M.E. Degree

in

COMPUTER SCIENCE AND ENGINEERING

CURRICULUM AND SYLLABUS (CBCS)

(Innovation and Product Development for Sustainability)

(For students admitted from the Academic Year 2026-2027)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

VISION OF THE INSTITUTION

To be a centre of excellence in engineering education and research for a technically empowered humane society

MISSION OF THE INSTITUTION

M1. Foster a vibrant academic environment for learning fundamental concepts, emerging technologies, and research-oriented practices.
M2. Cultivate personal maturity and professional skills through stimulating coaching and practical training.
M3. Provide inspiring high caliber faculty to mentor students from diverse backgrounds, especially the underprivileged.
M4. Create ample opportunities to transform rural youth into top class professionals and technocrats, capable of serving at the local and global levels with ethical integrity.

VISION OF THE PROGRAMME

Creating accomplished innovative and ethical computer professionals.

MISSION OF THE PROGRAMME

- To provide an environment that promotes professional and personal growth for the students.
- To provide quality education to the students and train them effectively to solve real-world problems with criticality.
- To develop a desire in the learners for higher education and research by providing them with exposure, inspiration and opportunities.
- To inculcate ethical values and leadership abilities in the young minds so as to work with passion and commitment for the progress of the society

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1 : Develop proficiency as a computer science engineer with an ability to solve a wide range of computational problems and have sustainable development in industry or any other work environment.

PEO2 : Analyze and adapt quickly to new environments and technologies, gather new information, and work on emerging technologies to solve multidisciplinary engineering problems.

PEO3 : Possess the ability to think analytically and logically to understand technical problems with computational systems for a lifelong learning which leads to pursuing research.

PEO4 : Adopt ethical practices to collaborate with team members and team leaders to build technology with cutting edge technical solutions for computing systems.

PEO5 : Model a computer based automation system and design algorithms that explore the understanding of the tradeoffs involved in digital transformation.

PROGRAMME OUTCOMES

PO1 : An ability to independently carry out research/investigation and development work to solve practical problems.

PO2 : An ability to write and present a substantial technical report/document.

PO3 : Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 : Efficiently design, build and develop system application software for distributed and centralized computing environments in varying domains and platforms.

PO5 : Design solutions for real world problems by communicating and effectively working with professionals in various engineering fields.

PO6 : Pursue research orientation for a lifelong professional development in computer and automation arenas.

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1 : A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2 : Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3 : A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4 : Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5 : Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6 : Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7 : Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8 : Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9 : Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PEO's – PO's MAPPING:

PEO	PROGRAMME OUTCOMES					
	1	2	3	4	5	6
I	3	-	3	3	2	1
II	3	-	2	3	2	-
III	3	-	2	2	1	3
IV	1	2	-	2	2	-
V	2	-	-	1	-	-

PROGRAMME ARTICULATION MATRIX

Year	Semester	Course Code	PO					
			1	2	3	4	5	6
I	I	IP26C07	2	2	2	-	-	-
		MA26101	2	-	1	2	-	-
		CP26101	3	2	2	2	1	2
		CP26102	3	1	2	3	2	1
		CP26103	2	2	3	1	-	-
		CP26104	3	2	3	3	2	2
		RM26C01	3	3	2	2	2	2
		RM26C02	2	2	2	3	3	2
		CP26105	3	1	1	1	2	2
		CP26106	3	3	2	-	-	3
I	II	CP26201	3	2	3	3	2	1
		CP26202	2	2	2	3	-	2
		CP26203	2	1	2	2	1	1

SUSTAINABLE DEVELOPMENT GOALS

GOAL 1 : No Poverty

End poverty in all its forms everywhere

GOAL 2 : Zero Hunger

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

GOAL 3 : Good Health and Well-being

Ensure healthy lives and promote well-being for all at all ages

GOAL 4 : Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

GOAL 5 : Gender Equality

Achieve gender equality and empower all women and girls

GOAL 6 : Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all

GOAL 7 : Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all

GOAL 8 : Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

GOAL 9 : Industry, Innovation and Infrastructure

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

GOAL 10 : Reduced Inequality

Reduce inequality within and among countries

GOAL 11 : Sustainable Cities and Communities

Make cities and human settlements inclusive, safe, resilient and sustainable

GOAL 12 : Responsible Consumption and Production

Ensure sustainable consumption and production patterns

GOAL 13 : Climate Action

Take urgent action to combat climate change and its impacts

GOAL 14 : Life Below Water

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

GOAL 15 : Life on Land

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

GOAL 16 : Peace and Justice Strong Institutions

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

GOAL 17 : Partnerships to achieve the Goal

Strengthen the means of implementation and revitalize the global partnership for sustainable development.

SEMESTER: I

Number of Courses: 9

Total Credits: 25

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Team Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
IP26C07	Induction Programme*	IP	24	0	0	6	30	0	4,8,9, 16,17	IP
MA26101	Optimization Techniques and Statistical Modelling for Computer Science Engineering	TC	45	15	0	60	120	4	4,8,9, 12	BSC
CP26101	Advanced Data Structures and Algorithms	TC	45	0	0	45	90	3	4,9	PCC
CP26102	Modern Database Technologies	TCP	30	0	30	30	90	3	4,8,9, 11,12	PCC
CP26103	Network Technologies	TC	45	0	0	45	90	3	4,9, 11	PCC
CP26104	Advanced Operating Systems	TC	45	0	0	45	90	3	4,7,9, 12,16	PCC
RM26C01	Research Methodology	TC	45	15	0	60	120	4	1,2,3,	FC

	and Intellectual Property Rights								7	
RM26C02	Research Tool Laboratory	PC	0	0	60	0	60	2	4,9,16,17	FC
CP26105	Advanced Data Structures and Algorithms Laboratory	PC	0	0	60	0	60	2	4,9	PCC
CP26106	Technical Seminar**	PC	0	0	30	0	30	1	4,8,9,13,17	EEC
Total			255	30	180			25		

* - Refer clause 21 in regulation 2026. The evaluation procedure is detailed in the syllabus.
** - Internally Evaluated Course. The evaluation procedure is detailed in the syllabus.

SEMESTER: II

Number of Courses: 7
Total Credits: 17

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Team Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
CP26201	Cloud Computing Technologies	TC	45	0	0	45	90	3	4,8,9,7,11,12,16,17	PCC
CP26202	Multicore Architecture and Programming	TCP	30	0	30	30	90	3	4,8,9	PCC
CP26203	Artificial Intelligence Systems and Applications	TCP	30	0	30	30	90	3	4,8,9,11,12	PCC
	Open Elective I	TC	45	0	0	AAS45	90	3	-	OEC
	Professional Elective I	TC	45	0	0	45	90	3	-	PEC
CP26S01	Industry Collaborated Course I*		-	-	-	-	-	1	-	ICC
CP26S02	Self-Learning Course*		-	-	-	-	-	1	-	SLC
Total			195	0	60			17		

* - Evaluation and certification by course offering body

PROFESSIONAL ELECTIVE I - SEMESTER II

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Team Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
CP26001	Natural Language Processing Techniques	TC	45	0	0	45	90	3	4,8,9, 16,17	PEC
CP26002	Data Visualization Techniques	TC	45	0	0	45	90	3	4,9,11,16, 17	PEC
CP26003	Green Computing and Sustainability	TC	45	0	0	45	90	3	7, 9,11, 12, 13	PEC
CP26004	Big Data Mining and Analytics	TC	45	0	0	45	90	3	3,4,8, 9, 11,12 ,16	PEC
CP26005	Human Computer Interaction	TC	45	0	0	45	90	3	4,8,9, 10,11 ,16	PEC

OPEN ELECTIVE I - SEMESTER II

(Offered to other P.G. Programmes)

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Team Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
CP26901	Generative AI	TC	45	0	0	45	90	3	4,8,9, 12	OEC
CP26902	Cyber Security and Ethical Hacking	TC	45	0	0	45	90	3	4, 8, 9,11, 16	OEC

SYLLABUS

SEMESTER I

IP26C07	INDUCTION PROGRAMME	L	T	P	TW/ SL	Total	C	SDG
		24	0	0	6	30	0	4,8,9, 16,17

COURSE OBJECTIVES:

- To familiarize students with institutional policies, academic regulations, and programme structure.
- To introduce research methodology, ethical practices, and emerging engineering trends.
- To develop communication, technical writing, and presentation skills.
- To create awareness about career opportunities, higher education, and industry expectations.
- To inculcate professional ethics, teamwork, and leadership qualities.

COURSE CONTENT:

Unit 1	INSTITUTIONAL ORIENTATION	4	0	0	1	5		4

Vision, Mission, and Quality Policy – Organizational structure – Campus facilities – Library, laboratory, and IT infrastructure – Student support systems – Interaction with faculty and peers.
Activities: Campus Resource Mapping and Group Presentation.

Unit 2	ACADEMIC REGULATIONS & PROGRAMME STRUCTURE	4	0	0	1	5		4,9

Choice Based Credit System (CBCS) – Curriculum framework – Credit requirements – Evaluation and assessment procedures – Attendance norms – Examination system – Academic integrity guidelines.

Activities: Preparation of Individual Academic Plan.

Unit 3	RESEARCH METHODOLOGY & EMERGING TECHNOLOGIES	8	0	0	2	10		4

Research process – Problem identification – Literature review – Research ethics and plagiarism – Overview of emerging technologies (AI, Data Science, IoT, etc.) – Interdisciplinary research opportunities.
Activities: Mini Research Problem Identification and Presentation.

Unit 4	SKILL DEVELOPMENT & CAREER PLANNING	4	0	0	1	5		8

Communication skills – Technical writing – Presentation skills – Resume preparation – Career opportunities – Higher studies – Competitive exams – Internship and placement readiness.

Activities: Resume Preparation and Elevator Pitch Presentation.								
Unit 5	**PROFESSIONAL DEVELOPMENT & WELL-BEING**	**4**	**0**	**0**	**1**	**5**		**16,17**
Engineering ethics – Professional values – Teamwork and leadership – Innovation and entrepreneurship – Startup ecosystem – Time management – Stress management – Counseling and mentoring support. **Activities:** Case Study Analysis on Ethics and Teamwork.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1 :** Apply institutional policies and academic regulations to manage postgraduate studies effectively. **CO2 :** Apply research methodologies and ethical principles to identify research problems. **CO3 :** Demonstrate communication, technical writing, and presentation skills. **CO4 :** Analyze career opportunities and industry expectations for informed decision-making. **CO5 :** Apply professional ethics and teamwork skills in academic and organizational environments.								
Weightage: Continuous Assessment: 100%								
Assessment Methodology: Active Participation (40%), Assignments (30%), Quiz (30%)								
REFERENCES:								
1.	Johri, A., "International Handbook of Engineering Education Research", Taylor & Francis, 2023.							
2.	Murthy, D. N. P., & Page, N. W., "Education and Research for the Future", Springer, 2023.							
3.	Oliveira, T. A., & Hebebci, M. T. (Eds.), "Current Academic Studies in Technology and Education 2024", ISRES Publishing, 2024.							
4.	Kannan, R., Thirumalai, P., & Geetha, T. V. (Eds.), Proceedings of the International Conference on Technology for Education (T4E 2024), Springer, 2024.							
5.	Rajesh, S., Raghu Prasad, B. K., & Praveen, K. V. (Eds.), "Recent Advances in Sustainable Construction Technology, Geotechnics and Structural Engineering", Springer, 2026.							
E resources/E materials:								
1.	https://alison.com/course/essentials-of-research-methodology							
2.	https://www.coursera.org/learn/research-methodologies							

Mapping of Course Outcomes to Programme Outcomes

COs \ POs	PO1 **(Research Capability)**	PO2 **(Technical Communication)**	PO3 **(Domain Mastery)**
CO1	2	1	2
CO2	3	2	2
CO3	1	3	1
CO4	2	2	2
CO5	1	2	1
CO	1.8	2.0	1.6

3–High, 2– Medium, 1–Low

MA26101	**OPTIMIZATION TECHNIQUES AND STATISTICAL MODELLING FOR COMPUTER SCIENCE ENGINEERING**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**15**	**0**	**60**	**120**	**4**	**4,8,9, 12**

COURSE OBJECTIVES:

- To familiarize the students with the formulation and construction of mathematical models for a linear programming problem in real-life situations.
- To develop student's ability to formulate and solve real-world optimization problems using transportation and assignment models.
- To grasp the basics of simulation.
- To enable students to understand the concepts of correlation, regression curve fitting and Estimation.
- To acquaint the student with the basic concept of Multivariate analysis and its applications.

COURSE CONTENT:

Unit 1	**LINEAR PROGRAMMING**	**9**	**3**	**0**	**12**	**24**		**4,8,9,12**

Formulation of linear programming problems – Graphical solution method – Canonical and standard form of linear programming problem – Simplex method – Artificial variables: Big-M method.

Activity: Model a real-world resource allocation problem in cloud computing as a Linear Programming Problem and solve it using the simplex method.

Unit 2	**TRANSPORTATION AND ASSIGNMENT MODELS**	**9**	**3**	**0**	**12**	**24**		**4,8,9,12**

Definition of the transportation model – Mathematical formulation of transportation models – Basic feasible solution: Vogel's approximation method – Optimal solution by modified distribution (MODI) method – Definition of the assignment model – Mathematical formulation of assignment models – Hungarian method for solving assignment problems.

Activity: Formulate the assignment problem and obtain the optimal assignment using the Hungarian method for a set of computational tasks assigned to processors with different execution costs.

Unit 3	**SIMULATION**	**9**	**3**	**0**	**12**	**24**		**4,8,9,12**
Discrete event simulation – Monte Carlo simulation – Use of random numbers – Generation of random numbers. **Activity:** Apply Monte Carlo simulation to estimate resource utilization in a cloud server where request arrivals are random.								
Unit 4	**CORRELATION, REGRESSION AND MODEL FITTING**	**9**	**3**	**0**	**12**	**24**		**4,8,9, 12**
Correlation (discrete case) – Karl Pearson's coefficient of correlation and Spearman's rank correlation – Linear regression – Regression coefficients – Definitions: Unbiased estimators, Efficiency, Consistency, Sufficiency – Curve fitting by the method of least squares (linear and quadratic forms). **Activity:** Analyze the relationship between input size and execution time of an algorithm using Karl Pearson's correlation.								
Unit 5	**MULTIVARIATE ANALYSIS**	**9**	**3**	**0**	**12**	**24**		**4,8,9.12**
Random vectors and matrices – Mean vectors and covariance, correlation matrices – Partitioning of Covariance Matrices – Combination of Random Variables for Mean Vector and Covariance Matrix – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables. **Activity:** Model system performance parameters as a random vector and compute the correlation matrix.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1 :** Apply graphical, simplex and Big-M methods to solve linear programming problems and obtain optimal solutions. **CO2 :** Solve transportation problems using modified distribution method and assignment problems using Hungarian Method to obtain optimal allocation results. **CO3 :** Apply simulation methods to real-world problems. **CO4 :** Apply curve fitting, regression and correlation techniques to analyze and interpret experimental data. **CO5 :** Analyze and interpret the results of multivariate statistical models.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Internal Assessment Test (70%) and Activity (30%).								
REFERENCES:								
1.	Taha. H.A., "Operation Research: An Introduction", Eleventh edition, Pearson Education, New Delhi, Reprint 2023.							
2.	Kanti Swarup, P. K. Gupta and Man Mohan, "Operation Research", Twentieth edition, Sultan Chand & sons, 2022.							

3.	Gupta. P.K. and Hira. D.S., "Problems in Operations Research", Fourth edition, S.Chand and Co, 2015.
4.	Johnson. R.A., Miller. I.R. and Freund. J.E., Miller and Freund's, "Probability and Statistics for Engineers", Ninth edition, Pearson Education, Asia, Reprint 2024.
5.	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., Schaum's, "Outline of Theory and Problems of Probability and Statistics", Fourth edition, Tata McGraw-Hill, Reprint 2023.
6.	Richard A. Johnson and Dean W. Wichern, "Applied multivariate statistical Analysis", Sixth edition, Pearson Education, New Delhi, Reprint 2023.
E resources/E materials:	
1.	https://nptel.ac.in/courses/110106062
2.	https://allen.in/jee/maths/graphical-method-linear-programming
3.	https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/1585041316993_Module-4.pdf
4	Introduction to Operations Research, Nptel course - https://onlinecourses.nptel.ac.in/noc22_mg30/preview.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	2	-	-
CO2	2	-	1	2	-	-
CO3	2	-	1	2	-	-
CO4	2	-	1	2	-	-
CO5	2	-	1	2	-	-
CO	2	-	1	2	-	-

3–High, 2– Medium, 1–Low

CP26101	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	TW/ SL	Total	C	SDG
		45	0	0	45	90	3	4,8,9

COURSE OBJECTIVES:

- To comprehend the working of advanced trees, skip lists, and flow algorithms
- To learn interval trees, disjoint sets, and binomial queues.
- To learn probabilistic, divide-and-conquer algorithms with performance analysis.
- To learn dynamic programming and greedy algorithm strategies.
- To learn NP-complete, polynomial, and approximation problems.

COURSE CONTENT:

Unit 1	TREE AND GRAPH ALGORITHMS	9	0	0	9	18		4,9

Representing rooted trees -Binary Search Trees: Querying- Insertion - deletion, Red-Black Trees: properties - rotations- insertion- deletion, Skip lists: Search - Update Operations, Representations of graphs- Maximum Flow: Flow networks- The Ford-Fulkerson method- Maximum bipartite matching.

Activities: Assignment:

1. Insert the following sequence of keys into an empty Red-Black Tree: 41, 38, 31, 12, 19, 8, performing all necessary recoloring and rotations. Draw the tree after each insertion and verify that all Red-Black Tree properties are maintained in the final tree.

2.Given the flow network with capacities: S → A (10), S → B (5), A → B (15), A → T (10), B → T (10), identify augmenting paths from S to T, and determine the maximum flow.

Unit 2	AUGMENTED TREES AND DISJOINT SET STRUCTURES	9	0	0	9	18		4,9

Augmenting Data Structures: Dynamic order statistics- How to augment a data structure- Interval trees, B-Trees : Definition of B-trees - Basic operations on B-trees - Deleting a key from a B-tree , Data Structures for Disjoint Sets: Disjoint-set operations- Linked-list representation of disjoint sets- Disjoint-set forests, Binomial Queues: Structure - Operations

Activities: Hands-on/Group Method:

1. Given a set of intervals, e.g., [5,10], [8,12], [15,20], [18,22], and construct an interval tree on paper, marking the max endpoint at each node. Then perform a query to find all intervals overlapping a given interval, e.g., [9,19], and report the results.
2. Given a set of keys, e.g., 10, 5, 15, 20, 25, construct a binomial queue on paper by performing successive insertions, showing the binomial trees formed. Perform a delete-min operation and update the queue structure, recording the resulting trees.

Unit 3	**ALGORITHM ANALYSIS**	**9**	**0**	**0**	**9**	**18**		**4,9**

Mathematical Background- Typical growth rates- Running Time Calculations: General Rules- Recurrence solving :Master theorem, Probabilistic Analysis and Randomized Algorithms: The hiring problem - randomized quick sort- randomized quick select, Divide-and-Conquer: Multiplying square matrices- Strassen's algorithm for matrix multiplication

Activities: Team work

1.Each team is given a set of recurrences and must classify each case using the Master Theorem
2. Make the students simulate randomized quicksort with different pivot selections and record comparisons..

Unit 4	**DYNAMIC PROGRAMMING AND GREEDY ALGORITHMS**	**9**	**0**	**0**	**9**	**18**		**4,8,9**

Dynamic Programming: Elements of Dynamic Programming –Matrix-Chain Multiplication – Longest Common Subsequence- Optimal binary search trees, Greedy Algorithms: Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

Activities:

Assignment: 1. Matrix chain multiplication: Explanation, algorithm, example. 2. Optimal binary search trees: Explanation, algorithm, example.

Unit 5	**NP-COMPLETENESS, POLYNOMIALS, APPROXIMATION ALGORITHMS**	**9**	**0**	**0**	**9**	**18**		**4,9**

NP-Completeness: Polynomial-time verification - NP-completeness and reducibility, Polynomials and the FFT: Representing polynomials- The DFT and FFT- Polynomials and the FFT, Approximation Algorithms: The traveling-salesperson problem- The subset-sum problem

Activities: Quiz: Topics: NP-Completeness, Approximation Algorithms

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Implement advanced trees, skip lists, and flow algorithms.

CO2: Apply interval trees, disjoint sets, and binomial queues to solve computational tasks.

CO3: Develop probabilistic, divide-and-conquer algorithms with performance analysis.

CO4: Solve problems using dynamic programming and greedy algorithm strategies.

CO5: Construct and solve NP-complete, polynomial, and approximation algorithm problems.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%) & Internal Examinations (70%)

REFERENCES:	
1.	T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms"", Fourth Edition, Prentice Hall of India, 2022.
2.	Goodrich, Michael T., Roberto Tamassia, Michael H. Goldwasser, & Subhasish Banerjee., "Data Structures and Algorithms in Java", Sixth Edition (Indian Adaptation). Wiley India Pvt. Ltd., 2022.
3.	Vijayalakshmi Pai, G. A, "A Textbook of Data Structures and Algorithms, Volume 3: Mastering Advanced Data Structures and Algorithm Design Strategie", John Wiley & Sons, 2023.
4.	Dan S. Myers, "Data Structures and Algorithms in Java: A Project-Based Approach", Cambridge University Press & Assessment, 2024.
5.	Sridharan, S. & Balasubramanian, R., "Advanced Data Structures and Algorithmic Design", McGraw Hill, 2023.
E resources/E materials:	
1.	MIT OpenCourseWare – Introduction to Algorithms: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
2.	NPTEL – Programming, Data Structures and Algorithms using Python: https://nptel.ac.in/courses/106106145
3.	NPTEL –Data Structures and Algorithms http://digimat.in/nptel/courses/video/106102064/L11.html
4.	NPTEL : NOC:Data Structure and Algorithms using Java http://www.digimat.in/nptel/courses/video/106105225/L27.html
5.	freeCodeCamp.org: https://youtu.be/RBSGKlAvoiM

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	2
CO2	3	2	2	2	1	2
CO3	3	2	2	2	1	2
CO4	3	2	2	2	1	2
CO5	3	2	2	1	1	2
CO	3	2	2	2	1	2

3–High, 2– Medium, 1–Low

CP26102	MODERN DATABASE TECHNOLOGIES	L	T	P	TW/ SL	Total	C	SDG
		30	0	30	30	90	3	4,8,9, 11,12

COURSE OBJECTIVES:

- To familiarize students with the principles, architectures, and mechanisms used in distributed database systems.
- To learn spatial and temporal database concepts and their real-world applications.
- To explore NoSQL databases, data models and operations used in modern large-scale systems.
- To study XML data models, schemas and querying techniques for semi-structured data.
- To gain knowledge of emerging database technologies such as cloud, graph, and blockchain database systems.

COURSE CONTENT:

Unit 1	DISTRIBUTED DATABASES	6	0	6	6	18		9

Distributed Systems – Distributed DBMS Architecture – Distributed Database Concepts – Data Fragmentation, Replication and Allocation- Distributed Transactions – Commit Protocols.

Practical:

- Implement data fragmentation by creating horizontally and vertically fragmented tables and reconstruct the original relation using SQL queries.
- Write a SQL script to simulate a transaction with COMMIT and ROLLBACK and observe its effect on database consistency.

Activities:

- Prepare a diagram in Draw.io showing a simple distributed database with three sites and describe the role of each site.
- Survey an open-access research paper on distributed transactions from Google Scholar and prepare a brief summary.

Unit 2	SPATIAL AND TEMPORAL DATABASES	6	0	6	6	18		9, 11

Active Database Model – Triggers and Rules – Design & Implementation Issues – Temporal Databases – Temporal Querying – Spatial Databases: Spatial Data Types, Operators, Queries – Spatial Indexing (R-tree) – Spatial Mining – Applications.

Practical:

- Create a table with spatial attributes (latitude, longitude) and execute basic spatial queries (distance or overlap).
- Create a temporal table with time-stamped data and perform simple temporal queries such as retrieving data within a specific time range.

Activities:

- Write an assignment on spatial features (point, line, polygon) by observing an OpenStreetMap layer in QGIS.
- Perform a role-play on how city planners use spatial and temporal data to solve problems like traffic or flood management.

Unit 3	**NoSQL DATABASES**	**6**	**0**	**6**	**6**	**18**		**8,9**

NoSQL Overview – Types of NoSQL Databases – CAP Theorem – Sharding – Document-based Systems – MongoDB: Insert, Update, Delete, Query, Indexing, Aggregation, Replication, Sharding – Cassandra: Data Model, Keyspace, Tables, CRUD.

Practical:

- Perform basic CRUD operations on a MongoDB collection and retrieve data using simple query filters.
- Create a Cassandra table with primary key and clustering key definitions and execute basic CQL operations.

Activities:

- Conduct a short quiz on NoSQL concepts such as CAP theorem, sharding, and document models.
- Perform a role-play on choosing SQL or NoSQL for a new application and justify your choice as a system architect.

Unit 4	**XML DATABASES**	**6**	**0**	**6**	**6**	**18**		**4,9**

Structured, Semi-Structured & Unstructured Data – XML Hierarchical Data Model – XML Documents – DTD – XML Schema – XPath – XQuery.

Practical:

- Create an XML document for a sample dataset and validate it using a DTD.
- Write XPath expressions to select and retrieve elements or attributes from the XML document.

Activities:

- Write an assignment on validating an XML file using an open-source XML validator (CodeBeautify/XMLGrid) and list the errors corrected.
- Conduct a peer-review activity where students exchange XML + XPath files and check each other's documents for correctness.

Unit 5	**EMERGING DATABASE TECHNOLOGIES AND APPLICATIONS**	**6**	**0**	**6**	**6**	**18**		**9,12**

Cloud Database Architectures – DBaaS – Federated Databases – Data Lakes & Polystore Systems – Graph Databases: Data Models, Cypher Queries, Use Cases – Blockchain Databases: Immutable Storage, Smart Contracts.

Practical:

- Create a small graph in Neo4j with nodes and relationships and execute simple Cypher queries.
- Implement a basic blockchain structure in Python by linking blocks using hash values.

Activities:

1. Conduct a mini case-study discussion on any one open-source technology such as Hadoop, Kafka, Spark, or Hyperledger by examining how it handles large-scale or real-time data and presenting the key points in class.
2. Observe the functioning of a blockchain using an open-source blockchain visualizer and describe how blocks are chained, how hashing ensures immutability, and how transactions are added in distributed nodes.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Apply distributed database architectures, data fragmentation, replication, and distributed transaction techniques in database applications.
CO2 : Apply spatial and temporal database concepts to analyze real-world data scenarios.
CO3 : Use NoSQL databases such as MongoDB and Cassandra for data storage and retrieval.
CO4 : Design and validate XML documents and perform XML querying using XPath and XQuery.
CO5 : Implement cloud databases, federated systems, graph queries, and blockchain storage solutions for data management applications.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Activities (10%), Practical (10%), Internal Assessment Test (30%)

REFERENCES:

1.	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2021(Reprint).
2.	R. Elmasri, S. B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson, 2021 (Reprint).
3.	Martin Kleppmann, Chris Riccomini, “Designing Data-Intensive Applications”, Second Edition, O’Reilly Media, 2024.
4.	Imran Bashir, “Mastering Blockchain: Inner workings of blockchain, from cryptography and decentralized identities, to DeFi, NFTs and Web3”, Fourth Edition, Packt Publishing, 2023.
5.	Pramod J. Sadalage, Martin Fowler, “NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence”, Second Edition, Addison-Wesley, 2023.

E resources/E materials:	
1.	NPTEL – Database Management Systems https://nptel.ac.in/courses/106106093
2.	NPTEL – Big Data Computing & NoSQL Databases https://nptel.ac.in/courses/106104189
3.	W3Schools – XML, XPath, XQuery Tutorials https://www.w3schools.com/xml
4.	MongoDB University – Free Online Courses on NoSQL & MongoDB https://learn.mongodb.com
5.	Neo4j Graph Academy – Free Courses on Graph Databases & Cypher https://graphacademy.neo4j.com

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	3	1	1
CO2	3	1	2	3	2	1
CO3	3	1	1	3	2	1
CO4	3	2	2	3	1	1
CO5	3	1	3	3	2	2
CO	**3**	**1**	**2**	**3**	**2**	**1**

3-High, 2- Medium, 1-Low

CP26103	**NETWORK TECHNOLOGIES**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**4,8,9, 11**

COURSE OBJECTIVES:

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

COURSE CONTENT:

Unit 1	**NETWORKING CONCEPTS**	**9**	**0**	**0**	**9**	**18**		**4,9**

The Network Edge-The Network Core-Performance: Delay, Loss and Throughput Protocol Layers - OSI Model-IP Addressing-Data Center Networking: Data Center Architectures -Trends in Data Center Networking.

Activities:
- Flipped Classroom discussion on Basics and OSI Layers
- IP Addressing hands-on problem-solving session

Unit 2	**WIRELESS NETWORKS**	**9**	**0**	**0**	**9**	**18**		**8,9,11**

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be –Bluetooth – Protocol Stack – Security – Profiles – Zigbee – QoS.

Activities:
- Comparison activity: Preparing a chart for IEEE 802.11 standards
- Demonstration of Bluetooth/Zigbee protocol operation

Unit 3	**MOBILE DATA NETWORKS**	**9**	**0**	**0**	**9**	**18**		**8,9**

4G LTE Cellular Network: Architecture and Elements, LTE Protocols Stacks, LTE Radio Access Network, Mobile Management-Principles-Concepts of 5G – channel access –air interface - Cognitive Radio spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G.

Activities:
- Debate activity: “Is 6G essential for future networks?”
- Quiz: LTE Architecture, 5G Concepts

Unit 4	**SOFTWARE DEFINED NETWORKS**	**9**	**0**	**0**	**9**	**18**		**9**

The SDN Approach, SDN- and NFV- Related Standards. SDN Data Plane- OpenFlow Logical Network Device, OpenFlow Protocol. SDN Control Plane Architecture,ITU-T Model. OpenDaylight, SDN Application Plane Architecture.

Activities:
- Assignment: Northbound vs Southbound APIs
- Video review: OpenDaylight Architecture

Unit 5	**NETWORK FUNCTIONS VIRTUALIZATION**	**9**	**0**	**0**	**9**	**18**		**9,11**

Motivation-Virtual Machines –NFV benefits-requirements – architecture- NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration- NFV Use Cases- NFV and SDN –Network virtualization – VLAN and VPN

Activities:
- Group activity: Compare VLAN vs VPN vs Network Virtualization
- Quiz: NFV

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Employ the fundamental concepts of computer networks.
CO2: Implement wireless networking concepts and standards.
CO3: Utilize 4G and 5G concepts in mobile data networks.
CO4: Execute the features of Software Defined Networking.
CO5: Integrate Network Functions Virtualization concepts in networking environments.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%) & Internal Examinations (70%)

REFERENCES:

1.	James F. Kurose Keith W. Ross, "Computer networking A Top-Down Approach", Eighth Edition, Pearson Education, 2023.
2.	Keunwoo Lim, "Next Generation of Bluetooth and Wi-Fi", John Wiley & Sons (Wiley-ISTE), 2024.
3.	William Stallings, "5G wireless: a comprehensive introduction", Pearson, 2021.
4.	Hassan, Syed Farrukh, Alexander Orel, and Kashif Islam, "A network architect's guide to 5G", Addison-Wesley Professional, 2022.
5.	William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Addision Wesley, 2022.

E resources/E materials:

1.	NPTEL Course – Computer Networks https://nptel.ac.in/courses/10610508
2.	**Coursera – Software Defined Networking (SDN)** https://www.coursera.org/learn/sdn
3.	**5G Mobile Networks – 3GPP Specifications** https://www.3gpp.org/release-16
4	**Cisco Digital Learning – Wireless Technologies** https://www.cisco.com/c/en/us/training-events/training-certifications.html
5.	**IEEE Xplore Digital Library – Latest research on 6G & NFV** https://ieeexplore.ieee.org/

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	-	-
CO2	2	2	3	2	-	-
CO3	1	2	2	2	-	-
CO4	2	2	3	1	-	-
CO5	2	2	3	1	-	-
CO	**2**	**2**	**3**	**1**	**-**	**-**

3-High, 2- Medium, 1-Low

CP26104	**ADVANCED OPERATING SYSTEMS**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**4**	**4, 7, 9, 12, 16**

COURSE OBJECTIVES:

- Provide an in-depth understanding of modern and advanced operating system architectures, components, and principles.
- Explore advanced concepts in process management, concurrency, synchronization, and deadlock handling.
- Examine modern memory management, virtual memory, file systems, storage design, and performance optimization.
- Understand virtualization technologies, OS security, protection mechanisms, I/O systems, and reliability.
- Introduce advanced distributed system concepts, cloud/edge OS trends, CDN-based OS models, and emerging OS paradigms.

COURSE CONTENT:

Unit 1	**ADVANCED PROCESS, THREADS AND SYNCHRONIZATION**	**9**	**0**	**0**	**9**	**18**		**4.9**

OS structures: monolithic, microkernel, modular, hybrid - Processes: lifecycle, control blocks, context switching - Threads: user-level, kernel-level, hybrid; multicore awareness - IPC: shared memory, message passing, pipes, sockets - Synchronization primitives: semaphores, mutexes, condition variables.

Activities: Implement producer-consumer or reader-writer problem using semaphores.								
Unit 2	**SCHEDULING, CONCURRENCY CONTROL & DEADLOCKS**	**9**	**0**	**0**	**9**	**18**		**9,12**
Scheduling algorithms: FCFS, SJF, RR, priority-based - Multiprocessor and multicore scheduling: load balancing, affinity - Real-time scheduling concepts - Concurrency control: monitors, barriers, lock-free data structures - Deadlocks: conditions, detection, avoidance, prevention, Distributed deadlock handling **Activities:** CPU scheduler simulation for multicore systems.								
Unit 3	**MEMORY MANAGEMENT, STORAGE & FILE SYSTEMS**	**9**	**0**	**0**	**9**	**18**		**9,12**
Memory abstraction, paging, segmentation, address translation - Virtual memory algorithms: FIFO, LRU, Clock, NFU, WSClock - File system design: allocation, directories, metadata, journaling, Log-structured file systems, crash recovery - Disk scheduling: SSTF, SCAN, C-SCAN **Activities:** Implement FIFO, LRU, CLOCK page replacement algorithms.								
Unit 4	**VIRTUALIZATION, SECURITY & I/O SYSTEMS**	**9**	**3**	**0**	**12**	**18**		**7,16**
Hypervisors: Type 1, Type 2; paravirtualization - OS-level virtualization: namespaces, cgroups, Docker architecture - I/O hardware: controllers, DMA, interrupts - OS security: access control, authentication, MAC, DAC - Threats: buffer overflow, malware, privilege escalation - Protection mechanisms: ASLR, stack canaries, sandboxing, secure boot **Activities:** Demonstrate buffer overflow and mitigation (ASLR) in a secure environment.								
Unit 5	**DISTRIBUTED SYSTEMS, CLOUD OS, EMERGING OS & CDN-ORIENTED ARCHITECTURES**	**9**	**3**	**0**	**12**	**18**		**9,7,16**
Distributed system architecture and transparency - CDN-enabled OS concepts: caching, replication, edge delivery - Emerging OS paradigms: Cloud/Serverless OS, Unikernels, lightweight OS, Mobile OS (Android, iOS) **Activities:** Analyze Android's system architecture using emulator tools.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1 :** Employ process management, thread management, synchronization, and IPC mechanisms in operating system applications. **CO2 :** Evaluate scheduling algorithms, concurrency control, and deadlock handling in contemporary systems. **CO3 :** Use advanced memory management, file system, and storage system concepts to solve operating system problems. **CO4 :** Analyze virtualization models, security mechanisms, OS protection, and I/O system								

	architecture.
CO5 :	Apply distributed OS principles and understand modern/emerging OS platforms such as CDN/Cloud/Android/iOS.
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Activities (30%) & Internal Examinations (70%)	
REFERENCES:	
1.	Andrew S. Tanenbaum and Herbert Bos, "Modern Operating Systems", Fifth Edition, Pearson Education, 2023.
2.	Thomas E. Anderson and Michael Dahlin, "Operating Systems: Principles and Practice", Second Edition, Recursive Books, 2021.
3.	Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, "Operating Systems: Three Easy Pieces", Arpaci-Dusseau Books, LLC, 2020.
4	Abraham Silberschatz, Peter B. Galvin and Greg Gagne, "Operating System Concepts", Tenth Edition, Wiley India, 2022.
5	Rajkumar Buyya, Mukaddim Pathan and Athena Vakali, "Content Delivery Networks", Springer, 2022.
E resources/E materials:	
1.	Prof. Smruti Ranjan Sarangi, Advanced Distributed Systems, IIT Delhi, NPTEL, https://onlinecourses.nptel.ac.in/noc22_cs80/preview
2.	Prof. Rajiv Misra, "Cloud Computing and Distributed Systems", IIT Patna, NPTEL, https://nptel.ac.in/courses/106104182

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	1
CO2	3	2	3	3	2	1
CO3	3	2	3	3	2	2
CO4	3	2	3	3	2	2
CO5	2	2	3	3	3	3
CO	3	2	3	3	2	2

3-High, 2- Medium, 1-Low

RM26C01	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	TW/SL	Total	C	SDG
		45	15	0	60	120	4	1,2,3, 7

COURSE OBJECTIVES:

- To understand modern research processes, ethics, and data-driven decision making.
- To familiarize students with research design, data collection, and analysis methods.
- To develop skills in technical writing, publication, and presentation.
- To create awareness on Intellectual Property Rights and patent systems.
- To introduce contemporary research tools and innovation protection mechanisms.

COURSE CONTENT:

Unit 1	RESEARCH DESIGN AND MODERN RESEARCH APPROACHES	9	3	0	12	24		1

Research ecosystem and lifecycle, types of research, problem identification, literature gap analysis, research questions and hypotheses, AI-assisted literature review tools, research design frameworks, qualitative and quantitative research, experimental and survey methods, research ethics and plagiarism awareness.

Activities: Literature gap identification, ethics discussion.

Unit 2	DATA COLLECTION, SOURCES AND PREPARATION	9	3	0	12	24		3

Primary and secondary data sources, digital and open datasets, measurement scales, questionnaire design, sampling techniques, sample size estimation, data preprocessing, cleaning, transformation, and basic data visualization.
Activities: Questionnaire design, data visualization exercise.

Unit 3	DATA ANALYSIS, INTERPRETATION AND SCIENTIFIC COMMUNICATION	9	3	0	12	24		2

Descriptive and inferential statistics, hypothesis testing, correlation and regression basics, introduction to multivariate analysis, use of analytical tools (Excel/SPSS/Python – overview), interpretation of results, technical report writing, journal and conference paper formats (IEEE/IET), presentation techniques.
Activities: Data analysis demo, paper formatting.

Unit 4	INTELLECTUAL PROPERTY RIGHTS AND INNOVATION ECOSYSTEM	9	3	0	12	24		7

Concept, meaning, and significance of Intellectual Property Rights (IPR); types of IPR including patents, copyrights, trademarks, industrial designs, and geographical indications; role of IPR in innovation, research, and economic development; overview of national IPR framework with reference to Indian Patent Office and international agreements under World Intellectual Property Organization; importance of IPR in academia, industry, and technology-driven entrepreneurship.
Activities: IPR case study.

Unit 5	**PATENTS AND TECHNOLOGY PROTECTION**	**9**	**3**	**0**	**12**	**24**		**2,7**

Patent concepts and objectives, patentability criteria, novelty and inventive step, patent specifications, prior art search, types of patent applications, patent filing process, examination and grant, licensing and technology valuation, career opportunities in patent and innovation management.
Activities: Patent search exercise.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Apply suitable research methodologies to formulate research problems.
CO2 : Design data collection instruments and choose appropriate sampling methods.
CO3 : Analyze and interpret research data using basic analytical tools.
CO4 : Apply appropriate IP strategies for safeguarding innovations and research outputs.
CO5 : Apply principles of IPR, patents, and ethical research practices in research and innovation activities.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%) & Internal Assessment Test (70%)

TEXT BOOKS:

1.	John W. Creswell, J. David Creswell, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches”, Fifth Edition, Sage Publications, 2023.
2.	Deborah E. Bouchoux, “Intellectual Property: Patents, Trademarks, Copyrights and Trade Secrets”, Fifth Edition, Cengage Learning, 2021.

REFERENCES:

1.	Pamela S. Schindler, “Business Research Methods”, Fourteenth Edition, McGraw Hill, 2025.
2.	Deborah E. Bouchoux, “Intellectual Property: Patents, Trademarks, Copyrights and Trade Secrets”, Fifth Edition, Cengage Learning, 2021.

3.	David Hitchcock, “Patent Searching Made Easy”, Second Edition, Routledge, 2020.
4.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald, “The Craft of Research”, Fifth Edition, University of Chicago Press, 2024.
5.	V.K. Ahuja, “Intellectual Property Rights: Law and Practice”, Third Edition, LexisNexis, 2022.
E resources/E materials:	
1.	WIPO IP Portal – Online learning modules on Intellectual Property Rights and patents.(https://www.wipo.int/academy)
2.	Google Scholar – Scholarly literature search and citation tracking platform. (https://scholar.google.com)
3.	Indian Patent Office (IPO) Website – Patent search, filing procedures, and legal guidelines. (https://ipindia.gov.in)

Mapping of Course Outcomes to Programme Outcomes

CO	**Programme Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	1
CO2	3	3	3	2	2	1
CO3	3	3	2	3	3	1
CO4	2	2	3	2	2	3
CO5	2	2	2	2	1	3
CO	**3**	**3**	**2**	**2**	**2**	**2**

3–High, 2– Medium, 1–Low

RM26C02	**RESEARCH TOOL LABORATORY**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		0	**0**	**60**	**0**	**60**	**2**	**4,9, 16,17**

COURSE OBJECTIVES:

- To provide hands-on training in modern research and project management tools.
- To develop skills in literature review, reference management, and plagiarism checking.
- To train students in research paper formatting, writing, and publication workflow.
- To introduce data analysis and visualization tools for research applications.
- To enable preparation of professional research reports and technical presentations.

LIST OF ACTIVITIES:

1. Research Planning and Project Management
1.1 Research lifecycle, milestones, and project planning
1.2 Gantt chart preparation using MS Project / Notion / OneNote

2. Literature Review and Reference Management
2.1 Advanced literature search using Google Scholar / Scopus
2.2 Reference management using Mendeley / Zotero

3. Research Problem Identification
3.1 Literature gap analysis, AI-assisted literature gap analysis
3.2 Research problem, objectives, and hypothesis formulation

4. Research Paper Formatting
4.1 IEEE / IET journal and conference templates
4.2 Professional writing using Overleaf , Grammarly

5. Publication Workflow
5.1 Journal selection using Elsevier Journal Finder
5.2 Peer review process and reviewer response simulation

6. Data Analysis – Basic Tools
6.1 Data entry, cleaning, and preprocessing
6.2 Descriptive statistics and graphical visualization

7. Data Analysis – Advanced Tools
7.1 Introduction to SPSS / MATLAB for research analysis
7.2 Interpretation of results and inference

8. Plagiarism Detection and Research Ethics
8.1 Plagiarism checking using Turnitin / Urkund
8.2 Ethical paraphrasing and citation practices

9. Referencing and Citation Standards
9.1 IEEE, APA referencing styles
9.2 Automated citation generation and consistency check

10. AI in Research and Automation 10.1 AI tools for research assistance, ChatGPT ,Perplexity AI -Automated summarization, idea generation 10.2 Ethical use of AI in research	
COURSE OUTCOMES:	
At the end of the course, the students will be able to: **CO1:** Plan and manage research activities using modern research tools. **CO2:** Conduct systematic literature review and manage references effectively. **CO3:** Analyze and interpret research data using suitable software tools. **CO4:** Prepare plagiarism-free research papers and technical reports. **CO5:** Present research findings professionally through reports and presentations.	
Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%	
Assessment Methodology: Evaluation of Student's work, Observation, Record, Activities etc. (75%), Model Practical Exam (25%)	
REFERENCES:	
1.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald, "The Craft of Research", Fifth Edition, University of Chicago Press, 2024.
2.	John W. Creswell, J. David Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", Fifth Edition, SAGE Publications, 2023.
3.	Mark N. K. Saunders, Philip Lewis, Adrian Thornhill , "Research Methods for Business Students" , Ninth Edition, Pearson Education, 2023.
4.	Herman Aguinis, "Research Methodology: Best Practices for Rigorous, Credible, and Impactful Research", SAGE Publications, 2025.
5.	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, 2025.
E resources/E materials:	
1.	Reference organization, citation generation, PDF management https://www.mendeley.com
2.	Collaborative LaTeX writing for research papers https://www.overleaf.com

3.	Plagiarism detection and originality reports https://www.turnitin.com

Mapping of Course Outcomes to Programme Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	1
CO2	2	3	2	3	3	1
CO3	3	3	2	3	3	1
CO4	2	2	3	2	2	3
CO5	2	2	2	2	2	2
CO	**2**	**2**	**2**	**3**	**3**	**2**

3–High, 2– Medium, 1–Low

CP26105	**ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY**	**L**	**T**	**P**	**TW /SL**	**Total**	**C**	**SDG**
		0	**0**	**60**	**0**	**60**	**2**	**4, 9**

COURSE OBJECTIVES:

- To implement skip lists and flow algorithms
- To develop interval trees, and binomial queues to solve computational tasks.
- To develop probabilistic, divide-and-conquer algorithms
- To implement dynamic programming and greedy algorithm strategies
- To implement polynomial, and approximation algorithm problems

PRACTICAL EXPERIMENTS:

1. Implementation of skip list with insert, delete and query operations
2. Implementation of Ford–Fulkerson method to find the maximum bipartite matching
3. Implementation of an interval tree
4. Implementation of a binomial queue that supports the operations: insert(key), find-min(), delete-min(), display the binomial tree
5. Implementation of hiring problem
6. Randomized quick sort implementation
7. Implementation of Strassen's algorithm for matrix multiplication
8. Longest common subsequence implementation
9. Implementation of optimal binary search trees
10. Implementation of Huffman coding
11. Implementation of polynomial multiplication using fast fourier transform

12. Implement a 2-approximation algorithm for the Traveling Salesperson Problem

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Design and implement skip lists and flow algorithms
CO2: Design and implement interval trees, and binomial queues to solve computational tasks.
CO3: Design and develop probabilistic, divide-and-conquer algorithms
CO4: Design and implement dynamic programming and greedy algorithm strategies
CO5: Design and implement polynomial, and approximation algorithm problems

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Model Practical (25%) & Evaluation of Student's Work, Observation, Record, etc. (75%)

Software requirements: JAVA/C++

REFERENCES:

1.	T.H. Cormen, C. E. Leiserson, R.L. Rivest and C. Stein, "Introduction to Algorithms", Fourth Edition, Prentice Hall of India, 2022.
2.	Goodrich, Michael T., Roberto Tamassia, Michael H. Goldwasser, & Subhasish Banerjee., "Data Structures and Algorithms in Java", Sixth Edition (Indian Adaptation), Wiley India Pvt. Ltd., 2022.
3.	Vijayalakshmi Pai, G. A, "A Textbook of Data Structures and Algorithms, Volume 3: Mastering Advanced Data Structures and Algorithm Design Strategies", John Wiley & Sons, 2023.
4.	Dan S. Myers, "Data Structures and Algorithms in Java: A Project-Based Approach", Cambridge University Press & Assessment, 2024.
5.	J. Erickson, "Algorithms", University of Illinois at Urbana–Champaign, 2019.

E resources/E materials:

1.	MIT OpenCourseWare – Introduction to Algorithms: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
2.	NPTEL – Programming, Data Structures and Algorithms using Python: https://nptel.ac.in/courses/106106145
3.	NPTEL –Data Structures and Algorithms http://digimat.in/nptel/courses/video/106102064/L11.html

4.	NPTEL : NOC:Data Structure and Algorithms using Java http://www.digimat.in/nptel/courses/video/106105225/L27.html
5.	freeCodeCamp.org: https://youtu.be/RBSGKlAvoiM

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	2	2
CO2	3	1	1	1	2	2
CO3	3	1	1	1	2	2
CO4	3	1	1	1	2	2
CO5	3	1	1	1	2	2
CO	**3**	**1**	**1**	**1**	**2**	**2**

3-High, 2- Medium, 1-Low

CP26106	TECHNICAL SEMINAR	L	T	P	TW/SL	Total	C	SDG
		0	0	30	0	30	1	4,8,9,13,17

COURSE OBJECTIVES:

- To work on a specific technical topic in Computer Science and Engineering in order to acquire the skills of oral presentation and to acquire technical writing abilities for seminars and conferences

Course Content:

The students will work for two hours per week. They will be asked to choose any topic of their choice related to Computer Science and Engineering for presentation. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Identify latest developments in the field of Computer Science and Engineering
CO2: Develop technical writing abilities for seminars, conferences and journal publications
CO3: Make use of modern tools to present the technical details

Weightage: Continuous Assessment: 100%, End Semester Examinations: 0%
Assessment Methodology: Technical paper preparation (50%), Presentation (50%)

Mapping of Course Outcomes to Programme Outcomes

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	-	3	1	-	-	3
CO3	-	-	1	-	-	3
CO	3	3	2	-	-	3

SEMESTER II

CP26201	CLOUD COMPUTING TECHNOLOGIES	L	T	P	TW/ SL	Total	C	SDG
		45	0	0	45	90	3	4,8,9,7,11,12,16,17

COURSE OBJECTIVES:

- To understand cloud fundamentals and cloud architecture used in industry.
- To learn virtualization, containerization, and orchestration technologies.
- To study cloud storage, compute, database, and security services.
- To introduce serverless computing and DevOps practices on cloud.
- To provide hands-on exposure to AWS/Azure/GCP used in cloud job roles.

COURSE CONTENT:

Unit 1	CLOUD FOUNDATIONS	9	0	0	9	18	3	9,12

Cloud Computing – Characteristics of Cloud – Cloud Service Models (IaaS, PaaS, SaaS) – Deployment Models: Public, Private, Hybrid – Cloud Architecture Components – Account Setup and Billing Basics – Overview of AWS, Azure, and GCP – Industrial Applications of Cloud.

Activities: Group Discussion: Advantages of distributed computing in real-time applications (banking, IoT).

Unit 2	VIRTUALIZATION & CONTAINER TECHNOLOGIES	9	0	0	9	18	3	7,9

Virtualization Concepts – Hypervisors (KVM, VMware, Hyper-V) – VM Creation and Management – Containers vs VMs – Docker Architecture, Images, Containers, Dockerfile – Kubernetes Concepts: Pods, Deployments, Services – Cloud-native container orchestration (EKS, AKS, GKE).

Activities: Hands-on Demo: Install VirtualBox / VMware and create a virtual machine.

Unit 3	**CLOUD STORAGE, COMPUTE & DATABASE SERVICES**	**9**	**0**	**0**	**9**	**18**	**3**	**4,9,11**

Cloud Storage: Object, File, Block – AWS S3, Azure Blob, Google Cloud Storage – Cloud Databases: RDS, Azure SQL, DynamoDB, Firestore – Compute Services: EC2, Azure VM, GCE – Load Balancing, Auto Scaling – Content Delivery Networks (CDN).

Activities: Hands-on: Create an account in AWS/Azure/GCP (free tier) and explore dashboard.

Unit 4	**CLOUD SECURITY & IAM**	**9**	**0**	**0**	**9**	**18**	**3**	**8,9,17**

Cloud Security Principles – Network Security: VPC Basics, Subnets, Security Groups, Firewalls – Encryption at Rest and in Transit – Key Management: AWS KMS, Azure Key Vault – Monitoring and Logging: CloudWatch, Azure Monitor – Backup and Disaster Recovery – Identity and Access Management (IAM) – IAM Components: Users, Roles, Policies – Multi-Factor Authentication (MFA) – Permission Management and Access Control.

Activities:

- Hands-on: Deploy a simple web application on AWS EC2 / Azure VM / GCP Compute Engine.
- Storage Activity**:** Upload files to S3 / Azure Blob / GCP Cloud Storage.
- IAM Task: Create and test user accounts with different permissions.

Unit 5	**DEVOPS ON CLOUD, SERVERLESS & MERGING TECHNOLOGIES**	**9**	**3**	**0**	**12**	**24**	**3**	**16,9**

DevOps Overview – CI/CD Pipelines (GitHub Actions, AWS CodePipeline) – Serverless Computing: AWS Lambda, Azure Functions – API Gateway Concepts – Introduction to Cloud AI/ML Services – Cloud IoT Basics – Edge and Fog Computing – Introduction to Quantum Cloud.

Activities: Case Study: Analyze a real cloud security breach and present mitigation.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Use cloud computing fundamentals, service models, and virtualization concepts to configure basic cloud environments.

CO2 :	Implement cloud architecture principles, distributed systems, and scalable infrastructure components in cloud solution design.
CO3 :	Deploy and manage cloud-based applications using core services of AWS/Azure/GCP.
CO4 :	Implement cloud security mechanisms such as IAM, encryption, and governance controls to secure cloud resources and applications.
CO5 :	Integrate DevOps automation, serverless computing, and emerging cloud technologies to build job-oriented cloud solutions.
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Activities (30%) & Internal Examinations (70%)	
REFERENCES:	
1.	Douglas E. Comer**,** "The Cloud Computing Book: The Future of Computing Explained", CRC Press, 2021.
2.	Sunilkumar S. Manvi & Gopal Shyam, "Cloud Computing: Concepts and Technologies", CRC Press, 2021.
3.	Thomas Erl, Ricardo Puttini & Zaigham Mahmood**,** "Cloud Computing: Concepts, Technology & Architecture", Pearson, 2022.
4.	Kief Morris**,** "Infrastructure as Code: Managing Servers in the Cloud", Second Edition, O'Reilly Media, 2023.
5.	Michael Wittig & Andreas Wittig**,** "Amazon Web Services in Action", Third Edition, Manning Publications, 2024.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	1	1
CO2	2	2	3	3	1	1
CO3	3	2	3	3	2	1
CO4	3	2	2	3	2	2
CO5	3	2	3	3	3	2
CO	**3**	**2**	**3**	**3**	**2**	**1**

3-High, 2- Medium, 1-Low

CP26202	MULTICORE ARCHITECTURE AND PROGRAMMING	L	T	P	TW/ SL	Total	C	SDG
		30	0	30	30	90	3	4,8,9

COURSE OBJECTIVES:

- To explain the architectural evolution from single-core to multicore processors.
- To provide knowledge on parallel programming models, paradigms, and synchronization mechanisms.
- To develop skills to design, implement, debug, and optimize multicore programs using OpenMP, MPI and Pthreads
- To analyze performance issues and apply techniques to improve speedup and efficiency.
- To provide hands-on experience through lab exercises that reinforces parallel algorithm design.

COURSE CONTENT:

Unit 1	OVERVIEW OF MULTICORE ARCHITECTURE	6	0	0	6	12		4,9

Single core to Multi-core architecture - Types of parallelism: Instruction, Data and Task-level parallelism - Basics of parallel computer architecture - Multicore processors, many-core processors, heterogeneous architecture - Memory models: UMA, NUMA, cache coherence - Flynn's taxonomy, Amdahl's Law.
Activities: Architecture Identification, Speedup Calculation Exercise

Unit 2	FUNDAMENTALS OF PARALLEL PROGRAMMING	6	0	0	6	12		4,8,9

Parallel programming challenges - Processes vs. Threads - Thread lifecycle, context switching - Concurrency issues: race conditions, deadlocks, livelocks - Synchronization concepts: Mutex, semaphore, condition variables - Barriers, atomic operations - Parallel programming patterns: Map, Reduce, Pipeline, Divide-and-Conquer.
Activities: State Transition Diagram, Role-play

Unit 3	SHARED MEMORY PROGRAMMING WITH OPENMP	6	0	10	6	22		4,8,9

OpenMP Execution Model – OpenMP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance Considerations.

Practical:
1. Write a simple Program to demonstrate an OpenMP Fork-Join Parallelism.
2. Create a program that computes a simple matrix-vector multiplication b=Ax, either in C/C++.
Use OpenMP directives to make it run in parallel.

3. Create a program that computes the sum of all the elements in an array A (C/C++) or a program that finds the largest number in an array A. Use OpenMP directives to make it run in parallel.

Activities: Case study: N - body solver, Pair programming

Unit 4	**DISTRIBUTED MEMORY PROGRAMMING WITH MPI**	**6**	**0**	**10**	**6**	**22**		**4,8,9**

MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and
Collective communication – MPI derived datatypes – Performance evaluation.

Practical:
1. Write a Program to demonstrate MPI-broadcast-and-collective-communication in C.
2. Write a Program to demonstrate MPI-scatter-gather-and-all gather in C.
3. Write a Program to demonstrate MPI-send-and-receive in C.

Activities: Case study: Tree Search , Pair programming

Unit 5	**THREAD PROGRAMMING USING PTHREADS**	**6**	**0**	**10**	**6**	**22**		**4,8,9**

Pthreads library overview - Thread creation, joining, attributes - Mutex locks, condition variables, thread-safe operations - Producer-consumer, readers-writers problems - Load balancing and thread affinity - Debugging multithreaded applications.

Practical:
1. Write a program to implement thread creation and synchronization.
2. Write a program to implement Producer-consumer problem using Pthreads
3. Write a program to implement dining philosophers / readers-writers using pthreads.

Activities: Case study: High-Performance Log Processing System Using Pthreads, Pair programming

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Implement multicore architectures, memory models, and parallelism types in parallel computing systems.
CO2 : Utilize programming patterns and techniques to address issues in parallel processors.
CO3 : Write shared memory programs using OpenMP
CO4 : Implement Distributed memory programs using MPI.
CO5 : Apply Thread programming concepts using Pthreads.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Activities (10%), Practical (10%), Internal Assessment Test (30%)

REFERENCES:	
1.	Hennessy, J. L., Patterson, D. A., & Kozyrakis, C, "Computer Architecture: A Quantitative Approach", Seventh Edition, Elsevier, 2025
2.	Peter S. Pacheco, "An Introduction to Parallel Programming", Second Edition, Morgan-Kauffman/Elsevier, 2021.
3.	Gerassimos Barl, "Multicore and GPU Programming: An Integrated Approach", Second Edition, Morgan Kaufmann, 2022.
4.	Thomas Rauber & Gudula Rünger, "Parallel Programming: for Multicore and Cluster Systems", Third Edition, Springer, 2023.
5.	Victor Eijkhout, "Parallel Programming in MPI and OpenMP - The Art of HPC", Vol.2, Second Edition, Lulu Press, 2022.
E resources/E materials:	
1.	MIT OpenCourseWare: *Multicore & Parallel Programming*, https://ocw.mit.edu
2.	NPTEL: Multi-Core Computer Architecture (IIT Guwahati) https://nptel.ac.in

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	-	2
CO2	2	1	1	2	-	2
CO3	2	2	2	3	-	2
CO4	2	2	2	3	-	2
CO5	2	2	2	3	-	2
CO	**2**	**2**	**2**	**3**	**-**	**2**

3-High, 2- Medium, 1-Low

CP26203	ARTIFICIAL INTELLIGENCE SYSTEMS AND APPLICATIONS	L	T	P	TW/SL	Total	C	SDG
		45	0	30	45	120	4	4,8,9, 11,12

COURSE OBJECTIVES

- To understand the fundamental concepts and mathematical foundations of artificial intelligence and deep learning.
- To design and train neural network architectures for classification and sequence learning tasks.
- To apply reinforcement learning techniques for decision-making problems.
- To develop NLP solutions using Transformer-based models and apply computer vision techniques.
- To gain knowledge of ethical principles and responsible AI practices for societal applications.

COURSE CONTENT:

Unit 1	MATHEMATICAL FOUNDATIONS FOR AI	9	0	6	9	24		4

Scalars, Vectors, Matrices and Tensors – Matrix multiplication – Norms – Eigendecomposition – SVD – Random variables – Probability distributions – Bayes' Rule – Entropy – Derivatives – Partial derivatives – Chain rule – Gradient Descent – Stochastic Gradient Descent – Learning rate – Supervised Learning – Unsupervised Learning – Overfitting and Underfitting – Model Evaluation.

Practical:

- Perform SVD on a real-world dataset and interpret the components.
- Implement Gradient Descent from scratch to minimize a cost function.

Activities:

- Apply Bayes' theorem to classify a real-world dataset and analyze the results.
- Compare supervised and unsupervised learning on the same dataset and report observations.

Unit 2	NEURAL NETWORKS AND DEEP LEARNING	9	0	6	9	24		4, 9

Biological vs artificial neuron – Perceptron – Multilayer Perceptron – Activation functions – Backpropagation – Convolution operation – Feature maps – Pooling layers – Fully connected layer – Batch normalization – Dropout – ResNet – Sequence modeling – Vanishing gradient problem – LSTM – GRU.

Practical:

- Build and train an MLP for a classification task; observe the effect of different activation functions.
- Implement and compare LSTM and GRU on a sequential dataset.

Activities:

- Build a CNN model for image classification and analyze the effect of pooling and dropout on accuracy.
- Visualize feature maps of a trained CNN and interpret what each layer learns.

Unit 3	**REINFORCEMENT LEARNING**	**9**	**0**	**6**	**9**	**24**		**9**

Agent, Environment, State, Action, Reward – Markov Decision Process – Temporal-Difference Learning – Q-Learning – SARSA – Exploration vs Exploitation – Deep Q-Network (DQN) – Policy Gradient – Applications of Reinforcement Learning.

Practical:

- Implement Q-Learning in a grid-world environment to find the optimal path.
- Implement SARSA on the same grid-world and compare convergence with Q-Learning.

Activities:

- Design an MDP for a simple autonomous agent problem and identify states, actions and rewards.
- Study and present a real-world application of Deep Reinforcement Learning such as AlphaGo or autonomous driving.

Unit 4	**DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING**	**9**	**0**	**6**	**9**	**24**		**4,12**

Word embeddings – Word2Vec – Contextual embeddings – Encoder-Decoder architecture – Attention mechanism – Self-attention – Multi-head attention – Positional encoding – Transformer encoder and decoder stacks – BERT – GPT – Fine-tuning for downstream tasks.

Practical:

- Train Word2Vec embeddings on a text corpus and visualize word similarities.
- Fine-tune a pretrained BERT model for a text classification or sentiment analysis task.

Activities:

- Compare RNN-based and Transformer-based models on a text classification problem and report performance differences.
- Explore the attention weights of a trained Transformer and interpret what the model attends to.

Unit 5	**AI APPLICATIONS AND RESPONSIBLE AI**	**9**	**0**	**6**	**9**	**24**		**11, 12**

Bias and Fairness – Transparency and Explainability – AI Safety – Responsible AI principles – Privacy and data ethics – AI Governance and regulations – Societal impact of AI – SDG alignment – Case studies on AI failures.

Practical:

- Build and evaluate a CNN-based image classification model on a standard dataset such as CIFAR-10.
- Apply a pretrained object detection model and evaluate its performance on a custom image set.

Activities:

- Analyze a real-world AI system for bias and fairness issues and suggest mitigation strategies.
- Design a responsible AI prototype aligned with a selected SDG and presents an impact assessment.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Apply mathematical tools and optimization techniques to formulate AI learning problems.
CO2 : Design and train MLP, CNN, RNN and LSTM architectures for standard AI tasks.
CO3 : Implement Q-Learning and policy-based reinforcement learning for decision-making problems.
CO4 : Build NLP and vision solutions using Transformer-based deep learning models.
CO5 : Apply responsible AI principles to evaluate AI systems for ethical, safety and societal implication.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%), Internal Examinations (70%)

REFERENCES:

1.	Stuart Russell & Peter Norvig**, "**Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson, 2020.
2.	Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, "Dive into Deep Learning", Cambridge University Press, 2023.
3.	David Foster**, "**Generative Deep Learning", Second Edition, O'Reilly, 2023.
4.	Lior Rokach, Oded Maimon and Erez Shmueli, "Machine Learning for Data Science Handbook: Data Mining and Knowledge Discovery", Springer, 2023.
5.	Virginia Dignum**, "**Responsible Artificial Intelligence", Springer, 2023.

E-Resources / E-Materials	
1.	**NPTEL – Artificial Intelligence** https://nptel.ac.in/courses/106105077
2.	**NPTEL – Deep Learning** https://nptel.ac.in/courses/106106184
3.	**NPTEL – Reinforcement Learning** https://nptel.ac.in/courses/106106143
4.	**MIT OpenCourseWare – Introduction to Deep Learning** https://ocw.mit.edu
5.	**Kaggle Learn – Machine Learning & Deep Learning (Practice-oriented)** https://www.kaggle.com/learn

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	1	1
CO2	2	1	2	2	1	1
CO3	2	1	2	2	1	1
CO4	2	2	2	2	1	1
CO5	2	2	2	1	2	2
CO	**2**	**1**	**2**	**2**	**1**	**1**

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVE I

CP26001	NATURAL LANGUAGE PROCESSING TECHNIQUES	L	T	P	TW/ SL	Total	C	SDG
		45	0	0	45	90	3	4,8,9, 16,17

COURSE OBJECTIVES:

- To understand basics of linguistics, probability and statistics
- To study statistical approaches to NLP and understand sequence labeling
- To outline different parsing techniques associated with NLP
- To explore semantics of words and semantic role labeling of sentences
- To understand discourse analysis, question answering and chatbot.

COURSE CONTENT:

UNIT 1	**FOUNDATIONS OF NATURAL LANGUAGE PROCESSING**	**9**	**0**	**0**	**9**	**18**		**4,8,9**

Components - Basics of Linguistics and Probability and Statistics -Words-Tokenization- Simple Unix Tools for Word Tokenization- Finite State Automata.

Activities:

1. Design and implement a Finite State Automaton (FSA) to recognize patterns such as email IDs, dates, and verb forms.

UNIT 2	**STATISTICAL NLP AND SEQUENCE LABELING**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 17**

N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models –Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging

Activities:

1. Compute TF-IDF values for a document set and analyze limitations of the Vector Space Model with respect to synonymy and polysemy.

UNIT 3	**CONTEXTUAL EMBEDDING**	**9**	**0**	**0**	**9**	**18**		**4,9**

Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing - Transition Based - Graph Based.

Activities:

1. Given a sentence, manually simulate Hidden Markov Model (HMM) computations for POS tagging (transition and emission probabilities).
2. Parse a sentence using CKY algorithm and construct its parse tree based on a given Context-Free Grammar.

UNIT 4	**COMPUTATIONAL SEMANTICS**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 16**

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank- FrameNet- Selectional Restrictions - Information Extraction - Template Filling.

Activities:

1. Perform Word Sense Disambiguation (WSD) on ambiguous words in a given paragraph using Lesk algorithm or context-based approach.

UNIT 5	**DISCOURSE ANALYSIS AND SPEECH PROCESSING**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 17**

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture.

Activities:
1. Design and implement a rule-based chatbot for a specific domain (e.g., college enquiry system) using dialogue flow and intent recognition.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Apply linguistic, probabilistic, and statistical concepts to analyze natural language data.
CO2 : Implement a Part-of-Speech Tagger using appropriate NLP techniques.
CO3 : Develop sequence labeling models for domain-specific applications.
CO4 : Implement semantic processing tasks and simple document indexing and searching system using the concepts of NLP.
CO5 : Implement a simple chatbot using dialogue system concepts.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Assignments (30%) & Internal Examinations (70%)

REFERENCES:

1.	Daniel Jurafsky & James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Third Edition (Draft), Stanford University, 2023.
2.	Jacob Eisenstein, "Natural Language Processing", MIT Press, 2023.
3.	Raymond S. T. Lee, "Natural Language Processing: A Textbook with Python Implementation", Springer Singapore, 2025.
4.	Hobson Lane & Maria Dyshel, "Natural Language Processing in Action", Second Edition, Manning Publications, 2025.
5.	Atefeh Farzindar,Diana Inkpen, "Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)", Third Edition, Springer, 2020.

E resources/E materials:

1.	Stanford CS224N – Natural Language Processing with Deep Learning (Video + Slides + Assignments) https://web.stanford.edu/class/cs224n/ Stanford University+2csdiy.wiki

2.	Hugging Face – Free NLP Course (Interactive Notebooks) https://huggingface.co/learn/llm-course/en/chapter1/1
3.	NLTK + SpaCy Official Documentation & Tutorial – https://spacy.io/api/doc

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	–	2	1	–
CO2	-	1	3	2	-	3
CO3	3	2	1	-	-	2
CO4	1	-	3	-	2	–
CO5	2	3	-	1	3	1
CO	**2**	**2**	**2**	**2**	**2**	**2**

3-High, 2- Medium, 1-Low

CP26002	**DATA VISUALIZATION TECHNIQUES**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**4,9, 11,16, 17**

COURSE OBJECTIVES:

- To develop skills to both design and critique visualizations.
- To introduce visual perception and core skills for visual analysis.
- To understand technological advancements of data visualization.
- To understand various data visualization techniques.
- To understand the methodologies used to visualize large data sets.

COURSE CONTENT:

Unit 1	**FUNDAMENTALS OF VISUALIZATION AND DATA PROCESSING**	**9**	**0**	**0**	**9**	**18**		**4,9,17**

Basics - Relationship between Visualization and Other Fields - The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets. Introduction to Modern Visualization Tools-Power BI and Tableau.

Activities: Cleaning and preprocessing datasets using Pandas/NumPy.
Creating basic visualizations using Matplotlib, Seaborn and Plotly**.**

Unit 2	**FOUNDATIONS FOR VISUALIZATION**	**9**		**0**	**9**	**18**		**4,9**

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson ‘s Affordance theory – A Model of Perceptual Processing. case study: Design a visual encoding scheme and dashboard layout using Tableau.

Activities: Design a visual encoding scheme for a dataset.
Evaluate dashboard designs using perceptual and Gestalt rules.

Unit 3	**VISUALIZATION TECHNIQUES**	**9**		**0**	**9**	**18**		**9,11**

Spatial Data - Geospatial Data- Time-Oriented Data- Multivariate Data– Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks. Case-study: Weather pattern visualization using Power BI.

Activities: Graph visualization of social network
Geospatial visualization using Kepler.gl or equivalent tool.

Unit 4	**INTERACTION CONCEPTS AND TECHNIQUES**	**9**		**0**	**9**	**18**		**9,16**

Text and Document Visualization - Interaction Concepts - Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control- Interactive Dashboarding, Case-study: Customer Review Text Visualization using Power BI.

Activities: Build an interactive dashboard in Power BI.
Implementing Interactive filtering & brushing

Unit 5	**RESEARCH DIRECTIONS IN VISUALIZATIONS**	**9**		**0**	**9**	**18**		**9,16, 17**

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation, Hardware and Applications. Case-study: Real-time anomaly detection visualization for cybersecurity using Tableau.

Activities: Analysis of misleading visualizations (media, business reports).
Research mini-survey: Visualization for deep learning or blockchain data.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Visualize the objects in different dimensions.
CO2: Identify appropriate data visualization techniques given particular requirements imposed by the data.
CO3: Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.

CO4: Implement visualization techniques in research and industry-level projects. **CO5:** Design, preprocess and manage data for visualization using modern tools and platforms.	
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Activities (50%), Internal Examinations (50%)	
REFERENCES:	
1.	Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques", Applications, Second Edition, CRC Press, 2021.
2.	Jack Dougherty and Ilya Ilyankou, "Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code", O'Reilly Media, 2021.
3.	Desireé Abbott, "Everyday Data Visualization", Manning Publications, 2024.
4.	Sumit Chopra, Navjot Kaur Basra, Simran & Debjit Mohapatra, "Fundamentals of Data Handling and Visualization", Bhumi Publishing, 2025.
5.	Wolfgang Aigner, Silvia Miksch, Heidrun Schumann & Christian Tominski, "Visualization of Time-Oriented Data", Second Edition, Springer, 2023.
E resources/E materials:	
1.	Tableau Learning: https://learning.tableau.com
2.	Microsoft Power BI Guided Learning
3.	Python Visualization tutorials (Matplotlib, Seaborn, Plotly, Bokeh)
4.	Kaggle Datasets for Visualization Projects
5.	Google Cloud Public Datasets for hands-on visualization

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	2
CO2	3	3	2	-	-	2
CO3	3	3	2	-	-	2

CO4	3	3	2	-	-	2
CO5	3	3	2	-	-	2
CO	**3**	**3**	**2**	**-**	**-**	**2**

3-High, 2- Medium, 1-Low

CP26003	**GREEN COMPUTING AND SUSTAINABILITY**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**7,9,11 ,12,13**

COURSE OBJECTIVES:

- To learn the fundamentals of Green Computing.
- To analyze energy-efficient hardware and software solutions
- To apply principles of sustainable software development
- To evaluate the strategies for green data centers and storage systems
- To examine policies, standards, and management practices.

COURSE CONTENT:

Unit 1	**FUNDAMENTALS OF GREEN COMPUTING**	**9**	**0**	**0**	**9**	**18**		**7,12,13**

Scope and Objectives of green computing - Environmental Impact of Computing -Need for Sustainable Computing -Power-Aware Resource Management -Concepts of Green IT -OECD Green IT Framework -Greening IT Practices -Benefits and Challenges of Green Computing - Quantifying IT Energy Efficiency

Activities:

1. Case Study Analysis: Analyze the environmental impact of a large IT company (e.g., data centers, carbon footprint) and present findings.
2. Energy Audit Activity: Measure and compare power consumption of computing devices in a lab or home environment.

Unit 2	**GREEN HARDWARE AND SOFTWARE**	**9**	**0**	**0**	**9**	**18**		**12,9,13**

Life Cycle of Hardware: Production, Usage, and End-of-Life Phases - Reuse, Recycling, and Disposal Techniques - Green Design and Manufacturing of Computers - Introduction to Green Software - Energy-Saving Software Techniques.

Activities:

1. E-Waste Management Survey: Conduct a survey on electronic waste disposal practices in your

locality and propose improvements.
2. Green Software Demo: Develop or demonstrate a simple program optimized for reduced CPU/memory usage and compare performance.

Unit 3	**SUSTAINABLE SOFTWARE DEVELOPMENT**	**9**	**0**	**0**	**9**	**18**		**9,12,13**

Sustainable Software Attributes - Metrics for Software Sustainability - Sustainable Software Development Methodology - Energy-Aware Software Engineering - Design and Analysis of Green Algorithms.

Activities:
1. Case study: Project's Carbon Footprint
2. Algorithm Comparison: Compare two algorithms (e.g., sorting/searching) based on execution time and energy efficiency.

Unit 4	**GREEN DATA CENTERS AND STORAGE**	**9**	**0**	**0**	**9**	**18**		**7,9,13**

Green Data Center Concepts - Infrastructure for Energy Efficiency - Server Power Management Techniques - Green Data Storage Systems - Practices for Improving Energy Efficiency in Data Storage - Optical Interconnects for Green Computers and Data Centers.
Activities:
1. Poster presentation: Energy issues in Data Centers
2. Case study: Energy-efficient cloud computing

Unit 5	**MANAGING GREEN IT AND SUSTAINABILITY POLICIES**	**9**	**0**	**0**	**9**	**18**		**12,13,11**

Strategizing Green IT Initiatives - Implementation of Green IT Practices - Green IT Laws, Standards, and Protocols - Regulatory Environment and Role of IT Manufacturers - Non-Regulatory Government Initiatives - Green Building Standards - Sustainability Reporting - Green Audits.
Activities:
1. Debate: Role of IT professional in Green Computing
2. Demo: Perform Energy audit in computer lab using software tools.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Apply the principles of green computing to evaluate the environmental impacts of Information Technology and propose sustainable computing practices.

CO2 : Implement hardware lifecycle management techniques to promote reuse, recycling, and energy-efficient system design.

CO3 : Apply sustainable software development practices, including the use of metrics, methodologies, and energy-aware programming.

CO4 : Analyze energy-efficient strategies in data centers and storage systems, including server power management and green infrastructure.

CO5 : Assess Green IT policies, standards, and regulatory frameworks, and propose suitable strategies for implementing sustainable IT initiatives.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Activities (30%), Internal Assessment Test (70%)	
REFERENCES:	
1.	Albert Sabban (Ed.), "Green Computing Technologies and Computing Industry in 2021", IntechOpen, 2021.
2.	Debashis De, Anwesha Mukherjee and Rajkumar Buyya (Eds.), "Green Mobile Cloud Computing", Springer, 2022.
3.	Shashank Awasthi, Goutam Sanyal, Carlos M. Travieso-Gonzalez, Pramod Kumar Srivastava, Dinesh Kumar Singh and Rama Kant (Eds.), "Sustainable Computing: Transforming Industry 4.0 to Society 5.0", Springer, 2023.
4.	Neha Sharma, Jai Prakash Verma, Sunil Gautam, Valentina Emilia Balas and Saravanan Krishnan, "Green Computing for Sustainable Smart Cities: A Data Analytics Applications Perspective", CRC Press, 2024.
5.	Niharika Singh, Thipendra P. Singh, Amar Ramdane-Cherif, Ravi Tomar and Richa Choudhary (Eds.), "Green Computing for Sustainable Development", CRC Press, 2025.
E resources/E materials:	
1.	https://www.thegreenwebfoundation.org/
2.	https://cloud.sustainability.watch/
3.	https://www.green-algorithms.org/resources/
4.	https://www.greenict.org.uk/
5.	https://www.greenit.net/resources.html

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	1	2
CO2	3	2	2	2	2	3
CO3	3	2	3	3	2	3

CO4	2	2	3	3	2	3
CO5	2	3	2	1	2	2
CO	**2**	**2**	**2**	**2**	**2**	**3**

3-High, 2- Medium, 1-Low

CP26004	**BIG DATA MINING AND ANALYTICS**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**15**	**0**	**60**	**120**	**4**	**3,4,8,9, 11,12,16**

COURSE OBJECTIVES:

- To understand the computational approaches to Modelling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyze and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

COURSE CONTENT:

Unit 1	**DATA MINING AND LARGE SCALE FILES**	**9**	**3**	**0**	**12**	**24**		**8,9,11, 12, 16**

Statistical modelling – Machine Learning – Computational approaches to modelling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

Activities: Build a logistic regression classifier to predict pass/fail from student marks.
Implement text summarization (extractive) for a news article using sentence ranking.

Unit 2	**SIMILAR ITEMS**	**9**	**3**	**0**	**12**	**24**		**4,9,11, 12,16**

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.

Activities: Implement k-Nearest Neighbor (k-NN) using a real dataset, Implement a text plagiarism checker using document shingling

Unit 3	**MINING DATA STREAMS**	**9**	**3**	**0**	**12**	**24**		**3,9,11,12, 13, 16**

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows. **Activities:** Implement an exponential decay model where recent events have higher weight than older events, Demonstrate the effect of filtering by comparing input stream vs filtered stream.								
Unit 4	**LINK ANALYSIS AND FREQUENT ITEMSETS**	**9**	**3**	**0**	**12**	**24**		**8,9,11, 12,16**
Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets. **Activities:** Implement a simple PageRank algorithm in Python/Java and compare convergence speed, Perform sparse matrix representation for a web graph and show improvement in memory usage.								
Unit 5	**CLUSTERING**	**9**	**3**	**0**	**12**	**24**		**4, 8, 9, 11,12,16**
Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems. **Activities:** Identify real-life clustering applications (banking, marketing, fraud detection) and present examples, Use any software (Python/Excel/Orange) to generate a dendrogram and interpret the cluster cut.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1:** Implement MapReduce techniques to solve Big Data problems. **CO2:** Utilize appropriate similarity measures to determine data similarities. **CO3:** Apply suitable methods to manage issues associated with streaming data. **CO4:** Employ link analysis and frequent itemset mining algorithms in Big Data applications. **CO5:** Construct Big Data solutions using appropriate clustering techniques.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Assignments (30%) & Internal Examinations (70%)								
REFERENCES:								
1.	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Third Edition, 2020.							
2.	Mohammed J. Zaki and Wagner Meira Jr., “Data Mining and Machine Learning: Fundamental Concepts and Algorithms”, Second Edition, Cambridge University Press, 2020.							

3.	Ian H. Witten, Eibe Frank and Mark A. Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Fourth Edition, Morgan Kaufmann Publications, 2023.
4.	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar, “Introduction to Data Mining”, Second Edition, Pearson Education, 2021.
5.	Charu C. Aggarwal, “Data Mining: The Textbook”, Second Edition, Springer, 2023.
E resources/E materials:	
1.	https://swayam.gov.in/nd2_arp19_ap60/preview 25 26
2.	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf
3.	https://examupdates.in/big-data-analytics/
4.	https://www.tutorialspoint.com/big_data_analytics/index.htm
5.	https://www.tutorialspoint.com/data_mining/index.htm

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	-	1	1
CO2	2	1	2	-	1	1
CO3	2	1	2	-	2	1
CO4	2	-	2	-	2	3
CO5	2	-	2	-	2	3
CO	2	1	2	-	2	2

3-High, 2- Medium, 1-Low

CP26005	HUMAN COMPUTER INTERACTION	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	4,8,9,10,11,16

COURSE OBJECTIVES:

- To understand the fundamental concepts of Human–Computer Interaction, including human capabilities, computer systems, and interaction paradigms.
- To understand interactive design principles, usability engineering, and prototyping methods in software development.
- To explore cognitive models, communication theories, and socio-organizational factors influencing system design.
- To analyze mobile ecosystems, application types, and mobile interface design elements.
- To design effective web interfaces using modern interaction techniques, tools, and case-based learning.

COURSE CONTENT:

Unit 1	FOUNDATIONS OF HCI	9	0	0	9	18		4

The Human: I/O channels – Reasoning and problem solving-Emotion; The computer: Devices – Physical controls, Sensors and Special Devices-Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Activities:

- Quiz: Compare human I/O channels with computer I/O devices,
- Flipped class room: Memory

Unit 2	DESIGN & SOFTWARE PROCESS	9	0	0	9	18		9,10

Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Activities:

- Flipped Classroom: Create a low-fidelity prototype (paper sketch) for a simple application screen using design principles.
- Assignment: Write a scenario and task flow for a user performing an activity (e.g., online ticket booking).

Unit 3	MODELS AND THEORIES	9	0	0	9	18		4,16

Cognitive models: Linguistic Models, Cognitive Architectures –Socio-Organizational issues and stake holder requirements –Communication and collaboration models: Conversation, Text based

Communication-Hypertext, Multimedia and WWW.

Activities:

- Assignment: Analyze communication models by comparing how conversation flows differ in WhatsApp, Gmail, and Telegram.

Unit 4	**MOBILE HCI**	**9**	**0**	**0**	**9**	**18**		**9,11**

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Activities:

- Quiz: Classify mobile apps into Widgets, Applications, and Games and present examples.
- Flow Diagram: Design a mobile information architecture for a food delivery or shopping app.

Unit 5	**WEB INTERFACE DESIGN**	**9**	**0**	**0**	**9**	**18**		**8,9**

Designing Web Interfaces: Introduction– Drag & Drop using Figma, Direct Selection using canva, Contextual Tools using Azure RP, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.

Activities:

- Flow Diagram: Create a process for a user journey (e.g., buy product → cart → checkout → confirmation).

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1 : Utilize the use of human cognitive processes in designing effective user interfaces.

CO2 : Construct user-centered interfaces using interaction models, design rules, and usability principles.

CO3 : Examine user behavior and system requirements using cognitive and communication models.

CO4 : Develop mobile interface designs using mobile platforms, architectures, and design elements.

CO5 : Implement modern interaction techniques to create and evaluate web interfaces through case studies.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%), Internal Examinations (70%)

REFERENCES:	
1.	K. Hornbaek and P. O. Kristensson, “Introduction to Human-Computer Interaction”, Oxford University Press, 2025.
2.	Yvonne Rogers, Helen Sharp, and Jennifer Preece, “Interaction Design: Beyond Human-Computer Interaction”, Sixth edition, Wiley, 2023.
3.	Christopher Reid Becker, “Learn Human-Computer Interaction”, Packt Publishing, 2020.
4.	Kasper Hornbaek, Per Ola Kristensson, Antti Oulasvirta, “Introduction to Human-Computer Interaction”, Oxford University Press, 2025.
5.	Gerard Jounghyun Kim, “Human-Computer Interaction: Fundamentals and Practice”, CRC Press, 2020.
E resources/E materials:	
1.	https://www.interaction-design.org/
2.	https://www.nngroup.com/articles/
3.	https://ocw.mit.edu/courses/6-831-user-interface-design-and-implementation-spring-2011/

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	2	-	-	-
CO4	3	3	2	-	-	-
CO5	2	3	1	-	-	-
CO	**3**	**3**	**2**	-	-	-

3-High, 2- Medium, 1-Low

OPEN ELECTIVE I

CP26901	GENERATIVE AI	L	T	P	TW/ SL	Total	C	SDG
		45	0	0	45	90	3	4,8,9, 12

COURSE OBJECTIVES:

- To apply the fundamental concepts of Generative AI to develop solutions for suitable applications.
- To build Generative AI systems for generating content across different domains.
- To deploy Generative AI models for solving real-world application problems.
- To compare and apply different Large Language Models based on specific application requirements.
- To apply prompt engineering techniques to generate effective and reliable outputs from Generative AI models.

COURSE CONTENT:

Unit 1	GENERATIVE AI CONCEPTS	9	0	0	9	18		4,8,9 12

Introduction to Generative Modeling– Deep Learning – Deep Neural Networks – Multi-Layer Perceptron – Convolutional Neural Network – Auto encoders - Variational Autoencoders

Activities:

1. Use a generative AI tool to create text or images and identify how AI generates the output.

Unit 2	GENERATIVE ADVERSARIAL NETWORKS	9	0	0	9	18		4,8,9 12

Deep Convolutional GAN (DCGAN) - Conditional GAN (CGAN) - Autoregressive Models - Long Short-Term Memory Network (LSTM).

Activities:

1. Use an online AI image-generation tool to create images with different prompts and compare the generated outputs.

Unit 3	FLOW MODELS	9	0	0	9	18		4,8,9 12

Normalizing Flows – RealNVP - Energy-Based Models - Denoising Diffusion Models (DDM).

Activities:

1. Generate images using a text-to-image AI tool and observe how changing the prompt affects the generated image.

Unit 4	LARGE LANGUAGE MODELS	9	0	0	9	18		4,8,9 12

Overview of LLMs - Transformers – GPT – Types of LLMs – Key concepts – other Transformers – T5 – Generative Pre-Trained Models– Multi-modal Models – DALL.E2

Activities:

1. Prepare a short comparison table and identify which LLM provides the better response and why.

Unit 5	**PROMPT ENGINEERING**	**9**	**0**	**0**	**9**	**18**		**4,8,9 12**

Basics – In-Context Learning – In-Context Prompting – Techniques – Image Prompting – Prompt Hijacking – Challenges.

Activities:

1. Create different prompts for the same task using zero-shot and few-shot prompting and compare the quality of the outputs.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Apply the basic concepts of Generative AI to develop solutions for suitable applications.
CO2: Build Generative AI systems to generate outputs for different domains.
CO3: Deploy Generative AI models for solving real-world application problems.
CO4: Compare and use different Large Language Models for appropriate application requirements.
CO5: Apply prompt engineering techniques and appropriate strategies to address prompting challenges and improve the quality and reliability of Generative AI outputs.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%), Internal Assessment Test (70%)

REFERENCES:

1.	David Foster, “Generative Deep Learning”, Second Edition, O'Reilly Media, 2023.
2.	Amit Bahree, “Generative AI in Action”, Manning Publication, 2023.
3.	Numa Dhamani and Maggie Engler, “Introduction to Generative AI”, Manning Publication, 2024.
4.	Valentina Alto, “Modern Generative AI with ChatGPT and OpenAI Models”, Packt publications, 2024.
5.	Carlos Rodriguez, “Generative AI Foundations in Python”, Packt Publishing, 2024.

E resources/E materials:

1.	Hugging Face – Large Language Models (LLM) Course https://huggingface.co/learn/llm-course
2.	DeepLearning.AI – Generative AI for Everyone https://www.deeplearning.ai/courses/generative-ai-for-everyone
3.	DeepLearning.AI – Generative AI with Large Language Models https://www.deeplearning.ai/courses/generative-ai-with-llms
4.	Google – Machine Learning Crash Course https://developers.google.com/machine-learning/crash-course

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**PO**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	1	2
CO2	3	2	3	2	2	2
CO3	3	2	3	3	3	2
CO4	2	2	3	3	3	2
CO5	3	2	3	3	3	3
CO	**3**	**2**	**3**	**3**	**2**	**2**

3–High, 2– Medium, 1–Low

CP26902	**CYBER SECURITY AND ETHICAL HACKING**	**L**	**T**	**P**	**TW/ SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**4, 8, 9,11, 16**

COURSE OBJECTIVES:

- To explain the fundamentals of number theory and cyber security.
- To understand cybercrimes and cyber offences.
- To analyze information risk assessment techniques.
- To describe the policies and practices of security management.
- To explore the fundamentals of ethical hacking.

COURSE CONTENT:

Unit 1	**NUMBER THEORY AND CYBER SECURITY**	**9**	**0**	**0**	**9**	**18**		**4, 9,16**

Number Theory Concepts: Divisibility – Modular Arithmetic – Prime Numbers – Test for Primality – Fermat's and Euler's Theorem – Chinese Remainder Theorem. Defining Cyberspace and Cyber security – Effective Cyber security – Security Governance and Security Management – Security Governance Principles and Desired Outcomes – Security Governance Components – Security Governance Approach.

Activities:
1. Solve practical problems on modular arithmetic and implement a simple encryption method (like Caesar cipher using mod operations).

Unit 2	**CYBER CRIMES AND CYBER OFFENCES**	**9**	**0**	**0**	**9**	**18**		**4, 9, 11,16**

Classification of Cyber Crimes – Planning and Execution of Cyber Attacks – Social Engineering Attacks: Phishing, Spear Phishing, and Email Spoofing – Cyber stalking and Cyber bullying – Cybercrime through Social Media Platforms – Botnets and Tools Used in Cyber Crime – Identity Theft and Online Fraud.

Activities:
1. Case study analysis of famous cybercrime incidents (like phishing or identity theft cases) and identifying attack methods.

Unit 3	**INFORMATION RISK ASSESSMENT**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 16**

Risk Assessment Concepts– Asset Identification and Classification – Threat Identification and Analysis – Vulnerability Identification – Control Identification and Security Controls – Risk Analysis and Evaluation – Qualitative and Quantitative Risk Assessment Approaches – Risk Mitigation and Management Strategies.

Activities:
1. Perform a mock risk assessment for a small organization (identify assets, threats, and vulnerabilities).

Unit 4	**CYBER SECURITY MANAGEMENT**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 16**

The Security Management Function – Security Policy – Technical Security Management: Security Architecture - Malware Protection Activities - Malware Protection Software - Intrusion Detection.

Activities:
1. Draft a basic security policy for a company or college (password policy, data protection rules).

Unit 5	**ETHICAL HACKING**	**9**	**0**	**0**	**9**	**18**		**4,8,9, 16**

Principles of Ethical Hacking – Foot printing – System Hacking: Introduction - Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools –

Password Cracking Countermeasures – Escalating Privileges

Activities:

1. Conduct a basic foot printing exercise using publicly available tools to gather information about a website (ethical and legal context emphasized).

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Apply the concepts of number theory in cyber security applications.
CO2: Analyze cybercrimes and cyber offences to identify security threats.
CO3: Apply risk assessment techniques to evaluate information security risks.
CO4: Implement security management policies and practices in organizational environments.
CO5: Apply ethical hacking and penetration testing techniques to identify system vulnerabilities.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Activities (30%), Internal Assessment Test (70%)

REFERENCES:

1.	Daniel G. Graham, "Ethical Hacking: A Hands-On Introduction to Breaking In", No Starch Press, 2021.
2.	Renee Dudley and Daniel Golden, "The Ransom ware Hunting Team: A Band of Misfits' Improbable Crusade to Save the World from Cybercrime", Farrar, Straus and Giroux, 2022.
3.	Ariel Evans, "Enterprise Cyber security in Digital Business", Apress, 2022.
4.	Scott J. Shapiro, "Fancy Bear Goes Phishing: The Dark History of the Information Age in Five Extraordinary Hacks", Farrar, Straus and Giroux, 2023.
5.	Jessica Barker, "Hacked: The Secrets Behind Cyber Attacks", Kogan Page, 2024.

E resources/E materials:

1.	https://www.cybrary.it/
2.	https://owasp.org/
3.	https://www.iso.org/standard/75281.html
4.	https://www.sans.org/white-papers/

5.	https://www.kali.org/docs/

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	1	1	2
CO2	2	2	2	1	2	2
CO3	3	2	2	2	2	3
CO4	2	3	2	2	2	2
CO5	3	2	3	3	2	3
CO	**2**	**2**	**3**	**2**	**2**	**2**

3–High, 2– Medium, 1–Low