Types of Failures, Log-Based Recovery, Shadow Paging, ARIES Recovery Algorithm, Introduction to NoSQL, Types (Key-Value, Column, Document, Graph), Big Data & Hadoop Overview, Introduction to Data Warehousing and Data Mining, Database Security Concepts
Learning Outcome:*Explore database recovery techniques and evaluate modern database trends and technologies.*

Module	No of Pre Recordings
1	**10**
2	**12**
3	**10**
4	**12**

5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of computer fundamentals.

Pedagogy / Teaching Methodology:

- Lectures, Hands-on Lab Sessions, Problem-solving Tasks, Case-based Assignments, Group Projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

5. Database Management System by Prof. P. P. Chakrabarti (IIT Kharagpur) NPTEL: https://nptel.ac.in/courses/106105175

Suggested Reading:

- Ramez Elmasri & Shamkant Navathe, *Fundamentals of Database Systems*, Pearson
- Silberschatz, Korth, & Sudarshan, *Database System Concepts*, McGraw-Hill
- NPTEL Database Management Systems Modules
- Practice Resources: SQLZoo, LeetCode (SQL), DB-Fiddle

Suggested Tools / Activities:

- Use of MySQL / PostgreSQL / Oracle XE
- Lab practice: SQL query execution, ER diagram to schema mapping
- Projects: Library Management System, Online Store Schema Design
- Tools: DB Designer, SQL Workbench, pgAdmin, MongoDB Compass (for NoSQL demos)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	–	3	2	1
CO2	3	3	3	3	3	2	–	2	2	1
CO3	3	3	3	3	3	1	–	1	2	1
CO4	3	3	3	3	3	1	2	1	2	2
CO5	3	3	3	3	3	2	1	1	2	2
Articulation	3	2.8	2.8	2.8	3	1.4	1.5	1.6	2	1.4

Semester III

Common Course

Course Title:	Python Programming
Course Code:	25VBT0C301
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamental concepts of Python programming, covering syntax, data types, control structures, functions, and object-oriented principles. It also explores data structures, file handling, databases, web services, and networking. The course emphasizes problem-solving using Python and provides hands-on experience with real-world applications.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the basic syntax, data types, and control structures in Python.	L2
CO2	Apply functions, modules, and object-oriented concepts to solve problems.	L3
CO3	Develop programs using file handling, exceptions, and standard libraries.	L3
CO4	Analyze and implement data structures such as lists, dictionaries, and tuples.	L4
CO5	Design real-world applications using Python frameworks and libraries.	L6

Course Modules

No. of Hours: 24

Module 1: Introduction to Python and Basic Programming Concepts

Scope of Module: This module covers Python programming basics, syntax, variables, mathematical operations, and debugging techniques. It also introduces expressions, Boolean logic, and user input handling.
Topics: Introduction to programming concepts, Python as a programming language, writing and running Python scripts, variables and assignment statements, data types (integers, floats, and strings), arithmetic operations and expressions, Boolean expressions and logical operators, modulus operator and integer division, order of operations in expressions, working with user input and output, string operations and concatenation, naming conventions and keywords, writing meaningful comments in code, debugging techniques and best practices, common syntax errors and troubleshooting.
Learning Outcome: *Understand the fundamental concepts and terminology of Python programming while developing the ability to write and debug simple programs***.**

No. of Hours: 24

Module 2: Functions, Iteration, and String Manipulation
Scope of Module: This module explores functions, control structures like loops, and handling string operations, enabling efficient program flow and data processing.
Topics: Function definitions and structure, function calls and return values, built-in functions in Python, parameters and arguments in functions, type conversion functions, recursive functions and base cases, iteration using while loops, iteration using for loops, using break and continue statements, nested loops and loop efficiency, string sequences and indexing, string slicing and concatenation, string immutability and methods, string formatting techniques, debugging functions and loops.
Learning Outcome: *Implement functions, loops, and string operations effectively for structured programming in Python.*

No. of Hours: 24

Module 3: Data Structures – Lists, Dictionaries, and Tuples
Scope of Module: This module covers essential Python data structures, including lists, dictionaries, and tuples, focusing on operations and efficient data handling.
Topics: Introduction to lists and their properties, list indexing and slicing, adding and removing list elements, list mutability and copying, iterating over lists using loops, list comprehensions and filtering, dictionary creation and key-value pairs, accessing and updating dictionary values, looping through dictionaries, dictionary operations and methods, introduction to tuples and immutability, tuple assignment and multiple return values, tuples as dictionary keys, comparing lists, dictionaries, and tuples, debugging common data structure issues.
***Learning Outcome*:** *Analyze and manipulate Python's core data structures to store, retrieve, and* **process data effectively.**

No. of Hours: 24

Module 4: File Handling, Object-Oriented Programming, and Inheritance
Scope of Module: This module introduces file handling, object-oriented programming, and inheritance principles to build reusable and structured code.
Topics: Reading and writing text files, handling different file formats, file paths and directory navigation, exception handling in file operations, object-oriented programming (OOP) concepts, defining classes and objects, attributes and instance methods, encapsulation and data hiding, mutability of objects and copying, understanding object lifecycles, inheritance and subclassing, overriding methods in subclasses, polymorphism and method resolution order, class diagrams and object hierarchies, debugging OOP-based programs.
***Learning Outcome*:**Develop structured, reusable programs using file handling, OOP, and inheritance concepts in Python.

No. of Hours: 24

Module 5: Databases, Web Services, and Networking
Scope of Module: This module explores database management, web services, APIs, and network programming, enabling interaction with external data sources and networked systems.
Topics: Introduction to databases and SQL, creating and managing tables in SQL, writing and executing SQL queries, relational database modeling and normalization, handling multiple tables and relationships, constraints and data integrity, introduction to web services and APIs, understanding XML and JSON formats, parsing XML and JSON in Python, working with third-party APIs, introduction to networking concepts, sending and receiving data over networks, Python sockets for client-server communication, web scraping techniques using Python, debugging network and database programs.
Learning Outcome*: *Develop proficiency in handling databases, web services, and networking concepts for real-world applications.

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**
4	**12**

5	11

Note: Min no of pre recordings 10.

Prerequisites

- Basic understanding of programming logic and flowcharts
- Familiarity with any programming language (C/C++ preferred)
- Logical reasoning and problem-solving mindset

Pedagogy / Teaching Methodology

- ✓ Hands-on coding sessions in labs and online IDEs
- ✓ Mini-projects on text processing, games, or web apps
- ✓ Weekly coding challenges and debugging practice
- ✓ Group tasks involving script design or automation
- ✓ Integration with tools like Jupyter Notebooks, GitHub, and Colab

Certificate / Value Added Courses

17. Python for Everybody – Coursera (University of Michigan)
18. Google IT Automation with Python – Coursera
19. Introduction to Python – edX (Microsoft)
20. Automate the Boring Stuff with Python – Udemy

Suggested Readings

- Eric Matthes, *Python Crash Course*
- Charles Dierbach, *Introduction to Computer Science Using Python*
- Mark Lutz, *Learning Python*
- Al Sweigart, *Automate the Boring Stuff with Python*
- Guido van Rossum (online documentation): https://docs.python.org/3/

Recommended Software / Tools

13. **IDE/Editors:**
    a. Jupyter Notebook
    b. Visual Studio Code
    c. PyCharm (Community Edition)
    d. Thonny (for beginners)
14. **Online Platforms:**
    a. Google Colab
    b. Replit
    c. HackerRank / LeetCode (for Python practice)
15. **Libraries and Frameworks:**
    a. NumPy, Pandas (for data analysis)
    b. Tkinter, PyQt (for GUI development)
    c. Flask, Django (for web development)
    d. Matplotlib, Seaborn (for data visualization)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	-	1	1	1

CO2	3	3	3	3	3	2	1	1	1	1
CO3	2	3	2	2	3	2	1	1	2	-
CO4	3	3	2	2	2	2	1	2	1	1
CO5	2	3	3	3	3	3	1	1	1	1
Articulation	2.6	3	2.4	2.4	2.6	2.4	1	1.2	1.2	1

Course Title:	Design and Analysis of Algorithms
Course Code:	25VBT0C302
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course explores the fundamental principles and advanced techniques in algorithm design and analysis. Students will learn to develop computational solutions for problems like searching and sorting, apply divide-and-conquer, greedy, and dynamic programming techniques, and analyze algorithmic efficiency. The course will also cover space-time tradeoffs, iterative improvements, and approaches to solving NP-hard problems, providing industry-relevant problem-solving skills.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand basic algorithmic strategies and their time/space complexities.	L2
CO2	Apply divide and conquer, greedy, and dynamic programming paradigms to solve problems.	L3
CO3	Analyze algorithm efficiency using Big-O, Big-Ω, and Big-Θ notations.	L4
CO4	Evaluate and compare the performance of different algorithms.	L5
CO5	Design efficient algorithms for real-world problems using suitable techniques.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Algorithm Design and Analysis
Scope of Module:

This module introduces fundamental algorithm concepts, including problem-solving strategies, computational limits, and performance analysis. It covers basic searching, sorting techniques, and asymptotic notation for algorithm efficiency.
Topics: Definition and importance of algorithms, understanding problem complexity and computational constraints, importance of selecting appropriate data structures, algorithm design techniques, methods of specifying an algorithm, proving correctness of an algorithm, performance analysis and computational efficiency, space complexity and time complexity, asymptotic notations including Big-O, Omega, and Theta, mathematical analysis of recursive and non-recursive algorithms, selection sort and bubble sort fundamentals, sequential search and brute-force string matching, closest-pair problem using brute-force technique, convex hull problem using brute-force method, exhaustive search techniques.
Learning Outcome*: Understand the role of algorithms in problem-solving and analyze algorithm efficiency using mathematical models.*

No. of Hours: 24

Module 2: Divide and Conquer and Decrease and Conquer Approaches
Scope of Module: This module delves into the divide-and-conquer and decrease-and-conquer techniques, helping students analyze problems that can be solved by breaking them into smaller subproblems.
Topics: Introduction to divide-and-conquer strategy, recurrence equations and their significance, finding maximum and minimum elements, merge sort algorithm and analysis, quick sort algorithm and complexity, binary search and efficiency, binary tree traversals and their properties, multiplication of large integers using divide-and-conquer, Strassen's matrix multiplication algorithm, closest-pair problem using divide-and-conquer, convex hull problem via divide-and-conquer, insertion sort algorithm and its efficiency, depth-first search algorithm (DFS), breadth-first search algorithm (BFS), topological sorting and its applications.
Learning Outcome*: Analyze and implement divide-and-conquer and decrease-and-conquer techniques to optimize problem-solving.*

No. of Hours: 24

Module 3: Space-Time Tradeoffs, Greedy Approach, and Iterative Improvement
Scope of Module: This module focuses on space-time tradeoffs, string matching algorithms, and greedy techniques for optimization problems. Students will explore graph algorithms and iterative improvement techniques in optimization.

Topics: Introduction to space-time tradeoff principles, sorting by counting methods, input enhancement in string matching, Boyer-Moore algorithm for string matching, Horspool's algorithm and performance analysis, hashing fundamentals and applications, open hashing vs. closed hashing, Prim's algorithm for minimum spanning trees, Kruskal's algorithm using disjoint subsets, union-find method in Kruskal's algorithm, Dijkstra's algorithm for shortest path, Huffman tree construction and encoding, simplex method for linear programming, geometric interpretation of linear programming, maximum-flow problem and optimization strategies.
Learning Outcome: *Apply space-time tradeoffs, greedy techniques, and iterative improvement methods to solve optimization problems.*

No. of Hours: 24

Module 4: Transform and Conquer, Dynamic Programming, and Algorithmic Optimization
Scope of Module: This module covers algorithm transformation strategies, pre-sorting techniques, dynamic programming principles, and optimization algorithms used in shortest path problems and combinatorial optimization.
Topics: **I**ntroduction to transform and conquer approach, pre-sorting and its advantages, Gaussian elimination method, balanced search trees and their importance, heaps and heap sort algorithm, Horner's rule and its applications, binary exponentiation technique, problem reduction approach, overview of dynamic programming, computing binomial coefficients using dynamic programming, Warshall's algorithm for transitive closure, Floyd's algorithm for all-pairs shortest paths, principle of optimality in dynamic programming, optimal binary search trees, knapsack problem and memory functions.
Learning Outcome: *Design and implement dynamic programming solutions for combinatorial optimization problems.*

No. of Hours: 24

Module 5: Limitations of Algorithmic Power and Approximation Algorithms
Scope of Module: This module examines the theoretical limitations of algorithmic power, computational complexity classes, and approximation algorithms for NP-hard problems. It also introduces backtracking and branch-and-bound methods.

Topics:
Introduction to lower-bound arguments, trivial lower bounds and problem complexity, information-theoretic arguments in complexity analysis, adversary arguments and decision trees, complexity classes: P, NP, and NP-complete problems, challenges in numerical algorithms, backtracking technique and its applications, N-Queens problem using backtracking, sum of subsets problem using backtracking, branch-and-bound method for optimization, knapsack problem using branch-and-bound, traveling salesperson problem and branch-and-bound, approximation algorithms for NP-hard problems, traveling salesman problem approximation techniques, knapsack problem approximation methods.

Learning Outcome: Analyze computational complexity, apply backtracking and branch-and-bound techniques, and develop approximation algorithms for NP-hard problems.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Knowledge of basic programming (C/C++/Python)
- Understanding of discrete mathematics
- Familiarity with data structures

Pedagogy

- ✓ Whiteboard algorithm walkthroughs
- ✓ Pseudocode-to-code transformation exercises
- ✓ Complexity analysis using real-world problems
- ✓ Case studies and project-based learning

Value Added Courses / Certificates

9. Algorithmic Toolbox – Coursera
10. Data Structures and Algorithms – Udacity

Suggested Readings

- Thomas H. Cormen et al., *Introduction to Algorithms*
- Jon Kleinberg & Éva Tardos, *Algorithm Design*
- Anany Levitin, *Introduction to the Design & Analysis of Algorithms*

Recommended Tools

9. Python/C++ IDEs (e.g., VS Code, Code::Blocks)
10. Online judges: HackerRank, LeetCode, Codeforces

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- Note: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	-	1	2	3
CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	2	2	1	1	1	1

CO4	1	1	2	1	3	2	1	1	1	2
CO5	1	2	2	3	2	2	1	2	2	2
Articulation	1.8	2.2	2.4	2	2.2	1.8	1	1.2	1.4	1.8

Course Title:	Software Engineering
Course Code:	25VBT0C303
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course introduces the fundamentals of software engineering**,** including software development models, agile methodologies, requirements engineering, software design, testing, maintenance, and emerging trends**.** Students will explore industry-standard practices, software quality assurance, and modern development approaches such as DevOps, cloud computing, and AI-driven software engineering**.** By the end of the course, students will be equipped with the skills **to** design, develop, test, and maintain software systems efficiently**.**

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the phases of software development life cycle (SDLC).	L2
CO2	Apply appropriate process models for software projects.	L3
CO3	Analyze software requirements and specifications.	L4
CO4	Evaluate software design methodologies and testing techniques.	L5
CO5	Create documentation and design for real-world software applications.	L6

Course Modules

No. of Hours: 24

Module 1: Fundamentals of Software Engineering
Scope of Module: This module introduces software engineering principles, software processes, and different software

application domains.
Topics Covered: The nature of software, defining software, software application domains, the unique nature of web applications, software engineering and the software process, software engineering practice, software myths, a generic process model, defining a framework activity, identifying a task set, process assessment and improvement, prescriptive process models (waterfall, incremental, **evolutionary,** concurrent), specialized process models (component-based development, formal methods model, aspect-oriented development), the Unified Process and its phases, personal and team process models (PSP, TSP).
Learning Outcome: *Define software engineering principles, differentiate between software application domains, and describe various software process models.*

No. of Hours: 24

Module 2: Agile Development and Requirements Engineering
Scope of Module: This module explores agile methodologies and techniques for requirements gathering, analysis, and modeling.
Topics Covered: The concept of agility and its impact on the cost of change, agile process and principles, the politics of agile development, human factors in agility, extreme programming (XP) and its process, industrial XP, adaptive software development, Scrum framework, dynamic systems development method (DSDM), feature-driven development (FDD), lean software development, agile modeling, requirements engineering and stakeholders, developing use cases and UML models, requirements modeling for web applications.
Learning Outcome: *Explain agile methodologies, analyze software requirements, and apply modeling strategies for software specification.*

No. of Hours: 24

Module 3: Software Design and Architecture
Scope of Module: This module focuses on software design principles, architectural styles, and user interface design strategies.
Topics: The role of design in software engineering, the design process, software quality guidelines and attributes, evolution of software design, design concepts, the design model, software architecture, architectural genres and styles, component-level design, object-oriented view of components, designing class-based components, user interface design, web application interface design, interface

analysis and guidelines, interface design steps.
Learning Outcome: *Apply software design principles, develop architectural models, and implement user interface design guidelines.*

No. of Hours: 24

Module 4: Software Quality and Testing
Scope of Module: This module focuses on software quality assurance, verification, validation, and testing strategies.
Topics: Software quality and its dimensions, the software quality dilemma, achieving software quality through engineering methods, cost impact of software defects, review metrics and their use, software quality assurance (SQA) and its elements, SQA tasks, goals, and metrics, formal approaches to SQA, statistical software quality assurance, software reliability and availability, a strategic approach to software testing, verification and validation, unit testing, security testing, debugging and the debugging process.
Learning Outcome*: Analyze software quality assurance strategies and implement software testing techniques for defect prevention and validation.*

No. of Hours: 24

Module 5: Software Maintenance and Emerging Trends
Scope of Module: This module covers software maintenance techniques, risk management, and evolving trends in software engineering.
Topics: Software maintenance and evolution, legacy system maintenance, capability maturity models (CMM), software project risk management, risk mitigation strategies, software configuration management, change control, refactoring strategies, version control systems, release management, continuous integration and deployment (CI/CD), DevOps practices, cloud computing and microservices, AI in software development, future trends in software engineering.
Learning Outcome: *Evaluate software maintenance strategies, implement cost estimation models, and explore emerging trends in software engineering.*

Module	**No of Pre Recordings**
1	**10**

2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites

- Familiarity with basic programming
- Understanding of software applications

Pedagogy

- ✓ SDLC-based project development
- ✓ Use case modeling and UML design
- ✓ Agile and traditional model simulation
- ✓ Code review and testing labs

Value Added Courses / Certificates

9. Software Processes and Agile Practices – Coursera
10. Software Engineering Essentials – edX

Suggested Readings

- Ian Sommerville, *Software Engineering*
- Roger Pressman, *Software Engineering: A Practitioner's Approach*
- Pankaj Jalote, *An Integrated Approach to Software Engineering*

Recommended Tools

17. Visual Paradigm, StarUML (UML modeling)
18. GitHub (Version control)
19. JIRA (Agile project management)
20. Selenium, JUnit (Testing)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules

1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	-	1	1	1
CO2	2	3	2	3	2	1	1	1	1	1
CO3	2	2	2	2	3	1	1	1	1	1
CO4	1	1	2	1	1	2	-	1	3	2
CO5	1	1	1	1	3	2	2	3	2	1
Articulation	1.8	1.8	2	1.8	2.2	1.4	1.3	1.4	1.6	1.2

Course Title:	Computer Networks
Course Code:	25VBT0C304
Semester:	**III**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:
This course provides a comprehensive introduction to computer networks, covering fundamental networking principles, architectures, and protocols. Students will explore different network layers, their functionalities, and the mathematical calculations associated with data transmission. The course also introduces advanced networking concepts such as cloud computing, IoT, and network security.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand network architectures, protocols, and models.	L2
CO2	Apply network principles to configure and troubleshoot basic networks.	L3
CO3	Analyze different layers of the OSI and TCP/IP models.	L4
CO4	Evaluate network performance and security mechanisms.	L5
CO5	Design secure and scalable network infrastructures.	L6

Course Modules

No. of Hours:24

Module 1: Fundamentals of Computer Networks

Scope of Module: This module introduces fundamental networking concepts, network models, and physical layer functionalities. It provides an overview of computer networks, transmission media, and error detection mechanisms.
Topics: Overview of computer networks and their importance, Historical evolution of networking technologies, Network types and their applications (LAN, MAN, WAN), Network topologies and their impact on performance, The OSI reference model: layers and their functions, The TCP/IP model: comparison with OSI model, Analog and digital signals in networking, Transmission media: guided and unguided media, Signal encoding techniques and modulation schemes, Multiplexing techniques: FDM, TDM, and WDM, Spread spectrum techniques and their applications, Transmission errors: causes and effects, Error detection techniques: parity checks and checksums, Error correction mechanisms: Hamming code and CRC, Physical layer functions and performance metrics.
Learning Outcome: *Explain the fundamental concepts of computer networks, transmission media, and error detection techniques*

No. of Hours:24

Module 2: Data Link Layer and Medium Access Control
Scope of Module:
This module explores the data link layer, its role in error detection, flow control, and MAC protocols for wired and wireless networks.
Topics Covered:
Framing methods and techniques in data transmission, Flow control mechanisms: stop-and-wait and sliding window protocols, Error detection techniques: CRC, checksums, and parity bits, Error correction methods: Hamming code and ARQ techniques, Medium Access Control (MAC) protocols and their importance, CSMA/CD: collision detection and resolution, CSMA/CA: collision avoidance in wireless networks, Ethernet standards and frame structure, Token Ring: access method and frame structure, Wireless LAN standards: IEEE 802.11 and Wi-Fi, Bluetooth technology and applications, MAC addressing and its role in data link layer, LAN switching techniques: circuit switching vs. packet switching, Virtual LANs (VLANs) and their configurations, Data link layer security threats and mitigation techniques
Learning Outcome:*Describe data link layer functions, error detection techniques, and MAC protocols in wired and wireless networks.*

No. of Hours: 24

Module 3: Network Layer and Transport Layer
Scope of Module: This module covers network-layer functionalities, IP addressing, subnetting, and transport-layer protocols, including TCP and UDP.

Topics: Introduction to the network layer and its services, IP addressing schemes: IPv4 and IPv6, Subnetting techniques and IP address allocation, Routing algorithms: distance vector vs. link state, Static and dynamic routing protocols: RIP, OSPF, and BGP, ICMP protocol and error reporting in networks, IPv4 and IPv6 coexistence strategies, Address Resolution Protocol (ARP) and its working, Network Address Translation (NAT) and its applications, Transport layer functions and its role in networking, TCP and UDP: comparison and applications, Connection establishment and termination in TCP, Congestion control and flow control in TCP, Error detection and correction in transport layer, QoS mechanisms and performance optimization techniques
Learning Outcome: *Analyze IP addressing, subnetting, and routing algorithms, and describe transport-layer services.*

No. of Hours:24

Module 4: Network Security, Wireless & Multimedia Network
Scope of Module: This module covers network security principles, wireless communication fundamentals, and multimedia networking technologies.
Topics Covered: Network security threats and vulnerabilities, Cryptography basics: symmetric vs. asymmetric encryption, Authentication mechanisms and secure communication, Integrity and confidentiality mechanisms in networking, Wireless transmission fundamentals and radio communication, Cellular networks: architecture and mobile IP, IEEE 802.11 standard and wireless LAN protocols, Bluetooth technology: architecture and applications, Wireless security threats and mitigation techniques, Streaming and real-time communication protocols, Quality of Service (QoS) in multimedia networking, Voice over IP (VoIP) and its applications, Video conferencing protocols and challenges, Delay-sensitive traffic management in multimedia applications, Performance optimization for wireless and multimedia networks
Learning Outcome: *Understand and apply multimedia networking protocols to ensure secure, efficient, and high-quality real-time communication over wireless and mobile networks.*

No. of Hours: 24

Module 5: Advanced Networking and Emerging Technologies
Scope of Module: This module introduces advanced networking concepts such as network management, cloud computing, IoT, and blockchain.

Topics Covered:
SNMP protocol and network monitoring techniques, Fault management and performance optimization in networks, Configuration management in enterprise networks, Distributed computing fundamentals and architectures, Client-server vs. peer-to-peer networking models, Distributed file systems and coordination algorithms, Cloud computing models: IaaS, PaaS, SaaS, Virtualization techniques and resource management, Cloud security challenges and privacy concerns, IoT architecture and components, Communication protocols for IoT applications, IoT security challenges and mitigation techniques, Software-Defined Networking (SDN) architecture and benefits, Network Function Virtualization (NFV) and its impact, Blockchain technology in networking and its applications

Learning Outcome: *Evaluate network management strategies, cloud computing models, and emerging technologies like IoT, SDN, and blockchain.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10**.**

Prerequisites

- Basic computer system knowledge
- Understanding of binary arithmetic
- Familiarity with operating systems

Pedagogy

- ✓ Packet tracer simulations (Cisco)
- ✓ Layer-by-layer protocol analysis
- ✓ Wireshark labs and trace evaluations
- ✓ Network design mini-projects

Value Added Courses / Certificates

9. Computer Networking – Coursera (Stanford)
10. Cisco CCNA Introduction – NetAcad

Suggested Readings

- Andrew S. Tanenbaum, *Computer Networks*
- Behrouz A. Forouzan, *Data Communications and Networking*
- William Stallings, *Data and Computer Communications*

Recommended Tools

13. Cisco Packet Tracer
14. Wireshark
15. GNS3, NS2/NS3 simulators

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO - PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	-	1	1	1

CO2	2	3	2	2	1	1	-	1	1	1
CO3	2	2	3	2	3	1	-	2	2	1
CO4	1	2	2	3	2	2	1	2	2	1
CO5	1	1	1	1	1	1	2	1	3	3
Articulation	1.8	2	1.8	1.8	1.6	1.2	1.5	1.4	1.8	1.4

Course Title:	Environmental, Social, and Governance (ESG) in IT
Course Code:	25VBT0C305
Semester:	**III**
Credits:	**3**
Course Type	Ability Enhancement Compulsory Course
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course provides an in-depth exploration of Environmental, Social, and Governance (ESG) principles and their critical application within the Information Technology (IT) sector. Students will examine how ESG factors influence IT operations, strategy, and policy-making, gaining insights into sustainable practices, ethical considerations, and effective governance in technology-driven environments. Through case studies and practical projects, learners will develop the skills necessary to integrate ESG considerations into IT frameworks, ensuring responsible and sustainable technological development.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand environmental principles and sustainability concepts.	L2
CO2	Identify the effects of human activities on ecosystems.	L3
CO3	Analyze environmental challenges and sustainability goals (SDGs).	L4
CO4	Evaluate policies and practices for sustainable development.	L5
CO5	Propose eco-friendly solutions for community or industry applications.	L6

Course Modules: **No. of Hours: 18**

Module 1: Introduction to ESG and Digital Responsibility

Scope of Module:
This module lays the foundation of ESG principles and their relevance to the IT industry. It explores the global push toward sustainability, ethical tech development, and corporate responsibility.

Topics:
Definition and Origin of ESG, Importance of ESG in IT, Sustainable Development Goals (SDGs) and IT alignment, Environmental Impact of Digital Technologies, Ethical Considerations in Tech Development, IT and Climate Change, ESG Ratings and Digital Business Performance, Role of IT Professionals in ESG, Green Certifications and IT Compliance, Digital Transformation and ESG Goals, Circular Economy in IT, Impact of Cloud and Data Centers on Environment, Tech Industry ESG Benchmarks, Digital Minimalism and Eco-design, Global ESG Reporting Frameworks.

Learning Outcome: *Understand ESG foundations, the importance of responsible tech, and the environmental impact of digital systems.*

No. of Hours: 18

Module 2: Environmental Sustainability in IT

Scope of Module:
Focuses on sustainable computing, energy-efficient infrastructure, and green software engineering.

Topics:
Green IT Practices, Energy-Efficient Hardware and Systems, Carbon Footprint of IT Operations, Sustainable Data Center Management, E-Waste Management and Recycling, Renewable Energy Use in Tech Firms, Virtualization and Cloud Sustainability, Lifecycle Assessment of IT Products, Power Management in Devices, Paperless Office and Digital Workflows, Sustainable Supply Chains in IT, Greener Coding Practices, Use of AI for Environmental Monitoring, IoT in Smart Environment Systems, IT and Climate Action Technologies.

Learning Outcome: *Evaluate IT strategies that promote environmental sustainability and carbon reduction.*

No. of Hours: 18

Module 3: Social Responsibility and Inclusion in Technology

Scope of Module:
Covers how IT contributes to equity, digital literacy, accessibility, and ethical labor practices.

Topics:
Digital Inclusion and Access to Technology, Gender Equality in Tech, Accessibility Standards (WCAG, ADA), Ethical Labor in Tech Supply Chains, Community Engagement through Technology, Corporate Social Responsibility (CSR) in IT, Digital Literacy and Education Programs, Tech for Good Initiatives, Bridging the Digital Divide, AI Bias and Fairness, Inclusive Design Principles, Social Impact Assessment in Tech Projects, Diversity in IT Workforce, Data for Social Good, Digital Safety and Well-being.

Learning Outcome: *Analyze IT's role in promoting social responsibility and inclusive technology design.*

No. of Hours:18

Module 4: Governance, Ethics, and Regulation in IT

Scope of Module:
Discusses governance mechanisms, risk management, data ethics, and compliance in the IT context.

Topics: IT Governance Models, Data Privacy and Protection Laws (GDPR, PDP Bill India), Cyber Ethics and Accountability, Risk Management in Tech Projects, Regulatory Compliance in IT, Digital Rights Management, Transparent AI and Algorithm Auditing, Corporate Governance in IT Companies, Role of CIOs in ESG Governance, ESG Metrics and KPIs in Tech, Open Data and Public Interest, Whistleblowing Mechanisms in Tech Industry, IT Policy Frameworks, Blockchain for Governance Transparency, ESG Risks in IT Investments.
Learning Outcome: *Explore ethical governance practices, digital compliance, and risk management in IT.*

No. of Hours: 18

Module 5: ESG Implementation and Case Studies in IT
Scope of Module: Focuses on practical ESG integration into IT systems, success stories, frameworks, and tools.
Topics: ESG Strategy Development in Tech Organizations, Sustainability Reporting Tools (GRI, SASB), Role of CIOs and IT Managers in ESG, Measuring ESG Performance in IT Projects, ESG-Focused Software Development Lifecycle (SDLC), ESG Dashboards and Analytics, Green Procurement for IT Assets, Case Studies: Google, Microsoft, Infosys ESG Programs, IT in Disaster Response and Crisis Management, ESG Risk Mitigation Frameworks, ESG Investment in Tech Startups, ESG Certifications for IT Professionals, Open-source Tools for ESG Monitoring, ESG KPIs in Software Products, ESG Innovation Labs and Incubators.
Learning Outcome: *Apply ESG principles through frameworks, tools, and real-world tech case studies.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Suggested Readings:

Prerequisites

- General awareness of science and ecology
- Basic understanding of social issues

Pedagogy

- ✓ Eco-surveys and field visits
- ✓ Case studies on climate change and pollution
- ✓ Group discussions on policy impacts
- ✓ Sustainable campus or local community projects

Value Added Courses / Certificates

9. Sustainable Development Goals – edX
10. Introduction to Sustainability – Coursera

Suggested Readings

- Erach Bharucha, *Environmental Studies*
- R.Rajagopalan, *Environmental Studies from Crisis to Cure*
- UNEP Reports and SDG Guidelines

Recommended Tools

13. ArcGIS (for environment mapping)
14. SDG Tracker
15. OpenLCA (for life cycle assessment)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools

5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Concerns)
6.	Indian Knowledge System

Note: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping Table

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	3	2	1	2
CO2	2	3	2	2	3	2	3	2	1	2
CO3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	2	3	2	3	3	3	2	3
CO5	1	2	3	3	3	3	3	3	3	3
Articulation	2	2.2	2.2	2.2	2.6	2.6	2.8	2.6	1.8	2.6

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Centre for Distance & Online Education
319, 25th Main, 17th Cross,
J P Nagar 6th Phase
Bengaluru – 560 078
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Course Title:	Web Technologies
Course Code:	25VBT0C401
Semester:	**IV**
Credits:	**4**
Course Type	Core Course
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to essential web development technologies, covering both front-end and back-end aspects. Students will learn to design, develop, and deploy interactive websites using HTML, CSS, JavaScript, and server-side scripting with PHP or Node.js, along with database integration. The course focuses on hands-on learning and equips students for careers in web development, UI/UX design, and full-stack engineering.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	**Course Outcome**	**BTL**
CO1	Understand the structure and design principles of web applications.	L2
CO2	Develop interactive and responsive web pages using HTML, CSS, and JavaScript.	L3
CO3	Implement dynamic web applications using server-side scripting.	L3
CO4	Connect web applications with databases for data management.	L4
CO5	Deploy and manage complete web applications using modern web tools.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Web Technologies
Scope of Module: Covers the fundamentals of how the web works, including protocols, architecture, and core components.
Topics: Introduction to Internet and Web, Web Servers and Clients, HTTP and HTTPS Protocols, URL and URI Concepts, DNS and Hosting Basics, Static vs. Dynamic Websites, Web Browsers and Developer Tools, MIME Types and Web Content Types, TCP/IP and Sockets Overview, Browser Rendering Process, HTML Document Structure, Responsive Design Principles, Introduction to Web Accessibility (WCAG), Browser Compatibility Issues, Role of Web Standards (W3C).
Learning Outcome: *Understand the core architecture and functioning of the web ecosystem.*

No. of Hours: 24

Module 2: Frontend Technologies – HTML, CSS, JavaScript
Scope of Module: Focuses on creating structured, styled, and interactive user interfaces using frontend technologies.
Topics: HTML5 Elements and Semantics, Forms and Validation, CSS3 Selectors and Properties, Responsive Design with Media Queries, CSS Frameworks (Bootstrap/Tailwind), Flexbox and Grid Layouts, Introduction to JavaScript Syntax, DOM Manipulation, Events and Event Handling, JavaScript Functions and Scope, Objects and Arrays, Form Validation with JavaScript, ES6 Features (Let, Const, Arrow Functions), Browser Storage (LocalStorage, SessionStorage), Introduction to AJAX and Fetch API.
Learning Outcome: - *Build responsive, accessible, and interactive front-end user interfaces.*

No. of Hours: 24

Module 3: Server-Side Programming and Backend Integration
Scope of Module: Introduces backend development and connecting frontend applications to databases and servers.
Topics: Introduction to Server-Side Scripting, Node.js and Express.js Basics, RESTful API Design, Routing and Middleware in Express, Working with JSON Data, Handling HTTP Requests and Responses, Templating Engines (EJS, Handlebars), Introduction to PHP (Optional), Error Handling in Server-Side Apps, Session Management and Cookies, Uploading and Handling Files, Working with Forms (POST, GET), Basic Authentication and Authorization, Connecting Frontend with Backend APIs, Building a Simple Full-Stack App.
Learning Outcome: *Create and connect server-side logic to client-side interfaces using web frameworks.*

No. of Hours:24

Module 4: Databases and Web Integration
Scope of Module: Focuses on integrating databases into web applications and managing data using queries.
Topics: Relational Databases Overview (MySQL, PostgreSQL), NoSQL Databases (MongoDB), Database Design Basics, CRUD Operations in SQL, Mongoose with MongoDB in Node.js, Connecting Backend to Database, Query Parameters and Filtering, ORM Basics (Sequelize/Mongoose), Data Validation and Sanitization, Indexing and Performance Tuning, Managing Relationships and Joins, Authentication Data Storage, Environment Variables and DB Security, Transactions and Error Handling, Integrating Search in Web Applications.

***Learning Outcome**: Design and connect databases to dynamic web applications for persistent storage.*

No. of Hours:24

Module 5: Web Deployment, Security, and Modern Trends
Scope of Module: Covers web application deployment, security, DevOps integration, and modern web development trends.
Topics: Deployment on Platforms (Vercel, Netlify, Heroku), Git and GitHub for Version Control, Continuous Deployment Pipelines, Domain Registration and DNS Setup, SSL Certificates and HTTPS, Security Best Practices (XSS, CSRF, SQL Injection), HTTPS and Secure Headers, Content Delivery Networks (CDN), CORS Policy and Management, Progressive Web Apps (PWA), Introduction to Single Page Applications (React, Angular), WebSockets and Real-Time Communication, SEO Optimization for Web Apps, Lighthouse and Performance Auditing, Introduction to JAMstack Architecture.
***Learning Outcome**: Deploy, secure, and optimize modern web applications using best practices*

.

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- ➢ Basic understanding of programming concepts (e.g., loops, functions)
- ➢ Exposure to HTML or any markup language is beneficial
- ➢ Logical reasoning and analytical thinking

Pedagogy / Teaching Methodology:

✓ Hands-on coding with integrated browser tools
✓ Live problem-solving through lab exercises
✓ Real-world project-based learning
✓ Git-based version tracking and collaboration
✓ Assignments, quizzes, and mini-projects

Certificate / Value Added Courses Recommended (with Free Resource Links):

17. Web Development by NPTEL (IIT Madras)
    https://nptel.ac.in/courses/106105084
18. Responsive Web Design by freeCodeCamp
    https://www.freecodecamp.org/learn
19. Full Stack Open 2024 by University of Helsinki
    https://fullstackopen.com/en/
20. HTML, CSS, and JS for Web Developers (Coursera)
    https://www.coursera.org/learn/html-css-javascript-for-web-developers

Suggested Readings:

- Jon Duckett, *HTML & CSS: Design and Build Websites*, Wiley
- Robin Nixon, *Learning PHP, MySQL & JavaScript*, O'Reilly
- Ethan Brown, *Web Development with Node and Express*, O'Reilly
- MDN Web Docs: https://developer.mozilla.org/
- W3Schools Reference: https://www.w3schools.com/

Recommended Software/Tools (If applicable):

22. Visual Studio Code
23. Node.js + npm
24. Postman for REST API testing
25. MongoDB Atlas and phpMyAdmin
26. Bootstrap, Tailwind CSS
27. Heroku / Netlify / Vercel for deployment
28. React / Angular (for SPA introduction)

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	–	2	3	2	–	–	2
CO2	3	3	3	2	3	3	3	–	1	3
CO3	3	3	3	3	3	3	2	1	1	3
CO4	3	3	2	3	3	3	3	–	1	3
CO5	3	3	3	3	3	3	3	2	2	3
Articulation	3	2.8	2.6	2.75	2.8	3	2.6	1.5	1.25	2.8

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Course Code:	25VBT0C402
Semester:	**IV**
Credits:	**4**
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	**12 hours**

Course Description:

This course introduces students to the fundamental principles of Object-Oriented Programming (OOP) using Java. It covers basic to advanced Java concepts including classes, objects, inheritance, polymorphism, exception handling, multithreading, and file I/O. The course emphasizes writing robust and efficient programs that solve real-world problems using Java's extensive features and libraries.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Develop a strong foundation in OOP concepts and core Java programming principles.	L2
CO2	Apply core Java constructs such as variables, loops, arrays, and control statements to develop simple applications.	L3
CO3	Apply exception handling techniques to manage runtime errors effectively.	L3
CO4	Develop multithreaded applications and implement synchronization mechanisms.	L4
CO5	Design and implement Java applications to solve real-world problems using complete Java concepts.	L5

Course Modules

No. of Hours :

24

Module 1: Object-Oriented Concepts and Java Fundamentals
Scope of Module: Covers the basic structure of object-oriented programming and introduces Java as an OOP language.

Topics:
Introduction to the key principles of object-oriented programming including objects, classes,abstraction,encapsulation, inheritance,polymorphism, and abstract classes, Java programming fundamentals, understanding bytecode, and the Java development kit (JDK), Java Runtime Environment (JRE), and Java Virtual Machine (JVM), primitive data types, literals, variables, typecasting, operators, and shorthand assignments, control flow constructs including if-else, switch statements, and input reading, looping constructs like for, while, do-while,and enhanced for-loops with break, continue, and nesting techniques.

Learning Outcome: *Understand the fundamentals of Java and OOP principles, and apply control statements and loops in programs.*

No. of Hours : 24

Module 2:Classes, Objects, Methods, and Arrays

Scope of Module:
Explores the core building blocks of Java programs including class design, object instantiation, and method usage.

Topics:
Class fundamentals, object declaration, method definitions, constructors (default and parameterized), the use of this keyword, scanner class, garbage collection, and the finalize() method, constructor and method overloading, recursion, static and final keywords, and access control, inner and nested classes, array handling(one-dimensional and multi-dimensional arrays), alternative array declarations, enhanced for-loops, and array references, Java built-in functions for arrays and array-based problem-solving.

Learning Outcome: *Comprehend and implement class structures, object interaction, method overloading, and array operations*.

No. of Hours: 24

Module 3:Working with Strings, Inheritance, and Interfaces

Scope of Module:
Focuses on handling string data, using inheritance to model hierarchies, and applying interfaces for abstraction.

Topics:
String class, constructors, length property, string comparison, character extraction, string modification, case conversion, StringBuffer and StringBuilder formutable strings, inheritance in depth, including member access, method overriding, super keyword usage, constructor chaining, abstract classes, dynamic method dispatch, the Object class, Interface concepts include creating and implementing interfaces, multiple inheritance using interfaces, extending interfaces, constants and variables in interfaces, distinguishing between interfaces and abstract classes.

Learning Outcome: *Implement inheritance and interfaces to build reusable and flexible code structures while managing string data effectively.*

No. of Hours :24

Module 4: Exception Handling and Multithreading

Scope of Module: Introduces robust programming techniques using exception handling and explores process-based multitasking with threads
Topics: Introduction to Java's exception handling model including try-catch-finally blocks, throw and throws keywords, exception hierarchy, multiple catch blocks, nested try statements, and handling subclass exceptions, custom exception creation, exception subclasses, chained exceptions, and exception handling with method overriding, multithreading fundamentals, the main thread, creating and managing threads using the Thread class and Runnable interface, thread priorities, lifecycle management, synchronization using methods and synchronized blocks.
Learning Outcome: *Design applications that handle runtime errors gracefully and manage concurrent execution using multithreading.*

No. of Hours : 24

Module 5: Java File I/O and Real-World Applications
Scope of Module: Covers input/output operations using Java I/O streams and applies learned concepts to build complete Java applications.
Topics: Introduction to JavaI/O classes and interfaces, byte and character stream classes, stream hierarchy, text and binaryfile handling,file reading, writing, random access files, serialization and deserialization,Java-based applications combining all key concepts including classes, objects, inheritance, exception handling, file operations, and multithreading, use cases such as calculators, student record systems, file processors, and real-time data handling apps .
Learning Outcome: *Design complete Java programs incorporating object-oriented principles, exception handling, file operations, and multithreading*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic programming knowledge
- Familiarity with procedural programming
- Understanding of problem-solving using algorithms

Pedagogy / Teaching Methodology:

- ✓ Hands-on programming exercises using IDEs like Eclipse or IntelliJ
- ✓ Real-time code walkthroughs and live debugging
- ✓ Mini-projects like file processors, calculators, and student record systems
- ✓ Case studies based on real-world Java applications
- ✓ Weekly coding challenges and quizzes

Certificate / Value Added Courses Recommended (Free Resource Links):

13. Coursera: Java Programming and Software Engineering Fundamentals – Duke University
14. Oracle Java Tutorials
15. JetBrains Academy: Java Developer Track
16. Udacity: Java Programming Basics

Suggested Readings:

- Herbert Schildt, *Java: The Complete Reference*, McGraw Hill
- Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall
- Kathy Sierra and Bert Bates, *Head First Java*, O'Reilly Media
- Y. Daniel Liang, *Introduction to Java Programming and Data Structures*, Pearson

Recommended Software/Tools:

16. **Java Development Tools:** Eclipse, IntelliJ IDEA, NetBeans
17. **JDK Version:** Java SE 17 or latest LTS version
18. **Build Tools:** Maven, Gradle
19. **Version Control:** Git/GitHub

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	–	2	–	–	1	–	2
CO2	2	3	3	–	3	–	–	1	1	2
CO3	2	3	3	2	3	–	1	–	–	2
CO4	2	3	3	2	3	2	2	1	–	2
CO5	1	2	3	3	3	3	2	2	2	3
Articulation	2	2.8	3	2.3	2.8	2.5	1.6	1.25	1.5	2.2

Course Title:	Containers and Microservices
Course Code:	25VBT3E403
Semester:	IV
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course introduces the fundamentals of containerization and microservices, essential for modern cloud-native application development. Students will learn to create and manage containerized applications using Docker and orchestrate them with Kubernetes. The course covers microservices design, communication, security, and scaling. Emphasis is placed on hands-on practice with tools like CI/CD pipelines, service mesh, and event-driven systems, preparing students to build scalable and resilient microservices-based solutions aligned with industry best practices.

Course Outcomes (COs) :

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Fundamentals of containers and microservices architecture, including benefits and design principles	L2
CO2	Containerization techniques using Docker and deployment of applications	L3
CO3	Challenges and solutions in microservices communication, testing, and security	L4
CO4	Scalable and maintainable microservices systems using container orchestration and CI/CD	L5
CO5	Advanced topics such as service mesh, event-driven architecture, and industry trends in cloud-native applications	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to Containers and Microservices

Scope of Module: This module introduces the fundamental concepts of containerization and microservices architecture. It covers the purpose and benefits of containers, compares them with virtual machines, and explains the core principles of microservices including patterns, benefits, and challenges.
Topics: Definition and purpose of containers, benefits of containerization, comparison between containers and virtual machines, container lifecycle and how containers work, popular container technologies such as Docker and Podman, introduction to microservices architecture, monolithic vs. microservices approach, benefits of adopting microservices, challenges and limitations in microservices, common microservices design patterns, principles of microservices design, domain-driven design and service decomposition, API design fundamentals, data management strategies in microservices, microservices versioning and maintenance.
Learning Outcome: *Understand the basics of containers and microservices architecture, and recognize the benefits, patterns, and challenges involved in adopting these technologies.*

No. of Hours : 24

Module 2: Containerization and Orchestration Tools
Scope of Module: This module focuses on practical aspects of containerization using Docker and introduces Kubernetes for container orchestration. It includes image creation, container networking, service discovery, and managing deployments.
Topics: Container images and image layers, creating Docker images using Dockerfiles, managing container images in registries, understanding Docker CLI commands, using Docker Compose for multi-container applications, image versioning and tagging strategies, container networking concepts, container volumes and storage mechanisms, introduction to Kubernetes architecture, pods and deployments in Kubernetes, writing Kubernetes YAML configuration files, scaling applications in Kubernetes, service discovery and networking in Kubernetes, managing secrets and ConfigMaps, implementing health checks and probes.
Learning Outcome: *Apply containerization and orchestration tools such as Docker and Kubernetes to build, deploy, and manage scalable containerized applications.*

No. of Hours : 24

Module 3: Microservices Communication, Security, and Testing
Scope of Module: This module explains how microservices communicate and interact securely. It also introduces the importance of testing and the tools used to ensure reliable microservices-based systems.

Topics: Synchronous vs. asynchronous communication models, using RESTful APIs in microservices, implementing gRPC for efficient communication, message brokers such as Kafka and RabbitMQ, event-driven architecture fundamentals, setting up API gateway for routing, service discovery mechanisms, authentication strategies in microservices, authorization using OAuth and JWT, securing APIs and token management, centralized logging strategies, introduction to monitoring tools, unit and integration testing in microservices, contract testing using Pact, end-to-end testing approaches and tools.
Learning Outcome: *Analyze communication and security mechanisms in microservices, and evaluate appropriate testing methodologies to ensure secure and reliable services.*

No. of Hours : 24

Module 4: CI/CD, Scaling, and Service Mesh in Microservices
Scope of Module: This module explores automation of software delivery using CI/CD, strategies for scaling microservices, and the use of service mesh for secure and observable communication.
Topics: Principles of CI/CD in microservices, configuring CI/CD pipelines with Jenkins, implementing GitHub Actions for automation, automating tests and builds in deployment workflows, blue-green deployment strategy, canary deployment strategy, rollback mechanisms for failed deployments, horizontal scaling in Kubernetes, vertical scaling and resource allocation, load balancing strategies, Kubernetes auto-scaling features, performance tuning and optimization, introduction to service mesh architecture, implementing Istio in Kubernetes, observability with service mesh dashboards.
Learning Outcome: *Develop and manage efficient CI/CD workflows, implement scalable deployment practices, and utilize service mesh tools for robust microservices communication.*

No. of Hours : 24

Module 5: Advanced Microservices Design and Industry Trends
Scope of Module: This module delves into advanced microservices techniques such as event-driven design and addresses real-world challenges. It also discusses emerging trends in containerization and cloud-native development.
Topics: Understanding event-driven microservices, using event sourcing for state management, applying

CQRS design pattern, tools for event streaming like Kafka and RabbitMQ, handling asynchronous communication challenges, ensuring data consistency across services, designing for fault tolerance and resilience, inter-service communication issues, debugging distributed microservices, using observability tools like Prometheus and Grafana, managing microservices complexity, exploring serverless architectures, containerization in edge computing environments, future trends in cloud-native ecosystems, real-world case studies and industry best practices.
Learning Outcome: *Design advanced microservices solutions, manage complexity in large-scale systems, and stay informed about emerging trends and technologies in the container and microservices ecosystem.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of operating systems and networks
- Knowledge of web development and APIs
- Familiarity with cloud computing concepts
- Awareness of software development life cycle and DevOps principles

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs with Docker, Kubernetes, and CI/CD pipelines
- ✓ Real-world simulation projects using containerized microservices
- ✓ Case studies of industry adoption and architectural patterns
- ✓ Group assignments on service design and orchestration

Certificate / Value Added Courses Recommended:

1. Introduction to Containers – Red Hat
2. Docker Essentials – IBM via Coursera
3. Kubernetes Basics – Kubernetes.io
4. Google Cloud: Architecting with Kubernetes – Coursera

Suggested Readings:

- Nigel Poulton, *The Docker Book*
- Sam Newman, *Building Microservices: Designing Fine-Grained Systems*
- Brendan Burns, *Designing Distributed Systems*
- Bilgin Ibryam, *Kubernetes Patterns*
- Morgan Bruce & Paulo A. Pereira, *Microservice Architecture*

Recommended Software/Tools:

1. **Containerization**: Docker, Podman
2. **Orchestration**: Kubernetes, Helm
3. **CI/CD**: Jenkins, GitHub Actions, GitLab CI
4. **Service Mesh**: Istio, Linkerd

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-		2	1	1	1	2
CO2	2	3	3	2	3	2	1	1	2	2
CO3	2	2	2	2	3	3	2	2	2	3
CO4	1	3	2	3	3	2	-	2	2	2
CO5	1	3	3	2	3	3	2	3	3	3
Articulation	1.8	2.6	2.2	2.25	2.8	2.4	1.5	1.8	2	2.4

Course Title:	AWS Cloud Computing Essentials
Course Code:	25VBT3E404
Semester:	IV
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course introduces the foundational principles of Amazon Web Services (AWS), covering its core services, architecture, security, and cost management. Students will explore AWS deployment models, virtualization, and automation strategies while gaining hands-on experience with cloud computing tools and services. The course prepares learners to design, deploy, and manage cloud-based solutions effectively, aligned with industry standards and practices.

Course Outcomes

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Foundational concepts, architecture, and services of AWS	L2
CO2	AWS deployment and service models, including applications and implications	L4
CO3	AWS services and their use cases, offerings, and benefits	L5
CO4	Virtualization and its role within AWS	L3
CO5	AWS security, governance, and compliance for secure cloud operations	L3

Course Modules

No. of Hours : 24

Module 1: AWS Foundations and Architecture
Scope of Module: This module introduces the fundamental concepts, characteristics, and components of AWS cloud infrastructure. It provides an understanding of the global AWS architecture and foundational services used in cloud deployments.
Topics: Definition and characteristics of AWS, overview of AWS global infrastructure, benefits of using AWS, challenges of adopting AWS, key AWS services and their categories, AWS cloud architecture basics, understanding EC2, S3, RDS, Lambda, role of availability zones and regions, AWS Well-Architected Framework principles, public cloud deployment on AWS, hybrid cloud with AWS Outposts, multi-cloud strategies using AWS, use cases of AWS deployment models, comparison of deployment models.
Learning Outcome: *Explain foundational AWS concepts, cloud architecture, and deployment models with real-world examples.*

No. of Hours : 24

Module 2: Core AWS Services and IAM
Scope of Module: This module focuses on the core service models provided by AWS and the identity and access control mechanisms to securely manage AWS resources.
Topics: Infrastructure as a Service (IaaS) with AWS EC2, Platform as a Service (PaaS) with Elastic Beanstalk, Software as a Service (SaaS) via AWS Marketplace, comparison of AWS service models, selecting the right service model, introduction to AWS IAM, creating and managing IAM users, managing IAM groups and roles, IAM policies and permissions, IAM best practices, enabling multi-factor authentication (MFA), role-based access control in AWS, AWS CLI for IAM, audit logs and monitoring with IAM, AWS Organizations and SCPs.
Learning Outcome: *Evaluate AWS service models and apply IAM best practices to manage secure user access and permissions.*

No. of Hours : 24

Module 3: Networking, Storage, and Security in AWS
Scope of Module: This module covers AWS networking concepts, storage solutions, and security mechanisms used to safeguard cloud resources.

Topics: Fundamentals of AWS networking, creating and managing Virtual Private Clouds (VPCs), subnets and route tables, configuring internet gateways and NAT gateways, security groups and NACLs, Elastic Load Balancing (ELB), overview of AWS storage types (S3, EBS, EFS), data redundancy and replication strategies, cost optimization for storage, lifecycle management policies, introduction to AWS KMS, data encryption in AWS, identity-based and resource-based security policies, security best practices and compliance standards, shared responsibility model.
Learning Outcome: *Explain how AWS handles networking, storage, and security to ensure scalable and secure infrastructure management..*

No. of Hours : 24

Module 4: Monitoring, Cost Management, and Migration
Scope of Module: This module explores AWS tools for monitoring, billing, automation, and migrating workloads to the cloud with reliability and cost-effectiveness.
Topics: AWS CloudWatch for monitoring resources, CloudTrail for auditing and logs, performance tuning strategies in AWS, incident response using AWS tools, automation with AWS Lambda, introduction to CloudFormation templates, cost structure and billing in AWS, AWS pricing calculator, AWS Budgets and alerts, cost optimization techniques, AWS Cost Explorer and Trusted Advisor, AWS Migration Hub overview, database migration with AWS DMS, challenges in AWS migration, case studies on AWS migration.
Learning Outcome: *Utilize AWS tools for monitoring, automation, cost control, and plan effective cloud migration strategies.*

No. of Hours : 24

Module 5: Advanced AWS Concepts and Trends
Scope of Module: This module introduces advanced AWS services including databases, serverless computing, machine learning, and explores current trends and innovations in cloud computing.
Topics: Overview of AWS database services, RDS for relational databases, DynamoDB for NoSQL solutions, Redshift for data warehousing, introduction to serverless computing, AWS Lambda use cases, serverless architecture benefits and limitations, AI/ML integration in AWS, SageMaker for machine learning, AWS Rekognition and Lex for AI applications, edge computing with AWS Greengrass, IoT integration using AWS IoT Core, cloud-native application development, emerging trends in cloud security, industry innovations using AWS.
Learning Outcome: *Explore advanced AWS services and analyze emerging trends and technologies shaping the future of cloud computing.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of cloud computing concepts
- Familiarity with networking, virtualization, and operating systems
- Exposure to programming (e.g., Python, JavaScript) and system administration (preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using AWS Free Tier and Management Console
- ✓ Practical walkthroughs of EC2, IAM, S3, and Lambda
- ✓ Case study analysis of AWS use cases across industries
- ✓ Group-based cloud migration and cost management simulations

Certificate / Value Added Courses Recommended (Free Resources):

1. AWS Cloud Practitioner Essentials – AWS Skill Builder
2. AWS Technical Essentials – Coursera
3. AWS Certified Solutions Architect – Udemy/ACloudGuru
4. AWS Educate: Cloud Foundations Course

Suggested Readings:

- Mark Wilkins, *Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals*
- Tom Carpenter, *AWS Certified Cloud Practitioner Study Guide*
- Stephen Baron, *AWS for Non-Engineers*
- Amazon Web Services, *AWS Well-Architected Framework Whitepaper*
- Official AWS Documentation – https://docs.aws.amazon.com

Recommended Software/Tools:

1. **AWS Console & CLI**: EC2, S3, IAM, Lambda, RDS
2. **Monitoring & Auditing**: AWS CloudWatch, CloudTrail, AWS Config
3. **Automation & Templates**: AWS CloudFormation, AWS Elastic Beanstalk
4. **Cost Tools**: AWS Pricing Calculator, AWS Budgets, Cost Explorer

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	-	1	1	2
CO2	2	3	3	2	3	2	1	1	1	2
CO3	2	3	3	2	3	2	1	-	1	2
CO4	2	2	3	3	3	3	2	2	2	2
CO5	2	2	3	3	3	3	2	2	2	3
Articulation	2.2	2.4	2.8	2.2	2.8	2.6	1.5	1.5	1.4	2.2

Course Title:	Quantitative Techniques
Course Code:	25VBT0C404
Semester:	**IV**
Credits:	**3**
Course Type	Generic Elective
Learning Hours	90
Live Sessions	**12 hours**

Course Description:
This course aims to equip students with the mathematical and statistical tools required for decision-making and problem-solving in computer applications and business scenarios. It covers topics such as linear programming, probability, statistics, correlation, regression, and queuing theory. These quantitative techniques are essential for data analysis, operations research, and software modeling.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO	Course Outcome	BTL
CO1	Understand the fundamentals of quantitative methods and their applications in computer science.	L2
CO2	Solve optimization problems using linear programming and graphical methods.	L3
CO3	Apply concepts of probability and distributions in real-life decision-making.	L3
CO4	Analyze data using correlation, regression, and index numbers.	L4
CO5	Demonstrate the use of queuing theory and statistical decision-making tools.	L5

Course Modules

No. of Hours:18

Module 1: Linear Algebra and Equations
Scope of Module: Covers matrix operations, system of linear equations, and their computational applications.
Topics: Types of Matrices, Matrix Operations, Determinants and Properties, Inverse of a Matrix, Solving Linear Equations (Cramer's Rule, Matrix Inversion), Gauss Elimination Method, Rank of a Matrix, Eigenvalues

and Eigenvectors, Applications in Computer Graphics, Linear Dependence and Independence, Linear Transformation, Diagonalization, Vector Spaces, Basis and Dimension, Applications in Data Science.
Learning Outcome: *Use matrix algebra to solve linear systems and perform transformations in computing.*

No. of Hours: 18

Module 2: Descriptive Statistics
Scope of Module: Focuses on summarizing and interpreting data using various statistical measures.
Topics: Types of Data, Data Collection Methods, Frequency Distribution, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Variance, Standard Deviation), Skewness and Kurtosis, Percentiles and Quartiles, Data Visualization (Histograms, Pie Charts, Box Plots), Cross-tabulation and Contingency Tables, Correlation Analysis, Covariance, Scatter Plots, Use of Excel/SPSS for Data Analysis, Real-life Data Interpretation.
Learning Outcome: *Analyze and describe data using statistical measures and visualizations.*

No. of Hours: 18

Module 3: Linear Programming and Optimization
Scope of Module: Explores techniques for modeling and solving optimization problems using LPP.
Topics: Introduction to Linear Programming, Formulating LPPs, Graphical Method, Simplex Method, Duality in LPP, Sensitivity Analysis, Transportation Problem, Assignment Problem, Degeneracy and Unbalanced Problems, Maximization and Minimization Models, Profit and Cost Optimization, Integer Programming, Decision Variables and Constraints, Real-world Applications, Use of Solver Tools in Excel.
Learning Outcome: *Formulate and solve optimization problems using linear programming techniques.*

No. of Hours: 18

Module 4: Probability and Distributions
Scope of Module: Introduces probability concepts and probability distributions for quantitative reasoning.
Topics: Basic Probability Rules, Conditional Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Expected Value and Variance, Binomial Distribution, Poisson Distribution, Normal Distribution, Central Limit Theorem, Applications in Risk Analysis, Z-scores and Standardization, Probability Trees, Joint and Marginal Probabilities, Monte Carlo Simulations, Statistical Applications in IT.
Learning Outcome: *Apply probability and distributions to evaluate uncertain events and risks.*

No. of Hours: 18

Module 5: Decision Theory and Forecasting

Scope of Module: Focuses on decision-making techniques and forecasting tools for business applications.
Topics: Decision-Making Under Certainty, Uncertainty, and Risk, Payoff Tables and Decision Trees, Expected Monetary Value, Maximax, Maximin, Minimax Regret, Forecasting Techniques (Moving Average, Exponential Smoothing), Time Series Analysis, Trend and Seasonality Detection, Regression Models, Index Numbers, Error Analysis (MAD, MSE), Use of Forecasting in Business and IT, Software Tools for Decision Analysis.
Learning Outcome: *Implement decision analysis and forecasting models for planning and problem-solving.*

Module	No of Pre Recordings
1	10
2	12
3	10
4	12
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic mathematics at the undergraduate level
- Understanding of algebra, probability, and basic statistics
- Familiarity with spreadsheet tools (like MS Excel)

Pedagogy / Teaching Methodology:

- ✓ Problem-based and application-oriented learning
- ✓ Visualization of data through graphs, charts, and software tools
- ✓ Case studies and simulations
- ✓ Hands-on exercises using Excel/SPSS
- ✓ Interactive problem-solving and interpretation sessions

Certificate / Value Added Courses Recommended (with Free Resource Links):

16. NPTEL: Probability and Statistics
    https://nptel.ac.in/courses/111105090
17. Coursera: Statistics with Excel
    https://www.coursera.org/learn/basic-statistics-excel
18. edX: Data Science: Probability
    https://learning.edx.org/course/course-v1:HarvardX+PH525.1x+3T2020/home
19. MIT OpenCourseWare: Introduction to Probability and Statistics
    https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/

Suggested Readings:

- Richard I. Levin & David S. Rubin, Statistics for Management, Pearson
- S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House
- Taha H. A., Operations Research: An Introduction, Pearson
- Vohra N.D., Quantitative Techniques in Management, Tata McGraw-Hill
- Online articles from JSTOR, ScienceDirect, and SpringerLink for research-based insights

Recommended Software/Tools (If applicable):

14. Microsoft Excel (with Solver add-in)
15. SPSS for statistical analysis
16. R or Python (NumPy, SciPy, Pandas, Statsmodels)
17. Tableau or Power BI for data visualization

Curriculum Development:

Sl.No	**Identify and Highlight in the Modules**
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

- **Note**: It is not necessary that all the courses must have all the above said points.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	2	3	2	2
CO2	3	2	3	3	2	3	2	3	3	2
CO3	3	2	2	2	2	-	1	1	1	2
CO4	2	3	3	3	2	1	1	2	2	3
CO5	3	3	3	2	2	-	1	2	3	2
Articulation	2.8	2.6	2.6	2.6	2	2.3	1.4	2.2	2.2	2.2

Semester V

Course Title	Block Chain Technologies
Course Code	25VBT0C501
Semester	V
Credits	4
Course Type	Core Course
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course introduces the foundational and advanced aspects of blockchain technology. Students will explore blockchain architecture, cryptographic techniques, smart contracts, and application platforms. They will also evaluate blockchain's impact on security, privacy, business ecosystems, and societal implications. The course emphasizes practical skills through development environments and case studies.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Understand the fundamental concepts of blockchain technology.	L2
CO2	Explore various blockchain platforms and their applications.	L3
CO3	Develop skills to design and implement blockchain-based solutions.	L4
CO4	Analyze the security and privacy aspects of blockchain.	L4
CO5	Assess the impact of blockchain technology on business and society.	L5

Course Modules

No. of Hours: 24

Module 1: Foundations of Blockchain Technology
Scope of Module: Introduces the basics, architecture, and cryptographic foundation required for understanding blockchain systems.
Topics: Introduction to Blockchain Technology, History and Evolution of Blockchain, Types of Blockchains: Public, Private, Consortium, Applications of Blockchain Technology, Components of Blockchain: Blocks, Chains, Nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Smart

Contracts and Their Execution, Blockchain Forks, Basic Cryptographic Concepts: Hash Functions, Digital Signatures, Public Key Infrastructure (PKI), Cryptographic Algorithms Used in Blockchain
Learning Outcome: - *Gain foundational understanding of blockchain principles, architecture, and cryptography.*

No. of Hours: 24

Module 2: Blockchain Platforms and Development
Scope of Module: Focuses on blockchain ecosystems and hands-on development using Ethereum and other platforms.
Topics: Bitcoin and Ethereum: Structure and Functionality, Hyperledger Fabric, Ripple, Corda and Other Blockchain Platforms, Setting Up Blockchain Development Environment, Writing Smart Contracts in Solidity, Deploying Smart Contracts on Ethereum, Decentralized Applications (DApps), Detailed Study of Smart Contracts, Smart Contract Development and Testing, Real World Use Cases of Smart Contracts
Learning Outcome: - *Explore and implement blockchain-based solutions using various platforms and tools.*

No. of Hours: 24

Module 3: Blockchain Security, Privacy and Compliance
Scope of Module: Analyzes the threats and solutions related to blockchain security, privacy regulations, and standards.
Topics: Security Issues in Blockchain, Attacks on Blockchain: 51% Attack, Sybil Attack, Privacy Solutions in Blockchain, Regulatory and Legal Implications, Data Privacy Laws and Regulations, Blockchain's Role in Ensuring Data Privacy, Case Studies on Privacy Issues in Blockchain, Overview of Popular Cryptocurrencies, Cryptocurrency Mining and Transactions, Regulatory Aspects of Cryptocurrencies, International Standards for Blockchain Technology, Frameworks and Protocols for Blockchain Development, Compliance and Best Practices
Learning Outcome: - *Evaluate security vulnerabilities, privacy frameworks, and compliance in blockchain systems.*

No. of Hours: 24

Module 4: Blockchain Applications in Industry and Society
Scope of Module: Explores how blockchain is transforming industries and provides real-world use cases across various domains.
Topics: Blockchain in Financial Services: Cryptocurrencies, Payment Systems, Supply Chain Management, Healthcare and Identity Management, Government and Public Services, Impact of Blockchain on Business Models, Case Studies in Finance, Supply Chain and Healthcare, Blockchain for Enterprise Solutions, Emerging Research Areas in Blockchain, Potential Future Applications, Ethical and Societal Implications
Learning Outcome: - *Assess real-world blockchain use cases, societal impacts, and business transformation through blockchain.*

No. of Hours: 24

Module 5: Advanced Blockchain Integration and Emerging Trends
Scope of Module: Covers the integration of blockchain with other technologies and future innovations.
Topics: Interoperability and Scalability in Blockchain, Blockchain and the Internet of Things (IoT), Blockchain and Artificial Intelligence (AI), Future Trends and Innovations in Blockchain, Integrating Blockchain with Cloud Platforms, Use Cases of Blockchain in Cloud Computing, Advantages and Challenges
Learning Outcome: - *Analyze the integration of blockchain with emerging technologies and its future direction.*

Module	No of Pre Recordings
1	**10**
2	**12**
3	**10**
4	**12**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of cryptography and networking
- Familiarity with distributed systems
- Programming experience (preferably in JavaScript, Python, or Solidity)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for smart contract development using Solidity
- ✓ Simulations and projects involving blockchain platforms like Ethereum and Hyperledger
- ✓ Case study discussions on real-world blockchain implementations

- ✓ Group activities on blockchain architecture and DApp design
- ✓ Evaluation through mini-projects, quizzes, and practical assignments

Certificate / Value Added Courses Recommended (Free Resource Links):

13. Coursera: Blockchain Specialization – University at Buffalo & SUNY
14. IBM Blockchain Foundation Developer Course
15. edX: Blockchain Fundamentals – UC Berkeley
16. Blockchain Council: Free Blockchain Courses

Suggested Readings:

- Arvind Narayanan et al., *Bitcoin and Cryptocurrency Technologies*, Princeton University Press
- Melanie Swan, *Blockchain: Blueprint for a New Economy*, O'Reilly
- Imran Bashir, *Mastering Blockchain*, Packt Publishing
- Don Tapscott & Alex Tapscott, *Blockchain Revolution*, Penguin

Recommended Software/Tools:

7. **Smart Contract Development:** Remix IDE, Truffle, Hardhat
8. **Blockchain Platforms:** Ethereum, Hyperledger Fabric, Corda
9. **Languages:** Solidity, JavaScript, Go
10. **Testing and Deployment:** Ganache, MetaMask, Infura
11. **Development Environments:** Visual Studio Code, Docker
12. **Version Control:** Git/GitHub

Curriculum Development:

Sl.No	Identify and highlight in the module
1	Local, Regional, National and Global
2	Employability, Entrepreneurship and Skill Development

3	Value Added Courses (Module)
4	Integration of Digital Learning Tools
5	Crossing Cutting Edges (Ethics, Gender Equality, Sustainability and Environmental concerns)
6	Indian Knowledge System

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	–	1	1	2
CO2	2	–	2	2	–	3	2	–	1	2
CO3	2	3	–	2	–	2	2	2	–	2
CO4	2	3	2	–	2	–	3	2	1	2
CO5	1	2	1	2	1	3	–	2	2	–
Articulation	2	2.5	1.5	1.75	1.67	2.5	2.33	1.75	1.25	2

Course Title:	Cloud Infrastructure and Services
Course Code:	25VBT3E502
Semester:	V
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course introduces the foundational concepts, design principles, and tools essential for deploying, managing, and optimizing cloud infrastructure. It explores compute, storage, networking, orchestration, monitoring, security, and cost management within cloud environments. Students will gain practical knowledge of managing cloud infrastructure efficiently and securely, preparing them to build scalable, resilient, and cost-effective cloud-based systems.

Course Outcomes

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Fundamental principles of cloud infrastructure and its components	L2
CO2	Cloud services and infrastructure solutions for deployment and management	L4
CO3	Cloud infrastructure strategies for performance, scalability, and cost optimization	L5
CO4	Cloud infrastructure management using tools and platforms	L3
CO5	Best practices for monitoring, troubleshooting, and securing cloud infrastructure	L4

Course Modules

No. of Hours : 24

Module 1: Cloud Infrastructure Fundamentals and Compute Services
Scope of Module:

This module introduces the core concepts of cloud infrastructure and explains the principles of data center design. It also covers compute services including VMs, containers, and serverless technologies.
Topics: Definition and components of cloud infrastructure, comparison with traditional infrastructure, infrastructure management approaches, data center architecture principles, power and cooling systems, network architecture in data centers, compute models in cloud, virtual machines and hypervisors, containers and container engines, differences between VMs and containers, introduction to serverless computing, use cases of compute services, provisioning compute resources, elasticity and scalability in compute services, performance tuning for compute workloads.
Learning Outcome: *Explain the components and operations of cloud infrastructure and compute services, highlighting differences from traditional IT systems*

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No. of Hours : 24

Module 2: Storage, Networking, and Cost Management
Scope of Module: This module focuses on the storage and networking services in cloud infrastructure and introduces effective cost management strategies and tools.
Topics: Overview of cloud storage types (block, object, file), choosing the right storage solution, data lifecycle policies, storage cost management techniques, data replication and durability, scalability and performance considerations, virtual private cloud (VPC) concepts, subnets and routing tables, internet gateways and NAT gateways, network access controls and firewalls, load balancing strategies, content delivery networks (CDNs), cost structure of cloud resources, budgeting and forecasting techniques, cost monitoring tools (Cost Explorer, CloudHealth).
Learning Outcome: *Evaluate storage and networking solutions in cloud infrastructure and apply cost management techniques effectively.*

No. of Hours : 24

Module 3: Cloud Automation, Monitoring, and Security
Scope of Module: This module covers orchestration and automation using IaC tools, monitoring systems for cloud environments, and best practices in securing cloud infrastructure.
Topics: Introduction to orchestration platforms, Kubernetes architecture and deployments, OpenStack components and services, automation tools like Terraform and Ansible, benefits of Infrastructure as Code (IaC), implementation of IaC using Terraform, cloud monitoring tools (CloudWatch, Prometheus), performance monitoring strategies, incident detection and response, introduction to cloud security challenges, securing cloud networks with firewalls and VPNs, identity and access management,

encryption and key management, multi-factor authentication and role-based access control, compliance and governance policies.
Learning Outcome: *Implement automation, monitoring, and security strategies for efficient cloud infrastructure management.*

No. of Hours : 24

Module 4: Scalability, Disaster Recovery, and Cloud Migration
Scope of Module: This module explores principles of high availability, disaster recovery strategies, and tools for migrating on-premise infrastructure to the cloud.
Topics: High availability concepts, vertical and horizontal scaling, auto-scaling groups and policies, load balancing and failover mechanisms, designing resilient architectures, backup and restore strategies, disaster recovery objectives (RTO/RPO), DR planning and implementation, real-world DR scenarios, cloud migration planning steps, tools for migration (AWS Migration Hub, Azure Migrate), overcoming migration challenges, risk analysis during migration, case studies of successful cloud migration, lessons learned from real migrations.
Learning Outcome: *Design resilient cloud architectures, plan migration strategies, and implement disaster recovery for business continuity.*

No. of Hours : 24

Module 5: Advanced Concepts and Industry Trends
Scope of Module: This module addresses emerging technologies and use cases in cloud infrastructure, including edge computing, serverless models, and real-world case studies.
Topics: Infrastructure as Code principles, benefits and challenges of IaC, tools like AWS CloudFormation and Terraform, introduction to serverless architectures, advantages of function-as-a-service (FaaS), cloud-native development practices, AI/ML integration with cloud infrastructure, edge computing and its role in latency reduction, IoT integration with cloud services, governance frameworks for compliance (GDPR, HIPAA), risk management strategies, real-world use cases from finance and healthcare, cloud usage in enterprise environments, green computing in cloud infrastructure, future innovations and trends.
Learning Outcome: *Identify advanced practices and emerging trends in cloud infrastructure and apply them to real-world business solutions.*

Module	No of Pre Recordings
1	12
2	11
3	10
4	11
5	12

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of computer networks and virtualization
- Familiarity with operating systems and system administration
- Awareness of cloud computing service models and platforms

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using platforms like AWS, Azure, and GCP
- ✓ Real-world case studies on migration, DR, and cost management
- ✓ Guided tutorials on IaC tools (Terraform, Ansible) and orchestration (Kubernetes)
- ✓ Performance monitoring simulations using tools like Prometheus and CloudWatch

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. AWS Cloud Practitioner Essentials – AWS Skill Builder
2. Google Cloud: Cloud Infrastructure Specialization – Coursera
3. Azure Infrastructure Fundamentals – Microsoft Learn
4. Terraform for IaC – HashiCorp Learn
5. Monitoring and Observability – New Relic University

Suggested Readings:

- Mark Wilkins, *Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud*
- Rajkumar Buyya et al., *Mastering Cloud Computing: Foundations and Applications Programming*
- Jeff Carpenter, *Cloud Native Infrastructure*
- Thomas Erl, *Cloud Computing: Concepts, Technology & Architecture*

- Official documentation and whitepapers from AWS, Azure, and GCP

Recommended Software/Tools:

1. **Cloud Platforms**: AWS, Azure, GCP
2. **Compute Tools**: EC2, Azure VMs, Google Compute Engine
3. **Storage Tools**: AWS S3, Azure Blob Storage, GCP Storage
4. **IaC & Orchestration**: Terraform, CloudFormation, Ansible, Kubernetes

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	-	1	2	2	1	1	1	2
CO2	2	3	2	2	3	2	-	2	1	2
CO3	2	3	2	3	3	2	1	2	2	2
CO4	1	2	3	2	3	2	2	2	2	2
CO5	2	2	2	3	3	2	3	2	2	3
Articulation	2	2.4	2.25	2.2	2.8	2	1.75	1.8	1.6	2.2

Course Title:	DevOps Fundamentals
Course Code:	25VBT3E503
Semester:	V
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course provides an in-depth understanding of DevOps principles, tools, and practices essential for modern cloud-native software development. Students will explore CI/CD, automation, monitoring, collaboration, and security within DevOps workflows. Emphasis is placed on industry practices, performance optimization, and real-world implementation strategies in cloud computing environments.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Principles and practices of DevOps methodology in cloud computing environments	L2
CO2	Tools and techniques for CI/CD and automated deployment in cloud-based systems	L3
CO3	Challenges encountered during DevOps implementation in cloud scenarios	L4
CO4	Strategies for collaboration, communication, and teamwork in DevOps teams	L5
CO5	Performance and efficiency of DevOps processes and tools with proposals for optimization	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to DevOps and Automation

Scope of Module: This module introduces DevOps methodology, its cultural aspects, tools, automation fundamentals, and continuous integration/delivery practices essential in cloud development.
Topics: Definition of DevOps, evolution and history of DevOps, core principles and values, DevOps lifecycle overview, role of DevOps in cloud computing, continuous integration (CI) and continuous delivery (CD), version control systems (Git), build automation techniques, configuration management tools (e.g., Ansible, Puppet), containerization basics with Docker, infrastructure as code (IaC) introduction, automation testing fundamentals, unit and integration testing automation, CI/CD pipeline design, benefits of automation in cloud environments.
Learning Outcome: *Describe the foundational principles, tools, and automation practices in DevOps and understand their application in cloud environments.*

No. of Hours : 24

Module 2: Deployment, Monitoring, and Cloud-Native DevOps
Scope of Module: Covers deployment strategies, performance monitoring, cloud-native development, and infrastructure resiliency in DevOps environments.
Topics: Deployment strategies overview, blue-green deployment, canary deployment, A/B testing strategies, monitoring fundamentals in DevOps, log management techniques, metrics and dashboards, cloud-native architecture concepts, container orchestration with Kubernetes, microservices principles, serverless computing models, fault tolerance strategies, scalability patterns in cloud-native apps, high availability architecture, use of Prometheus and Grafana for monitoring.
Learning Outcome: *Apply effective deployment and monitoring strategies in cloud-native DevOps to ensure application performance, scalability, and resilience.*

No. of Hours : 24

Module 3: Security, Collaboration, and Governance in DevOps
Scope of Module: Explores DevSecOps integration, collaboration practices, and governance principles essential for secure and compliant DevOps adoption.
Topics: DevSecOps principles and practices, secure software development lifecycle (SDLC), security automation tools, static and dynamic security testing, identity and access management in pipelines, compliance as code, policy enforcement tools, collaboration and communication tools (Slack, Teams), agile methodologies for DevOps teams, leadership in DevOps environments, change management processes, cultural transformation strategies, governance frameworks, DevOps ethics and privacy considerations, ethical hacking and penetration testing.
Learning Outcome: *Integrate security, collaboration, and governance into DevOps practices to enhance compliance, teamwork, and ethical implementation in cloud environments.*

No. of Hours : 24

Module 4: Optimization, Performance, and Continuous Improvement
Scope of Module: Focuses on performance tuning, capacity planning, continuous learning, and applying metrics and feedback for improvement.
Topics: Performance monitoring tools (CloudWatch, Dynatrace), load and stress testing, performance bottleneck analysis, capacity planning strategies, optimization techniques for pipelines, chaos engineering introduction, root cause analysis, continuous learning principles (Kaizen), feedback loops in development, post-implementation reviews, DevOps maturity models, key performance indicators (KPIs), analyzing metrics for CI/CD pipelines, benchmarking and baselining, implementing data-driven improvement cycles.
Learning Outcome: *Optimize performance and implement continuous improvement strategies in DevOps using metrics, analytics, and monitoring tools.*

No. of Hours : 24

Module 5: Case Studies, Industry Practices, and Future Trends
Scope of Module: This module explores real-world implementations of DevOps, lessons from industry leaders, emerging innovations, and evolving technologies in the DevOps landscape.
Topics: Real-world case studies of DevOps in enterprises, best practices from leading tech companies, emerging DevOps trends, AI and ML in DevOps automation, edge computing applications in DevOps, serverless DevOps evolution, GitOps and declarative delivery, multi-cloud DevOps practices, DevOps in regulated industries (finance, healthcare), continuous compliance tools, platform engineering trends, DevOps toolchain integration, hybrid cloud DevOps strategies, site reliability engineering (SRE) overview, DevOps career pathways and certifications.
Learning Outcome: *Evaluate industry case studies and future directions of DevOps practices, identifying opportunities for innovation and growth in cloud-based environments.*

Module	No of Pre Recordings
1	10
2	12
3	11
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites:
- Basic knowledge of software development and cloud computing
- Familiarity with operating systems and scripting (e.g., Bash, Python)
- Exposure to version control systems (e.g., Git)
- Understanding of SDLC and Agile methodologies (preferred)

Pedagogy / Teaching Methodology:
- ✓ Hands-on lab sessions with CI/CD pipelines, version control, and containerization
- ✓ Tool-based practice using Jenkins, Git, Docker, Kubernetes, Prometheus, etc.
- ✓ Group assignments on DevOps planning, performance analysis, and automation
- ✓ Industry case studies and postmortem analysis of deployment failures

Certificate / Value Added Courses Recommended:
1. Introduction to DevOps – edX (Microsoft)
2. DevOps on AWS – AWS Skill Builder
3. DevOps Engineer Professional – Coursera
4. GitOps with ArgoCD – Codefresh Academy

Suggested Readings:
- Gene Kim, Jez Humble, *The Phoenix Project*
- Jez Humble, David Farley, *Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation*
- Len Bass, Ingo Weber, Liming Zhu, *DevOps: A Software Architect's Perspective*
- Emily Freeman, *DevOps for Dummies*
- O'Reilly Guides on Jenkins, GitOps, Kubernetes, and Prometheus

Recommended Software/Tools:

1. **Version Control**: Git, GitHub/GitLab
2. **CI/CD**: Jenkins, GitLab CI, Azure DevOps, CircleCI
3. **Containerization**: Docker, Podman
4. **Orchestration**: Kubernetes, Helm

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	1	2	3	2	1	2	2
CO2	1	2	3	2	3	2	1	2	2	2
CO3	2	3	3	3	2	-	1	2	2	2
CO4	1	1	-	1	1	2	2	3	3	2
CO5	2	3	2	3	3	2	1	2	2	3
Articulation	1.6	2.2	2.25	2	2.2	2.3	1.4	2	2.2	2.2

Course Title:	Cloud Managed Services
Course Code:	25VBT3E504
Semester:	V
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course provides a practical introduction to Cloud Managed Services, covering deployment models, service models, and the role of Managed Service Providers (MSPs). Students will learn to manage and optimize cloud resources while addressing security, automation, monitoring, and disaster recovery. Real-world case studies and trends help develop skills for building scalable and secure cloud solutions.

Course Outcomes

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Key concepts and components of cloud managed services	L2
CO2	Resource configuration and optimization in managed cloud environments	L3
CO3	Security and compliance considerations in cloud managed services	L4
CO4	Cost-effective and scalable cloud solutions for businesses	L5
CO5	Emerging trends and real-world applications of cloud managed services	L2

Course Modules

No. of Hours : 24

Module 1: Introduction to Cloud Managed Services
Scope of Module: This module introduces the fundamentals of cloud managed services, highlighting their purpose, architecture, benefits, and the role of Managed Service Providers (MSPs). Students will gain clarity on

how cloud-managed services differ from traditional cloud deployments and understand real-world use cases.
Topics: Definition and purpose of managed cloud services, benefits of managed services for organizations, differences between traditional cloud and managed services, key components of cloud-managed services, overview of cloud service providers, role and responsibilities of MSPs, types of services managed under MSPs, cloud service level agreements (SLAs), examples of popular cloud-managed solutions, cloud shared responsibility model, evaluating MSPs for business needs, managed service billing and pricing models, typical customer use cases, integration with existing IT infrastructure, key success factors for cloud-managed adoption.
Learning Outcome: *Understand the foundational concepts and advantages of cloud-managed services and the roles of providers and stakeholders involved.*

No. of Hours : 24

Module 2: Cloud Service and Deployment Models
Scope of Module: This module covers essential service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid, and Community), helping learners understand which combinations suit different organizational needs.
Topics: Overview of cloud service models (IaaS, PaaS, SaaS), differences and use cases of each model, benefits and limitations of IaaS, PaaS, and SaaS, understanding serverless computing in managed services, cloud-native vs traditional applications, deployment models (public, private, hybrid, community), use cases for each deployment model, managed cloud vs self-managed cloud, vendor lock-in concerns, selection criteria for deployment models, shared vs dedicated environments, cloud interoperability and portability, edge computing in managed environments, examples of industry-specific cloud deployments, challenges in model selection and integration.
Learning Outcome: *Identify and compare cloud service and deployment models, and determine suitable options for managed service environments.*

No. of Hours : 24

Module 3: Resource Management and Optimization
Scope of Module: This module provides in-depth knowledge about managing compute, storage, and networking resources in cloud-managed services and emphasizes optimization techniques for cost and performance efficiency.
Topics: Managing compute resources (VMs, containers), memory and CPU provisioning in managed environments, managing cloud storage types (block, object, file), cloud resource tagging and organization, optimizing storage and compute costs, auto-scaling policies and thresholds, managed

network services and configurations, cloud networking best practices, role of automation in resource provisioning, using Infrastructure as Code (IaC), monitoring resource usage and health, load balancing strategies, setting alerts and thresholds for performance, disaster recovery and resource replication, tools for resource monitoring and optimi ation.
Learning Outcome: *Efficiently manage cloud resources and apply optimization techniques to enhance performance, reliability, and cost-effectiveness.*

No. of Hours : 24

Module 4: Security, Compliance, and Governance
Scope of Module: This module explores security measures, compliance requirements, and governance practices necessary to manage cloud environments securely and in accordance with regulatory standards.
Topics: Importance of cloud security in managed services, identity and access management (IAM) practices, role-based access control (RBAC) and policies, encryption of data at rest and in transit, vulnerability management in managed cloud, implementing secure configurations and baselines, ensuring regulatory compliance (GDPR, HIPAA, etc.), audit logging and tracking, risk management and threat modeling, cloud security frameworks (e.g., NIST, CIS), third-party risk in managed services, compliance checklists and assessment tools, managing security incidents and response, governance policies and usage controls, building a compliance-ready architecture.
Learning Outcome: *Implement best practices in securing cloud-managed environments and ensure compliance with relevant standards and governance requirements.*

No. of Hours : 24

Module 5: Operations, Automation, and Trends
Scope of Module: This module focuses on operational excellence, automation, cost management, and future innovations in cloud-managed services. It introduces CI/CD, performance tuning, and emerging trends such as AI and green computing.
Topics: Cloud operations lifecycle and management, automating routine cloud operations, setting up CI/CD pipelines in managed services, infrastructure as code (IaC) with Terraform or CloudFormation, orchestration tools (e.g., Kubernetes, Ansible), cost control and billing strategies, cloud pricing models and budgeting, performance optimization techniques, monitoring tools and dashboards, application performance monitoring (APM), backup and disaster recovery planning, multi-cloud and hybrid operations, industry case studies and lessons learned, trends like serverless and edge computing, future of AI and sustainability in cloud management.
Learning Outcome: *Apply modern operational strategies, automation tools, and stay informed of emerging trends shaping the future of cloud-managed services.*

Module	No of Pre Recordings
1	12
2	11
3	10
4	11
5	10

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of cloud computing models and infrastructure
- Familiarity with virtualization and cloud platforms (e.g., AWS, Azure, GCP)
- Knowledge of IT operations or system administration (advantageous but not mandatory)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using managed cloud platforms (e.g., AWS Managed Services, Azure Arc)
- ✓ Use of real-time dashboards and monitoring tools
- ✓ Case studies from industries using MSPs (e.g., retail, finance, healthcare)
- ✓ Simulation-based learning for deployment and automation scenarios

Certificate / Value Added Courses Recommended (with Free Resource Links):

1. AWS Managed Services – AWS Learning
2. Google Cloud: Cloud Operations Learning Path
3. Microsoft Learn: Azure Management and Governance
4. Coursera: Site Reliability Engineering – Google Cloud
5. Terraform for Infrastructure as Code – HashiCorp Learn

Suggested Readings:

- Jeff Barr & Daniel Slater, *Host Your Web Site in the Cloud: Amazon Web Services Made Easy*
- Mark Wilkins, *Learning Amazon Web Services (AWS)*
- Tim Mather, *Cloud Security and Privacy*, O'Reilly
- Brian Noyes, *Cloud Architecture Patterns*

- Microsoft Docs / AWS Whitepapers / GCP Architecture Frameworks

Recommended Software/Tools:

1. Cloud Platforms**: AWS Managed Services, Azure Lighthouse, GCP Cloud Operations**
2. Automation Tools**: Terraform, CloudFormation, Ansible**
3. Monitoring Tools**: Datadog, AWS CloudWatch, Azure Monitor, Prometheus**
4. Security Tools**: AWS Security Hub, Azure Security Center, GCP Security Command Center**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	2	1	-	1	1	2
CO2	2	2	3	2	3	1	1	1	2	2
CO3	1	3	2	2	-	3	2	2	2	2
CO4	2	2	3	3	3	1	1	2	3	2
CO5	1	3	3	2	2	3	2	3	3	3
Articulation	1.8	2.6	2.4	2	2.5	1.8	1.5	1.8	2.2	2.2

Course Title:	Google Cloud Platform Essentials
Course Code:	25VBT3E505
Semester:	V
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course provides a foundational understanding of Google Cloud Platform (GCP), covering essential cloud computing concepts, identity management, compute and storage services, networking, security, DevOps, and cost optimization. The course emphasizes hands-on learning through real-world applications and best practices in managing and securing cloud-based solutions.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Core concepts of Google Cloud Platform and its role in cloud computing	L2
CO2	GCP identity management, security policies, and access control	L3
CO3	Application deployment and management using compute, container, and serverless services	L3
CO4	Cloud monitoring, logging, and automation techniques in GCP	L4
CO5	Cost management strategies, real-world GCP applications, and emerging cloud technologies	L5

Course Modules

No. of Hours : 24

Module 1: Introduction to Google Cloud and Identity Management
Scope of Module: This module introduces the fundamental concepts of Google Cloud Platform, its infrastructure, and identity management. Students will explore cloud computing models, security frameworks, and GCP resource management.

Topics: Overview of Google Cloud Platform, Importance of Cloud Computing, GCP Global Infrastructure, GCP Core Services, GCP vs. Other Cloud Providers, Introduction to Identity and Access Management (IAM), Users, Groups, and Roles in GCP, Service Accounts and Policies, Managing Access Control, Best Practices for IAM Security, GCP Resource Hierarchy and Organization, Quotas and Billing in GCP, Google Cloud Marketplace and Third-Party Integrations, APIs and SDKs in GCP.
Learning Outcome: Understand the fundamentals of GCP infrastructure, identity management, and resource security.

No. of Hours : 24

Module 2: Compute, Containers, and Serverless Computing
Scope of Module: This module covers GCP's compute services, including virtual machines, Kubernetes for containerized workloads, and serverless computing for scalable applications. Students will explore deployment strategies and workload optimization techniques.
Topics: Virtual Machines with Compute Engine, Autoscaling and Load Balancing, GCP Pricing and Cost Estimation for Compute Services, Best Practices for Compute Optimization, Custom Machine Types and Preemptible VMs, Introduction to Containerization, Google Kubernetes Engine (GKE) Overview, Deploying and Managing Containers, Kubernetes Networking and Storage, Scaling and Monitoring Kubernetes Workloads, Introduction to Serverless Computing, Google Cloud Functions, Google App Engine, Cloud Run for Containerized Applications, Use Cases for Serverless Applications.
Learning Outcome*: Deploy and manage cloud-based applications using virtual machines, Kubernetes, and serverless computing.*

No. of Hours : 24

Module 3: Data Storage, Networking, and Security in GCP
Scope of Module: Students will learn about GCP's storage solutions, networking architecture, and security best practices to safeguard cloud environments. This module also covers compliance and regulatory considerations.
Topics: Overview of Cloud Storage Services, Google Cloud Storage: Buckets and Objects, Managed Database Services (Cloud SQL, Firestore, Bigtable), Data Backup and Recovery in GCP, Storage Cost Optimization, Introduction to Google Cloud Networking, Virtual Private Cloud (VPC), Load Balancing and Cloud CDN, Hybrid and Multi-Cloud Networking, Securing Network Traffic in GCP, Security Fundamentals in GCP, Encryption and Key Management, GCP Security Command Center, Identity-Aware Proxy (IAP), Compliance and Regulatory Considerations.
Learning Outcome: *Manage cloud storage, configure networking components, and apply security best practices in GCP.*

No. of Hours : 24

Module 4: Cloud Monitoring, DevOps, and AI Services
Scope of Module: This module introduces cloud monitoring, DevOps methodologies, and AI services in GCP. Students will gain hands-on experience in automation, continuous integration/deployment, and machine learning tools.
Topics: Importance of Monitoring in Cloud, Google Cloud Operations Suite (Stackdriver), Logging and Metrics Collection, Alerts and Incident Management, Troubleshooting GCP Resources, Introduction to DevOps in GCP, CI/CD Pipeline with Cloud Build, Artifact Registry and Container Registry, Deployment Strategies in GCP, Best Practices for DevOps Automation, Introduction to AI and ML in GCP, Cloud AI Platform Overview, AutoML and Custom ML Models, BigQuery ML for Data Analytics, Ethical Considerations in AI and ML.
Learning Outcome: *Implement cloud monitoring, automation, and AI services for efficient cloud operations.*

No. of Hours : 24

Module 5: Cost Optimization, Real-World Applications, and Future Trends
Scope of Module: Students will explore cost management strategies in GCP, real-world industry use cases, and emerging technologies such as IoT, edge computing, and quantum computing.
Topics: Understanding GCP Pricing, Budgeting and Cost Monitoring Tools, Cost Optimization Strategies, Committed Use Contracts and Sustained Discounts, Best Practices for Financial Management in GCP, GCP in E-commerce, GCP in Healthcare, GCP in Financial Services, GCP for Startups and Enterprises, Lessons Learned from GCP Implementations, Emerging Technologies in Cloud Computing, Role of Edge Computing in GCP, Integration of IoT with GCP, Quantum Computing and GCP, Predictions for the Future of Google Cloud.
Learning Outcome: *Optimize cloud costs, analyze real-world applications, and explore future trends in GCP.*

Module	**No of Pre Recordings**
1	**10**
2	**11**
3	**12**
4	**12**

5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of cloud computing concepts
- Familiarity with networking and system administration
- Exposure to scripting or programming (e.g., Python, Bash)
- Awareness of DevOps and application lifecycle (preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using GCP Console and Cloud Shell
- ✓ Real-world project simulations with compute, IAM, and networking
- ✓ Guided demos of container orchestration and CI/CD
- ✓ Mini-case studies from industries like healthcare, finance, and retail

Certificate / Value Added Courses Recommended:

1. Google Cloud Digital Leader – Coursera
2. Google Cloud Fundamentals: Core Infrastructure – Qwiklabs
3. Associate Cloud Engineer – Google Cloud Training
4. Google Cloud Skill Badges (Qwiklabs)

Suggested Readings:

- Dan Sullivan, *Official Google Cloud Certified Associate Cloud Engineer Study Guide*, Wiley
- Mark C. Chu-Carroll, *Cloud Computing with Google Cloud*
- Ted Hunter & Steven Porter, *Google Cloud Platform for Architects*
- Saurabh Shrivastava, *GCP for Developers*

Recommended Software/Tools:

1. GCP Console / Cloud Shell
2. Compute Engine, GKE, Cloud Run, App Engine
3. Cloud Storage, Cloud SQL, Firestore, Bigtable
4. Google Cloud IAM and Security Command Center
5. Cloud Monitoring, Logging, Cloud Build, Artifact Registry
6. BigQuery, AI Platform, AutoML, Vertex AI

Curriculum Development:

Sl. No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO - PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	-	1	2	2	1	1	1	2
CO2	2	2	3	2	3	2	1	1	2	2
CO3	1	2	2	2	2	2	3	2	-	2
CO4	2	3	2	3	3	2	1	2	2	2
CO5	1	3	2	2	2	3	2	3	3	3
Articulation	1.8	2.4	1.8	2	2.4	2.2	1.6	1.8	2	2.2

Course Title:	Advanced Software Development Practices
Course Code:	25VBT0C503
Semester:	V
Credits:	2
Course Type	Skill Enhancement Course
Learning Hours	60
Live Sessions	12 hours

Course Description

This course introduces advanced principles, methodologies, and tools essential for modern software development. Emphasizing Agile methodologies, clean coding practices, scalable architecture, DevOps integration, quality assurance, and security, it equips learners with industry-ready skills to design, develop, and manage robust software systems.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Apply software development principles to design scalable and maintainable applications.	L3
CO2	Analyze software design patterns and architecture to solve real-world problems.	L4
CO3	Employ modern tools and practices such as version control, CI/CD, and testing in the development process.	L4
CO4	Demonstrate team collaboration, documentation, and agile methodologies in software projects.	L3
CO5	Evaluate software quality attributes including performance, security, and usability.	L5

Course Modules

No. of Hours: 12

Module 1: Foundations of Modern Software Development
Scope of Module: This module introduces the evolution of software development practices and explores traditional and modern software life cycle models. It also emphasizes Agile methodologies, focusing on the Scrum framework and real-world team roles.

Topics: History and evolution of software development, software development methodologies including Waterfall, Iterative, Spiral and V-Model, Agile manifesto and principles, introduction to Scrum including roles, ceremonies and artifacts, product backlog, sprint planning and burndown charts, comparison between Agile and traditional models, case study on Scrum in practice
Learning Outcome: - *Learning Outcome: - Explain the evolution of software development practices and their implementation using traditional SDLC models and Agile methodologies.*

No. of Hours: 12

Module 2: Designing Scalable and Maintainable Software
Scope of Module: This module focuses on the planning and design phase of software development. It covers capturing system requirements and applying design principles and architecture models that ensure maintainability and scalability.
Topics: Functional and non-functional requirements, requirement elicitation techniques including interviews, surveys and use cases, requirement specification and validation, SOLID principles, DRY and KISS principles, cohesion and coupling, modular design, refactoring strategies, architectural patterns including MVC, layered and microservices, system requirement and design documentation
Learning Outcome: - *Learning Outcome: Apply design principles and architecture models to create maintainable and scalable software solutions.*

No. of Hours : 12

Module 3: Practical Tools for Development and Quality Assurance
Scope of Module: This module introduces essential tools and techniques for writing efficient, testable, and reusable code. Students explore version control systems, reusable design patterns, and automated testing strategies.
Topics: Design patterns including Factory, Singleton, Observer and Strategy, advantages of design patterns in real-world applications, Git basics including initializing, cloning, committing and pushing repositories, branching and merging, resolving conflicts and using GitHub for collaboration, unit testing concepts, test-driven development including Red-Green-Refactor cycle, testing frameworks like JUnit and PyTest, test coverage analysis
Learning Outcome: - *Learning Outcome: Use design patterns, version control, and TDD practices to improve code quality and development efficiency.*

No. of Hours : 12

Module 4: DevOps Integration and Agile Project Management

Scope of Module:
Students will learn how to automate software build and deployment processes using DevOps tools and manage Agile projects using tracking tools.

Topics:
DevOps culture and principles, CI/CD concepts and benefits, setting up CI/CD pipelines using Jenkins or GitHub Actions, Infrastructure as Code tools and principles, Agile project management using Jira and Trello, sprint planning and backlog grooming, progress tracking using Kanban boards and velocity charts, team collaboration and documentation techniques

Learning Outcome: - *Learning Outcome: Integrate DevOps automation tools and Agile project management platforms to enhance software delivery efficiency.*

No. of Hours : 12

Module 5: Software Security, Quality, and Project Implementation

Scope of Module:
This final module prepares students to deliver secure, high-quality software by integrating secure coding principles, evaluating software performance, and implementing a capstone mini project.

Topics:
Secure coding principles and OWASP Top 10, input validation and secure authentication, software quality attributes including reliability, maintainability and usability, code quality metrics such as code coverage, defect density and cyclomatic complexity, software documentation including README, code comments and user manuals, project planning steps including defining scope, scheduling and risk management, preparing and presenting final deliverables, peer review and reflection

Learning Outcome: - *Learning Outcome: Apply quality and security practices to implement a complete mini software project with proper documentation and reporting.*

Module	No of Pre Recordings
1	11
2	12
3	11
4	10
5	12

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of programming (Java/Python recommended)
- Familiarity with object-oriented principles
- Understanding of software development lifecycle concepts

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs for version control, CI/CD pipelines, and Agile project tools
- ✓ Group-based mini software projects
- ✓ Live coding sessions and design pattern workshops
- ✓ Sprint-based evaluations and peer reviews
- ✓ Practical demos using industry-standard tools

Certificate / Value Added Courses Recommended (Free Resource Links):

13. Coursera: Agile Software Development – University of Minnesota
14. Udacity: Agile Software Development
15. edX: DevOps Practices and Tools – Linux Foundation
16. GitHub Learning Lab: Intro to GitHub

Suggested Readings:

- Robert C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, Prentice Hall
- Erich Gamma et al., *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison-Wesley
- Gene Kim, Jez Humble, and Patrick Debois, *The DevOps Handbook*, IT Revolution
- Martin Fowler, *Refactoring: Improving the Design of Existing Code*, Addison-Wesley

Recommended Software/Tools:

29. **Version Control:** Git, GitHub
30. **Testing Tools:** JUnit, PyTest
31. **CI/CD:** Jenkins, GitHub Actions
32. **Agile Management Tools:** Jira, Trello
33. **Code Analysis:** SonarQube, Codacy
34. **Development Environments:** VS Code, IntelliJ IDEA, Eclipse
35. **Documentation:** Markdown, Doxygen, Swagger

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	-	3	2	3	2	2
CO2	2	2	3	3	-	3	2	3	3	3
CO3	2	2	2	2	1	-	-	-	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	-	2	3	3
Articulation	2.2	2.4	2.6	2.6	1	3	2	2.5	2.4	2.8

Semester VI

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Course Title:	Cloud Application Development
Course Code:	25VBT3E601
Semester:	VI
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course explores the architecture, development, deployment, and management of modern cloud-based applications. It equips learners with knowledge and hands-on skills in cloud services, microservices, serverless computing, data integration, and DevOps practices. Students will gain insights into building scalable, secure, and high-performing cloud applications using various platforms, tools, and frameworks.

Course Outcomes (COs):

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Core concepts of cloud computing and its architecture, including service and deployment models	L2
CO2	Scalable cloud applications using different cloud platforms and technologies	L3
CO3	Cloud-based storage solutions and efficient data management on cloud platforms	L3
CO4	Cloud security practices for protecting data and applications	L4
CO5	Cloud application performance with cost-efficiency and high availability	L5

Course Modules:

No. of Hours : 24

Module 1: Core Concepts and Architecture of Cloud Applications
Scope of Module: This module provides foundational knowledge in cloud computing, emerging trends, cloud infrastructure, and architectural principles essential for designing and deploying scalable cloud-based applications.

Topics: Definition and characteristics of cloud computing, trends in cloud computing, cloud service and deployment models, core components of cloud infrastructure, virtualization and its role in cloud, types of virtualization, containerization fundamentals, introduction to serverless computing, innovative deployment models, architecture patterns for cloud applications, service-oriented architecture, microservices vs monolithic architectures, multi-cloud and hybrid cloud strategies, edge computing basics
Learning Outcome: *Understand core cloud computing concepts, deployment models, virtualization, and architectural approaches for cloud-based applications.*

No. of Hours : 24

Module 2: Cloud Application Development and Integration
Scope of Module: This module focuses on practical skills in developing and integrating modern cloud-native applications using APIs, web services, and frameworks.
Topics: Introduction to cloud-native development, frameworks for cloud applications, container-based application development, RESTful web services and principles, SOAP vs REST, API design and versioning, API gateways, API security and throttling, microservices communication, event-driven architectures, message brokers (Kafka, RabbitMQ), integrating third-party services, orchestration tools, service mesh concepts, CI/CD pipeline integration
Learning Outcome: *Design, develop, and integrate scalable cloud applications using microservices, APIs, and modern cloud-native frameworks.*

No. of Hours : 24

Module 3: Data, Storage, and Security in the Cloud
Scope of Module: This module explores advanced data management, storage systems, and essential security mechanisms needed for cloud environments.
Topics: Cloud storage types (object, block, file), cloud database types (SQL, NoSQL), AWS S3, Azure Blob, Google Cloud Storage, data access patterns in cloud apps, big data processing tools (Hadoop, Spark), data governance and compliance, IAM in cloud platforms, encryption in transit and at rest, secure key management, network security in cloud, security policies and roles, DevSecOps principles, compliance frameworks (GDPR, HIPAA), secure authentication and authorization
Learning Outcome: *Implement secure and efficient data storage and access strategies while adhering to cloud security and compliance best practices.*

No. of Hours : 24

Module 4: Automation, Monitoring, and Performance Optimization
Scope of Module: This module focuses on automation, monitoring, and performance tuning of cloud applications using modern DevOps tools and practices.
Topics: Infrastructure as Code (IaC), tools for IaC (Terraform, CloudFormation), DevOps in the cloud, CI/CD automation, cloud-native monitoring tools (CloudWatch, Prometheus), logging and observability, performance bottlenecks in cloud applications, load testing and stress testing, autoscaling and elasticity, caching strategies for performance, cost optimization tools and techniques, availability zones and fault tolerance, rollback and recovery plans, SLAs and SLOs, capacity planning
Learning Outcome: *Apply automation, monitoring, and optimization techniques to improve the performance and reliability of cloud applications.*

No. of Hours : 24

Module 5: Advanced Technologies and Future Trends
Scope of Module: This module introduces advanced technologies like AI, IoT, and blockchain in cloud, along with real-world case studies and future directions.
Topics: AI and ML in cloud (AWS SageMaker, Azure ML), cloud-based ML pipelines, predictive analytics for cloud applications, serverless computing principles, function-as-a-service, use cases of serverless apps, IoT-cloud integration, cloud-enabled edge computing, blockchain applications in the cloud, real-world cloud application case studies, best practices from leading tech firms, career trends in cloud development, future innovations in cloud computing, ethical and legal considerations in cloud
Learning Outcome: *Evaluate advanced cloud technologies, their practical applications, and explore emerging trends to stay future-ready.*

Module	No of Pre Recordings
1	11
2	12
3	11
4	10
5	12

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of web application development
- Familiarity with cloud computing concepts
- Understanding of programming languages such as Python, Java, or JavaScript
- Exposure to software development lifecycle and DevOps (preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using AWS, Azure, or GCP cloud platforms
- ✓ Mini-projects on developing and deploying cloud-native applications
- ✓ API integration exercises with microservices and third-party services
- ✓ DevOps pipeline implementation with CI/CD tools

Certificate / Value Added Courses Recommended:

1. Google Cloud: Application Development Specialization – Coursera
2. AWS Cloud Practitioner Essentials – AWS Skill Builder
3. Azure Developer Associate (AZ-204) – Microsoft Learn
4. Cloud DevOps Engineer – Udacity (Free Trial)

Suggested Readings:

- Praveen Kumar Sreeram, *Cloud Computing Using Azure*
- Gethyn Ellis, *Getting Started with Azure App Service*
- Peter Sbarski, *Serverless Applications with Node.js*
- Thomas Erl, *Cloud Computing: Concepts, Technology & Architecture*

Recommended Software/Tools:

1. **Cloud Platforms**: AWS, Azure, Google Cloud Platform
2. **Development Tools**: Visual Studio Code, GitHub
3. **APIs & Integration**: Postman, Swagger
4. **CI/CD & DevOps**: Jenkins, GitLab CI, Azure DevOps

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO - PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	-	2	3	1	1	1	2
CO2	2	3	3	3	3	2	1	2	2	2
CO3	2	3	3	3	3	2	2	-	2	2
CO4	2	3	3	2	3	3	3	2	2	3
CO5	3	3	3	3	3	2	-	2	2	3
Articulation	2.4	2.8	2.8	2.75	2.8	2.4	1.75	1.75	1.8	2.4

Course Title:	Azure Fundamentals
Course Code:	25VBT3E602
Semester:	VI
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course provides a foundational understanding of Microsoft Azure, including its architecture, core services, deployment models, and governance tools. Students will explore practical aspects such as Azure compute, storage, networking, security, and monitoring, with a focus on cloud-native application development and emerging trends.

Course Outcomes

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Basic concepts, architecture, and services of Microsoft Azure	L2
CO2	Azure deployment and service models, including applications and implications	L4
CO3	Azure services and offerings, including use cases and benefits	L5
CO4	Azure virtualization, storage, and networking solutions	L3
CO5	Azure security, governance, and compliance for secure cloud operations	L3

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Course Modules

No. of Hours : 24

Module 1: Azure Fundamentals and Architecture
Scope of Module: This module introduces Microsoft Azure, its global infrastructure, deployment models, and architectural components.

Topics: Definition and characteristics of Microsoft Azure, history and evolution of Azure, key features and benefits of Azure, Azure regions and availability zones, core components of Azure architecture, Azure Resource Manager (ARM), Azure service models: IaaS, PaaS, SaaS, Azure Marketplace, public cloud deployment on Azure, private cloud in Azure, hybrid cloud and Azure Stack, Azure Arc for multi-cloud, use cases for each deployment model.
Learning Outcome: *Describe Azure's architecture and deployment models, analyzing key components and their real-world relevance.*

No. of Hours : 24

Module 2: Compute, Storage, and Networking in Azure
Scope of Module: This module focuses on core infrastructure services in Azure, including compute, storage, and networking options and their management.
Topics: Azure Virtual Machines, Azure App Services, Azure Kubernetes Service (AKS), Azure Functions and serverless computing, Azure Blob Storage, Azure Files, Azure Queue Storage, Azure Disk Storage, data replication and redundancy, Azure Virtual Network (VNet), Azure Load Balancer, Azure VPN Gateway, Azure Traffic Manager, configuration of Azure networking components.
Learning Outcome: *Apply Azure compute, storage, and networking solutions in building cloud infrastructure.*

No. of Hours : 24

Module 3: Azure Identity, Security, and Governance
Scope of Module: This module introduces identity and access control in Azure, security management, and governance through policies and compliance tools.
Topics: Azure Active Directory (AAD), role-based access control (RBAC), Azure AD B2B and B2C, multi-factor authentication (MFA), Azure Security Center, Azure Key Vault, Azure Sentinel, Azure DDoS Protection, threat detection and monitoring, Azure Policy and governance tools, Azure Blueprints, compliance with GDPR and HIPAA, governance of Azure resources, monitoring and managing Azure compliance.
Learning Outcome: *Implement secure and compliant Azure environments using built-in security and governance tools.*

No. of Hours : 24

Module 4: Azure Management, Migration, and DevOps

Scope of Module: This module discusses Azure cost management, monitoring, migration, and DevOps practices for continuous delivery and automation.
Topics: Azure pricing models, cost optimization techniques, Azure Cost Management and Billing, budgeting and forecasting, Azure Monitor and Log Analytics, Azure Automation and Logic Apps, incident management tools, Azure Migrate, lift-and-shift strategy, Azure Site Recovery, Azure Database Migration Service, Azure DevOps Services, Azure Pipelines, continuous integration and continuous deployment (CI/CD) in Azure.
Learning Outcome: *Monitor and manage Azure workloads while implementing effective migration and DevOps strategies.*

No. of Hours : 24

Module 5: AI, Machine Learning, and Emerging Azure Technologies
Scope of Module: This module introduces advanced Azure services for AI, ML, blockchain, IoT, and quantum computing along with future trends.
Topics: Azure Cognitive Services, Azure Machine Learning, Azure Bot Service, use cases of AI/ML in Azure, edge computing and Azure IoT Hub, Azure Quantum and its use cases, Azure Blockchain Services, Industry 4.0 solutions on Azure, real-world case studies in Azure implementations, best practices from Azure enterprise deployments, future trends in cloud platforms, innovations in Azure infrastructure and AI integration.
Learning Outcome: *Evaluate emerging Azure services and trends and understand their impact on modern applications.*

Module	No of Pre Recordings
1	12
2	10
3	11
4	10
5	11

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of cloud computing concepts
- Familiarity with networking and virtualization fundamentals
- Exposure to IT infrastructure or system administration (preferred)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs using Microsoft Azure portal and CLI
- ✓ Guided tutorials for VM, storage, and network creation
- ✓ Case studies and real-world deployment scenarios
- ✓ Mini-projects involving Azure identity and governance setup

Certificate / Value Added Courses Recommended:

1. Microsoft Azure Fundamentals (AZ-900) – Microsoft Learn
2. Introduction to Azure – edX / Microsoft
3. Azure Developer Associate (AZ-204) – Microsoft Learn
4. Cloud Concepts - Fundamentals – Coursera (Microsoft)

Suggested Readings:

- Jim Cheshire, *Exam Ref AZ-900 Microsoft Azure Fundamentals*, Microsoft Press
- Michael Washam et al., *Exam Ref AZ-104 Microsoft Azure Administrator*, Microsoft Press
- Yaroslav Pentsarskyy, *Learn Azure in a Month of Lunches*

Recommended Software/Tools:

1. **Microsoft Azure Portal**
2. **Azure CLI / PowerShell**
3. **Azure DevOps Services**
4. **Azure Monitor and Log Analytics**

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO - PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	-	1	1	2
CO2	2	3	3	2	3	2	2	-	1	2
CO3	2	3	3	2	3	2	2	1	1	2
CO4	2	2	3	3	3	3	2	2	2	2
CO5	2	2	3	3	3	3	3	2	2	3
Articulation	2.2	2.4	2.8	2.2	2.8	2.6	2.25	1.5	1.4	2.2

Course Title:	Cloud Security
Course Code:	25VBT3E603
Semester:	VI
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description

This course introduces core security concepts in cloud computing. It provides learners with knowledge and practical insights on securing cloud environments, covering threats, technologies, legal considerations, access control, identity management, encryption, and auditing in public, private, and hybrid cloud models.

Course Outcomes (COs)

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Fundamentals of cloud computing and cloud security requirements	L2
CO2	Potential vulnerabilities and attacks in cloud infrastructure and services	L2
CO3	Authentication, encryption, and identity management techniques in cloud settings	L3
CO4	Compliance, legal and regulatory frameworks associated with cloud usage	L4
CO5	Risk management and security monitoring tools in cloud environments	L5

Course Modules

No. of Hours : 24

Module 1: Cloud Computing and Security Foundations
Scope of Module: This module introduces cloud computing and its service models while emphasizing the principles and challenges of cloud security.

Topics: Definition and characteristics of cloud computing, service models including IaaS, PaaS and SaaS, deployment models such as public, private, hybrid and community cloud, shared responsibility model, security triad (confidentiality, integrity, availability), threats and vulnerabilities in cloud computing, cloud-specific risks including multitenancy and virtualization exposure, need for security in distributed computing environments
Learning Outcome: *Understand cloud computing models and the fundamental principles and challenges of securing them*

No. of Hours : 24

Module 2: Cloud Threats, Attacks, and Risk Management
Scope of Module: This module explores the types of threats and attacks in cloud systems and introduces frameworks and techniques to assess and manage risks.
Topics: Cloud-specific threats including data breaches, account hijacking and DDoS attacks, insecure APIs and misconfigurations, malicious insiders, threat modeling in the cloud, risk management lifecycle, qualitative and quantitative risk assessment, impact and likelihood matrix, mitigation and risk response planning, case studies of real-world cloud attacks
Learning Outcome: *Identify key threats to cloud environments and apply risk assessment methodologies to mitigate them*

No. of Hours : 24

Module 3: Identity, Access Management, and Encryption
Scope of Module: This module focuses on mechanisms for ensuring that only authorized users can access cloud resources and that data remains confidential and secure.
Topics: Authentication vs authorization, role-based and attribute-based access control models, multi-factor authentication (MFA), single sign-on (SSO), identity federation and identity-as-a-service (IDaaS), cryptographic techniques in cloud security, symmetric and asymmetric encryption, TLS and SSL protocols, key management systems, data-in-transit and data-at-rest protection
Learning Outcome: *Apply access control models and cryptographic solutions to secure identities and data in cloud environments*

No. of Hours: 24

Module 4: Cloud Compliance, Governance, and Legal Aspects

Scope of Module: This module introduces compliance standards and regulations governing cloud operations, along with privacy and legal obligations.
Topics: Cloud security governance and policies, regulatory frameworks including GDPR, HIPAA, ISO/IEC 27001, PCI-DSS, legal concerns such as data sovereignty and jurisdiction, cloud service level agreements (SLAs), vendor management and auditing responsibilities, business continuity planning and disaster recovery requirements, auditing tools and reports
Learning Outcome: *Analyze cloud security compliance requirements and evaluate their impact on business and legal operations*

No. of Hours : 24

Module 5: Security Operations, Monitoring, and Incident Response
Scope of Module: The final module emphasizes operational controls and monitoring techniques to ensure security is maintained throughout the cloud system lifecycle.
Topics: Cloud Security Operations Center (CSOC), log monitoring and audit trails, security information and event management (SIEM), intrusion detection and prevention systems (IDPS), vulnerability scanning and penetration testing, incident detection and response workflow, real-time alerting and threat intelligence, automation in cloud security monitoring, cloud-native tools such as AWS GuardDuty, Azure Security Center and Google Cloud Security Command Center
Learning Outcome: *Implement security monitoring, incident detection and response practices in a cloud operations setting*

Module	No of Pre Recordings
1	11
2	12
3	10
4	12
5	11

Note: Min no of pre recordings 10.

Prerequisites:

- Basic knowledge of computer networks and operating systems
- Familiarity with cybersecurity principles
- Awareness of cloud computing concepts and architectures

Pedagogy / Teaching Methodology:

- ✓ Practical labs using cloud security tools (e.g., AWS IAM, Azure Security Center)
- ✓ Case studies of security breaches and cloud compliance issues
- ✓ Mini-projects on access control and encryption setups
- ✓ Interactive discussions on current trends and regulatory changes

Certificate / Value Added Courses Recommended :

1. AWS Cloud Security Learning Path – AWS Skill Builder
2. Microsoft Learn: Secure your cloud data
3. Google Cloud: Security in Google Cloud Specialization (Coursera)
4. IBM Cybersecurity Analyst Professional Certificate – Coursera

Suggested Readings:

- Raj Samani, Jim Reavis, Brian Honan, *CSA Guide to Cloud Computing*
- Tim Mather, Subra Kumaraswamy, and Shahed Latif, *Cloud Security and Privacy*
- Syed Rameem Zahoor, *Cloud Security Handbook*, Springer

Recommended Software/Tools:

1. **Cloud Platforms**: AWS, Microsoft Azure, Google Cloud Platform
2. **Monitoring Tools**: Splunk, Wireshark, CloudTrail, Nagios
3. **Encryption Tools**: OpenSSL, AWS KMS, Azure Key Vault
4. **Compliance Tools**: Nessus, CIS Benchmark tools, Prisma Cloud

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
6.	Indian Knowledge System

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	2	2	-	3	2	2	1	2
CO2	2	3	2	3	-	2	2	2	2	3
CO3	2	2	3	2	1	-	-	1	2	3
CO4	2	3	3	3	-	-	-	2	2	3
CO5	3	3	3	2	-	-	2	2	3	3
Articulation	2.4	2.6	2.6	2.4	1	2.5	3	1.8	2	2.8

CO-PO Mapping:

Course Title:	Internet of Things with Cloud
Course Code:	25VBT3E604
Semester:	V
Credits:	4
Course Type	Discipline Specific Elective
Learning Hours	120
Live Sessions	12 hours

Course Description:

This course provides foundational knowledge and practical insights into the integration of Internet of Things (IoT) with cloud computing. Learners will explore IoT architecture, communication protocols, device-cloud integration, data analytics, and emerging technologies. Emphasis is placed on real-world applications, security, and the development of scalable, intelligent IoT systems using cloud platforms.

Course Outcomes

Upon successful completion of this course, learners will be equipped to:

CO No.	Course Outcome	BTL
CO1	Fundamental concepts of IoT and cloud computing	L2
CO2	Architecture and communication protocols used in IoT	L2
CO3	Skills for integrating IoT devices with cloud platforms	L3
CO4	Security and data management challenges in IoT with cloud	L4
CO5	Real-world applications and future trends in IoT and cloud computing	L5

Course Modules

No. of Hours : 24

Module 1: Fundamentals of IoT and Cloud Computing
Scope of Module: This module introduces the basic concepts, evolution, and applications of IoT and cloud computing. It highlights the synergy between these technologies and their impact on various domains.
Topics: Definition of IoT, evolution of IoT and its relevance, introduction to cloud computing, importance of IoT-cloud integration, core components of IoT systems, role of sensors and actuators, real-time and batch data processing, applications of IoT in different sectors, characteristics of cloud computing, IoT and cloud synergy in smart systems, benefits of cloud in IoT applications, public, private, and hybrid clouds, overview of IoT platforms, case studies in IoT-cloud integration, current trends in IoT and cloud.
Learning Outcome: *Gain a foundational understanding of IoT and cloud computing, their core components, and how they work together to build modern, data-driven solutions.*

No. of Hours : 24

Module 2: IoT Architecture, Devices, and Communication Protocols
Scope of Module: This module focuses on IoT system architecture, types of devices and sensors used, and the communication protocols enabling data transfer between devices and the cloud.
Topics: IoT layered architecture (perception, network, application), characteristics of IoT devices, microcontrollers and edge devices (Arduino, Raspberry Pi), types of sensors and actuators, device-to-cloud communication models, wireless communication technologies (Wi-Fi, Bluetooth, Zigbee), cellular connectivity (GSM, LTE, NB-IoT), long-range protocols (LoRaWAN, Sigfox), RESTful APIs in IoT, message queuing telemetry transport (MQTT), Constrained Application Protocol (CoAP), HTTP and WebSocket for IoT, interoperability challenges, power management techniques in IoT, real-world examples of IoT communication systems.
Learning Outcome: *Understand IoT architecture and evaluate different communication technologies and devices used in developing efficient and scalable IoT systems.*

No. of Hours : 24

Module 3: Cloud Integration and Data Management for IoT
Scope of Module: This module covers how IoT devices are connected to cloud platforms, methods of managing data, and the tools for analytics and visualization.

Topics: Role of cloud in IoT data storage, real-time vs. historical data management, IoT data flow and ingestion pipelines, configuring devices on AWS IoT, Google Cloud IoT, and Azure IoT, cloud APIs for device integration, stream processing tools (Kafka, AWS Kinesis), storing IoT data in cloud databases, cloud-based dashboards and visualization, cloud-based analytics tools, real-time alerting and notifications, data lifecycle management, handling big data in IoT, cloud scalability for growing IoT networks, case studies of IoT-cloud integration, challenges in multi-cloud IoT environments.
Learning Outcome: *Demonstrate the ability to integrate IoT systems with cloud platforms and manage large-scale data effectively using cloud tools and services.*

No. of Hours : 24

Module 4: IoT Security, Edge Computing, and Artificial Intelligence
Scope of Module: This module explores key security practices for IoT systems, the role of edge computing for faster processing, and the use of AI and ML in enhancing IoT applications.
Topics: Security challenges in IoT, device authentication and authorization, secure data transmission methods, encryption protocols, privacy regulations in IoT, introduction to edge computing, edge vs. cloud processing, benefits of edge computing in latency-sensitive applications, examples of edge devices, AI and machine learning in IoT, predictive maintenance use cases, anomaly detection in IoT data, AI-based automation for IoT, edge AI for smart environments, use cases combining AI, IoT, and cloud.
Learning Outcome: *Apply principles of security, edge computing, and AI to design intelligent, secure, and efficient IoT systems integrated with cloud infrastructure.*

No. of Hours : 24

Module 5: Applications, Trends, and Future Directions of IoT with Cloud
Scope of Module: This module presents real-world applications, challenges, and future trends in IoT-cloud integration, including blockchain, 5G, and Industry 4.0 use cases.
Topics: IoT in smart cities and smart homes, healthcare and wearable IoT applications, agriculture and environmental monitoring, manufacturing and Industry 4.0, logistics and smart transportation systems, blockchain integration in IoT, decentralized IoT security with blockchain, role of 5G in IoT connectivity, green IoT initiatives, ethical considerations in IoT, future of IoT development tools, standardization challenges in IoT, career paths in IoT and cloud domains, emerging trends like serverless IoT, case studies of large-scale IoT deployments.

Learning Outcome: *Evaluate the potential of IoT-cloud systems in various industries, understand associated challenges, and explore innovations and future directions*

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Module	No of Pre Recordings
1	**10**
2	**11**
3	**10**
4	**11**
5	**10**

Note: Min no of pre recordings 10.

Prerequisites:

- Basic understanding of computer networks and Internet technologies
- Familiarity with programming (preferably Python or C/C++)
- Understanding of cloud computing concepts
- Awareness of embedded systems (helpful but not mandatory)

Pedagogy / Teaching Methodology:

- ✓ Hands-on labs with IoT kits and cloud platforms (AWS/GCP/Azure)
- ✓ Case studies of real-world IoT-cloud integrations
- ✓ Team-based mini-projects and simulations
- ✓ Interactive tool demonstrations (e.g., AWS IoT Core, Azure IoT Hub)

Certificate / Value Added Courses Recommended:

1. Google Cloud: IoT on Google Cloud Platform
2. AWS IoT: Getting Started – AWS Training
3. Microsoft Learn: Create and configure an Azure IoT Hub
4. NPTEL: Internet of Things – Prof. Sudip Misra, IIT Kharagpur

Suggested Readings:

- Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-on Approach*
- Srinivasa K. G., *Internet of Things with Raspberry Pi and Arduino*, Springer
- Honbo Zhou, *The Internet of Things in the Cloud: A Middleware Perspective*
- Pethuru Raj, Anupama C. Raman, *The Cloud-Based Demand-Driven Supply Chain*

Recommended Software/Tools:

1. **Cloud Platforms**: AWS IoT Core, Microsoft Azure IoT Hub, Google Cloud IoT Core
2. **IoT Device Platforms**: Arduino IDE, Raspberry Pi OS, Node-RED
3. **Protocols & Tools**: MQTT, CoAP, Postman (for REST APIs), Wireshark
4. **Data Analytics Tools**: ThingsBoard, Grafana, Power BI

Curriculum Development:

Sl.No	Identify and Highlight in the Modules
1	Local/Regional/National/Global
2	Employability/Entrep/ Skill Development
3	Value Added Courses(Module)
4	Integration of Digital Learning Tools
5	Cross Cutting Edges(Ethics, Gender Equality, Sustainability, Envt Conserns)
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CO - PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	1	2	2	1	1	1	2
CO2	2	3	2	2	3	1	1	2	1	2
CO3	2	2	3	3	3	2	2	1	2	2
CO4	1	2	2	2	2	2	3	2	1	2

CO5	1	3	2	2	2	3	-	3	2	3
Articulation	1.8	2.6	2.25	2	2.4	2	1.75	2.25	1.4	2.2

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