Curriculum Structure – B.Tech. Information Technology (R2025)

Sl. No.	Course Code	Course	L	T	P	C	POs	CA	ES	TOTAL
Humanities and Social Sciences, including Management courses (HSMC)										
1	25HS251	Technical English	2	0	2	3	5,9,11	40	60	100
2	25HS270/ 25HSXXX	Professional English/ Foreign Language	0	0	2	1	5,9,11	50	50	100
3	25IT210	Cybercrimes - Law, Practice and Procedures [CIP]	2	0	0	2	1,2,6,7,8,9,11	40	60	100
4	25HS207	Environment, Sustainability, and Society	2	0	0	2	1, 6,7,8,9,11	40	60	100
5	25IT211	Universal Human Values - III (Cyber Ethics)	1	0	0	1	1,2,3,6,7,11	40	60	100
6	25IT212	Information Standards	1	0	0	1	1,2,3,4,5	40	60	100
Basic Science Courses (BSC)										
1	25MA201	Matrices and Calculus	3	1	0	4	1,2,5,8,9,11	40	60	100
2	25CH201	Green Computing	2	0	0	2	1,6,11	40	60	100
3	25IT201	Bio-inspired Computing	1	0	0	1	1,2,3	40	60	100
4	25PH253	Engineering Physics	2	0	2	3	1,2,5,8,9	50	50	100
5	25MA202	Linear Algebra and Number Theory	3	1	0	4	1,2,8,9,11	40	60	100
6		Probability and Statistics	3	1	0	4	1,2,5	40	60	100
Engineering Science Course (ESC)										
1	25CS251	C Programming	2	0	4	4	1,2,3,59	50	50	100
2	25CS270	Computer Practices Workshop	0	0	2	1	1,2,3,4,5,9	60	40	100
3	25IT251	Object-Oriented Programming	2	0	4	4	1,2,3,4,5,9	50	50	100
4	25EC202	Digital Principles and System Design	3	0	0	3	1,2,5,8	40	60	100
5	25CS252	Data Structures	2	0	2	3	1,2,3,5,9	50	50	100
6	25CS253	Excel-Macros	1	0	2	2	1,2,3,4,5,9	50	50	100
7		Sensor and Instrumentation	1	0	2	2		50	50	100
8	25IT252	Python for Scientific Computing	2	0	2	3	1,2,3,4,5	50	50	100
9	25IT205	Universal Acceptance [ICANN]	2	0	0	2	1,3,5	40	60	100
Professional Core Course (PCC)										
1	25CS203	Design and Analysis of Algorithm	3	0	0	3	1,2,3,4	40	60	100

Sl. No.	Course Code	Course	L	T	P	C	POs	CA	ES	TOTAL
2	25CS204	Computer Organization and Architecture	3	0	0	3	1,2,3,4	40	60	100
3	25CS254	Operating Systems	2	0	2	3	1,2,3,5	50	50	100
4	25CS255	Database Management Systems [SFIA]	2	0	2	3	1,2,3,5	50	50	100
5	25IT253	Artificial Intelligence and Machine Learning	2	0	2	3	1,2,3,4,5	50	50	100
6	25CS205	Computational Theory and Automata	3	0	0	3	1,2,3,4	40	60	100
7	25IT254	Programming in Java	2	0	2	3	1,2,3,4.5	50	50	100
8	25IT205	Discrete Structures	3	0	0	3	1,2,5	40	60	100
9	25IT255	Computer Networks and Communication [CIP]	2	0	2	3	1,2,3,4,5	50	50	100
10	25IT206	Cyber Governance, Risk, and Compliance [SFIA]	2	0	0	2	1,2,3,5	40	60	100
11	25CS257	Software Engineering and Project Management	2	0	2	3	1,2,3,4,5	50	50	100
12	25IT256	Web Technologies and Full Stack Development	2	0	2	3	1,2,3,4,5	50	50	100
13	25CS258	Compiler Design and Program Translation	2	0	2	3	1,2,3,4,5	50	50	100
14	25IT257	Cloud Computing and Virtualization [CIP]	2	0	2	3	1,2,3,4,5	50	50	100
15	25IT258	Penetration Testing and Vulnerability Assessment [SFIA]	2	0	2	3	1,2,3,4,5	50	50	100
16	25IT259	Cryptography and Cybersecurity [SFIA]	2	0	2	3	1,2,3,4,5	50	50	100
17	25IT207	Human Computer Interaction	3	0	0	3	1,2,3	40	60	100
18	25IT260	Realtime and Embedded Systems Development [SFIA]	2	0	2	3	1,2,3,4,5	50	50	100
19	25IT208	Information Security [SFIA]	2	0	0	2	1,2	40	60	100
20	25IT209	AI Safety	3	0	0	3	1,2,3, 4, 6, 8	40	60	100
Professional Elective Course (PEC)										
1	25IT2E01	Hardware Security	3	0	0	3	1, 2, 3, 4	40	60	100
2	25IT2E02	Usable Security	3	0	0	3	1, 2, 3	40	60	100
3	25IT2E03	Data Management	3	0	0	3	1,2,3,4	40	60	100
4	25IT2E04	Infrastructure Management	3	0	0	3	1,2,3,4	40	60	100
5	25IT2E05	Information and Technology Law	3	0	0	3	1,2,3,4	40	60	100
6	25IT2E06	Data Ethics	3	0	0	3	1,2,3,4	40	60	100
7	25IT2E07	Infrastructure Design and Operations	3	0	0	3	1,2,3,4	40	60	100
8	25IT2E08	Software Defined Networks	3	0	0	3	1, 2, 3, 4	40	60	100
Emerging Technology Courses (ETC)										

Sl. No.	Course Code	Course	L	T	P	C	POs	CA	ES	TOTAL
1	25IT202	Modern Digital Technologies	2	0	0	2	1,2,3,4,5,6	40	60	100
2	25IT203	Prompt Engineering	2	0	0	2	1,2,3,4,5,6	40	60	100
3	25CS201	Data Science	2	0	0	2	1,2,3,4	40	60	100
4	25CS202	Artificial Intelligence	2	0	0	2	1,2,3,4	40	60	100
5	25IT204	Cybersecurity for Critical Infrastructure	2	0	0	2	1,2,3,4	40	60	100
Ability Enhancement Course (AEC)										
1	25HS204	Design Thinking	1	0	0	1	2,3,4	100	-	100
2		CDPC-1 Aptitude, Verbal, Logical	1	0	0	1		100	-	100
3		Linguaskill	1	0	0	1		100	-	100
4		CDPC-2 Technical	1	0	0	1		100	-	100
Liberal Arts (LA)										
1	25HS203	Yoga	1	0	0	1	6	100	-	100
2	25HS201	Heritage of Tamils	1	0	0	1	11	100	-	100
3	25HS202	Tamils and Technology	1	0	0	1	11	100	-	100
4	25MA205	Vedic Mathematics for Engineers	1	0	0	1	1,2,5, 11	100	-	100
5	25MA206	Foundations of Problem Solving	1	0	0	1	1,2,4,9,11	100	-	100
6	25ME202	Industrial Revolution & Emerging Trends in Manufacturing	2	0	0	2	1,2,5,6,10,11	40	60	100
7		Indian Knowledge System	1	0	0	1	1,3	40	60	100
Mandatory Course (MC)										
1	25HS252	Universal Human Values: Understanding Harmony I	1	0	0	0	7,11	100	-	100
2	25HS253	Universal Human Values: Understanding Harmony II	1	0	0	0	7,11	100	-	100
3		Constitution of India	1	0	0	0	6,8	100	-	100

25IT210	CYBERCRIMES - LAW, PRACTICE AND PROCEDURES	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the jurisprudential basis, scope, and classification of cybercrimes under Indian law.	2, 6, 8	-
CO2	Explain the key provisions of the Information Technology Act, 2000, and the Digital Personal Data Protection Act, 2023.	6, 8	-
CO3	Recall the procedural framework for cybercrime investigation.	6	-
CO4	Identify the legal principles governing the admissibility and evidentiary value of electronic records in court.	6	-
CO5	Apply legal principles to real-world cybercrime scenarios.	2, 6, 8	-

Foundations of Cyber Law and Jurisdiction [6]

Introduction to Cyberspace and Cyber Law - Definition, evolution, and need for cyber laws - Jurisprudence of Cyber Law: Challenges of regulating the borderless digital world - Overview of the Indian legal framework: Constitution of India, IPC/BNS, Evidence Act/BSA, and the IT Act - The Information Technology Act, 2000 - Objectives, scope, and salient features - Key amendments via the IT (Amendment) Act, 2008 - Legal recognition of electronic records and digital/electronic signatures - Jurisdictional Issues in Cyberspace - Theories of cyber jurisdiction - Issues in cross-border data flow and investigation - Provisions for extra-territorial application under the IT Act.

Cyber Offenses and Legal Provisions [6]

Offenses under the Information Technology Act, 2000 - Section 43: Penalty and compensation for damage to computer systems - Section 66: Computer-related offenses (Hacking, data alteration, virus dissemination) - Section 66B: Punishment for dishonestly receiving stolen computer resource - Section 66C: Punishment for identity theft - Section 66D: Punishment for cheating by personation by using computer resource - Section 66E: Punishment for violation of privacy - Section 66F: Punishment for cyber terrorism - Analysis of Specific Cybercrimes: Against Persons: Cyber stalking, cyber bullying, cyber defamation, online harassment, morphing, and publishing obscene content (Section 67, 67A, 67B) - Against Property: Phishing, vishing, online fraud, credit/debit card frauds, Intellectual Property (IP) crimes, and cybersquatting - Against Government: Cyber terrorism and espionage - Overlap with Traditional Laws: - Applicability of the Bharatiya Nyaya Sanhita (BNS), 2023 (and IPC) to cybercrimes - Mapping between IT Act offenses and BNS offenses (cheating, forgery, defamation, stalking) - Case studies.

Cybercrime Investigation and Procedure [6]

The Investigation Framework: Role and powers of the Investigating Officer (IO) - Procedure for registration of cybercrime complaints (FIR vs. NCR) - Issues of territorial and subject-matter jurisdiction for investigation - Search, Seizure, and Arrest: Procedural requirements for search and seizure of computer resources - Handling of digital evidence at the crime scene: Do's and Don'ts - Arrest of an accused in a cybercrime case - Intermediary Liability and Data Disclosure - Definition and role of intermediaries (ISPs, social media platforms) - Safe harbor provisions and due diligence requirements (Rules under IT Act) - Procedures for lawful interception, monitoring, and decryption (Section 69) - Obligations to preserve and retain user information (Section 67C).

Electronic Evidence and Courtroom Procedure [6]

Electronic Evidence under the Indian Evidence Act, 1872 / Bharatiya Sakshya Adhiniyam (BSA), 2023 - Concept of primary and secondary evidence for electronic records - Admissibility of electronic evidence (Section 65B of Evidence Act / corresponding provisions in BSA) - The "Certificate under Section 65B" – requirements and judicial interpretation - Forensic Analysis and Reporting - Trial of Cybercrime Cases - Pre-trial procedures (cognizance of offenses, taking of evidence) - Role of key players: Judge, Prosecutor, Defense Counsel, Expert Witness - Preparation of case materials for court: Chronology, evidence log, and presentation.

Emerging Issues, Ethics, and Case Laws [6]

Data Protection and Privacy: Overview of the Digital Personal Data Protection (DPDP) Act, 2023 - Rights and duties of data principals (citizens) and obligations of data fiduciaries - Interface between the DPDP Act and the IT Act - Specialized Cybercrimes: Legal issues in E-Banking and Mobile Payments - Social media-related crimes and platform accountability - Cryptocurrency and blockchain-related frauds.

60 Notional Hours

Text Book:

1. R.P. Kataria & S.K.P. Sriniwas. *Cyber Crimes: Law, Practice and Procedure, 2/E*. Orient Publishing Company, 2025.

REFERENCES:

1. Dr Gupta & Agrawal. *Cyberlaws*. Premier Publication Company, 2024.
2. D.P. Mittal. *Law Relating to Information Technology, E-Commerce, E-Governance & Cyber Crimes*. Orient Publishing Company, 2025.

ONLINE RESOURCES:

1. The Information Technology Act, 2000. *https://www.indiacode.nic.in/bitstream/123456789/13116/1/it_act_2000_updated.pdf*
2. The Digital Personal Data Protection Act, 2023. *https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf*

25IT211	CYBER ETHICS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the foundational ethical theories, normative principles, and the complex architecture of the internet that shape moral dilemmas in cyberspace.	1, 2, 7	1
CO2	Identify contemporary issues involving free speech, intellectual property, and privacy in digital contexts by applying ethical frameworks and relevant legal concepts.	2, 7	1
CO3	Interpret the societal, security, and environmental impacts of networked technologies and cybersecurity measures from the perspective of sustainable and ethical engineering practice.	3, 6	1
CO4	Propose ethical and legal strategies for protecting personal data, securing digital infrastructure, and managing online content, considering principles from statutes.	3, 7	1
CO5	Describe the professional and ethical responsibilities of engineers in promoting inclusive, secure, and rights-respecting digital ecosystems, and commit to the need for continuous learning in this evolving field.	7, 11	1

The Internet and Ethical Values **[3]**

Cyberethics and Code – Ethical Values and the digital frontier – Postscript on Moral Theory – Floridi's Macroethics – Normative Principles – Early history of the internet – The Internet's architecture – Net neutrality – The World Wide Web – Gatekeepers and Search Engines – Social Networking – Internet Governance – Contested Sovereignty in Cyberspace – Internet Monopolies – Case Studies.

Free Speech and Censorship **[3]**

Speech and Internet Architecture – Pornography – Hate Speech – Online Threats – Anonymous speech – Government censorship and the fate of political speech – Case Studies.

Intellectual Property **[3]**

Background on Intellectual Property – Issues for the internet and networking technologies – Digital Books and E-books – Case studies.

Privacy Rights in the Age of Surveillance **[3]**

Definition and Theory of Privacy – Personal Information on the Internet – Consumer Privacy on the Internet – Privacy Protection – Privacy in the Workplace - Digital Personal Data Protection Act, 2023 – Case Studies.

Securing the Digital Infrastructure **[3]**

Vulnerabilities of Networked Technologies – Cybercrime – Anti-Piracy Architectures – Trespass, Hackers and Hacktivism - Security Measures in Cyberspace –

Cybersecurity as a Moral Obligation – The Encryption Controversy – New Encryption Disputes and Challenges – Encryption code, Privacy and Free Speech – Case Studies.

30 Notional Hours

Text Book:

1. Richard A. Spinello. *Cyberethics: Morality and Law in Cyberspace, 7/E*. Jones & Bartlett Learning, 2021.

REFERENCES:

1. Terry Halbert, Elaine Ingulli. *Cyberethics*. CBS Publishers & Distributors Pvt. Ltd, 2004.
2. Sanjana Singh. *Digital Ethics and Cyber Security*. Yking Books, 2024.
3. Joseph Migga Kizza. *Computer Network Security and Cyber Ethics, 4/E*. McFarland & Company, Inc., 2014.

ONLINE RESOURCES:

1. The Digital Personal Data Protection Act, 2023. *https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf*
2. Ethics of Technology. *https://ocw.mit.edu/courses/24-131-ethics-of-technology-spring-2023/*

25IT212	INFORMATION STANDARDS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Understand the fundamental concepts of information security as defined by the ISO 27k series of standards.	1	1
CO2	Understand the organizational context requirements for establishing an ISMS.	1	1
CO3	Describe the complete ISMS lifecycle.	1	1
CO4	Apply risk assessment methodologies to identify, analyze, and evaluate information security risks based on organizational risk appetite and tolerance	1, 2, 3, 4, 5	1
CO5	Apply the ISO 27001 control framework across various domains to establish comprehensive information security controls.	1, 2, 3, 4, 5	1

Information Security Management Systems **[15]**

The CIA Triad (Confidentiality, Integrity, Availability) - Introduction to Management Systems - The ISO 27k Series - The Plan-Do-Check-Act (PDCA) Model - Business Benefits of an ISMS - Understanding the organization, interested parties, and defining the ISMS scope - Leadership & commitment, Policy, Roles - Addressing risks/opportunities, setting security objectives - Resources, Competence, Awareness, Communication, Documented Information - Operational Planning & Control - Risk Identification, Analysis, and Evaluation - Risk Assessment Methodologies (Qualitative vs. Quantitative) - Risk Appetite and Tolerance - The risk assessment process - Risk treatment options (Modify, Retain, Avoid, Share) - The Statement of Applicability (SoA) and Risk Treatment Plan (RTP) - Policies, Roles, Segregation of Duties, Asset Management, Access Control concepts - Supplier Relationships, Information Security Incident Management, Business Continuity, Compliance - HR Security, Training, Remote Work - Physical Perimeter, Secure Areas, Clear Desk/Screen - Endpoint Security, Privileged Access, Malware Protection, Vulnerability Management, Backup - Network Security, Cryptography, Secure Development Lifecycle (SDLC), Logging & Monitoring - Monitoring, Measurement, and Analysis - Conducting Internal Audits (Principles, Planning, Execution); Management Review - Nonconformity and Corrective Action; Continual Improvement - The 2-stage certification audit process; Maintaining certification - Review of the complete ISMS lifecycle - Integration with other frameworks (NIST, COBIT) - Future trends in information security management.

30 Notional Hours

Text Book:

1. *ISO/IEC 27001:2022 - Information security, cybersecurity and privacy protection — Information security management systems — Requirements*. ISO, 2022.

25IT252	PYTHON FOR SCIENTIFIC COMPUTING	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Apply Python programming constructs to solve engineering and scientific problems using appropriate data structures and program flow techniques.	1, 2, 5	1
CO2	Perform numerical computations using NumPy for vector/matrix operations, linear algebra, and statistical analysis.	1, 2, 4, 5	1
CO3	Visualize and animate mathematical models using Matplotlib for 2D/3D plotting, subplots, and dynamic simulations.	2, 3, 5	1
CO4	Utilize symbolic computation with SymPy for algebraic manipulation, equation solving, differentiation, integration, and differential equations.	2, 4, 6	1
CO5	Implement advanced numerical methods using SciPy for optimization, interpolation, numerical integration, and solving differential equations.	2, 4, 5	1
CO6	Develop interactive simulations and 3D visualizations using VPython and integrate GUI elements with Tkinter for engineering applications.	3, 5	1

Foundations of Python Programming **[6]**

Development Environments – Modules of Python: NumPy – Matplotlib – SymPy – SciPy – Vpython – Keywords – Linear Program Structures – Functions – Branching Structures – Repetitive Structures – Data Structures – Functional Program Style – Object-oriented program style.

Numerical Computing **[5]**

NumPy Functions – One-dimensional array – two-dimensional array – slicing – mathematical and statistical functions – Vectors: addition – product – Matrix Multiplication – Linear Systems of Equations.

Data Visualization and Animation **[5]**

2D function plots – 3D function plots – Vector Field – Displaying Figures, Lines and Arrows - Animations.

Symbolic Mathematics **[5]**

Basic Mathematical Operations – Multiplying Matrices – Equations – Simplification of terms – series expansion – partial fractions – Limits – Differentiation – Integrations – Differential Equations – Laplace Transform.

Advanced Numerical Methods **[9]**

Numerical computation of zeros – optimizations – interpolations – numerical differentiation – numerical integration – solving differential equations numerically – Discrete Fourier Transform – basic shapes, points, and lines – bodies in motion –

generating, saving, and reading measurements – frequency distribution – location parameters – dispersion parameters – normal distribution – skew – regression analysis – layout manager of Tkinter – Radio button - slider.

LAB EXPERIMENTS: **[60]**

1. Solve a system of linear equations using NumPy's solve() function.
2. Compute scalar, cross, and triple products for given vectors and visualize them using Matplotlib.
3. Plot multiple functions (e.g., harmonics of a square wave) with custom line styles, legends, and axis labels.
4. Use SymPy to find derivatives and integrals of given functions and plot the results alongside numerical approximations.
5. Compare rectangle, trapezoidal, and Simpson's rule using SciPy for a definite integral and analyze error trends.
6. Solve a second-order ordinary differential equation using SymPy and SciPy and animate the solution with Matplotlib.
7. Simulate a bouncing ball or planetary orbit using VPython and analyze motion parameters.
8. Generate normally distributed random data, compute mean/median/variance, and plot histograms with regression lines.

90 Notional Hours

Text Book:

1. Veit Steinkamp. *Python for Engineering and Scientific Computing*. Rheinwerk Computing, 2024.

REFERENCES:

1. Claus Führer, Jan Erik Solem, Olivier Verdier. *Scientific Computing with Python: High-performance scientific computing with NumPy, SciPy, and pandas, 2/E*. Packt Publishing Limited, 2021.
2. Stephen Lynch. *Python for Scientific Computing and Artificial Intelligence*. CRC Press, 2025.

ONLINE RESOURCES:

1. Scientific Computing using Python, 2023. *https://nptel.ac.in/courses/115104135*
2. The Joy of Computing using Python, 2025. *https://nptel.ac.in/courses/106106182*
3. Introduction to Computer Science and Programming in Python, *https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/*

25IT205	UNIVERSAL ACCEPTANCE	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Define the fundamental principles of Unicode.	1	1
CO2	Describe the architecture, necessity, and inherent security challenges of Internationalized Domain Names (IDNs) and Email Address Internationalization (EAI)	1,2	1
CO3	Apply Unicode standards and algorithms to manipulate and query textual data programmatically.	1, 2, 3, 4, 5	1
CO4	Deploy internationalization protocols and libraries to configure and handle non-ASCII data in network identifiers and messages.	1, 2, 3, 5	1
CO5	Use the Unicode and Internationalization frameworks in a development environment to build a feature for a mobile or web application that stores, processes, and validates internationalized data.	1, 2, 3, 4, 5	1

UNICODE PROGRAMMING [6]

Introduction to encoding schemes – Need for Unicode - Character data type for Unicode code points - Unicode code charts - Processing Unicode Strings - Store Unicode data - The character-glyph model - difference between processing textual information and displaying text - Displaying text - use of text engines, fonts, glyph shapers - Normalization of Unicode strings - NFC and NFD - Comparing Unicode strings - bidirectional and shaped scripts: Display format, File storage in key-press order, Glyph Shapers - Interface/Class/Object: Variables, Methods - Other file formats and their handling - JSON File Unicode handling - Unicode libraries - ICU and others.

UNICODE IN COMPUTATIONAL METHODOLOGIES [6]

Data structures using local language strings - Unicode collation algorithm for sorting of Unicode Strings - Searching through Unicode data (Normalization + Collation) – Unicode in Database Systems: Indexing on columns with Unicode characters - Integrity constraints based on columns - Queries- regular expression - Storing Unicode data in databases.

INTERNATIONALIZED DOMAIN NAMES (IDNS) [6]

Introducing the root zone: TLD, gTLD, ccTLD – Need for IDNs - Unicode-based domain names: U-label - Need for A-labels - Punycode algorithm (RFC 3492) - IDNA2003 and its limitations - IDNA2008 - Limitations of protocols on IDNs: FTP, HTTP, HTTPS - Network troubleshooting commands with U-Labels- IDNA2008 compatible libraries - Python, Java, and/or other platform(s) - Pitfalls of Using the IDNA2003 Library: Avoiding IDNA2003 libraries - Limitations of IDNA2008 - Label Generation Rules (LGRs) - Exploring XML-based Label Generation Rules format

(RFC7940; RFC 4690, and RFC 3743) - Using available LGRs in ICANN to create valid labels.

EMAIL ADDRESS INTERNATIONALIZATION (EAI) [6]

Need for EAI - Storing EAI mail - Email protocol changes for EAI - SMTP - signaling flag - POP/IMAP - EAI and Mail message formats - EAI and MIME standard - Adoption challenges - Technical Compatibility Issues – Technical Solutions - Email and Anti-spam measures - EAI and cross-cultural email communication skills - Communication Etiquette and Best Practices - Handling UTF-8/non-ASCII characters: Subject line, Header, Email body text, Attachments – Libraries/APIs that handle SMTP interactions with EAI support - Validating internationalized email addresses using confirmation link workflow - Email address parsing for internationalized email addresses - Considerations for setting up email mailbox names.

IDN MOBILE APPS, SECURITY AND SUPPORT [6]

Unicode Character set support - Unicode Text layout and rendering - Unicode Support in Mobile Apps Development Frameworks - iconv/ICU Converter APIs - Processing IDNs on mobile devices - relevant libraries - Processing EAI on mobile devices - relevant libraries - Unicode Security: Unicode Security Mechanisms, Mitigating EAI addresses blocking, DNS Security, ASCII Homograph, Phishing, Spamming - IDN Security - IDN homographs - LGRs and variants - String similarity - Unicode Support in Operating Systems: File systems support for Unicode - Working with Unicode - Unicode APIs for OS.

60 Notional Hours

Text Book:

1. Jukka K Korpela. *Unicode Explained: Internationalize Documents, Programs, and Web Sites.* O'Reilly Media, 2006.

REFERENCES:

1. Richard Gillam. *Unicode Demystified: A Practical Programmer's Guide to the Encoding Standard*. Addison Wesley, 2002.
2. *The Unicode® Standard Version 17.0 – Core Specification*. Unicode Consortium, 2025.

ONLINE RESOURCES:

1. ICANN Universal Acceptance. *https://www.icann.org/ua*
2. Unicode. *https://home.unicode.org/*

25CS203	DESIGN AND ANALYSIS OF ALGORITHMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental principles of algorithm analysis.	1, 2	1
CO2	Apply divide-and-conquer, greedy, and dynamic programming techniques to solve classical computational problems.	1, 2	1
CO3	Derive the time and space complexity of algorithmic strategies.	2, 4	1
CO4	Design algorithmic solutions for real-world problems using appropriate paradigms such as greedy methods, dynamic programming, and heuristic-based approaches.	3	1
CO5	Evaluate the suitability and efficiency of different algorithmic approaches for solving NP-hard problems and justify the use of approximation algorithms where exact solutions are intractable.	2, 4	1

Introduction to Algorithm Analysis [9]

Algorithm analysis: Fundamentals of Algorithmic Problem Solving, the Analysis Framework, Asymptotic Notations and its properties, Recurrence relation: substitution method and Master's method.

Divide-and-conquer [9]

Divide and Conquer: Finding Maximum and Minimum, Quick Sort, Merge Sort, Strassen's Matrix Multiplication, Closest pair and convex hull.

Greedy method and Dynamic Programming [9]

Knapsack problem, Dijkstra's Algorithm. Dynamic Programming techniques: Principle of Optimality, Floyd's algorithm, longest common subsequence, Optimal binary search trees.

Backtracking and Branch-and-bound [9]

N-Queens's problem, Sum of subsets, Hamiltonian Cycle, Branch and Bound: Knapsack problem – Traveling salesman problem.

NP-Problems and Approximation Algorithms [9]

P and NP problems, NP-Complete problems, Cook's theorem, Theory of reducibility, Approximation Algorithms: Knapsack problem, Traveling salesman problem.

90 Notional Hours

Text Book:

1. Anany Levitin. *Introduction to the Design and Analysis of Algorithms, 3/E*. Pearson, 2017.

REFERENCES:

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran. *Fundamentals of Computer Algorithms, 2/E*. University Press, 2024.
2. Sridhar S. *Design and Analysis of Algorithms, 2/E*. Oxford University Press, 2014.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein. *Introduction to Algorithms*, 4/E, PHI Learning, 2018.
4. Jon Kleinberg, Eva Tardos. *Algorithm Design*, Pearson, 2013.

ONLINE RESOURCES:

1. Design and analysis of algorithms, 2025. *https://nptel.ac.in/courses/106106131*
2. Design and Analysis of Algorithms, 2023. *https://nptel.ac.in/courses/106101060*
3. Design and Analysis of Algorithms, *https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2012/*

25CS204	COMPUTER ORGANIZATION AND ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental concepts of computer organization.	1, 2	1
CO2	Apply computer arithmetic principles to design and evaluate hardware algorithms for signed and unsigned integer operations, floating-point arithmetic, and their implementation in ARM architecture.	1, 2	1
CO3	Distinguish between processor design techniques.	2, 4	1
CO4	Design memory and I/O interfacing systems.	3	1
CO5	Evaluate parallel processing architectures and their performance implications.	2, 4	1

Basic Structure of Computers **[9]**

Functional units – basic operational concepts – Bus Structures - Technology – Performance – Power wall – Uniprocessor to multiprocessor – Instructions: Operations and Operands – Instruction Set: RISC and CISC - Representing Instructions — ARM Addressing for 32-bit Immediate and more complex addressing modes.

Computer Arithmetic **[9]**

Addition and Subtraction – Multiplication – Multiplication Algorithm and Hardware – Signed Multiplication - Faster Multiplication in ARM - Division – Division Algorithm and Hardware - Signed Division – Faster Division in ARM - Floating Point Representation – Floating Point Operations: Addition - Multiplication – Floating point instructions in ARM.

Processor Design **[9]**

An abstract view of implementation - Logic design Conventions - Building a datapath – Simple implementation scheme – Pipelining – Pipelined Datapath and Control - Hazards – Data Hazards – Control Hazards – Exceptions.

Memory and I/O Interfacing **[9]**

Memory Technologies – Basics of Caches – Measuring and Improving Cache Performance – Virtual Memory – Transaction- Look aside Buffer (TLB) - Memory Hierarchy - Input/output system, programmed I/O, DMA and interrupts, I/O processors.

Parallel Processing **[9]**

Parallelism - Instruction-level-parallelism – Parallel processing challenges - Hardware multithreading – SISD, MIMD, SIMD, SPMD and Vector - Multicore processors – Shared memory Multiprocessors – Graphical Processing Units – Multiprocessor Network Topologies.

90 Notional Hours

Text Book:

1. David A. Patterson and John L. Hennessey. *Computer Organization and Design: The Hardware / Software Interface*. Morgan Kaufman / Elsevier, ARM Edition, 2021.

REFERENCES:

1. V. Carl Hamacher, Zvonko G Vranesic and Safwat G Zaky. *Computer Organization, 6/E*. McGraw-Hill Inc, 2021.
2. William Stallings. *Computer Organization and Architecture – Designing for Performance*, *11/E*, PHI Learning, 2022.
3. Morris Mano M, Rajib Mall. *Computer System Architecture, 3/E*, Pearson, 2023.
4. Andrew S. Tanenbaum. *Structured Computer Organization, 6/E*, Pearson, 2024.

ONLINE RESOURCES:

1. Computer Architecture, 2025. *https://nptel.ac.in/courses/106102157*
2. Computer Architecture and Organization, 2023. *https://nptel.ac.in/courses/106105163*
3. Computer System Architecture, *https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005/*

25CS254	OPERATING SYSTEMS	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental organization and architecture of computer systems, the evolution of operating systems, OS structure, and the process of building and booting an OS.	1, 2	1
CO2	Implement process management techniques to solve scheduling problems.	1, 2	1
CO3	Apply synchronization mechanisms to coordinate concurrent processes and resolve resource conflicts.	1,2, 3, 5	1
CO4	Recommend memory management strategies to improve system performance.	1, 2, 3, 4, 5	1
CO5	Compare their trade-offs across different operating systems in terms of system structure.	1,2,4	1

Introduction to Operating Systems **[4]**

Computer System Organization – Computer System Architecture- Evolution of Operating System- OS Structures: OS Services - System Calls –OS Structures- Building and Booting an OS.

Process Management **[8]**

Processes: Process Concept- Process Scheduling-Operations on Process- Inter-process Communication – Threads - Multithread Models. CPU Scheduling: Basic Concept-Scheduling Criteria-Scheduling Algorithms- Multi-Processor Scheduling. Process Synchronization: Critical Section Problem – Peterson's Solution-Semaphores - Monitors – Hardware Synchronization: Deadlocks: System Model-Characterization-Methods-Prevention -Avoidance and Detection-Recovery from Deadlocks.

Memory Management **[6]**

Memory Management Strategies: Swapping – Contiguous Memory Allocation - Segmentation - Paging. Virtual Memory Management: Demand Paging - Page Replacement Algorithms- Thrashing.

File Management and Disk Management **[8]**

File System: File concepts – Access Methods -Directory and Disk Structure-File System Mounting- File System Structure-Implementation-Directory Implementation-Allocation Methods-Free Space Management. Mass Storage Structure: Disk Structure - Disk Scheduling - Disk Management -Swap Space Management- I/O Systems - System Protection and Security.

Advancements in Operating Systems **[4]**

Virtual Machines- Network and Distributed Systems – Case Studies: Linux-Windows 11.

LIST OF EXPERIMENTS

1. Linux Commands
2. System Calls
3. CPU Scheduling
4. Semaphore
5. Deadlock Avoidance
6. Paging
7. Page Replacement Algorithms
8. File Allocation Methods
9. Directory Implementation
10. Disk Scheduling

90 Notional Hours

Text Book:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne. *Operating System Concepts, 10/E*. John Wiley and Sons, 2021.

REFERENCES:

1. William Stallings. *Operating Systems - Internals and Design Principles, 9/E*. Pearson, 2018.
2. Andrew S. Tanenbaum. *Modern Operating Systems*, Pearson, 2024.

ONLINE RESOURCES:

1. Introduction to Operating Systems, 2021.
   https://onlinecourses.nptel.ac.in/noc21_cs72
2. Operating System Fundamentals, 2021.
   https://onlinecourses.nptel.ac.in/noc21_cs88/

25CS255	DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe fundamental DBMS concepts, data models, database architecture, and schema design principles.	1, 2	1
CO2	Apply relational algebra and SQL queries to create, manipulate, and retrieve database data.	1, 2	1
CO3	Recommend normalization techniques and ER modeling to eliminate redundancy and improve database integrity.	1,2,5	1
CO4	Evaluate query execution and optimization strategies for improving database performance.	1,2,3,5	1
CO5	Design ETL pipelines, data warehousing solutions, and data engineering workflows for scalable data processing.	1,2,3,5	1

DATABASE CONCEPTS AND ARCHITECTURE [6]

Database system overview, DBMS architecture, data models (hierarchical, network, relational), schema vs instance, data independence, ER modeling, enhanced ER concepts (specialization, generalization, aggregation), relational schema mapping.

RELATIONAL MODEL AND QUERY LANGUAGES [6]

Relational algebra (operators and expressions), relational calculus (tuple and domain), SQL: DDL, DML, DQL, constraints, joins, nested/correlated subqueries, views, triggers, assertions, transactions, concurrency basics.

NORMALIZATION AND INTEGRITY [6]

Functional, multivalued, and join dependencies, attribute closure, keys and candidate keys, normal forms (1NF, 2NF, 3NF, BCNF), lossless decomposition, dependency preservation, indexing concepts (B-tree, B+-tree).

QUERY PROCESSING, STORAGE & OPTIMIZATION [6]

Query execution stages, cost estimation, sorting, hashing, join techniques, query rewrite rules, plan selection, buffer management, caching, RAID storage, file organizations (heap, sorted, hashed, clustered).

DATA ENGINEERING AND WAREHOUSING [6]

Introduction to data engineering, ETL lifecycle, data integration techniques, data warehousing architecture, OLTP vs OLAP, star/snowflake schema, dimensional modeling, ETL/ELT tools, Big Data platforms and distributed processing.

LIST OF EXPERIMENTS

1. Create and query relational databases using SQL DDL/DML/DQL.
2. Implement joins, nested and correlated queries.
3. Apply constraints, triggers, and views in database design.

4. Perform ER modeling and map to relational schemas.
5. Normalize database tables to 3NF/BCNF and test for integrity.
6. Develop a mini ETL pipeline or data warehousing workflow using a sample dataset.

90 Notional Hours

Text Book:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan. *Database System Concepts, 7/E*. McGraw-Hill, 2021.

REFERENCES:

1. Ramez Elmasri and Shamkant B. Navathe. *Fundamentals of Database Systems, 7/E*. Pearson, 2017.
2. Garcia-Molina H., Ullman J.D., Widom J. *Database Systems: The Complete Book*, *3/E*, Pearson, 2020.
3. Mark L. Gillenson, Pradeep Singh. *Fundamentals of Database Management Systems, 3/E*, Wiley, 2025.

ONLINE RESOURCES:

1. Database Systems, 2025. *https://onlinecourses.nptel.ac.in/noc24_cs55*
2. Data Engineering Foundations, 2025. *https://www.coursera.org/specializations/data-engineering-foundations*

25IT253	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the fundamental concepts of AI and the ethical implications of modern AI systems.	1, 2	1
CO2	Apply supervised learning algorithms to build predictive models using appropriate performance metrics and optimization techniques.	1,2,3,5	1
CO3	Deploy unsupervised learning techniques to discover hidden patterns in unlabeled data.	1,2,3,5	1
CO4	Use reinforcement learning algorithms to develop agents that learn optimal behaviors through interaction with environments.	1,2,3,5	1
CO5	Select appropriate machine learning models considering the limitations, bias, fairness, and data privacy concerns.	1,2,3,4,5	1

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE [6]

History and evolution of AI - Turing Test - intelligent agents - agent environments - State space representation - uninformed search (BFS, DFS, UCS) - informed search (Greedy BFS, A* algorithm) - heuristic functions, adversarial search (Minimax, Alpha-Beta pruning) - Propositional logic - first-order logic - knowledge graphs - inference rules – resolution - expert systems.

MODERN AI CONCEPTS [6]

Bayesian networks - probabilistic inference - Markov chains - Monte Carlo methods - Dempster-Shafer theory for uncertainty handling - LLM architectures (transformers, attention mechanisms) - prompt engineering - fine-tuning - Retrieval-Augmented Generation (RAG) - ethical considerations - Fuzzy set theory - fuzzy inference systems - genetic algorithms (selection, crossover, mutation) - swarm intelligence - applications in optimization and control.

SUPERVISED LEARNING [6]

Linear regression - polynomial regression - logistic regression - performance metrics (MSE, MAE, R^2, accuracy, precision, recall, F1-score, ROC-AUC) - bias-variance tradeoff - cross-validation techniques - K-Nearest Neighbors (KNN) - Decision Trees (ID3, C4.5, CART) - Random Forest, Support Vector Machines (SVM) - Naïve Bayes classifier - ensemble methods (bagging, boosting, AdaBoost) – Perceptron - multi-layer perceptrons (MLP) - activation functions (sigmoid, ReLU, tanh) – backpropagation - gradient descent optimization (SGD, Adam) - introduction to CNNs and RNNs.

UNSUPERVISED LEARNING [6]

Curse of dimensionality - Principal Component Analysis (PCA) - t-SNE - Linear Discriminant Analysis (LDA) - feature selection methods - K-Means clustering,

hierarchical clustering – DBSCAN - Gaussian Mixture Models - cluster evaluation metrics (silhouette score, Davies-Bouldin index) - Apriori algorithm - FP-Growth - market basket analysis - support-confidence-lift framework - rule generation and pruning.

REINFORCED LEARNING **[6]**

Markov Decision Processes (MDPs) - rewards and returns - policy and value functions - exploration vs. exploitation - Q-learning - SARSA - Deep Q-Networks (DQN) - policy gradient methods (REINFORCE, PPO) - Actor-Critic architectures - applications in robotics and autonomous systems - AI ethics (bias, fairness, transparency, accountability) - explainable AI (XAI) - data privacy (GDPR, anonymization) - real-world case studies in healthcare, finance, autonomous vehicles and NLP.

LAB EXPERIMENTS

1. Introduction to Python for AI/ML
2. Search Algorithm Implementation
3. Knowledge Graph Construction
4. Bayesian Network Inference
5. Regression and Classification
6. Neural Network Implementation.
7. Dimensionality Reduction and Visualization
8. Clustering for Customer Segmentation
9. Q-Learning
10. Generative AI Application

90 Notional Hours

Text Book:

1. Pradeep Singh, Tapan K. Gandhi, & Balasubramanian Raman. *Artificial Intelligence and Machine Learning, 1/E*. McGraw-Hill, 2025.

REFERENCES:

1. Stuart Russell and Peter Norvig. *Artificial Intelligence: A Modern Approach, 4/E*. Pearson, 2022.
2. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das. *Machine Learning*, Pearson, 2024.
3. Reema Thareja. *Artificial Intelligence: Beyond Classical AI.* Pearson, 2023.

ONLINE RESOURCES:

1. Introduction to Machine Learning. *https://nptel.ac.in/courses/106106139*
2. Artificial Intelligence: Search Methods for Problem Solving. *https://nptel.ac.in/courses/106106226*

25CS205	COMPUTATIONAL THEORY AND AUTOMATA	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Recall the fundamental concepts of finite automata.	1,2	1
CO2	Describe regular expressions and the limitations of finite automata.	1, 2	1
CO3	Construct a DFA/NFA/ε-NFA for the given languages and apply the pumping lemma to prove that a language is not regular.	1,2,3,4	1
CO4	Design context-free grammar and construct push-down automata from CFGs for language acceptance by the final state or the empty stack.	1,2,3	1
CO5	Design Turing machines for language acceptance and integer functions to evaluate the halting problem and the Post correspondence problem (PCP).	1,2,3,4	1

Finite Automata **[9]**

Alphabets - Strings and Languages - Automata and Grammars - Deterministic Finite Automata (DFA) - Formal Definition - Simplified notation: State transition graph - Transition table - Language of DFA - Nondeterministic Finite Automata (NFA) - NFA with epsilon transition - Language of NFA - Equivalence of NFA and DFA - Minimization of Finite Automata – Weighted Automata.

Regular Expression **[9]**

Definition - Operators of regular expression and their precedence - Algebraic laws for Regular expressions - Kleene's Theorem - Regular expression to FA - DFA to Regular expression - Arden Theorem - Non Regular Languages - Pumping Lemma for Regular Languages. Application of Pumping Lemma - Closure properties of Regular Languages - Decision properties of Regular Languages - FA with output: Moore and Mealy machine - Equivalence of Moore and Mealy Machine - Applications and Limitation of FA.

Grammars **[9]**

Grammar Introduction– Types of Grammar - Context Free Grammars and Languages– Derivations and Languages – Ambiguity- Relationship between derivation and derivation trees – Simplification of CFG – Elimination of Useless symbols - Unit productions - Null productions – Greibach Normal form – Chomsky Normal form – Problems related to CNF and GNF.

Pushdown Automata **[9]**

Description and definition - Instantaneous Description - Language of PDA - Acceptance by Final state - Acceptance by empty stack - Deterministic PDA -

Equivalence of acceptance by empty stack and final state - Conversion of CFG to PDA and PDA to CFG.

Turing Machines & Undecidability **[9]**

Basic model - definition and representation - Instantaneous Description - Language acceptance by TM - Variants of Turing Machine - TM as Computer of Integer functions - Universal TM - Recursive and recursively enumerable languages - Halting problem - Introduction to undecidability - undecidable problems about TMs - Post correspondence problem (PCP) - Modified PCP and undecidable nature of Post correspondence problem.

90 Notional Hours

Text Book:

1. Hopcroft J.E., Motwani R. and Ullman J.D. *Introduction to Automata Theory, Languages and Computations, 2/E*. Pearson Education, 2016.

REFERENCES:

1. John C. Martin. *Introduction to Languages and the Theory of Computation, 4/E*. Tata McGraw-Hill, 2010.
2. Mishra K L P and Chandrasekaran N. *Theory of Computer Science – Automata, Languages and Computation, 3/E*, Prentice Hall of India, 2006.
3. K.R. Chowdhary. *Theory of Computation: Automata, Formal Languages, Computation and Complexity,* Springer, 2025.

ONLINE RESOURCES:

1. Theory of Computation, 2025. *https://nptel.ac.in/courses/106104148*
2. Theory of Computation, 2025. *https://nptel.ac.in/courses/106106242*
3. Theory of Computation*, https://ocw.mit.edu/courses/18-404j-theory-of-computation-fall-2020/*

25IT254	PROGRAMMING IN JAVA	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Apply fundamental Java programming concepts.	1,2	1
CO2	Apply inheritance, interfaces, packages, and exception handling to develop modular and robust programs.	1, 2, 4	1
CO3	Apply multithreading, concurrency, and Java I/O mechanisms to manage parallel execution and data streams.	1,2,3,5	1
CO4	Apply generics, collections, and functional programming (lambda expressions and the Stream API) to write efficient, reusable code.	1,2,3,5	1
CO5	Develop interactive Java applications using GUI components and JDBC for database connectivity.	1,2,3,5	1
CO6	Integrate modern Java features such as text blocks, records, switch expressions, and sealed classes into applications to enhance readability, scalability, and performance.	1,2,3,5	1

JAVA FUNDAMENTALS & OBJECT-ORIENTED CONCEPTS [6]

Introduction to Java – JDK, JRE, JVM, platform independence – Data types, variables, operators, expressions – Control statements (if, switch, loops) – Arrays, Strings, StringBuilder – Classes, objects, constructors, methods, this, static, access modifiers – Encapsulation and packages.

INHERITANCE, INTERFACES & EXCEPTION HANDLING [6]

Inheritance: super/subclasses, method overriding, dynamic dispatch, final classes/methods – Abstract classes and interfaces (default/private methods) – Nested and inner classes – Packages and access control – Exception handling: try/catch/finally, throw/throws, custom exceptions, assertions.

MULTITHREADING, CONCURRENCY & I/O [6]

Threads: Thread vs Runnable, lifecycle, priorities, synchronization, inter-thread communication – Concurrency utilities: ExecutorService, Future, concurrent collections – Java I/O: byte/character streams, buffered streams, Files API, serialization/deserialization.

GENERICS, COLLECTIONS & FUNCTIONAL PROGRAMMING [6]

Generics: parameterized types, wildcards, bounded types – Collections framework: List, Set, Map, Queue, iterators, comparators – Lambda expressions, method references, functional interfaces – Stream API: filtering, mapping, reducing, parallel streams.

GUI, JDBC & MODERN JAVA FEATURE [6]

GUI development using Swing: frames, panels, layout managers, event handling – JDBC: architecture, CRUD operations, transactions – Modern Java features: text blocks, records, switch expressions, sealed classes.

LAB EXPERIMENTS

1. Java basics: data types, operators, control statements, arrays, and Strings.
2. Object-oriented programming: classes, objects, constructors, encapsulation, inheritance, and polymorphism.
3. Exception handling and interfaces/abstract classes.
4. Multithreading and file I/O operations.
5. Generics, collections, lambda expressions, and Stream API operations.
6. GUI development and JDBC CRUD application (e.g., Student Record Management).

90 Notional Hours

Text Book:

1. Herbert Schildt. *Java: The Complete Reference, 12/E*. McGraw-Hill, 2021.

REFERENCES:

1. Cay S. Horstmann. *Core Java, Volume I: Fundamentals, 13/E*. Pearson, 2024.
2. Mishra K L P and Chandrasekaran N. *Java: How to Program, 12/E*, Pearson, 2025.
3. Joshua Bloch. *Effective Java,3/E,* Addison-Wesley, 2018.

ONLINE RESOURCES:

1. Programming in Java, 2025. *https://onlinecourses.nptel.ac.in/noc21_cs04/*
2. Learning Java Programming, 2025. *https://docs.oracle.com/javase/tutorial/*

25IT205	DISCRETE STRUCTURES	L	T	P	C
		2	1	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Apply basic set theory, relations, and function operations, including composition and inverse	1,2,5	1
CO2	Analyze partial orders, construct lattices and Boolean algebras, and apply them to logical reasoning.	1,2,5	1
CO3	Apply propositional and predicate logic to construct valid proofs using different proof strategies.	1,2,5	1
CO4	Use concepts of groups, monoids, and codes to solve algebraic and coding problems.	1,2,5	1
CO5	Analyze finite state machines and classify formal languages using grammar rules.	1,2,5	1

Sets, Relations and Functions **[9]**

Basic concepts- Algebra of sets - The power set - Ordered pairs and Cartesian product - Relations on sets -Types of relations and their properties - Relational matrix and the graph of a relation - Equivalence relations. Functions - Classification of functions- Types of functions- Composition of functions and inverse of a function.

Lattices and Boolean Algebra **[9]**

Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Direct product and homomorphism – Some special lattices – Boolean algebra.

Logic and Proofs **[9]**

Propositional logic – Propositional equivalences - Predicates and quantifiers – Nested quantifiers – Rules of inference - Introduction to proofs – Proof methods and strategy.

Algebraic Structures **[9]**

Algebraic systems – Semi groups and monoids - Groups – Subgroups – Homomorphism‘s – Normal subgroup and cosets – Lagrange‘s theorem – Rings and Fields (Definitions and examples).

Graph Theory **[9]**

Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

List of Experiments using MATLAB

1. Truth Table Generation for Propositional Logic
2. Implementation of Relations and Equivalence Classes
3. Hasse Diagram for Lattices

4. Boolean Algebra Expression Simplification
5. Predicate Logic Evaluation
6. Automated Proof Checker
7. Group Theory Operations
8. Coset Generation and Visualization
9. Graph Representation using Adjacency Matrix
10. Euler & Hamiltonian Graph Simulation

90 Notional Hours

Text Book:

1. Kenneth H. Rosen, and Kamala Krithivasan. *Discrete Mathematics and its Applications, 8/E*. Tata McGraw-Hill, 2021.
2. Tremblay, J.P. and Manohar, R. *Discrete Mathematical Structures with Applications to Computer Science, 1/E*. Tata McGraw-Hill, 2017.

REFERENCES:

1. Lipschutz, S. and Mark Lipson. *Discrete Mathematics, 3/E*, Tata McGraw-Hill, 2017.
2. Grimaldi, R.P. *Discrete and Combinatorial Mathematics: An Applied Introduction, 4/E*, Pearson Education Asia, Delhi, 2007.
3. Koshy, T. *Discrete Mathematics with Applications*, Elsevier Publications, 2006.

ONLINE RESOURCES:

1. Discrete Mathematics. *https://nptel.ac.in/courses/106106094*
2. Mathematical Foundations for Computer Science. *https://nptel.ac.in/courses/106102220*
3. Mathematics for Computer Science, *https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2005/*
4. Introduction to Discrete Mathematics for Computer Scientists, *https://www.coursera.org/learn/discrete-mathematics*
5. Mathematical Thinking in Computer Science, *https://www.coursera.org/specializations/mathematics*
6. Discrete Math – Set Theory and Logic, *https://www.khanacademy.org/computing/computer-science/cryptography*
   https://www.khanacademy.org/math/statistics-probability/probability-library

25IT255	COMPUTER NETWORKS AND COMMUNICATION	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental concepts, layered architectures (OSI/TCP-IP), and core functionalities of data communication and computer networks, from physical transmission to application protocols.	1, 2	1
CO2	Analyze the operation of key data-link and network-layer protocols to evaluate their design choices, addressing schemes, and performance across different network scenarios.	1, 2, 3, 4	1
CO3	Apply principles of reliable data transfer, flow control, and congestion control to configure, troubleshoot, and optimize transport layer protocols (TCP/UDP) for efficient end-to-end communication.	1,2,3, 4,5	1
CO4	Analyze the role, interaction, and security implications of standard application layer protocols and network management frameworks in the context of modern networked systems.	1,2,3,4, 5	1
CO5	Utilize foundational concepts of network security and emerging paradigms (IoT, SDN, virtualization) to design basic secure network architectures and assess their vulnerabilities.	1,2,3,4, 5	1

FUNDAMENTALS [6]

Introduction to data communications and networking – network types – OSI and TCP/IP models – signals – bandwidth – data rate limits – transmission media – line coding – modulation techniques – multiplexing – circuit and packet switching.

PHYSICAL AND DATA LINK LAYERS [6]

Error detection and correction – framing – flow control – MAC sublayer – channel access methods – Ethernet IEEE 802.3 – wireless LAN IEEE 802.11 – LAN switching and VLAN concepts.

NETWORK LAYER & INTERNETWORKING [6]

IPv4/IPv6 addressing – subnetting – CIDR – routing principles – distance vector and link state algorithms – router architecture – ARP, ICMP, NAT and forwarding.

TRANSPORT LAYER & CONGESTION CONTROL [6]

Transport layer services – UDP and TCP – connection establishment and release – reliable data transfer – flow and congestion control – SCTP overview – QoS basics.

APPLICATION LAYER, NETWORK MANAGEMENT & SECURITY [6]

Application protocols: HTTP, DNS, SMTP, FTP, DHCP – SNMP – network management – cryptography basics – TLS/SSL – firewalls – VPNs – introduction to IoT, SDN and network virtualization.

LIST OF EXPERIMENTS

1. Network Topology Design and Simulation using Cisco Packet Tracer
2. IP Addressing and Subnetting in Packet Tracer
3. Implementation of Error Detection Techniques
4. Simulation of Flow Control Protocols
5. Simulation of Error Control Protocols
6. Implementation of Distance Vector Routing Algorithm
7. Implementation of Link State Routing Algorithm
8. Configuration of VLANs and Inter-VLAN Routing in Cisco Packet Tracer
9. Socket Programming using TCP and UDP (Client–Server Communication)
10. Network Traffic Capture and Analysis using Wireshark.

90 Notional Hours

Text Book:

1. Behrouz A. Forouzan. *Data Communications and Networking, 6/E*. McGraw-Hill, 2023.

REFERENCES:

1. James F. Kurose and Keith W. Ross. *Computer Networking: A Top-Down Approach, 8/E*. Pearson, 2021.
2. Andrew S. Tanenbaum and David J. Wetherall. *Computer Networks*, *5/E*, Pearson, 2017.
3. William Stallings. *Data and Computer Communications, 10/E*, Pearson, 2020.
4. Larry L. Peterson and Bruce S. Davie. *Computer Networks: A Systems Approach, 6/E*, Morgan Kaufmann, 2022

ONLINE RESOURCES:

1. Cisco Networking Academy. *https://www.netacad.com/*
2. Computer Networks. *https://ocw.mit.edu/courses/6-829-computer-networks-fall-2002/*
3. Internet Engineering Task Force (IETF). *https://www.ietf.org/standards/*

25IT206	CYBER GOVERNANCE, RISK, AND COMPLIANCE	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the fundamental concepts of governance, risk management, and compliance (GRC) and the role of GRC in strategic planning.	1,2	1
CO2	Interpret the cybersecurity maturity landscape across different sectors and the traits, ethical dimensions, and strategic responsibilities of cybersecurity leadership.	1,2	1
CO3	Define the risk management lifecycle, regulatory expectations, third-party risk management, compliance and legal risk, and the distinction between different risk types.	1,2	1
CO4	Apply cybersecurity metrics to support decision-making, resource allocation, compliance tracking, and the integration of the overall cybersecurity strategy.	1,2,5	1
CO5	Implement major cybersecurity frameworks (ISO/IEC 27001, COBIT, CMMC, CIS Controls, PCI DSS, ISO 27701, etc.) to design, assess, compare, and improve an organization's security posture.	1,3,5	1

INTRODUCTION **[6]**

Understanding GRC – Business Case for GRC – Governance – Risk Management – Compliance – Intersection of Governance, Risk Management and Compliance – GRC Frameworks and Standards – GRC Tools and Technologies – Building GRC Culture – Role of GRC in Strategic Planning – Case Study: GRC Implementation at SpectraCorp.

CYBERSECURITY LANDSCAPE AND LEADERSHIP **[6]**

Overview of Cybersecurity Maturity – Cybersecurity in Finance, Healthcare, Government, Small and Larger Enterprises – Traits of a Cybersecurity Leader – building and leading effective cybersecurity reams – adapting to emerging trends – strategic decision making – developing the next generation – incident management – ethical dimensions – Case Study: Cybersecurity Leadership at CyberFusion Inc.

RISK MANAGEMENT **[6]**

Risk management in business – understanding the risk management life cycle – FFIEC Handbooks and Risk Management Guidance – Governance and Risk Management Framework – Risk approvals – Risk identification and Analysis – Third-party Risk Management – Regulatory Expectations – Compliance and Legal Risk Management – Monitoring and Reporting – Case Study: Navigating Risk Management at Phoenix Innovations.

CYBERSECURITY METRICS **[6]**

Importance of metrics in cybersecurity – role of metrics in decision making and resource allocation – differentiating between KPIs and KRIs – Role of Metrics in Compliance – challenges and considerations – KPIs – KRIs – Integrating KPIs and KRIs into Cybersecurity Strategy - Case Study: Transforming TechNova's Defense Landscape.

CYBERSECURITY FRAMEWORKS **[6]**

ISO/IEC 27001: Information Security Management - COBIT (Control Objectives for Information and Related Technologies) – CMMC (Cybersecurity Maturity Model Certification) - CIS (Center for Internet Security) Controls - PCI DSS (Payment Card Industry Data Security Standard) - ICFR (Internal Control Over Financial Reporting) - Cloud Security Alliance Controls - ISO 27017: Code of Practice for Information Security Controls - ISO 27701: Privacy Information Management - Comparing and Integrating Different Cybersecurity Frameworks - Future Trends in Cybersecurity Frameworks - Case Study: Securing Globex Corporation - top strengths of each framework.

60 Notional Hours

Text Book:

1. Jason Edwards, & Griffin Weaver. *The Cybersecurity Guide to Governance, Risk, and Compliance, 1/E*. Wiley, 2024.

REFERENCES:

1. Anne Kohnke, Dan Shoemaker, Ken E. Sigler. *The Complete Guide to Cybersecurity Risks and Controls*. CRC Press, 2022.
2. Akashdeep Bhardwaj. *Mastering Cybersecurity: A Practical Guide to Cyber Tools and Techniques Vol. 2*, CRC Press, 2025.
3. 2. Akashdeep Bhardwaj. *Mastering Cybersecurity: A Practical Guide for Professionals Vol. 1.* CRC Press, 2025.

ONLINE RESOURCES:

1. GRC Resources. *https://allaboutgrc.com/grc-resources/*

25CS257	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental principles, phases, and methodologies of the software development life cycle (SDLC).	1, 2	1
CO2	Extract software requirements using formal and agile techniques to develop, validate, and manage requirement specifications, ensuring traceability and alignment with stakeholder needs across the project lifecycle.	1, 2, 3, 4	1
CO3	Apply software modeling, architectural design principles, and standardized notations (such as UML) to translate requirements into structured design models that support maintainability, scalability, and DevOps integration.	1, 2, 3, 4, 5	1
CO4	Evaluate software project planning, estimation, scheduling, and risk management strategies using models such as COCOMO, CPM, and PERT, and assess their effectiveness in delivering projects within scope, time, and resource constraints.	1, 2, 3, 4	1
CO5	Utilize appropriate coding standards, testing techniques, and maintenance practices—supported by modern tools for development, testing, and CI/CD—to ensure software quality, reliability, and sustainable evolution.	1, 2, 3, 4, 5	1

SOFTWARE PROCESS MODELS [9]

Introduction – Software Development Life Cycle (SDLC) – Traditional Models: Waterfall, V-Model, Spiral – Alternative Techniques: Rapid Application Development (RAD), Agile Development Models – Scrum Framework – Agile Tools: JIRA (backlog management, sprint planning), Product Discovery, Team Collaboration – Extreme Programming (XP) – Comparison and Suitability of Models.

SOFTWARE PROJECT MANAGEMENT [9]

Role and responsibilities of a Software Project Manager – Project Planning – Metrics for Project Size Estimation – COCOMO (Basic, Intermediate & Detailed) – Scheduling Techniques: CPM & PERT – Risk Management: Identification, Assessment, Mitigation – Resource Allocation and Tracking – Modern Tools for Project Management (MS Project, Trello, Asana).

REQUIREMENTS ANALYSIS [9]

Requirements Gathering Techniques – Functional and Non-functional Requirements – Software Requirements Specification (SRS) – Formal Specification – Executable Specifications – Validating Requirements – Achieving Requirements Traceability –

Managing Changing Requirements – Reviews, Walkthroughs, Inspections – Tools: Jama Software, IBM Rational DOORS, JIRA.

SOFTWARE MODELLING AND DESIGN [9]

Elements of Software Modeling and Design – Translating Requirement Models into Design Models – Design Notations: DFDs, Structured Flowcharts, Decision Tables – UML: Use Case, Class, Sequence, Activity Diagrams – Data Modeling – Design Concepts and Principles – Architectural Mapping using Data Flow – Design Tools: Sparx Enterprise Architect – DevOps: Concepts, Lifecycle, Adoption, DevOps Tools.

CODING, TESTING, AND MAINTENANCE [9]

Coding Standards and Guidelines – Code Reviews – IDEs: Eclipse, IntelliJ IDEA, XCode, Atom – Testing Techniques: Black-box, White-box, Unit, Integration, System Testing – Testing Tools: JUnit, Selenium – Software Maintenance: Characteristics, Process Models, Reverse Engineering – Estimation of Maintenance Cost – Modern Practices: Continuous Integration and Continuous Deployment (CI/CD).

90 Notional Hours

Text Book:

1. Roger S. Pressman & Bruce R. Maxim. *Software Engineering: A Practitioner's Approach, 9/E*. McGraw-Hill, 2020.

REFERENCES:

1. Ian Sommerville. *Software Engineering, 10/E*. Pearson, 2019.
2. K. K. Aggarwal & Yogesh Singh. *Software Engineering*, *3/E*, New Age International, 2019.
3. Pankaj Jalote. *Software Project Management in Practice, 2/E*, Pearson, 2017.
4. Bertrand Meyer. *Software Engineering with Applications, 2/E*, Prentice Hall, 2018

ONLINE RESOURCES:

1. Software Engineering. *https://onlinecourses.nptel.ac.in/noc21_cs13*
2. Software Engineering Concepts. *https://ocw.mit.edu/courses/16-355j-software-engineering-concepts-fall-2005/*

25IT256	WEB TECHNOLOGIES AND FULL STACK DEVELOPMENT	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the structure and components of modern web applications.	1	1
CO2	Apply HTML5 semantic elements, forms, and multimedia, along with CSS3 styling, responsive layouts, and visual effects, to create accessible, SEO-friendly, and visually engaging web interfaces.	1, 2, 3,5	1
CO3	Implement client-side interactivity, form validation, and dynamic content updates using JavaScript, DOM manipulation, event handling, and asynchronous programming techniques (AJAX/fetch API).	1, 2, 3, 5	1
CO4	Develop server-side functionality using PHP to handle form data, manage sessions and cookies, perform CRUD operations with MySQL, and apply security best practices in web programming.	1, 2, 3, 4, 5	1
CO5	Integrate front-end and back-end technologies to design, build, test, and deploy a full-stack web application, incorporating version control (Git) and deployment on local or cloud platforms.	1, 2, 3, 4, 5	1

HTML5: WEB PAGE STRUCTURE AND ELEMENTS [6]

Introduction to web technologies – client–server architecture – structure of HTML document – headings, paragraphs, lists, tables, and hyperlinks – forms and input types – semantic tags: header, nav, section, article, footer – multimedia elements (audio, video, canvas) – metadata and accessibility – SEO-friendly markup.

CSS3: STYLING AND RESPONSIVE DESIGN [6]

Introduction to CSS3 – syntax and selectors – box model – borders, margins, padding, positioning – display properties – Flexbox and CSS Grid – typography and color schemes – gradients, shadows, transitions, animations – responsive design using media queries – mobile-first design principles.

JAVASCRIPT: CLIENT-SIDE PROGRAMMING [6]

Introduction to JavaScript – variables, data types, operators – control structures – functions, arrays, and objects – DOM manipulation – event handling (click, mouse, form) – form validation – ES6 features (let, const, arrow functions, template literals) – asynchronous JavaScript (AJAX, fetch API) – debugging and developer tools.

PHP: SERVER-SIDE SCRIPTING AND DATABASE CONNECTIVITY [6]

Introduction to PHP – syntax and variables – control structures and arrays – functions and file handling – form handling using GET and POST – session and cookie

management – error handling and input validation – connecting PHP with MySQL using MySQLi/PDO – CRUD operations – security practices in web programming.

FULL STACK INTEGRATION AND DEPLOYMENT [6]

Integration of front-end and back-end – combining HTML, CSS, JavaScript, PHP, and MySQL – designing a full stack architecture – client–server communication and data flow – user authentication and session tracking – testing and debugging – version control using Git – deployment on XAMPP/WAMP or cloud platforms – documentation and maintenance.

LAB EXPERIMENTS

1. Design a personal portfolio webpage using HTML5 structure and semantic tags.
2. Create a responsive web layout using CSS3 Flexbox and Grid system.
3. Develop a form with various HTML5 input types and validate it using JavaScript.
4. Implement JavaScript DOM manipulation to dynamically change web page content.
5. Use JavaScript events to create an interactive image gallery or slideshow.
6. Write a PHP program to process a feedback form using POST method.
7. Develop a PHP script for performing CRUD operations in MySQL (student database).
8. Implement user login and session management using PHP and MySQL.
9. Build an integrated mini web application combining HTML, CSS, JS, PHP, and MySQL.
10. Deploy the mini full stack web application on a local or cloud-based web server (e.g., XAMPP/WAMP/000webhost).

90 Notional Hours

Text Book:

1. Philip Ackermann. *Full Stack Web Development: The Comprehensive Guide*. Wiley, 2022.

REFERENCES:

1. Luke Welling & Laura Thomson. *PHP and MySQL Web Development*. Pearson, 2020.
2. Robin Nixon. *Learning PHP, MySQL & JavaScript, 5/E*, O'Reilly, 2022.
3. Jon Duckett. *Web Design with HTML, CSS, JavaScript and jQuery.* Wiley, 2021.

ONLINE RESOURCES:

1. W3Schools Online Web Tutorials . *https://www.w3schools.com*
2. Mozilla Developer Network. *https://developer.mozilla.org*

25CS258	COMPILER DESIGN AND PROGRAM TRANSLATION	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the phases of a compiler, the role of lexical and syntax analysis, and the translation process from source code to intermediate and target code.	1, 2	1
CO2	Apply formal language theory to design and implement lexical analyzers and parsers using tools such as LEX and YACC.	1, 2, 3, 4, 5	1
CO3	Distinguish between top-down (LL) and bottom-up (LR) parsing techniques, evaluate grammar for parsing suitability, and construct parsing tables (LL(1), SLR, CLR, LALR) to resolve syntactic structures.	1, 2, 3, 4	1
CO4	Utilize intermediate code representations and attribute grammar to translate programming language constructs and implement basic code generation for a target machine.	1, 2, 3, 4, 5	1
CO5	Evaluate code optimization techniques to improve the efficiency of generated code while preserving semantics.	1, 2, 3, 4, 5	1

INTRODUCTION & LEXICAL ANALYSIS [6]

Compilers- Phases of Compiler- Cousins of the Compiler - Grouping of Phases - Compiler construction tools- Need and Role of Lexical Analyzer - Input Buffering - Specification of Tokens - Lexical Errors - Expressing Tokens by Regular Expression - Finite Automata: NFA- DFA - Converting NFA to DFA - Minimization of DFA- Converting Regular Expression to DFA. LEX Tool: Structure of LEX Program – Predefined Variables – Library routines – Design of Lexical Analyzer for a Sample Language.

TOP DOWN PARSING [6]

Role of Parser-Grammars-Error Handling-Context-Free Grammars-Writing a grammar- Elimination of Ambiguity-Left Recursion- Left Factoring-Top Down Parsing — Recursive Descent Parser- Predictive Parser- LL(1) Parser- Computation of FIRST- Computation of FOLLOW-Construction of a predictive parsing table-Predictive Parsers LL(1) Grammars- Predictive Parsing Algorithm- Problems related to Predictive Parser - Error Recovery in Predictive Parsing.

BOTTOM UP PARSING [7]

Bottom Up Parsing-Reductions-Handle Pruning-Shift Reduce Parser-Problems related to Shift Reduce Parsing-Operator Precedence Parser, LEADING, TRAILING -LR Parser- LR Parsers- Need of LR Parsers-LR (0) Item-Closure of Item Sets- Construction of SLR Parsing Table -Problems related to SLR-Construction of Canonical LR(1)- Problems related to CLR - LALR Parser—Problems related to LALR- Error Handling

and Recovery in Syntax Analyzer – YACC Tool: Structure of YACC Program – Design of a Syntax Analyzer for a Sample Language.

CODE GENERATION **[6]**

Intermediate Code Generation- prefix – postfix notation - Quadruple - triple - indirect triples Representation- Syntax tree- Evaluation of expression - Three-address code- Synthesized attributes – Inherited attributes - Intermediate languages – Declarations- Assignment Statements- Boolean Expressions- Case Statements- Type Checking- Back patching – Procedure calls- Code Generation- Issues in the design of code generator- The target machine – Runtime Storage management- A simple Code generator- Code Generation Algorithm- Register and Address Descriptors.

CODE OPTIMIZATION **[5]**

Code optimization -Principal Sources of Optimization- Function Preserving Transformation- Loop Optimization- Peephole optimization — DAG- Basic Blocks- Flow Graphs- Global Data Flow Analysis — Efficient Data Flow Algorithm- Runtime Environments- Source Language issues- Storage Organization- Activation Records- Storage Allocation strategies.

LAB EXPERIMENTS

1. Using the LEX tool, Develop a lexical analyzer to recognize a few patterns in C. (Ex. identifiers, constants, comments, operators etc.). Create a symbol table, while recognizing identifiers.
2. Implement a Lexical Analyzer using LEX Tool
3. Generate YACC specification for a few syntactic categories.
    a. Program to recognize a valid arithmetic expression that uses operator +, -, * and /.
    b. Program to recognize a valid variable which starts with a letter followed by any number of letters or digits.
    c. Program to recognize a valid control structures syntax of C language (For loop, while loop, if-else, if-else-if, switch-case, etc.).
    d. Implementation of calculator using LEX and YACC
4. Generate three address code for a simple program using LEX and YACC.
5. Implement type checking using Lex and Yacc.
6. Implement simple code optimization techniques (Constant folding, Strength reduction and Algebraic transformation)
7. Implement back-end of the compiler for which the three address code is given as input and the 8086 assembly language code is produced as output.

90 Notional Hours

Text Book:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman and Sorav Bansal. *Compilers: Principles, Techniques, and Tools, 2/E*. Pearson, 2024.

REFERENCES:

1. S. Godfrey Winster, S. Aruna Devi, R.Sujatha. *Compiler Design, 2/E*. Yesdee Publishing Ltd., 2019.

2. V. Raghavan. *Principles Of Compiler Design*, Tata McGraw-Hill, 2016.
3. K. Muneeswaran. *Compiler Design, 4/E*, Oxford Higher Education, 2014.
4. Bertrand Meyer. *Software Engineering with Applications, 2/E*, Prentice Hall, 2018

ONLINE RESOURCES:

1. Compiler Design. *https://onlinecourses.nptel.ac.in/noc21_cs07*
2. Compiler Design. *https://nptel.ac.in/courses/106104123*
3. Principles of Compiler Design. *https://nptel.ac.in/courses/106108113*

25IT257	CLOUD COMPUTING AND VIRTUALIZATION	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the foundational concepts, architecture models (NIST), service and deployment models of cloud computing, along with its key characteristics, benefits, and challenges in modern IT infrastructure.	1	1
CO2	Apply principles of virtualization, containerization, and web service architectures to design, configure, and manage virtualized cloud environments using appropriate platforms and tools.	1, 2, 3,5	1
CO3	Recommend cloud storage solutions, interoperability standards, and deployment strategies to evaluate performance, cost, and suitability for different application scenarios across major cloud platforms.	1, 2, 3, 4, 5	1
CO4	Utilize cloud security frameworks, identity and access management (IAM) policies, and governance models to implement secure, compliant, and resilient cloud-based systems.	1, 2, 3, 4, 5	1
CO5	Evaluate the architectural trade-offs, security threats, and operational governance of virtualized and containerized cloud environments to recommend solutions that balance performance, cost, and risk.	1, 2, 3, 4, 5	1

CLOUD ARCHITECTURE & INFRASTRUCTURE [6]

Introduction to Cloud Computing – Need and Evolution of Cloud – Cloud Architecture – NIST Reference Model – Service Models (IaaS, PaaS, SaaS) – Deployment Models (Public, Private, Hybrid, Community Cloud) – Characteristics and Benefits of Cloud – Cloud Infrastructure Components – Cloud Challenges and Applications.

WEB SERVICES & VIRTUALIZATION BASICS [6]

Service-Oriented Architecture – SOAP & REST – Basics of Virtualization – Virtual Machine Concepts – Hypervisors (Type 1 & Type 2) – Virtualization Techniques: Full, Para and Hardware Virtualization – CPU, Memory and I/O Virtualization – Resource Allocation and Performance Considerations.

CLOUD STORAGE & CONTAINERIZATION [6]

Cloud Storage Fundamentals – Storage Provisioning – Managed vs Unmanaged Storage – Cloud Backup Strategies – Cloud Storage Interoperability (CDMI, OCCI) – Introduction to Containers – Docker Architecture – Docker Images, Containers and Repositories – Basics of Kubernetes.

CLOUD PLATFORMS & DEPLOYMENT [6]

Google App Engine – Amazon AWS – Microsoft Azure – OpenStack Overview and Architecture – Eucalyptus and OpenNebula – Programming on EC2 and S3 – Application Deployment Models – Performance Evaluation Parameters – Cost Optimization Concepts.

CLOUD SECURITY & GOVERNANCE [6]

Security Challenges in Virtualized Environments – VM Attacks: VM Escape, Guest Hopping, VM Migration Attacks – Hypervisor Threats – Data Security and Storage Security – Identity and Access Management (IAM) – IAM Architecture, Policies and Best Practices – Cloud Compliance and Governance.

LAB EXPERIMENTS

1. Study of Cloud Models – Demonstration of IaaS / PaaS / SaaS and Deployment Models
2. Creation and Management of Virtual Machines using VMware / VirtualBox
3. Study and Comparison of Hypervisors and Virtualization Types
4. Docker Installation and Basic Container Operations
5. Docker Image Building and Application Deployment
6. Implementation of Cloud Storage & Basic IAM Configuration on AWS / Azure.

90 Notional Hours

Text Book:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi. *Mastering Cloud Computing: Foundations and Application Programming*. Elsevier, 2021.

REFERENCES:

1. Kai Hwang, Jack Dongarra, Geoffrey Fox. *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*. Morgan Kaufmann, 2022.
2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood. *Cloud Computing: Concepts, Technology & Architecture.* Pearson, 2020.
3. Chris Dotson. *Practical Cloud Security*, O'Reilly, 2019.

ONLINE RESOURCES:

1. Cloud Computing. *https://nptel.ac.in/courses/106105167*
2. Cloud Computing and Distributed Systems. *https://nptel.ac.in/courses/106104182*

25IT258	PENETRATION TESTING AND VULNERABILITY ASSESSMENT	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the fundamental concepts of VAPT.	1,2	1
CO2	Perform infrastructure vulnerability assessment techniques using automated tools, static application security testing (SAST) tools and develop remediation methodologies for identified vulnerabilities.	1,2,3, 5	1
CO3	Apply dynamic application security testing (DAST) and penetration testing using industry tools to exploit vulnerabilities and work with payloads.	1,2,3, 5	1
CO4	Deploy web application penetration testing methodologies to identify and exploit OWASP Top 10 vulnerabilities.	1,2,3,5	1
CO5	Write comprehensive professional penetration testing reports using CVSS 4.0 for risk scoring and remediation recommendations.	1,2, 3, 4, 5	1

VAPT AND INFRASTRUCTURE SECURITY TOOLS [6]

Vulnerability, penetration testing, threats and risk exposure terminologies – Vulnerability Assessment Management Lifecycle – Cyber Kill Chain – MITRE Attack framework – STRIDE Model – OWASP Top 10 – Practical risk exposure approach – Setting up tools for VAPT – OWASP ZAP attack Proxy.

INFRASTRUCTURE VULNERABILITY ASSESSMENT & STATIC CODE ANALYSIS [6]

Vulnerability assessment using tools – Infrastructure Security Testing Methodology – Security Testing – Vulnerabilities identification using tools – Threats and risk exposure – Remediation methodology – Static application security testing – Vulnerabilities detected by SAST tools – Pros and cons of SAST – SAST testing tools - SonarQube.

DYNAMIC APPLICATION SECURITY TESTING ANALYSIS & PEN TESTING [6]

Pros and Cons of DAST – Requirements of DAST – Working of DAST – DAST testing alignment – Port Swigger – Burp Suite – ZAP Proxy tools – Metasploit Framework– Components – Basic Commands – Exploiting vulnerabilities –Working with payloads – Pot Exploitations.

WEB APPLICATION TESTING [6]

HTTP – HTTP Methods – Sessions – Cookies – HTML data in HTTP response – Secure Software Development Lifecycle – vulnerability assessment – Vulnerability scan – Nikto – Arachni – Web pen testing approach – Broken access control – cryptographic failures – injections – insecure design – security misconfiguration – vulnerable and

outdated components – identification and authentication failures – software and data integrity failures – server-side request forgery – post-exploitation.

API PEN TESTING AND REPORT WRITING [6]

API Penetration test – Burp Suite settings – Passive reconnaissance – active reconnaissance – reverse engineering – vulnerabilities – report writing stages – content of vulnerability testing report – penetration testing report – vulnerability assessment using new CVSS 4.0 – Conclusion of the report.

LAB EXPERIMENTS

1. Introduction to VAPT & Legal Frameworks
2. VAPT Methodologies
3. Building the Laboratory
4. Information Gathering & OSINT
5. Vulnerability Assessment
6. Analyzing Scanning Results.
7. Network Exploitation.
8. Web Application Testing
9. Specialized System Attacks
10. Post-Exploitation Fundamentals
11. Lateral Movement & Persistence
12. Evasion & Anti-Forensics
13. Professional Report Writing
14. Remediation & Retesting

90 Notional Hours

Text Book:

1. Rishabh Bhardwaj. *Vulnerability Assessment and Penetration Testing (VAPT): Detailed Guide with Highlighted Threats, Risk Exposure, and Remediations*. BPB Publications, 2025.

REFERENCES:

1. David Maynor. *Metasploit Toolkit for Penetration Testing, Exploit Development, and Vulnerability Research*. Syngress, 2021.
2. Ummed Meel. *Advanced Penetration Testing with Kali Linux: Unlocking Industry-Oriented VAPT Tactics.* Bpb Publications, 2023.
3. Saral Jeeva Jothy, Anne Michel. *Penetration Testing*, Khanna Publishing House, 2025.

ONLINE RESOURCES:

1. OWASP Top Ten Web Application Security Risks. *https://owasp.org/www-project-top-ten/*
2. Metasploit*. https://www.metasploit.com/*

25IT259	CRYPTOGRAPHY AND CYBERSECURITY	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the fundamental concepts of cryptography.	1	1
CO2	Recall the principles of data integrity mechanisms.	1	1
CO3	Apply symmetric and asymmetric cipher techniques for secure data transmission.	1, 2, 3, 5	1
CO4	Deploy cryptographic key management and distribution methods to establish mutual trust in networked environments.	1, 2, 3, 4, 5	1
CO5	Implement network and internet security protocols to protect data in transit across various network layers.	1, 2, 3, 4, 5	1
CO6	Apply appropriate security measures for diverse technological contexts based on specific security requirements and constraints	1, 2, 3, 4, 5	1

Cryptography Fundamentals **[5]**

Cybersecurity, Information Security and Network Security - OSI Security Architecture – Cryptography – Network Security – Trust and Trustworthiness – Standards – Number Theory – Divisibility and Division Algorithm – Euclidean Algorithm – Modular Arithmetic – Prime Numbers – Fermat's and Euler's Theorem – Testing for primality – Chinese Remainder Theorem – Discrete Logarithms.

Symmetric and Asymmetric Ciphers **[7]**

Symmetric Cipher Model – Substitution Techniques – Transposition Techniques – Data Encryption Standard – Block Cipher Design Principles – Finite Fields: Groups – Rings – Fields – Finite Fields of the Form GF(p) – Polynomial Arithmetic – Finite Fields of the Form GF(2^n) – Advanced Encryption Standard – Block Cipher Operation – Random Bit Generation and Stream Ciphers – Public Key Cryptography – RSA Algorithm – Diffe-Hellman Key Exchange – Elgamal Cryptographic System – Elliptic Curve Arithmetic – Elliptic Curve Cryptography.

Data Integrity **[5]**

Applications of Cryptographic Hash Functions – Requirements and Security – Secure Hash Algorithm – SHA-3 – Message Authentication Codes – Digital Signatures – Lightweight Cryptography – Post-Quantum Cryptography.

Mutual Trust **[6]**

Cryptographic Key Management and Distribution: Key distribution using symmetric and asymmetric encryption – Distribution of Public Keys – X.509 Certificates – Public Key infrastructure – Remote User-Authentication Principles – Remote User authentication using Symmetric and Asymmetric Encryption – Kerberos – Federated Identity Management.

Network and Internet Security **[7]**

Transport-level Security: Web Security Considerations – Transport Layer Security – HTTPS – SSH – Wireless Security – Mobile Device Security – IEEE 802.11i Wireless LAN Security – Electronic Mail Security – IP Security – Network Endpoint Security – Cloud Security – Internet of Things (IoT) Security.

LAB EXPERIMENTS

1. Classical and Modern Symmetric Ciphers.
2. Number Theory and Public-Key Cryptography.
3. Hash Functions and Digital Signatures.
4. PKI and Secure Communication.
5. Network Security Protocols and Attacks.

90 Notional Hours

Text Book:

1. Stallings, William. *Cryptography and Network security, 8/E*. Pearson Education India, 2023.

REFERENCES:

1. Forouzan, Behrouz A., and Debdeep Mukhopadhyay. *Cryptography and network security (SIE), 3/E*. McGraw-Hill Education, 2023.
2. Kahate, Atul. *Cryptography and network security, 4/E*. McGraw-Hill Education, 2024.
3. Katz, Jonathan, and Yehuda Lindell. *Introduction to Modern Cryptography, 4/E*. Chapman and Hall/CRC, 2025.
4. Dholakia, Sandip. *Modern Cryptography: The Practical Guide*. Rheinwerk Publishing, 2024.

ONLINE RESOURCES:

1. Cryptography and Network Security. *https://nptel.ac.in/courses/106105162*
2. Computational Number Theory & Cryptography *https://nptel.ac.in/courses/106103015*
3. Cryptography and Network Security *https://nptel.ac.in/courses/106105031*

25IT207	HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Distinguish between the human cognitive and physical characteristics and computer capabilities that influence the design of interactive systems.	1	1
CO2	Describe the fundamental models of interaction and their role in capturing requirements and designing user interfaces.	1	1
CO3	Deploy the principles of the user-centered design process to create effective interactive systems.	1, 2, 3	1
CO4	Apply task analysis techniques to gather user requirements and inform interface design decisions.	1, 2, 3	1
CO5	Use dialog design notations to specify, analyze, and design user-computer dialogues for interactive applications.	1, 2, 3	1
CO6	Choose appropriate evaluation methods to assess and improve the usability of interactive systems for diverse user populations.	1, 2, 3	1

Foundations of Human Computer Interaction [9]

The Human: Input-output channel – Human Memory – Thinking: reasoning and problem solving – emotion – individual differences – Psychology and the design of interactive systems – The computer: Text entry devices – Positioning, pointing and drawing – Display devices – Devices for virtual reality and 3D interaction – physical controls, sensors and special devices – Paper: Printing and scanning – Memory – Processing and Networks – Interaction: Models of Interaction – Frameworks and HCI – Ergonomics – Interaction styles – Elements of the WIMP interface – Interactivity – Paradigms for interaction.

Design Process [9]

Process of design – User focus – Scenarios – navigation design – Screen design and layout – iteration and prototyping – usability engineering – iterative design and prototyping – design rationale – principles to support usability – standards – guidelines – Golden rules and heuristics – HCI patterns – Elements of windowing system – user interface management systems- evaluation: expert analysis – user participation – Universal design principles – Multi-modal interaction – Designing for diversity – user support.

Models [9]

Cognitive Models: Goals and task hierarchies – Linguistic Models – Physical and device models – cognitive architectures – organisational issues – capturing requirements – Communication and collaboration models – face-to-face

communication – conversation – text-based communication – group working – standard formalisms – interaction models – continuous behavior.

Task Analysis and Dialog notations [9]

Task analysis – differences – task decomposition – knowledge-based analysis – Entity-relationship-based techniques – sources of information and data collection – uses – dialog – dialog design notations – diagrammatic notations – textual dialog notations – dialog semantics – dialog analysis and design – status-event analysis – rich contexts-low intention and sensor-based interaction.

Advanced interaction systems [9]

Groupware systems - computer-mediated communication – meeting and decision support systems – shared applications and artifacts – Frameworks for groupware – synchronous groupware – ubiquitous computing applications research – Virtual and augmented reality – information and data visualization – Hypertext – web technology and issues – static web content – dynamic web content.

90 Notional Hours

Text Book:

1. Dix, Alan, Finlay, Janet, Gregort D. Abowd, Russell Beale. *Human-computer Interaction, 3/E*. Pearson Education India, 2024.

REFERENCES:

1. Samit Bhattacharya. *Human-computer Interaction*. McGraw-Hill, 2019.
2. Scott MacKenzie. *Human-Computer Interaction: An Empirical Research Perspective*. Morgan Kaufmann, 2013.

ONLINE RESOURCES:

1. Human-Computer Interaction: The Foundations of UX Design. *https://www.interaction-design.org/courses/hci-foundations-of-ux-design*
2. Human Computer Interaction. *https://www.coursera.org/learn/human-computer-interactions-odc*

25IT260	REALTIME AND EMBEDDED SYSTEMS DEVELOPMENT	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Interpret the fundamental concepts of real-time systems, RTOS, development boards (STM32), hardware/software roles, super-loop architectures, interrupts, timers, and the STM32Cube IDE toolchain.	1,2	1
CO2	Implement FreeRTOS scheduler mechanisms to develop multi-tasking embedded applications.	1, 2, 3, 5	1
CO3	Use synchronization and inter-task communication primitives to protect shared data and coordinate tasks.	1, 2, 3, 5	1
CO4	Apply driver development models for peripherals for hardware sharing among tasks.	1, 2, 3, 5	1
CO5	Troubleshoot real-time embedded system issues and optimize system performance.	1, 2, 3, 4, 5	1

RTOSes, the Dev-Board and Tools [6]

Real-time Systems – Hardware and Software roles in real-time systems – Defining RTOses – Practical Real-time Systems – Development Boards – Dev-board components – hardware documentation – Development Tools – STM32Cube IDE – Debugging tools: J-link, Ozone and SystemView – Super-Loops – improving super-loops with interrupts – adding timer to super-loop – implanting super-loop – Design and testing considerations – developing super-loop program.

FreeRTOS Scheduler, Tasks and Primary APIs [6]

RTOS tasks – FreeRTOS – scheduler and tasks – creating tasks and starting the scheduler – deleting tasks – coding – task states – idle task – scheduler architecture –

Tasks and Primary APIs [6]

Task implementation and troubleshooting - task memory allocation – optimizing task states – troubleshooting task startup problems – protecting data and synchronizing tasks – semaphores – priority inversion – mutexes – race conditions – software timers – intertask communication – task notifications.

Building Systems [6]

Drivers and ISRs – UART – polled UART driver – tasks vs ISRs – creating ISR-based drivers – buffer-based driver – DMA-based drivers – double-buffered DMA – implementing driver – choosing driver model – third-party libraries and drivers – sharing hardware peripherals among tasks – using simple USB API – creating VCP driver – enhancing VCP driver – loose coupling with queues – reusing queue definition – queues as interfaces.

System Design and Troubleshooting **[6]**

Memory Management – Static and dynamic allocation – multi-processor and multi-core systems - troubleshooting.

LAB EXPERIMENTS

1. Toolchains & Debugging
2. RTOS Architecture & Tasks
3. Scheduling Algorithms
4. Queues & Message Passing
5. Event Management
6. Memory Management
7. Interrupt Management
8. Peripheral Drivers
9. Advanced RTOS/SMP
10. Low-Power Design

90 Notional Hours

Text Book:

1. Jim Yuill, Penn Linder. *Hands-On RTOS with Microcontrollers*. Packt Publishing, 2025.

REFERENCES:

1. Ivan Cibrario Bertolotti, Gabriele Manduchi. *Real-time Embedded Systems With Open-source Operating Systems*. CRC Press, 2025.
2. Gedare Bloom, Joel Sherrill, Tingting Hu, Ivan Cibrario Bertolotti. *Real-time Systems Development with RTEMS and Multicore Processors.* CRC Press, 2022.

ONLINE RESOURCES:

1. Introduction to Embedded System Design. *https://nptel.ac.in/courses/108102169/*
2. Real Time Systems. *https://nptel.ac.in/courses/106105086*

25IT208	INFORMATION SECURITY	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Recall the importance of information security.	1, 2	1
CO2	Deploy risk identification, risk assessment, and risk control practices to organizational security planning.	2	1
CO3	Apply appropriate security technologies to protect information assets.	3	1
CO4	Implement physical security measures and strategies to protect facilities and systems.	3	1
CO5	Recommend suitable security personnel, employment policies, maintenance approaches, and digital forensics mechanisms for continuous security management.	2	1

Information Security: Need and Issues [6]

History – CNSS Security Model – Components – Approaches – Security in Systems Development Life Cycle – Security Professionals and the organization – Threats and Attacks – Compromises to Intellectual Property – Deviations in QoS – Espionage – Forces of Nature – Human Error – Information Extortion – Sabotage – Software Attacks – Failures and Errors – Technological Obsolescence – Theft – Law and Ethics in Information Security – International Laws and Legal Bodies – Ethics and Information Security – Codes of Ethics of Professional Organization.

Planning and Risk Management [6]

Information Security Planning and Governance – Information Security Policy, Standards and Practices – The information security blueprint – Security Education, Training, and Awareness program – Continuity strategies – overview of risk management – risk identification – assessment – control – Quantitative vs Qualitative Risk Management Practices – Recommended Risk Control Practices.

Security Technologies [6]

Access Control – Firewalls – Protecting Remote Connections – Intrusion Detection and Prevention Systems – Honeypots, Honeynets, and Padded Cell Systems – Scanning and Analysis tools.

Physical Security and Information Security Implementation [6]

Physical Access Controls – Fire Security and Safety – Failure of Supporting Utilities and Structural Collapse – Interception of Data – Securing Mobile and Portable Systems – Special Considerations – Information Security Project Management – Technical and nontechnical aspects of implementation – Information System Security Certification and Accreditation.

Personnel and Maintenance **[6]**

Positioning and Staffing the security function – credentials for information security professionals – employment policies and practices – security considerations for temporary employees, consultants, and other workers – Security Management Maintenance Models – Digital Forensics.

60 Notional Hours

Text Book:

1. Whitman, M. E., & Mattord. *Principles of Information Security*. *7/E.* Cengage, 2022.

REFERENCES:

1. Stallings, W., & Brown, L. *Computer Security: Principles and Practice, 5/E*. Pearson, 2024.

ONLINE RESOURCES:

1. NIST Special Publications (SP 800 series). *https://csrc.nist.gov/publications/sp800*

25IT209	AI SAFETY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Describe the major categories of catastrophic AI risks.	1, 6, 8	1
CO2	Apply monitoring and robustness techniques to detect emergent goal-directed behavior, proxy gaming, and adversarial attacks in AI systems.	2, 3	1
CO3	Implement safety engineering principles to design safer AI systems.	3, 8	1
CO4	Use game-theoretic and governance concepts to analyze collective action problems, commitment problems, and compute governance in AI safety.	2, 4, 6	1
CO5	Evaluate failure modes in AI deployment based on complex systems paradigms, systemic accident models, and tail events.	1, 2, 6, 8	1

Catastrophic AI Risks **[9]**

Introduction to Catastrophic Risks – Malicious Use: Bioterrorism – Unleashing AI Agents, Persuasive AIs – Concentration of Power – AI Race: Military AI Arms Race – Corporate AI Race – Evolutionary Pressures – Organizational Risks – Rogue AIs: Proxy Gaming – Goal drift – Power seeking – Deception – Connections between risks – Scaling Laws – Speed of AI Development.

Single-Agent Safety **[9]**

Monitoring: Opaqueness of ML Systems – Transparency Research – Approaches to Transparency – Emergent Capabilities – Emergent Goal-directed behavior – Tail Risk of Emergent Goals – Evaluations and Anomaly Detection – Robustness: Proxies – Proxy Gaming – Adversarial attacks – Trojan Attacks and other security threats – Tail Risk of AI Evaluator Gaming – Alignment: Deception – Deceptive Evaluation Gaming – Tail Risk of Deceptive Alignment and Treacherous Turns – Power – Using AI for power seeking – instrumental rationality of power seeking – Structural pressures – Tail risk of power seeking behavior – Techniques to control AI systems – Systemic Safety – Safety and General Capabilities.

Safety Engineering **[12]**

Risk Decomposition: Failure Modes, Hazards and Threats – Classic Risk Equation – Risk reduction as a goal – Disaster Risk Equation – Applying the disaster risk equation – Nines of reliability – Safe Design Principles: Redundancy – Separation of Duties – Principle of Least Privilege – Fail Safes – Antifragility – Negative Feedback Mechanisms – Transparency – Defense in Depth – Review of Safe Design Principles – Component Failure Accident Models and Methods: Swiss Cheese Model – Bow Tie Model – Fault Tree Analysis Method – Limitations – Systemic Accident Models – Drift

into Failure and Existential risks – Tail events and black swans: Identification of Tail events – caricature of tail events – black swans: known unknown and unknown unknown - implications.

Complex Systems **[6]**

The reductionist paradigm – complex systems paradigm – DL systems as complex systems – hallmarks of complex systems – social systems as complex systems – complex systems for AI safety: general lessons – puzzles, problems, and wicked problems – challenges with interventionism – systemic issues.

Ethics and Society **[9]**

Collective action problems: motivation – game theory: fundamentals – Prisoner's Dilemma – The iterated Prisoner's Dilemma – Collective action problems – cooperation – conflict: bargaining theory – commitment problems – Information Problems – Factors outside bargaining theory – Evolutionary Pressures: Generalized Darwinism – Levels of selection and selfish – Governance – Economic Growth – Distribution of AI – Corporate Governance – National Governance – International Governance – Compute Governance.

90 Notional Hours

Text Book:

1. Dan Hendrycks. *Introduction to AI Safety, Ethics and Society*. CRC Press, 2025.

REFERENCES:

1. Ambuj Agrawal. *LLM Development and AI Ethics: A guide to AI safety, governance, generative AI, LLM, prompt engineering, and AGI*. BPB Publishers, 2025.
2. Zacharias Voulgaris, Arnoud Engelfriet. *AI Safety: Strategies for Ensuring Responsible, Ethical, and Reliable AI Systems*. Technics Publications, 2025.

ONLINE RESOURCES:

1. AI Safety, Ethics and Society. *https://www.aisafetybook.com/*
2. Ethics and Safety in Open AI. *https://www.coursera.org/learn/ethics-and-safety-in-open-ai*

25IT2E01	HARDWARE SECURITY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Recall the basic taxonomy of hardware attacks, vulnerabilities, and countermeasures.	1	1
CO2	Use hardware Trojan taxonomy to classify and detect malicious modifications in RTL/FPGA designs and trust benchmarks.	2, 4	1
CO3	Perform side-channel analysis and test-oriented attacks to extract secret keys or compromise hardware IP.	2, 4	1
CO4	Deploy hardware security primitives and design-for-security techniques to develop countermeasures for pre-silicon and post-silicon threats.	3	1
CO5	Implement hardware obfuscation and PCB-level security methods to prevent Trojan insertion, IP theft, and counterfeiting.	3	1

Electronic Hardware **[9]**

Computing System – Electronic Hardware – Types of Electronic Hardware – Hardware Security vs Hardware Trust – Attacks, Vulnerabilities and Countermeasures – Conflict between Security and Test/Debug – Evolution of Hadware Security – Nanoscale Technologies – Digital Logic – Circuit Theory – ASICs and FPGAs – Printed Circuit Board – Embedded Systems – Hardware – Firmware – Software Interaction – SoC Design and Test: Test Cost and Product Quality – Test Generation – IP-based SoC life-cycle – SoC Design Flow – SoC Verification Flow – SoC Test Flow – Design for Debug – At-Speed Delay Test – PCB Life cycle – Reverse Engineering Attacks.

Hardware Attacks **[9]**

Hardware Trojans – SoC Design Flow – Hardware Trojans – Hardware Trojans in FPGA Designs – Activation Characteristic – Payload Characteristics – Hardware Trojans Taxonomy: Insertion Phase – Abstraction Level – Activation Mechanism – Payload – Location – Trust Benchmarks – Countermeasures against Hardware Trojans – Electronic Supply Chain: Modern Electronic Supply Chain – Electronic Components Supply Chain Issues – Security Concerns – Trust Issues – Potential Countermeasures.

Reverse Engineering and Side-Channel Attacks **[9]**

Hardware Intellectual Property – Security Issues in IP-based SoC Design – Security Issues in FPGA – Side-Channel Attacks: Background – Power Analysis Attacks – Electromagnetic Side-channel Attacks – Fault Injection Attacks – Timing Attacks – Covert Channels – Test-oriented Attacks: Scan-based attacks – JTAG-Based Attacks – Reverse Engineering – Probing Attack – Invasive Fault Injection Attack – Attacks on PCB – Attack Models.

Security Primitives and Design for Security **[9]**

Hardware Security Primitives – Physical Unclonable Function – PUF Classifications – Quality Properties – Common PUF Architectures – PUF Applications – True Random Number Generator – Design for Anti-counterfeit – Existing Challenges and Attacks – Primitive Design with emerging nanodevices – Security assets and Attack Models – Pre-silicon Security and Trust Assessment for SoCs – Post-silicon Security and Trust Assessment for ICs – Design for Security: Architecture – Policy Enforcer – Side-channel resistant design – Trojan insertion prevention.

Hardware Obfuscation and PCB Security **[9]**

Software vs Hardware Obfuscation – Obfuscation Techniques – Hardware obfuscation methods – Emerging Obfuscation Approaches – Obfuscation against Trojan Attacks – PCB authentication – sources of PCB Signature – Signature Procurement and Authentication methods – Signature assessment metric – System-level mutual authentication – authentication using resonance frequency – PCB integrity validation – SoC Design – SoC Security Requirements – Security Policy Enforcement – Secure SoC design process – Threat modeling.

90 Notional Hours

Text Book:

1. Swarup Bhunia and Mark Tehranipoor. *Hardware Security: A Hands-on Learning Approach.* Morgan Kaufmann Publishers, 2019.

REFERENCES:

1. Mark Tehranipoor, Kimia Zamiri Azar, Navid Asadizanjani, Fahim Rahman, Hadi Mardani Kamali, and Farimah Farahmandi. *Hardware Security: A Look into the Future*. Springer, 2024.

ONLINE RESOURCES:

1. Trust Hub. *https://trust-hub.org*

25IT2E02	USABLE SECURITY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental relationship between usability and security.	1	1
CO2	Describe the design principles, quality criteria, and environmental considerations for various authentication mechanisms.	1	1
CO3	Apply user-centered design strategies and guidelines to create usable secure systems.	2, 3	1
CO4	Recommend privacy frameworks and anonymity systems to identify, design pitfalls, and propose privacy-preserving solutions	2, 3	1
CO5	Design usable security products for consumers in collaborative applications.	3	1

Usability and Security **[10]**

Psychological Acceptability – Passwords – Patching – Need for considering usability – Product: Human Factors – Policies – Security Mechanisms – Impossible Demands – Beyond User Interface – Process: Applying Human Factors Knowledge and User-centered Approaches to Security Design – Designing Usable Secure Systems – Importance of the Environment – Role of Education, Training, Motivation and Persuasion – Design for Usability – Death by Security – Balancing Security and Usability – User vs Bad Guys – vary security with the task – increasing partnership with user – achieving balanced authentication design – balancing privacy and security – usability in the software and hardware life cycle – aspects of HCI in Privacy and Security – Usability in requirements – Usability in Design and Development – Case Studies – Trust-Risk relationship – Time-course of trust – Models of Trust – Trust Designs.

Authentication Mechanisms **[10]**

Evaluating Authentication Mechanism: Authentication – Authentication Mechanisms – Quality Criteria – Environmental Considerations – Memorability and Security of Passwords: Existing advice on password selection – experimental studies – Designing Authentication Systems with Challenge Questions: Challenge Questions as a form of authentication – criteria for building and evaluating a challenge question system – types of questions and answers – designing a challenge question authentication system – Graphical Passwords – Usable Biometrics – Users and Typing patterns: Typing pattern biometrics – applications – privacy and security issues – usability of security devices – usability testing.

Secure Systems **[10]**

Guidelines and strategies for secure interaction design: design guidelines – design strategies – fighting phishing at the user interface – attack techniques – defenses – sanitization and usability – remembrance of data passed study – clean computing – Usable PKI – Desktop Security with Chameleon – Chameleon User Interface – Interface development – implementation – security administration tools and practices – attacks, detection and prevention – security administrators – case studies.

Privacy and Anonymity Systems **[10]**

Privacy and HCI – User-centric Privacy Space Framework – Security and Privacy Frameworks – Privacy as a process – Five pitfalls in the design for privacy – Privacy policies and privacy preferences: platform for privacy preferences – Privacy Bird Design – Privacy Bird Evaluation – Beyond the browser – Privacy analysis for the casual user with bugnosis: audience for bugnosis – cookies, web bugs and user tracking – graphic identity – making it simple is complicated – informed consent by design – model of informed consent for information systems – cookie handling in web browsers – Usability and Network Effect.

Commercializing Usability **[5]**

Creating Usable Security Products for consumers – Worry-free web: The Five Golden Rules – Users and Trust – Consent Dialogs – Pop-up blocking – Embedding Security in Collaborative Applications – Usable Secure Collaboration – Embedding and Simplifying Public Key Security – Designing Security Displays – User control of active content security – Usable security in virtual office.

90 Notional Hours

Text Book:

1. Lorrie Faith Cranor, Simson Garfinkel. *Security and Usability.* O'Reilly Publishers, 2005 (2025 Reprint).

REFERENCES:

1. Markus Jakobsson. *Understanding Social Engineering-Based Scams*. Springer, 2016.

ONLINE RESOURCES:

1. Usable Security. *https://www.coursera.org/learn/usable-security*

25IT2E03	DATA MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamentals of cloud-native data infrastructure.	1	1
CO2	Describe the mechanisms for automating database deployment and management in cloud-native environments.	1,2	1
CO3	Explain the integration of data infrastructure with native databases.	1,2	1
CO4	Implement streaming data pipelines and analytics workloads.	1,2,4	1
CO5	Design and deploy cloud-native AI/ML data infrastructure incorporating efficient data movement.	1,2,3,4	1

Data Infrastructure, Storage and Databases [9]

Cloud Native Data – Infrastructure Problem – Cloud Native Data Components – Docker, Containers and State – Resources for Data Storage – Storage Architecture – Prerequisites for running Data Infrastructure – Running MySQL – Running Apache Cassandra.

Automating Database Deployment and Management [9]

Deploying application with Helm Charts – Using Helm to deploy MySQL – Using Helm to deploy Apache Cassandra – Helm, CI/CD and Operations – Extending conteol plane – The Operator Pattern – Managing MySQL using Vitess Operator – Growing Ecosystem of Operators.

Integrating Data Infrastructure and Native Database [9]

Production-ready Cassandra – Managing Cassandra with Cass Operator – Enabling Developer Productivity with Stargate APIs – Unified Monitoring Infrastructure with Prometheus and Grafana – Performing repairs with Cassandra Reaper – Backing Up and Restoring Data with Cassandra Medusa – Deploring Multi-cluster Applications – Need for Native Approach – Hybrid Data Access – Serverless Cassandra with DataStaz Astra DB.

Streaming Data and Analytics [9]

Streaming – Role of Streaming – Streaming with Apache Pulsar – Stream analytics with Apache Flink – Analytics – Deploying Analytic Workloads – Apache Spark – Deploying Apache Spark – Operator for Apache Spark – Alternative Schedulers – Analytic Engines.

Machine Learning and Data Workload Migration [9]

Cloud Native AI/ML Stack – Efficient Data Movement with Apache Arrow – Versioned Object Storage with lakeFS – Application-aware platforms – future of Cloud Native data.

90 Notional Hours

Text Book:

1. Jeff Carpenter, Patrick McFadin. *Managing Cloud Native Data on Kubernetes*. O'Reilly, 2022.

REFERENCES:

1. Francesco Diaz, Roberto Freato. *Cloud Data Design, Orchestration, and Management Using Microsoft Azure: Master and Design a Solution Leveraging the Azure Data Platform*. Apress, 2018.

ONLINE RESOURCES:

1. Cloud Data Management. *https://edu.alibabacloud.com/course/333/lesson/list?spm=a2c4d.8764728.aliyun-edu-course-tab.2.59bf71cf0GnUfm*
2. Cloud Computing. *https://nptel.ac.in/courses/106105167*

25IT2E04	INFRASTRUCTURE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental concepts of cloud native infrastructure.	1	1
CO2	Describe the evolution of cloud native deployments from infrastructure as a diagram to infrastructure as code (IaC) and infrastructure as software.	1,2	1
CO3	Explain the design and development of infrastructure applications.	1,2,3	1
CO4	Implement testing and management strategies for cloud native applications.	1,2,3,4	1
CO5	Implement security and operational controls for cloud native infrastructure.	1,2,3,4	1

Cloud Native Infrastructure **[9]**

Cloud Native Benefits – Servers – Virtualization - Infrastructure as a Service - Platform as a Service - Cloud Native Infrastructure - Cloud Native Applications – People – Systems - Business.

Evolution of Cloud Native Deployments **[9]**

Representing Infrastructure - Infrastructure as a Diagram - Infrastructure as a Script - Infrastructure as Code - Infrastructure as Software - Deployment Tools – Idempotency - Handling Failure.

Designing and Developing Infrastructure Applications **[9]**

The Bootstrapping Problem - The API - The State of the World - The Reconciler Pattern - The Reconciler Pattern's Methods - The Auditing Relationship - Designing an API - Adding Features - Deprecating Features - Mutating Infrastructure.

Testing and Managing Cloud Native Applications **[9]**

Writing Testable Code – Validation - Entering Your Codebase - Self-Awareness - Types of Tests - Infrastructure Assertions - Integration Testing - Unit Testing - Mock Testing - Chaos Testing - Application Design - Implementing Cloud Native Patterns - Application Life Cycle – Deploy – Run – Retire - Application Requirements on Infrastructure - Application Runtime and Isolation - Resource Allocation and Scheduling - Environment Isolation - Service Discovery - State Management - Monitoring and Logging - Metrics Aggregation - Debugging and Tracing - Monitoring Infrastructure

Securing and Implementing Cloud Native Infrastructure **[9]**

Policy as Code - Deployment Gating - Conformity Testing - Compliance Testing - Activity Testing - Auditing Infrastructure - Immutable Infrastructure – People - Architecture - Chaos Management - Applications.

90 Notional Hours

Text Book:

1. Justin Garrison, Kris Nova. *Cloud Native Infrastructure*. O'Reilly, 2017.

REFERENCES:

1. Jeevan Gheevarghese Joseph, Adao Oliveira Junior, Mickey Boxell. *Oracle Cloud Infrastructure - A Guide to Building Cloud Native Applications*. Oracle Press, 2023.
2. Buyya, Rajkumar, Christian Vecchiola,, S. Thamarai Selvi, Shivananda Poojara, Dr. Satish Narayana Srirama. *Mastering Cloud Computing: foundations and applications programming*. McGraw Hill, 2024.

ONLINE RESOURCES:

1. Cloud Data Management. *https://edu.alibabacloud.com/course/333/lesson/list?spm=a2c4d.8764728.aliyun-edu-course-tab.2.59bf71cf0GnUfm*
2. Cloud Computing. *https://nptel.ac.in/courses/106105167*

25IT2E05	INFORMATION AND TECHNOLOGY LAW	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the key data security laws and litigation concepts.	1,4	1
CO2	Describe the cybersecurity requirements and corporate governance obligations for financial institutions, healthcare, energy, nuclear, insurance, and publicly traded companies.	1,2,4	1
CO3	Identify major anti-hacking laws and international cybercrime treaties.	1	1
CO4	Apply key privacy laws and compare international cybersecurity legal frameworks.	1,2,3	1
CO5	Analyze surveillance laws to real-world compliance and litigation scenarios.	1,2,3	1

Data Security Laws and Litigation **[9]**

FTC Data Security – State Data Breach Notification Laws – State Data Security Laws – State Data Disposal Laws – Common causes of action arising from data breaches – class action certification in data breach litigation – Insurance coverage for Cybersecurity Incidents – Protecting Cybersecurity Work Product and Communication from Discovery.

Cybersecurity requirements and corporate governance **[9]**

Financial Institutions: Gramm-Leach-Bliley Act Safeguards rule – New York Department of Financial Services Cybersecurity Regulations – Red Flags Rile – Payment Card Industry Data Security Standard – California Internet of Things Cybersecurity Lae – Health Insurance Portability and Accountability Act – Federal Energy Regulatory Commission Critical Infrastructure Protection Reliability Standards – Nuclear Regulatory Commission Cybersecurity Regulations – South Carolina Insurance Cybersecurity Law – Securities and Exchange Commission Cybersecurity Expectations for Publicly Traded Companies - Fiduciary Duty to Shareholders and Derivative Lawsuits Arising from Data Breaches - Committee on Foreign Investment in the United States and Cybersecurity.

Anti-Hacking Laws and Cyber Structure **[9]**

Computer Fraud and Abuse Act - State Computer Hacking Laws - Section 1201 of the Digital Millennium Copyright Act - Economic Espionage Act - Budapest Convention on Cybercrime - U.S. Government's Civilian Cybersecurity Organization - Department of Homeland Security Information Sharing under the Cybersecurity Act of 2015 - Critical Infrastructure Executive Order and the National Institute of Standards and Technology's Cybersecurity Framework - Posse Comitatus Act - Vulnerabilities Equities Process.

Surveillance and Federal Government Contractors **[9]**

Electronic Communications Privacy Act - Communications Assistance for Law Enforcement Act (CALEA) - Encryption and the All Writs Act - Encrypted Devices and the Fifth Amendment - Federal Information Security Management Act - NIST Information Security Controls for Government Agencies and Contractors - Classified Information Cybersecurity - Covered Defense Information and Controlled Unclassified Information.

Privacy and International Cybersecurity Law **[9]**

Section 5 of the FTC Act and Privacy - CAN-SPAM Act - Video Privacy Protection Act - Children's Online Privacy Protection Act - California Online Privacy Laws - California Consumer Privacy Act - Illinois Biometric Information Privacy Act - European Union – Canada – China – Mexico – Japan - India.

90 Notional Hours

Text Book:

1. Jeff Kosseff. *Cybersecurity Law, 2/E.* Wiley, 2019.

REFERENCES:

1. Shimon Brathwaite. *Cybersecurity Law: Protect Yourself and Your Customers*. Business Expert Press, 2019.
2. Walter Rocchi. *Cybersecurity and Privacy Law Handbook*. Packt Publishing, 2022.

ONLINE RESOURCES:

1. The Information Technology Act, 2000. *https://www.indiacode.nic.in/bitstream/123456789/13116/1/it_act_2000_updated.pdf*

25IT2E06	DATA ETHICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the evolution of privacy and technology, key ethical theories, and contemporary concepts.	1	1
CO2	Describe the core ethical principles for data management.	1	1
CO3	Apply data governance, data quality management, data modeling, and data warehousing concepts to design ethical data management practices.	1,2,3	1
CO4	Implement the Ethical Enterprise Information Management (E2IM) framework to manage ethical risks in big data environments.	1,2,3	1
CO5	Integrate data governance with ethics by designing data review boards, using storytelling to communicate values, and applying Privacy by Design	1,2,3,4	1

Ethics and Data Management **[9]**

Ethics and Evolution of Technology – Privacy and the Environment – Evolution of Privacy and Technology – Data Ethics and Environmental Concerns – Volkswagen's 'dieselgate' scandal – ethical dilemmas – ethics in information management – Ethical theories – Relational Ethics – Data Colonialism and Ethics Washing – Elements of Ethical Frameworks.

Ethical Principles, privacy and analytics **[9]**

Principles – developing ethical data principles – data ethics principles in practice – ethics in society – analytics and data science: an ethical challenge – Data Analytics – Ethical issues in data analytics.

Data and Information Management **[9]**

Data Management – Data Governance – Data Quality Management – Data Modeling – Data Warehousing and Business Intelligence – Big Data, AI and Machine Learning – Data literacy and data acumen in data ethics – data-enabled actions – data ethics and architecture – implementing ethical architecture – challenges – Zachman ethical architecture.

Ethical Enterprise Information Management framework **[9]**

Model for ethical enterprise information management – ethics and big data – ethics as a quality system – applying quality management principles to ethical information management.

Information Ethics and Data Governance **[9]**

Data Governance and ethics – Principles and modes of governance – stewardship and governance – storytelling to communicate values – data review boards – change management – parallel models – Privacy by Design – Ethics by Design – Privacy Engineering – E2IM ethical impact assessment model.

90 Notional Hours

Text Book:

1. Katherine O'Keefe and Daragh O Brien. *Data Ethics, 2/E.* Kogan Page Publishers, 2023.

REFERENCES:

1. Kord Davis, Doug Patterson. *Ethics of Big Data*. O'Reilly Media, 2012.

ONLINE RESOURCES:

1. The Digital Personal Data Protection Act, 2023. *https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf*

25IT2E07	INFRASTRUCTURE DESIGN AND OPERATIONS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental Quality of Service (QoS) concepts.	1	1
CO2	Describe the QoS design considerations and recommended practices for campus and wireless LAN environments.	1,2	1
CO3	Explain the QoS design considerations and tools for data center networks.	1,2	1
CO4	Implement QoS strategies for WAN and branch networks.	1,2,3,4	1
CO5	Design QoS policies for MPLS VPN and IPsec VPN environments.	1,2,3,4	1

QoS Design and Strategies **[9]**

History of QoS and QoE – IOS-Based QoS Architectural Framework and Syntax Structure - Classification and Marking - Policing, Shaping, and Markdown Tools - Congestion Management and Avoidance Tools - Bandwidth Reservation Tools - QoS in IPv6 Networks – Medianet - Application Visibility Control (AVC) - Business and Application QoS Requirements - QoS Design Principles and Strategies - Strategic QoS Design Case Study.

Campus and Wireless LAN QoS Design **[9]**

Campus QoS Design Considerations and Recommendations - Campus Access QoS Design - Campus Distribution QoS Design - Campus Core QoS Design - Case Study - Wireless LAN QoS Considerations and Recommendations - Centralized (Cisco 5500 Wireless LAN Controller) QoS Design - Converged Access QoS Design – Case Study.

Data Center QoS Design **[9]**

Data Center QoS Design Considerations and Recommendations - Data Center Architectures - Data Center QoS Tools - NX-OS QoS Framework - Data Center QoS Models - Data Center Port QoS Roles - Data Center Virtual Access QoS Design - Data Center Access/Aggregation QoS Design – Data Center Core QoS Design – Case Study.

WAN and Branch QoS Design **[9]**

WAN and Branch QoS Design Considerations and Recommendations - WAN and Branch Architectures - Hardware Versus IOS Software QoS - Latency and Jitter - Tx-Ring – CBWFQ – LLQ – WRED – RSVP – AutoQoS – Control Plane Policing – Link Types and Speeds – WAN and Branch QoS Models – WAN and Branch Interface QoS Roles – WAN Aggregator QoS Design – Branch Router QoS Design – Case Study.

MPLS VPN and IPSec QoS Design **[9]**

MPLS VPN QoS Design Considerations and Recommendations - Enterprise Customer Edge QoS Design - Service Provider Edge QoS Design - Service Provider Core QoS

Design – Case Study - IPsec VPN QoS Considerations and Recommendations - DMVPN QoS Design - GET VPN QoS Design - Home Office VPN QoS Case Study.

90 Notional Hours

Text Book:

1. Tim Szigeti, Christina Hattingh, Robert Barton, Kenneth Briley Jr., *End-to-End QoS Network Design: Quality of Service for Rich-Media & Cloud Networks, 2/E.* Cisco Press, 2013 (2024 Reprint).

REFERENCES:

1. Saida Helali. *Systems and Network Infrastructure Integration*. Wiley, 2020.
2. Silvano Gai. *Building a Future-Proof Cloud Infrastructure: A Unified Architecture for Network, Security, and Storage Services*. Addison-Wesley Professional, 2020.

ONLINE RESOURCES:

1. Data Center Infrastructure & Design: Operation & Maintenance. *https://www.udemy.com/course/data-center-infrastructure-design-datacenter/*

25IT2E08	SOFTWARE DEFINED NETWORKS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the limitations of traditional network architectures and the fundamental advantages of SDN.	1	1
CO2	Describe the architecture, features, benefits, and implementation challenges of SD-WAN and SD-LAN technologies.	1	1
CO3	Implement OpenFlow-based switching solutions by configuring flow tables, flow entries, and switch management operations.	2, 4	1
CO4	Design network virtualization solutions using NFV and VXLAN overlay technologies.	2, 3, 4	1
CO5	Construct automated network orchestration workflows using Ansible and SDN orchestrators.	3, 4	1

Network Programming and Automation [9]

Traditional Network Architectures – Limitations – SDN Network Overview – Advantages – Components – API North and South – SDN Network Models – SDN Controllers – SDN multi-controller Network – Network Programming and SDN Networks – Network Programmability Models – Imperative and Declarative Programming Models – APIs – Network Automation via RESTful API.

Openflow Protocol and SD-WAN Technology [9]

Benefits of OpenFlow Protocol – Versions – Components – Management and Role of Tables in OpenFlow Switching – Flow Table and Flow Entries – Messages – Ecosystem and Switch Management – Other SDN protocols – SD-WAN – SD-WAN Features – SD-WAN Architecture – Issues and Challenges of SD-WAN technology.

SD-LAN and Group-based policy Management [9]

Campus Networks – Key Requirement for Campus Network Optimization – SD-LAN Technology – Segmentation – Architecture – Components – AAA Servers – Group-based Policy Management – Presentation – Micro-segmentation – Zero Trust Approach – Components of GBP – GBP management with SDN Controller – Automated Campus Network Solutions.

NFV and SDN Overlay Networks [9]

Network Virtualization Standards – Data Center Optimization through NFV – Interaction between NFV and SDN – Diversified applications of overlay networks – technologies and methods – VXLAN network Overlay – VXLAN and SDN – VXLAN Management Methods – Technical Challenges.

Orchestration **[9]**

Definition and role of SDN orchestrators – advantages of SDN Orchestrators – General architecture of an SDN orchestrator – Leading SDN orchestrators – orchestrating with Ansible – Synergy between Ansible and SDN networks – SD-Access Solution – SD-ACCESS architecture – Platform and Management Tools – Integration in external networks.

90 Notional Hours

Text Book:

1. Ali Sadiqui, Moulay Rachid Filali. *Fundamentals of Software-Defined Networking: Towards Intelligent and Flexible Networks.* CRC Press, 2026.

REFERENCES:

1. Paul Goransson, Chuck Black, Timothy Culver. *Software Defined Networks: A Comprehensive Approach*. Morgan Kaufmann Publishers, 2016.
2. Thomas D. Nadeau and Ken Gray, Timothy Culver. *Software Defined Networks*. O'Reilly, 2025.

ONLINE RESOURCES:

1. SDN Resources. *https://github.com/sadiqui-ali/SDN_resources*
2. Open Networking Foundation. *https://opennetworking.org/sdn-definition/*

25CS201	DATA SCIENCE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the architecture and components of modern language models.	1	-
CO2	Describe methods for interpreting model outputs.	1,2	-
CO3	Identify the processes for labeling data, generating synthetic data, and prompt engineering.	3	-
CO4	Implement retrieval-augmented generation (RAG) and retrieval-augmented classification to build applications.	1,2,3	-
CO5	Implement agentic AI systems by decomposing complex tasks and integrating language models.	1,2,3	-

Language Models, Tools and Terminology [9]

Language Model – Representing Meaning – Encoder-Decoder Models – Attention Mechanism – The Transformer – Self-attention – Encoder Language Models – Decoder Language Models – InstructGPT and Fine-Tuning – Text Generation – Distillation – AI Agents – Libraries – Language Model Vendors – Frameworks – Data-Generating Processes – Adequate Experimentation – Test and Measure – Business Case Metrics – Launch and Evaluate – Case Studies.

Semantic Vectors and Interpretability [9]

Case Study: Detecting AI-Generated Text – Topic Modeling – Analyzing Semantic Vectors – Explaining Model Outputs – Explaining Semantic Vector Models – Mechanistic Interpretability – Comment Classification – Sorting Resumes by Selection Criteria.

Labeling and Synthetic Data Generation [9]

Case Study: Industry Vertical Classification – Student Essay Features – Case-based Prompting – Prompt Variation – Iterated Auditing – Case Study: Customer Complaint Routing – Variables – Custom Parser – Case Study: Translation of Idioms – Sentence Pair Classification.

Retrieval Applications and Code as Language [9]

Retrieval Augmented Generation – Case Study: RAG for Recruiters – Retrieval Augmented Classification – Code Comprehension – Case Study: Code Reviewer – Code Generation – Case Study: Code Revisions.

Automated Analytics and Agentic AI [9]

Task Decomposition – EDS Analyst Bot – Agents – Language Models into Agents – Tool Use – Case Study: Data Query Engine – Model Context Protocol – Case Study: Dataset Research Agent – Checks and Balances – Agentic Use Cases.

90 Notional Hours

Text Book:

1. John Hawkins. *Data Science First.* Wiley, 2026.

REFERENCES:

1. Joel Grus. *Data Science from Scratch, 2/E*. O'Reilly Media, 2019.
2. Thomas Nield. *Essential Math for Data Science*. O'Reilly Media, 2022.

ONLINE RESOURCES:

1. Python for Data Science. *https://nptel.ac.in/courses/106106212*
2. Scalable Data Science. *https://nptel.ac.in/courses/106105186*

25CS202	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental concepts of artificial intelligence.	1	-
CO2	Describe intelligent agent architectures, uninformed and informed search algorithms.	1,2	-
CO3	Explain probabilistic reasoning, reinforcement learning, and the operation of convolutional neural networks.	1,2	-
CO4	Apply supervised and unsupervised machine learning algorithms to preprocess data, train models, and evaluate performance using appropriate metrics and tools.	1,2,3,4	-
CO5	Implement a natural language processing (NLP) component, such as a simple chatbot, and integrate speech recognition fundamentals.	2,3	-

Artificial Intelligence Technologies **[9]**

Introduction – History – Types – Machine Learning and Deep Learning – Applications of AI – Robotics – Drones using AI – Future of AI – No Code AI – Low Code AI – Techniques in AI – Machine Learning Model – Regression Analysis in Machine Learning - Classification Techniques – Clustering Techniques – Naïve Bayes Classification – Neural Network – Support Vector Machines.

AI Machine and Knowledge Representation **[9]**

Intelligence – Components of Intelligence – Human vs Machine Intelligence – Agent and Environment – Search – Uninformed Search Algorithms – Informed Search Algorithms – Hill Climbing Algorithm – Adversarial Search – Alpha-beta Pruning – Local Search Algorithms – Single Agent Path-finding problems – Knowledge Representation – Knowledge-based Agent – Types of Knowledge – Techniques of Knowledge Representation in AI – Propositional Logic – Inference Rules – Forward Chaining and Backward Chaining.

Reasoning and Computer Vision **[9]**

Reasoning – Probabilistic Reasoning – Baye's Theorem – Learning – Clustering – Explanation-based Learning – Reinforcement Learning – Human Vision vs Computer Vision – Working of Computer Vision – Evolution – Tasks – Applications – Challenges – Understanding Image Pixels – Convolutional Neural Networks – Immersive Experience.

Natural Language Processing and Current Trends **[9]**

Introduction – Everyday NLP examples – Chatbot – Working – Components – Steps – Phases – Syntax vs Semantic analysis – Applications – Pros and Cons – Evolution –

Handling Ambiguities – NLP model of Perceptron – Constituency Grammar – Context-Free Grammar – Speech Recognition – AI and ethical concerns – AI as a Service – Robotics – Recent Trends in AI.

AI Today **[9]**

Expert Systems – Internet of Things – Artificial Intelligence of Things – Edge Computing – Metaverse – Fuzzy Logic – Genetic Algorithms – Soft Computing – Transfer Learning.

90 Notional Hours

Text Book:

1. Reema Thareja. *Artificial Intelligence: Beyond Classical AI.* Pearson India, 2024.

REFERENCES:

1. Tom Taulli. *Artificial Intelligence Basics: A Non-Technical Introduction*. Apress, 2019.
2. John Paul Mueller, Luca Massaron, Stephanie Diamond. *Artificial Intelligence For Dummies, 3/E*. Wiley, 2024.

ONLINE RESOURCES:

1. An Introduction to Artificial Intelligence. *https://nptel.ac.in/courses/106102220*
2. Artificial Intelligence. *https://nptel.ac.in/courses/106105077*

25IT204	CYBERSECURITY FOR CRITICAL INFRASTRUCTURE	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the interdependencies and sector-specific impacts of cyberattacks across the critical infrastructure sectors.	1	-
CO2	Describe the evolution of cyber threats against critical infrastructure.	1	-
CO3	Conduct a vulnerability assessment for a critical infrastructure asset.	2, 4	-
CO4	Interpret the impact of common cyberattacks against critical infrastructure.	2, 4	-
CO5	Design a protection strategy for a critical infrastructure environment.	3	-

Critical Infrastructure and Cybersecurity [6]

Impact of compromise and cyberattack scenarios in Chemical Sector – Commercial facilities – Communications – Critical Manufacturing - Dams – Defense Industrial base - Emergency Services – Energy – Financial Service – Food and agriculture services – Government facilities – Healthcare – Information Technology – Nuclear reactors – Transportation system – Water and Wastewater.

Growing Threat of Cyberattacks on Critical Infrastructure [3]

History of CI protection and attacks – impact of 9/11 attacks on CI – old attacks – cyberattacks and countermeasures – state of CI in the face of cyberattacks – COVID-19 period cyberattack landscape – The colonial pipeline ransomware attack – attacks in 2023.

Critical Infrastructure Vulnerabilities [7]

Difference between threat, vulnerability and risk – vulnerability assessment – scope definition – asset inventory – threat modeling – vulnerability scanning – manual assessment – risk prioritization – remediation planning – verification and validation – ongoing monitoring – reporting and documentation – security vulnerability management life cycle – Most common vulnerabilities and threats in CI – Inadequately secured industrial control systems – common vulnerabilities in industrial control systems – ransomware targeting CI – Physical Security breaches – IoT vulnerabilities.

Common attacks against CI [7]

DDoS attack – Volumetric attacks – reflection and amplification attacks – resource depletion attacks – protocol-based attacks – application layer attacks – ransomware attack – infection – encryption – ransom note – ransom payment – data recovery – no guarantee of data recovery – supply chain attack – scope of attack – attack vector – stealth and persistence – data exfiltration – impersonation – APT – phishing – deception and lure – malicious links and attachments.

Incidents and Protection **[7]**

Stuxnet attack on Iran's nuclear program – Ukrainian power grid attack – Dyn attack – Wannacry – Notpetya – Solarwinds attack – Colonial pipeline ransomware attack – network security and continuous monitoring – access control – Intrusion detection and prevention systems – VPNs – Security audits and penetration testing – Honeypots and deception techniques – Zero trust architecture - NIST cybersecurity framework – ISO/IEC 27001 and 27002.

60 Notional Hours

Text Book:

1. Soledad Antelada Toledano. *Critical Infrastructure Security.* Packt Publishing, 2024.

REFERENCES:

1. Sajal K. Das, Krishna Kant, Nan Zhang. *Handbook on Securing Cyber - Physical Critical Infrastructure Foundations and Challenges*. Morgan Kaufmann, 2012.
2. Betty Biringer, Eric Vugrin, Drake Warren. *Critical Infrastructure System Security and Resiliency*. CRC Press, 2013.

ONLINE RESOURCES:

1. MITRE ATT&CK for Industrial Control Systems. *https://attack.mitre.org/matrices/ics/*
2. CISA (Cybersecurity and Infrastructure Security Agency) – Industrial Control Systems. *https://www.cisa.gov/ics*

25IT2E51	PRINCIPLES OF UNIVERSAL ACCEPTANCE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the fundamental need for Unicode over legacy encoding schemes.	1	-
CO2	Describe the purpose, limitations, and evolution of IDNA standards.	1,2	-
CO3	Apply Unicode normalization forms, string comparison techniques, and libraries to process and compare Unicode strings across different scripts and platforms..	1, 2, 3	-
CO4	Interpret the technical requirements for Email Address Internationalization.	1, 2	-
CO5	Implement Unicode, IDN, and EAI support in mobile applications using relevant libraries and development frameworks.	1, 2, 3	-

UNICODE **[9]**

Introduction to encoding schemes – Need for Unicode - Character data type for Unicode code points - Unicode code charts - Processing Unicode Strings - Store Unicode data - The character-glyph model - difference between processing textual information and displaying text - Displaying text - use of text engines, fonts, glyph shapers

UNICODE OPERATIONS **[9]**

Normalization of Unicode strings - NFC and NFD - Comparing Unicode strings - bidirectional and shaped scripts: Display format, File storage in key-press order, Glyph Shapers - Unicode libraries - ICU and others.

INTERNATIONALIZED DOMAIN NAMES (IDNS) **[9]**

Introducing the root zone: TLD, gTLD, ccTLD – Need for IDNs - Unicode-based domain names: U-label - Need for A-labels - Punycode algorithm (RFC 3492) - IDNA2003 and its limitations - IDNA2008 - Limitations of protocols on IDNs: FTP, HTTP, HTTPS - Pitfalls of Using the IDNA2003 Library: Avoiding IDNA2003 libraries - Limitations of IDNA2008.

EMAIL ADDRESS INTERNATIONALIZATION (EAI) **[9]**

Need for EAI - Storing EAI mail - Email protocol changes for EAI - SMTP - signaling flag - POP/IMAP - EAI and Mail message formats - EAI and MIME standard - Adoption challenges - Technical Compatibility Issues – Technical Solutions - Email and Anti-spam measures - EAI and cross-cultural email communication skills - Email address parsing for internationalized email addresses - Considerations for setting up email mailbox names.

IDN MOBILE APPS, SECURITY AND SUPPORT [9]

Unicode Character set support - Unicode Text layout and rendering - Unicode Support in Mobile Apps Development Frameworks - iconv/ICU Converter APIs - Processing IDNs on mobile devices - relevant libraries - Processing EAI on mobile devices - relevant libraries.

90 Notional Hours

Text Book:

1. Jukka K Korpela. *Unicode Explained: Internationalize Documents, Programs, and Web Sites.* O'Reilly Media, 2006.

REFERENCES:

1. Richard Gillam. *Unicode Demystified: A Practical Programmer's Guide to the Encoding Standard*. Addison Wesley, 2002.
2. *The Unicode® Standard Version 17.0 – Core Specification*. Unicode Consortium, 2025.

ONLINE RESOURCES:

1. ICANN Universal Acceptance. *https://www.icann.org/ua*
2. Unicode. *https://home.unicode.org/*

25IT2E52	DIGITAL PRIVACY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

At the end of the course, students will have the ability to:

COs	COURSE OUTCOMES	PO	PSO
CO1	Explain the core concepts of data governance, simple privacy approaches, and differential privacy.	1	-
CO2	Describe the legal frameworks governing data privacy and their implications for internal policies, contracts, and privacy risk management.	6	-
CO3	Build privacy-aware data pipelines by integrating differential privacy libraries, anonymization techniques, and data governance controls.	1,2,3,4	-
CO4	Implement privacy-preserving machine learning (PPML) using open-source libraries, and design federated learning architectures.	1,2,3	-
CO5	Apply encrypted computation techniques to real-world privacy scenarios	1,2,3,4	-

Data Governance, Simple Privacy Approaches and Anonymization [9]

Data Governance – Identifying Sensitive Data – Identifying PII – Documenting Data for Use – Basic Data Documentation – Finding and Documenting Unknown Data – Tracking data Lineage – Data Version Control – Pseudonymization for Privacy by Design - Anonymization – Differential Privacy – Privacy Loss – Understanding differential privacy – Laplace Mechanism – Gaussian Noise for Differential Privacy – Sensitivity and Privacy Units – k-Anonymity.

Privacy in Data Pipelines and Privacy Attacks [9]

Building Privacy into Data Pipelines – Engineering Privacy and Data Governance into Pipelines – Using Differential Privacy Libraries in Pipelines – Collecting Data Anonymously - Privacy Attacks: Analyzing Common Attack Vectors – Data Security – Probabilistic Reasoning about Attacks – Data Security Mitigations.

Privacy-aware Machine Learning and Federated Learning [9]

Using Privacy-preserving techniques in Machine Learning – Open-Source Libraries for PPML – Architecting Privacy in Data and Machine Learning Projects - Distributed Data – Federated Learning – Architecting Federated Systems – Open Source Federated libraries.

Encrypted Computation [9]

Encrypted Computation – Privacy versus Secrecy – Threat Modeling – Secure Multiparty Computation – Homomorphic Encryption – Private Set Intersection – Private Join and Compute – Secure Aggregation – Encrypted Machine Learning – PSI and Moose.

Legal Side of Privacy and Practicality **[9]**

GDPR – CCPA – DPDP Act, 2023 – HIPAA – LGPD – PIPL – Internal Policies and Contracts – Data Governance 2.0 – Managing Privacy and Security Risk – Practical Privacy Technology: Use Case – Integrating and Automating Privacy in ML.

90 Notional Hours

Text Book:

1. Katharine Jarmul. *Practical Data Privacy.* O'Reilly Publishers, 2023.

REFERENCES:

1. Sanjay Sharma. *Data Privacy and GDPR Handbook*. Wiley, 2019.
2. Nishant Bhajaria. *Data Privacy*. Manning Publishers, 2022.

ONLINE RESOURCES:

1. The Digital Personal Data Protection Act, 2023. *https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf*