KPR Institute of Engineering and Technology

Learn Beyond

(Autonomous | Affiliated to Anna University)

POSTGRADUATE PROGRAMMES

CURRICULUM AND SYLLABI

PROGRAMME

M.E. | Computer Science and Engineering

REGULATIONS

2026

CONTROLLED COPY

I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of industry, society, the nation and the world at large

Mission

- Commitment to offer value-based education and enhancement of practical skills
- Continuous assessment of teaching and learning processes through scholarly activities
- Enriching research and innovation activities in collaboration with industry and institutes of repute
- Ensuring the academic processes to uphold culture, ethics and social responsibilities

II. Vision and Mission of the Department

Vision

To be a premier centre for education, dissemination of knowledge and research in the frontier areas of computer science and engineering to serve the community with moral values

Mission

The mission of the department is to

- Provide holistic education incorporating the state-of-the-art technologies to produce successful professionals
- Facilitate the students to pursue higher education and research in the areas related to Computer Science and Engineering
- Promote strong collaborations with the industries and steer the students to nurture their interest in continuous learning to meet the changing needs of the society

III. Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the COMPUTER SCIENCE AND ENGINEERING (PCS) represent major accomplishments that the graduates are expected to achieve after two years of graduation.

PEO1: To enable graduates to pursue higher education, research, entrepreneurship, or successful professional careers by applying advanced knowledge and competencies in Computer Science and Engineering

PEO2: To equip students with advanced techniques, tools, and competencies to develop innovative and sustainable computing solutions by adapting to emerging technologies and addressing multidisciplinary, industrial, and societal challenges

PEO3: To empower students with leadership, professional ethics, effective communication, and lifelong learning skills to contribute responsibly in diverse and global environments

IV. Program Outcomes (POs)

Graduates of the COMPUTER SCIENCE AND ENGINEERING will be able to

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

PO2: An ability to write and present a substantial technical report, research paper, or design document

PO3: An ability to demonstrate a degree of mastery over the domains of Computer Science and Engineering

PO4: An ability to analyze complex computing problems and provide solutions using modern engineering tools and technologies

PO5: An ability to synthesize innovative computational models and intelligent solutions for multidisciplinary, open-ended, and complex engineering challenges

PO6: An ability to uphold professional and research ethics, incorporate sustainability considerations, engage in lifelong learning, and contribute to the development of socially and globally relevant computing solutions

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V. PEO / PO Mapping

Following three levels of correlation should be used:

1: Low

2: Medium

3: High

Particular	PO1	PO2	PO3	PO4	PO5	PO6
PEO 1	3	2	3	3	2	1
PEO 2	2	1	2	3	3	3
PEO 3	1	3	1	1	2	3

VI. Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Sem	Course Title	PO1	PO2	PO3	PO4	PO5	PO6
I	Applied Mathematical Methods	✓	✓	✓	-	-	-
	Advanced Data Structures and Algorithms	✓	-	✓	✓	✓	✓
	Agile Software Development and Usability Engineering	✓	✓	✓	✓	✓	✓
	Intelligent Computing Techniques	✓	-	✓	✓	✓	✓
	Research Methodology and IPR	✓	✓	-	-	-	✓
	Intelligent Computing Techniques Laboratory	✓	✓	✓	✓	✓	✓
II	Advanced Operating Systems	✓	-	✓	✓	✓	✓
	Cloud and Big Data Analytics	✓	-	✓	✓	✓	✓
	Multicore Architectures	✓	-	✓	✓	✓	-
	Cloud and Data Analytics Laboratory	✓	✓	✓	✓	✓	✓
	Technical Seminar	✓	✓	✓	✓	✓	✓

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COMPUTER SCIENCE AND ENGINEERING

Regulation 2026

For the students admitted from 2026 onwards

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I - IV SEMESTERS

KPR Institute of Engineering and Technology ★ Centre for Academic Courses ★ Coimbatore ★

SEMESTER I

No	Course Code	Title	Category	Type	L	T	P	J	C
1	P26MA101	Applied Mathematical Methods	FC	T	3	-	-	-	3
2	P26CS101	Advanced Data Structures and Algorithms	PCC	TwL	2	-	2	-	3
3	P26CS102	Agile Software Development and Usability Engineering	PCC	T	3	-	-	-	3
4	P26CS103	Intelligent Computing Techniques	PCC	T	3	-	-	-	3
5	P26RMC01	Research Methodology and IPR	RMC	T	3	-	-	-	3
6	P26CS104	Intelligent Computing Techniques Laboratory	PCC	L	-	-	4	-	2
7	-	Professional Elective - I	PEC	T	3	-	-	-	3
Total									**20**

SEMESTER II

No	Course Code	Title	Category	Type	L	T	P	J	C
1	P26CS201	Advanced Operating Systems	PCC	T	3	-	-	-	3
2	P26CS202	Cloud and Big Data Analytics	PCC	T	3	-	-	-	3
3	P26CS203	Multicore Architectures	PCC	TwL	2	-	2	-	3
4	P26CS204	Cloud and Data Analytics Laboratory	PCC	L	-	-	4	-	2
5	P26CS205	Technical Seminar	EEC	Technical Seminar	-	-	-	-	1
6	-	Professional Elective - II	PEC	T	3	-	-	-	3
7	-	Open Elective - I	OEC	T	3	-	-	-	3
Total									**18**

T - Theory, **L** - Laboratory, **TwL** - Theory with Laboratory, **TwP** - Theory with Project

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PROFESSIONAL ELECTIVES COURSES (PEC)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P26CSP01	Advanced Deep Learning and Neural Networks	PEC	3	0	0	3
2	P26CSP02	Quantum Cryptography	PEC	3	0	0	3
3	P26CSP03	AI in IoT	PEC	3	0	0	0
4	P26CSP08	Digital Image Processing and Computer Vision	PEC	3	0	0	3
5	P26CSP11	Cybersecurity Practices	PEC	3	0	0	3
6	P26CSP17	Large Language Models	PEC	3	0	0	3

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SEMESTER I

		Category: FC				
P26MA101	Applied Mathematical Methods (Common to PCS, PHDSH)	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To provide linear algebra foundations for data representation, dimensionality reduction, and optimization.
- To introduce statistical inference methods for model validation and uncertainty quantification.
- To develop number theory and algebraic structures for cryptographic applications.

COURSE OUTCOMES:

CO 1:	Apply linear algebra concepts (SVD, PCA) for data representation and dimensionality reduction	Apply
CO 2:	Apply matrix methods (Cholesky, gradient descent, regularization) for solving optimization problems	Apply
CO 3:	Apply statistical inference methods (MLE, bootstrap, Bayesian, FDR) for model evaluation	Apply
CO 4:	Apply number theory algorithms (modular arithmetic, CRT, Miller–Rabin) for RSA cryptography	Apply
CO 5:	Apply algebraic structures (groups, rings, fields) and elliptic curves for cryptographic systems	Apply

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	2	-	-	-
CO 2	3	3	2	-	-	-
CO 3	2	3	2	-	-	-
CO 4	2	2	1	-	-	-
CO 5	2	2	1	-	-	-

SYLLABUS:

UNIT I: ADVANCED LINEAR ALGEBRA 9

Vector spaces & linear transformations – QR factorization – Eigenvalues & eigenvectors – Singular Value Decomposition (SVD) – Principal Component Analysis (PCA) – Low-rank approximations

UNIT II: MATRIX METHODS FOR OPTIMIZATION 9

Positive definite matrices – Cholesky decomposition – Matrix norms & condition numbers – Gradient descent for linear systems – Least squares problems – Regularization (Ridge, Lasso)

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UNIT III: STATISTICAL METHODS FOR COMPUTING 9

Maximum likelihood estimation (MLE) with properties – Bootstrap for confidence intervals – Bayesian inference (prior/posterior) – False Discovery Rate (FDR) – Cross-validation for model selection

UNIT IV: NUMBER THEORY BASICS 9

Modular arithmetic & inverses – Fermat's & Euler's theorems – Chinese Remainder Theorem – Primitive roots – Primality testing (Miller–Rabin) – RSA cryptosystem

UNIT V: ADVANCED NUMBER THEORY 9

Discrete logarithm problem – Diffie-Hellman key exchange – Elliptic curves over finite fields – Elliptic Curve Cryptography (ECC) basics – Polynomial arithmetic over finite fields

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Gilbert Strang, "Introduction to Linear Algebra", 6th Edition, Wellesley-Cambridge Press, 2021
2. Larry Wasserman, "All of Statistics: A Concise Course in Statistical Inference", 1st Edition, Springer, 2010
3. Kenneth H. Rosen, "Elementary Number Theory and Its Applications", 6th Edition, Pearson, 2010
4. Jeffrey Hoffstein, Jill Pipher, and Joseph H. Silverman, "An Introduction to Mathematical Cryptography", 2nd Edition, Springer, 2014

REFERENCES:

1. David C. Lay, Steven R. Lay, and Judi J. McDonald, "Linear Algebra and Its Applications", 6th Edition, Pearson, 2021
2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009
3. Neal Koblitz, "A Course in Number Theory and Cryptography", 2nd Edition, Springer, 1994
4. Lawrence C. Washington, "Elliptic Curves: Number Theory and Cryptography", 2nd Edition, CRC Press, 2008

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Learn Beyond

SEMESTER I

		Category: PCC				
P26CS101	Advanced Data Structures and Algorithms (Common to DS, PCS, PHDIC)	L	T	P	J	C
		2	0	2	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To acquire knowledge in role of algorithms and tree structures
- To gain knowledge on the graphs and linear programming
- To understand the concept of NP completeness and approximation algorithms

COURSE OUTCOMES:

CO 1:	Determine the time complexity of algorithms using asymptotic notations and mathematical methods	**Apply**
CO 2:	Perform efficient insertion, deletion, and searching operations using binary search trees, red-black trees, B-trees, and Fibonacci heaps	**Apply**
CO 3:	Solve graph-based problems using graph traversal, minimum spanning tree, and single-source shortest path algorithms	**Apply**
CO 4:	Evaluate the performance of multithreaded algorithms and formulate solutions using linear programming techniques for complex computational problems	**Analyze**
CO 5:	Classify computational problems based on NP-completeness and formulate near-optimal solutions using approximation algorithms	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	3	-	3	2
CO 2	2	-	3	-	3	2
CO 3	2	-	3	1	3	2
CO 4	2	-	3	-	3	2
CO 5	2	-	3	1	3	2

SYLLABUS:

UNIT I: ROLE OF ALGORITHMS IN COMPUTING **6 + 6**

Algorithms – Algorithms as a Technology – Insertion Sort – Analyzing Algorithms – Designing Algorithms – Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions-Recurrences: The Substitution Method – The Recursion-Tree Method

UNIT II: HIERARCHICAL DATA STRUCTURES **6 + 6**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of Btrees – Basic operations on B-Trees – Deleting a key from a B-Tree – Fibonacci Heaps: structure – Mergeable-heap operations

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UNIT III: GRAPHS **6 + 6**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest Paths in Directed Acyclic Graphs – Dijkstra's Algorithm

UNIT IV: MULTITHREADED ALGORITHMS AND LINEAR PROGRAMMING **6 + 6**

Dynamic multithreading – Multithreaded matrix multiplication – Multithreaded merge sort – Linear Programming – Standard and slack forms – Formulating problems as linear programs – Simplex algorithm – Duality – Feasible solution

UNIT V: NP-COMPLETENESS AND APPROXIMATION ALGORITHMS **6 + 6**

Polynomial time – verification – NP-completeness and reducibility – NP-completeness proofs – NP complete problems – Approximation Algorithms – Vertex-cover problem – Traveling-salesman problem – Set-covering problem – Randomization and linear programming – Subset-sum problem

LIST OF EXPERIMENTS

1. A company has an unsorted list of employee records (ID, salary). Use Insertion Sort to arrange them in ascending order of salary and analyze how sorting time grows as the number of employees increases
2. Design a Binary Search Tree–based contact book that stores names/phone numbers, allowing fast insertion of new contacts, deletion of old ones, and quick lookup — and compare search time against a simple unsorted list
3. Simulate how a database index (e.g., for a banking application with continuous insertions of transaction records) stays balanced using a Red-Black Tree, so search/insert operations remain efficient even under heavy, frequent updates
4. Simulate how an operating system or DBMS indexes large files on disk using a B-Tree, where each node represents a disk block — demonstrating why B-Trees are preferred over BSTs for large-scale disk-based storage
5. Model a social network (or website links) as a graph and use BFS to suggest "friends of friends," and DFS to detect connected communities or crawl through the network, including topological sorting for task/course-prerequisite scheduling
6. Given a set of cities/villages and the cost of laying cables/wires between them, use Kruskal's and Prim's algorithms to design the minimum-cost network connecting all locations
7. Model a city's road network as a weighted graph and use Dijkstra's algorithm to find the shortest route between two locations (like Google Maps); use Bellman-Ford to handle a network with toll discounts/negative edge weights or detect fare-scam negative cycles
8. Use multithreaded matrix multiplication to speed up a real workload such as image transformation or scientific computation, and multithreaded merge sort to sort large-scale sensor/log data faster using multi-core processors
9. A factory wants to maximize profit given limited raw materials, labor hours, and machine time. Formulate this as a Linear Program (standard/slack form) and solve using the Simplex algorithm to find the optimal product mix
10. Use an approximation algorithm for the Vertex-Cover problem to place the minimum number of CCTV cameras/security guards covering all road junctions in a city
11. Use an approximation algorithm for the Traveling Salesman Problem to plan the shortest delivery route for a courier/ logistics company visiting multiple cities

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Lecture: 30 Periods **Tutorial:** - Periods **Practical:** 30 Periods **Project:** - Periods **Total:** 60 Periods

TEXTBOOKS:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 4th Edition, The MIT Press, 2022
2. Jon Kleinberg and Éva Tardos, Algorithm Design, 1st Edition, Pearson, 2005

REFERENCES:

1. Robert Sedgewick and Kevin Wayne, Algorithms, 4th Edition, Addison-Wesley Professional, 2011. The book covers algorithm analysis, searching, balanced search trees, graph algorithms, minimum spanning trees and shortest paths
2. Sanjoy Dasgupta, Christos H. Papadimitriou and Umesh Vazirani, Algorithms, 1st Edition, McGraw-Hill, 2006

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SEMESTER I

		Category: PCC				
P26CS102	Agile Software Development and Usability Engineering (Common to PCS, PHDIC)	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To understand the values, principles, and frameworks that underpin Agile software development
- To gain proficiency in Agile methodologies such as Scrum, Extreme Programming (XP), and Kanban for managing iterative software delivery
- To learn the principles of usability engineering and human-centered design for building user-friendly software systems
- To apply usability evaluation techniques and integrate UX practices within Agile development cycles

COURSE OUTCOMES:

CO 1:	Utilize the foundational principles of Agile software development to choose and adopt a suitable Agile methodology for a given project context	**Apply**
CO 2:	Use Scrum framework roles, artifacts, and events to plan, estimate, and manage iterative software projects	**Apply**
CO 3:	Build Extreme Programming and Agile engineering practices such as TDD, continuous integration, and refactoring into software projects to improve quality	**Apply**
CO 4:	Examine user requirements and design usable and accessible software interfaces through human-centered design principles	**Analyze**
CO 5:	Inspect software usability using appropriate evaluation techniques and classify user feedback for integration into Agile development cycles	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	2	2	1	2
CO 2	1	1	2	2	1	2
CO 3	2	1	3	3	1	2
CO 4	3	1	2	3	2	2
CO 5	3	1	2	3	2	2

SYLLABUS:

UNIT I: FOUNDATIONS OF AGILE SOFTWARE DEVELOPMENT 9

Software Development Life Cycle – traditional models versus Agile approaches; Agile Manifesto – values and twelve principles; Agile versus Waterfall; Lean Software Development principles; overview of Agile methodologies – Scrum, Extreme Programming, Kanban, Crystal, DSDM, and Feature-Driven Development; Agile project management – roles and responsibilities; selecting an appropriate Agile method for a project; myths and misconceptions in Agile adoption; challenges of Agile in distributed and global teams

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UNIT II: SCRUM AND AGILE PROJECT MANAGEMENT 9

Scrum framework – roles of Product Owner, Scrum Master, and Development Team; Scrum artifacts – Product Backlog, Sprint Backlog, and Increment; Scrum events – Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective; writing and prioritizing User Stories, story mapping; estimation techniques – Planning Poker and T-shirt sizing; tracking progress with velocity, burndown, and burnup charts; Kanban boards and Work-In-Progress limits; an overview of scaling Agile using SAFe, LeSS, and Nexus.

UNIT III: EXTREME PROGRAMMING AND AGILE ENGINEERING PRACTICES 9

Extreme Programming values and core practices – pair programming, Test-Driven Development, continuous integration, and refactoring; collective code ownership and coding standards; Continuous Delivery and DevOps integration with Agile pipelines; version control and branching strategies; automated testing frameworks; Agile quality assurance – Definition of Ready and Definition of Done; identifying and managing technical debt; Agile metrics and dashboards for tracking team and project progress

UNIT IV: USABILITY ENGINEERING AND HUMAN-CENTERED DESIGN 9

Introduction To Usability Engineering – Usability Goals and Attributes Such as Learnability, Efficiency, Memorability, Error Tolerance, And Satisfaction; The Human-Centered Design Process as Per ISO 9241-210; User Research Methods – Interviews, Surveys, Contextual Inquiry, And Personas; Information Architecture and Interaction Design Principles; Nielsen's Usability Heuristics; Prototyping Techniques – Low-Fidelity and High-Fidelity Prototypes; Accessibility and Inclusive Design Principles

UNIT V: USABILITY EVALUATION AND AGILE UX INTEGRATION 9

Usability Testing Methods – Think-Aloud Protocol, A/B Testing, Cognitive Walkthrough, And Heuristic Evaluation; Usability Metrics and Measurement Techniques; Integrating UX And Usability Practices Within Agile Sprints – The Agile UX Workflow and Lean UX; Continuous User Feedback and Iterative Design; Industry Case Studies of Agile-UX Integration; Tools Supporting Agile-UX Collaboration Such as Wireframing and Prototyping Tools; Emerging Trends – Design Thinking with Agile and Designops.

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Kenneth S. Rubin, "Essential Scrum: A Practical Guide to the Most Popular Agile Process", 1st Edition, Addison-Wesley Professional, 2012
2. Helen Sharp, Jennifer Preece and Yvonne Rogers, "Interaction Design: Beyond Human-Computer Interaction", 5th Edition, Wiley, 2019

REFERENCES:

1. Robert C. Martin, "Clean Agile: Back to Basics", 1st Edition, Pearson, 2019
2. Alan Cooper, Robert Reimann, David Cronin and Christopher Noessel, "About Face: The Essentials of Interaction Design", 4th Edition, Wiley, 2014

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3. Jeff Sutherland and J. J. Sutherland, "Scrum: The Art of Doing Twice the Work in Half the Time", 1st Edition, Crown Business, 2014

4. Jeff Gothelf and Josh Seiden, "Lean UX: Designing Great Products with Agile Teams", 2nd Edition, O'Reilly Media, 2016

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SEMESTER I

		Category: PCC				
P26CS103	Intelligent Computing Techniques (Common to PCS, PHDIC)	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the fundamental paradigms, principles, and evolution of intelligent computing techniques
- To develop an understanding of fuzzy logic and approximate reasoning for handling uncertainty in engineering decision-making
- To familiarize students with evolutionary and swarm intelligence techniques for solving complex non-linear and multi-objective optimization problems
- To provide knowledge of hybrid and ensemble intelligent learning models for engineering prediction and classification applications
- To familiarize students with emerging concepts in explainable, trustworthy, and decision-oriented intelligent computing for engineering applications

COURSE OUTCOMES:

CO 1:	Utilize appropriate intelligent computing paradigms to model and solve real-world engineering problems involving uncertainty, imprecision, constraints, and optimization	**Apply**
CO 2:	Demonstrate fuzzy logic and approximate reasoning techniques for handling uncertainty in engineering decision-making	**Apply**
CO 3:	Design evolutionary and swarm intelligence algorithms for solving non-linear and multi-objective optimization problems	**Apply**
CO 4:	Examine hybrid and ensemble intelligent learning models for engineering prediction and classification tasks	**Analyze**
CO 5:	Compare the performance, explainability, and trustworthiness of intelligent computing solutions using appropriate evaluation metrics	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	3	-	2	2
CO 2	3	-	3	1	3	2
CO 3	3	-	3	1	3	2
CO 4	3	-	3	-	3	2
CO 5	3	-	3	-	2	2

SYLLABUS:

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UNIT I: FOUNDATIONS OF INTELLIGENT COMPUTING 9

Introduction to Intelligent Computing – need, scope, and evolution from Artificial Intelligence to Computational Intelligence, Hard computing versus soft/intelligent computing paradigms, Characteristics of intelligent systems – adaptability, approximate reasoning, uncertainty handling, Overview of major paradigms – fuzzy systems, evolutionary computing, swarm intelligence, neural computing, Problem representation and search-based intelligent computing, Handling uncertainty, imprecision, and vagueness in real-world data, Multi-objective and constraint-based problem formulation, Intelligent computing life cycle – problem identification, modelling, optimization, validation, Role of intelligent computing in Industry 4.0/5.0 and cyber-physical systems, Case study: Intelligent computing for engineering design optimization

UNIT II: FUZZY INTELLIGENCE AND APPROXIMATE REASONING 9

Fuzzy sets and membership functions – types and properties, Fuzzy set operations, fuzzy relations, and composition, Fuzzification and defuzzification techniques, Fuzzy rule base and fuzzy inference systems – Mamdani and Sugeno models, Approximate reasoning and fuzzy logic-based decision-making, Fuzzy control systems – design considerations and stability, Adaptive Neuro-Fuzzy Inference System (ANFIS) – overview and architecture, Type-2 fuzzy systems for handling higher-order uncertainty, Applications of fuzzy systems in classification and control, Case study: Fuzzy logic-based decision support in engineering systems

UNIT III: EVOLUTIONARY AND SWARM INTELLIGENCE 9

Principles of evolutionary computation – encoding, fitness, selection, Genetic Algorithms – crossover, mutation, and convergence analysis, Genetic Programming and Differential Evolution, Particle Swarm Optimization – concepts and variants, Ant Colony Optimization – pheromone-based search strategies, Artificial Bee Colony and Firefly Algorithm, Multi-objective evolutionary optimization – overview of NSGA-II, Hybrid evolutionary-swarm approaches for engineering optimization, Convergence, diversity, and performance evaluation of metaheuristics, Case study: Evolutionary optimization in engineering design problems

UNIT IV: INTELLIGENT LEARNING MODELS 9

Overview of learning paradigms in computational intelligence, Neuro-fuzzy hybrid systems and their architectures, Evolutionary neural networks – weight and architecture optimization, Extreme Learning Machines – concepts and applications, Rough set theory for feature selection and decision-making, Hybrid intelligent systems – fuzzy-genetic and neuro-genetic models, Ensemble intelligent computing models, Feature selection and dimensionality reduction using computational intelligence, Performance metrics for intelligent learning models, Case study: Hybrid intelligent model for predictive maintenance

UNIT V: EMERGING INTELLIGENT COMPUTING APPLICATIONS 9

Explainable Intelligent Computing – need and techniques, Trustworthy and responsible intelligent computing systems, Intelligent computing for decision intelligence and business analytics, Applications in smart manufacturing and digital twins, Applications in healthcare diagnostics and bio-informatics, Applications in smart grid, energy, and environmental optimization, Applications in robotics and autonomous systems, Intelligent computing for cybersecurity and anomaly detection, Emerging trends – quantum-inspired computational intelligence, Case study: Industry deployment of intelligent computing solutions

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Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Andries P. Engelbrecht, "Computational Intelligence: An Introduction", 2nd Edition, Wiley, 2007
2. Mayuri Mehta, Vasile Palade and Indranath Chatterjee (Eds.), "Explainable AI: Foundations, Methodologies and Applications", 1st Edition, Springer, 2023
3. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 2nd Edition, Academic Press, 2021

REFERENCES:

1. James Kennedy, Russell C. Eberhart and Yuhui Shi, "Swarm Intelligence", 1st Edition, Morgan Kaufmann, 2001
2. Nazmul Siddique and Hojjat Adeli, "Computational Intelligence: Synergies of Fuzzy Logic, Neural Networks and Evolutionary Computing", 1st Edition, Wiley, 2013
3. James M. Keller, Derong Liu and David B. Fogel, "Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation", 1st Edition, Wiley-IEEE Press, 2016
4. S. Rajasekaran and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications", 2nd Edition, Prentice-Hall of India, 2003

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SEMESTER I

		Category: RMC				
P26RMC01	Research Methodology and IPR (Common to CAD, DS, ES, PCS, PHDCE, PHDIC, PHDME, PHDSH, SE, VL)	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To impart knowledge in problem formulation, analysis and solutions
- To impart skills required for technical paper writing / presentation without violating professional ethics
- To familiarize knowledge on patent drafting and filing patents

COURSE OUTCOMES:

CO 1: Apply the principles of research problem formulation to identify, define, and investigate engineering research problems using appropriate data collection and analysis techniques — **Apply**

CO 2: Analyze research literature, data collection methods, research ethics, and plagiarism issues to identify research gaps and select suitable methodologies — **Analyze**

CO 3: Evaluate the quality of technical reports, research papers, and research proposals by applying standard scientific writing and presentation practice — **Evaluate**

CO 4: Apply the principles and procedures of Intellectual Property Rights (IPR), including patents, patent filing, and international patenting systems, to protect technological innovation — **Apply**

CO 5: Evaluate patent rights, technology transfer mechanisms, patent databases, geographical indications, and emerging developments in Intellectual Property Rights for engineering and research applications — **Evaluate**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-
CO 2	3	-	-	-	-	-
CO 3	3	3	-	-	-	-
CO 4	-	3	-	-	-	2
CO 5	-	3	-	-	-	2

SYLLABUS:

UNIT I: RESEARCH PROBLEM FORMULATION 9

Meaning of research problem – Sources of research problem – Criteria characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem. Approaches of investigation of solutions for research problem – Data collection – Analysis – Interpretation – Necessary instrumentations

UNIT II: LITERATURE REVIEW AND DATA COLLECTION 9

Effective literature studies approaches – Analysis – Plagiarism and research ethics. Method of data collection – Types of data – Primary Data – Scales of measurement – Source and collection of data observation method – Secondary data

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UNIT III: TECHNICAL WRITING / PRESENTATION 9

Effective technical writing: How to write report – Paper – Developing a research proposal – Format of research proposal – Presentation and assessment by a review committee

UNIT IV: INTRODUCTION TO INTELLECTUALPROPERTY RIGHTS 9

Nature of Intellectual Property: Patents – Designs – Trade and Copyright. Process of Patenting and Development – technological research – Innovation – Patenting – Development – International Scenario – International cooperation on Intellectual Property – Procedure for grants of patents – Patenting under PCT

UNIT V: INTELLECTUAL PROPERTYRIGHTS 9

Patent Rights: Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications – New Developments in IPR – Administration of Patent System – IPR of Biological Systems – Computer Software etc.

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

REFERENCES:

1. Cooper, DR and Schindler, P S., "Business Research Methods", 9th edition, Tata McGraw Hill, 2014
2. Robert P.Merges, Peter S, Menell, Mark A.Lemley, "Intellectual Property in New Technological age", Volume I, Clause 8 Publishing,2022
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 3rd edition, Sage Publications,2010

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SEMESTER I

		Category: PCC				
P26CS104	Intelligent Computing Techniques Laboratory (Common to PCS, PHDIC)	L	T	P	J	C
		0	0	4	0	2

QP PATTERN: B

COURSE OBJECTIVES:

- To develop practical skills in implementing fuzzy logic and approximate reasoning techniques using Python
- To familiarize students with evolutionary and swarm intelligence algorithms for solving optimization problems
- To develop computational models using hybrid and neuro-fuzzy intelligent techniques for prediction and classification
- To provide hands-on experience in feature selection and intelligent model development using real-world datasets
- To familiarize students with explainable AI techniques for interpreting and evaluating intelligent computing models

COURSE OUTCOMES:

CO 1:	Implement fuzzy inference systems using Python to model uncertainty in engineering decision-making problems	**Apply**
CO 2:	Implement genetic algorithms and differential evolution for solving continuous and combinatorial optimization problems	**Apply**
CO 3:	Implement particle swarm, ant colony, and artificial bee colony algorithms for solving engineering optimization problems	**Apply**
CO 4:	Examine hybrid neuro-fuzzy and evolutionary intelligent models for prediction and classification tasks using real-world datasets	**Analyze**
CO 5:	Compare the performance and explainability of intelligent computing models using appropriate evaluation metrics and explainable AI techniques	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	1	3	2	3	2
CO 2	3	1	3	2	3	2
CO 3	3	1	3	2	3	2
CO 4	3	1	3	2	3	2
CO 5	3	1	3	2	3	2

SYLLABUS:

LIST OF EXPERIMENTS

1. Introduction to Python for Intelligent Computing – NumPy, Pandas, and Matplotlib for data handling and visualization
2. Implementation of fuzzy sets and membership functions using Scikit-Fuzzy
3. Design of a Mamdani-type fuzzy inference system for a decision-making problem
4. Design of a Sugeno-type fuzzy inference system and comparison with the Mamdani model
5. Implementation of a fuzzy logic-based controller (e.g., temperature/washing-machine control)
6. Implementation of a Genetic Algorithm for continuous function optimization

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7. Implementation of a Genetic Algorithm for a combinatorial optimization problem (e.g., Travelling Salesman Problem)
8. Implementation of Differential Evolution for continuous optimization problems
9. Implementation of Particle Swarm Optimization for benchmark function optimization
10. Implementation of Particle Swarm Optimization for an engineering design optimization problem
11. Implementation of Ant Colony Optimization for shortest-path/routing problems
12. Implementation of the Artificial Bee Colony algorithm for optimization problems
13. Implementation of an Adaptive Neuro-Fuzzy Inference System (ANFIS) for prediction
14. Implementation of an Extreme Learning Machine for classification tasks
15. Feature selection using computational intelligence techniques (GA-based/PSO-based feature selection)
16. Implementation of Explainable AI techniques (SHAP/LIME) on an intelligent computing model
17. Design of a hybrid intelligent computing model for an engineering application (fuzzy-genetic/neuro-genetic system)
18. Mini Project: Design and implementation of an intelligent computing solution for a real-world optimization/classification problem

CONTACT PERIODS:

Lecture: - Periods **Tutorial:** - Periods **Practical:** 30 Periods **Project:** - Periods **Total:** 30 Periods

REFERENCES:

1. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 2nd Edition, Academic Press, 2021
2. Mayuri Mehta, Vasile Palade and Indranath Chatterjee (Eds.), "Explainable AI: Foundations, Methodologies and Applications", 1st Edition, Springer, 2023
3. James M. Keller, Derong Liu and David B. Fogel, "Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation", 1st Edition, Wiley-IEEE Press, 2016

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SEMESTER II

		Category: PCC				
P26CS201	Advanced Operating Systems	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the architectures, models, and design principles of distributed operating systems
- To develop an understanding of synchronization, coordination, consistency, and fault-tolerance mechanisms in distributed environments
- To familiarize students with distributed memory management, file systems, storage, and transaction management
- To provide knowledge of cloud, edge, mobile, IoT, microservices, and serverless distributed computing environments
- To develop an understanding of emerging technologies and trends in distributed operating systems

COURSE OUTCOMES:

CO 1:	Identify suitable distributed system architectures and computing models for developing scalable and fault-tolerant applications	**Apply**
CO 2:	Implement distributed synchronization and coordination mechanisms using clocks, mutual exclusion, and consensus algorithms	**Apply**
CO 3:	Demonstrate consistency models and replacement strategies for managing distributed shared memory	**Apply**
CO 4:	Implement distributed file system concepts for efficient file sharing and storage management	**Apply**
CO 5:	Examine operating system functions across cloud, edge, and mobile distributed environments	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	3	-	2	2
CO 2	3	-	3	-	2	2
CO 3	3	-	3	-	2	2
CO 4	3	-	3	-	2	2
CO 5	3	-	3	2	1	2

SYLLABUS:

UNIT I: INTRODUCTION TO DISTRIBUTED SYSTEMS **9**

Distributed Systems – System Architecture and Design Principles – Computing Models and Communication Paradigms – Distributed Operating Systems and Middleware – Resource Sharing – Scalability, Elasticity, and Availability – Fault Tolerance – Cloud-Native Systems – Challenges and Trends

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UNIT II: DISTRIBUTED SYNCHRONIZATION AND COORDINATION 9

Physical and Logical Clocks – Lamport Logical Clocks – Vector Clocks – Event Ordering and Causality – Distributed Mutual Exclusion – Distributed Deadlocks – Deadlock Prevention, Avoidance, and Detection – Leader Election Algorithms – Distributed Consensus – Coordination Services

UNIT III: MEMORY MANAGEMENT AND CONSISTENCY MODELS 9

Shared Memory Architecture – Communication and Synchronization – Design Issues – Memory Consistency Models – Cache Coherence and Data Replication – Replacement Strategies – Performance Optimization – Distributed Transaction

UNIT IV: FILE SYSTEMS AND STORAGE MANAGEMENT 9

File System Architecture – File Models – File Accessing Models – File Sharing Semantics – File Caching and Consistency – File Replication – Data Partitioning and Sharding – Distributed Storage – Fault-Tolerant Storage – Atomic Transactions – Distributed Commit Protocols – Distributed Databases and NoSQL Systems

UNIT V: CLOUD, EDGE AND MOBILE DISTRIBUTED SYSTEMS 9

Cloud Computing Architecture – Service Models and Cloud OS – Virtualization and Containerization – Microservices and SOA – Edge and Fog Computing – Mobile and IoT Computing – Event-Driven and Serverless Architecture, Case Study: AWS Cloud, Kubernetes and Edge AI-Based Face Recognition

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Maarten van Steen and Andrew S. Tanenbaum, "Distributed Systems", 4th Edition, Maarten van Steen, 2023
2. Martin Kleppmann and Chris Riccomini, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems", 2nd Edition, O'Reilly Media, 2026
3. Andrew S. Tanenbaum and Herbert Bos, "Modern Operating Systems", 5th Edition, Pearson, 2023

REFERENCES:

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, "Distributed Systems: Concepts and Design", 5th Edition, Pearson, 2011
2. Brendan Burns, "Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services", 2nd Edition, O'Reilly Media, 2024
3. Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach", 2nd Edition, CRC Press, 2020

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SEMESTER II

		Category: PCC				
P26CS202	Cloud and Big Data Analytics	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the architecture, service models, deployment models, and economics of cloud computing
- To familiarize students with virtualization, containerization, cloud services, security, and governance mechanisms
- To develop an understanding of Big Data characteristics, distributed storage, and the Hadoop ecosystem
- To familiarize students with NoSQL data models and statistical and data mining techniques for large-scale data analysis
- To provide knowledge of Apache Spark, real-time analytics, and cloud-native Big Data platforms

COURSE OUTCOMES:

CO 1:	Utilize cloud computing architectures, service models, deployment models, and economic considerations to address computing requirements	**Apply**
CO 2:	Demonstrate virtualization, containerization, resource management, security, and disaster recovery techniques in cloud environments	**Apply**
CO 3:	Implement distributed storage and MapReduce techniques for large-scale data processing	**Apply**
CO 4:	Examine NoSQL data models and statistical and data mining techniques for large-scale data analysis	**Analyze**
CO 5:	Utilize Apache Spark and cloud-native Big Data services for real-time analytics	**Apply**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	2	-	1	2
CO 2	2	-	2	-	1	2
CO 3	2	-	2	1	1	2
CO 4	2	-	2	-	2	2
CO 5	2	-	2	1	1	2

SYLLABUS:

UNIT I: CLOUD COMPUTING FOUNDATIONS **9**

Introduction to Cloud Computing: evolution – characteristics – NIST model – Cloud reference architecture and building blocks – Service models: IaaS – PaaS – SaaS – and emerging XaaS models – Deployment models: public – private – hybrid – community cloud – Cloud economics: pricing models – TCO – SLAs – Major cloud providers overview: AWS – Microsoft Azure – Google Cloud Platform – Cloud computing challenges

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UNIT II: VIRTUALIZATION, CLOUD SERVICES AND SECURITY 9

Virtualization fundamentals: hypervisors (Type I & II) – KVM – Xen – VMware – Containers and OS-level virtualization: Docker – LXC – container orchestration with Kubernetes – Cloud storage and compute services: object – block – and file storage – auto-scaling – load balancing – Identity and Access Management (IAM) – multi-tenancy – Cloud security: data security and privacy – encryption – threat models – Cloud governance – compliance – and regulatory frameworks (GDPR – ISO 27017) – Disaster recovery and business continuity in the cloud

UNIT III: BIG DATA AND HADOOP ECOSYSTEM 9

Big Data: characteristics – sources and use cases – Big Data analytics architecture and lifecycle – Distributed file systems: Google File System – HDFS architecture and concepts – MapReduce programming model: mappers – reducers – combiners – partitioners – Hadoop ecosystem: YARN – Hive – Pig – HBase – Sqoop – Flume – Oozie – Algorithms using MapReduce: matrix-vector multiplication – word count – relational joins

UNIT IV: NOSQL, DATA ANALYSIS AND MINING TECHNIQUES 9

Introduction to NoSQL: aggregate data models – key-value and document stores – Column-family stores and graph databases – schema-less design – distribution models (sharding – replication) – Case studies: MongoDB – Cassandra – HBase – Statistical methods for data analysis: regression modelling – multivariate analysis – Classification techniques: decision trees – SVM and kernel methods

UNIT V: APACHE SPARK, REAL-TIME ANALYTICS AND CLOUD-NATIVE BIG DATA 9

Introduction to Apache Spark: architecture – Spark vs MapReduce – Spark Core – RDDs – Spark SQL and DataFrames – Machine learning with Spark MLlib – Spark Streaming basics – Stream data model – sampling and mining data streams – Real-Time Analytics Platforms (RTAP) – Cloud-native big data services: managed Hadoop/Spark (AWS EMR – Azure HDInsight/Databricks – Google Dataproc/BigQuery)

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, "Mastering Cloud Computing: Foundations and Applications Programming", 1st Edition, Morgan Kaufmann, 2013
2. Tom White, "Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale", 4th Edition, O'Reilly Media, 2015
3. Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", 2nd Edition, Wiley India, 2019

REFERENCES:

1. Thomas Erl, Ricardo Puttini and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Pearson Education, 2013
2. Bill Chambers and Matei Zaharia, "Spark: The Definitive Guide: Big Data Processing Made Simple", 1st Edition, O'Reilly Media, 2018
3. Jure Leskovec, Anand Rajaraman and Jeffrey D. Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press, 2020

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SEMESTER II

		Category: PCC				
P26CS203	Multicore Architectures	L	T	P	J	C
		2	0	2	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce multicore computing architectures, memory organization, cache coherence, and heterogeneous computing systems for parallel execution
- To develop practical skills in shared-memory and distributed-memory parallel programming using OpenMP and MPI
- To develop skills in measuring and analyzing the performance, scalability, and efficiency of parallel applications using profiling tools and comparative case studies
- To introduce GPU architecture and CUDA programming, including thread organization, memory management, synchronization, and error handling for parallel applications

COURSE OUTCOMES:

CO 1: Examine multicore computing architectures, memory organization, threading, and cache coherence to determine performance requirements in parallel computing systems — **Apply**

CO 2: Develop shared-memory parallel applications using OpenMP constructs, work-sharing directives, tasks, and parallel loops — **Apply**

CO 3: Use MPI message-passing constructs and performance-tuning techniques to solve distributed-memory computing problems — **Apply**

CO 4: Compare the performance and scalability of parallel applications using profiling tools and OpenMP and MPI implementations — **Apply**

CO 5: Inspect CUDA thread organization, memory management, and synchronization mechanisms to identify performance bottlenecks and resolve errors in GPU-based applications — **Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	2	-	-
CO 2	-	-	2	3	2	-
CO 3	1	-	2	3	2	-
CO 4	2	-	2	3	1	-
CO 5	2	-	2	3	2	-

SYLLABUS:

UNIT I: MULTICORE ARCHITECTURES — **6 + 6**

Evolution from Single-core to Multicore Systems - SIMD vs MIMD Architectures - Shared and Distributed Memory Systems - Homogeneous and Heterogeneous Multi-core Architectures – Cache Coherence Issues – Performance Issues - Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-scale computers Architectures- Physical Infrastructure and Costs – Case Study - Google Warehouse-Scale Computer

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UNIT II: PARALLEL PROGRAMMING USING OPENMP FOR SHARED MEMORY **6 + 6**

OpenMP architecture and memory model - Directives and work-sharing constructs - Parallelizing Loops and Task Management - Performance optimization

UNIT III: MESSAGE PASSING PROGRAMMING WITH MPI **6 + 6**

MPI programming concepts - Point-to-point and collective communication - Derived data types and synchronization - Performance tuning

UNIT IV: EVALUATING PARALLEL PERFORMANCE AND SCALABILITY **6 + 6**

Measuring and analyzing performance: Scalability metrics - Use of Profiling Tools for Performance Bottlenecks. Case Studies: Tree search, N-body simulation - Comparative Analysis of OpenMP and MPI Implementations

UNIT V: GPU PROGRAMMING USING CUDA **6 + 6**

CUDA Hardware Overview - Threads – Blocks – Grids – Warps – Scheduling; Memory handling with CUDA - Shared memory – Global memory – Constant memory and texture memory. Common Problems - CUDA error handling – Parallel programming issues – Synchronization – Algorithmic issues – Finding and avoiding Errors

LIST OF EXPERIMENTS

1. Write a C program using Pthreads to create, execute, synchronize, and terminate multiple threads
2. Develop a Rust program to spawn multiple threads and exchange data between threads using channels
3. Develop an OpenMP program to compute the Fibonacci series using task-based parallelism
4. Implement parallel matrix multiplication using OpenMP and evaluate its execution time for different matrix sizes and thread counts
5. Develop an MPI program to calculate the average of an array using collective communication operations such as MPI_Scatter and MPI_Reduce
6. Implement parallel iteration of a data collection in Rust using the Rayon crate and compare its execution time with sequential execution
7. Profile parallel applications implemented using OpenMP and MPI with tools such as perf or gprof, and evaluate their execution time, computational overhead, and performance characteristics
8. Develop a CUDA C program for square matrix multiplication using GPU threads and blocks, and employ shared memory to improve data reuse and memory access efficiency
10. Mini Project: Develop parallel merge sort or breadth-first search using both OpenMP and MPI. Compare the implementations in terms of execution time, speedup, scalability, parallel overhead, and theoretical time complexity for different input sizes

CONTACT PERIODS:

Lecture: 30 Periods **Tutorial:** - Periods **Practical:** 30 Periods **Project:** - Periods **Total:** 60 Periods

TEXTBOOKS:

1. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP, McGrawHill, 2004

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2. Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015

3. Nicholas Wilt, CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013

REFERENCES:

1. Victor Alessandrini, "Shared Memory Application Programming: Concepts and Strategies in Multicore Application Programming", Morgan Kaufmann, 2015

2. Gerassimos Barlas, "Multicore and GPU Programming: An Integrated Approach", 1st Edition, Morgan Kaufmann, 2014

3. Darryl Gove, "Multicore Application Programming: For Windows, Linux, and Oracle Solaris", 1st Edition, Addison-Wesley Professional, 2010

4. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, Dror Maydan and Jeff McDonald, "Parallel Programming in OpenMP", 1st Edition, Morgan Kaufmann, 2000

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SEMESTER II

		Category: PCC				
P26CS204	Cloud and Data Analytics Laboratory	L	T	P	J	C
		0	0	4	0	2

QP PATTERN: B

COURSE OBJECTIVES:

- To acquire hands-on knowledge of cloud platforms and big data tools for real-world analytics
- To implement and evaluate distributed data processing solutions using Hadoop and Spark
- To apply NoSQL databases and data mining techniques for large-scale data analysis

COURSE OUTCOMES:

CO 1:	Install and configure Hadoop cluster and execute HDFS and MapReduce jobs	**Apply**
CO 2:	Use Hive and NoSQL databases to store, query, and manage large datasets	**Apply**
CO 3:	Apply clustering and classification techniques on Big Data using Python/R	**Apply**
CO 4:	Develop Spark and PySpark programs for data transformation and analysis	**Apply**
CO 5:	Deploy and manage containerized cloud applications using Docker and Kubernetes	**Apply**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	1	2	-	2
CO 2	2	1	1	2	-	2
CO 3	2	1	1	2	1	2
CO 4	2	1	1	2	1	2
CO 5	2	1	1	2	1	2

SYLLABUS:

LIST OF EXPERIMENTS

1. Install and configure a single-node Hadoop cluster; execute basic HDFS commands (put, get, ls, mkdir, rm)
2. Write and execute a MapReduce program for Word Count on a large text dataset
3. Implement a MapReduce program for Matrix Multiplication
4. Install and configure Apache Hive; perform HiveQL queries (DDL, DML, aggregation, joins) on a sample dataset
5. Perform CRUD operations and aggregation queries using MongoDB on a sample document dataset
6. Implement K-Means and K-Modes Clustering on a cloud dataset using Python/R
7. Implement a Classification algorithm (Decision Tree / SVM) on a Big Data sample and evaluate performance
8. Build a Spark application using RDDs and DataFrames for data transformation and aggregation
9. Develop a PySpark program with Spark SQL to query and analyse a structured dataset
10. Deploy a containerized application using Docker and orchestrate it with Kubernetes on a cloud platform (AWS/Azure free tier)

CONTACT PERIODS:

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Lecture: - Periods **Tutorial:** - Periods **Practical:** 60 Periods **Project:** - Periods **Total:** 60 Periods

REFERENCES:

1. Tom White, "Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale", 4th Edition, O'Reilly Media, 2015
2. Jure Leskovec, Anand Rajaraman and Jeffrey D. Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press, 2020
3. Nigel Poulton, "Docker Deep Dive", 2023 Edition, Leanpub, 2023
4. Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", 2nd Edition, Wiley, 2019
5. Kristina Chodorow, "MongoDB: The Definitive Guide", 3rd Edition, O'Reilly Media, 2019

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Learn Beyond

SEMESTER II

		Category: EEC			
P26CS205	Technical Seminar	L	T	P	J	C
		2				1

QP PATTERN: B

COURSE OBJECTIVES:

- To enable students to explore and gain in-depth knowledge of an emerging or specialized area of Computer Science and Engineering through technical literature
- To develop technical report writing, research citation, oral presentation, and communication skills
- To develop the ability to critically discuss technical contributions, respond to questions, and defend technical viewpoints
- To promote research awareness, academic integrity, and independent learning in emerging computing technologies

COURSE OUTCOMES:

CO 1: Demonstrate technical knowledge and defend key concepts of a specialized or emerging area of Computer Science and Engineering through an oral seminar and technical discussion — **Apply**

CO 2: Produce a structured technical seminar report based on scholarly literature, appropriate referencing, and academic integrity — **Create**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	3	2	2	2
CO 2	3	3	2	2	2	3

GUIDELINES:

- Students shall work on a specialized technical topic in Computer Science and Engineering under the guidance of a faculty member. They shall review relevant research papers, books, and other scholarly sources to understand the state of the art in the selected area.
- Each student shall prepare and deliver a technical seminar, submit a structured seminar report with appropriate references, and participate in a question-and-answer session. The presentation shall demonstrate technical understanding, critical discussion, effective communication, and the ability to defend the concepts presented
- Evaluation shall be based on the quality of the literature review, technical content, report preparation, presentation, response to questions, and adherence to academic integrity.

SYLLABUS:

CONTACT PERIODS:

Lecture: - Periods **Tutorial:** - Periods **Practical:** 1 Periods **Project:** - Periods **Total:** 1 Periods

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PROFESSIONAL ELECTIVE COURSES

		Category: PEC				
P26CSP01	Advanced Deep Learning and Neural Networks	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce advanced neural network architectures, optimization techniques, and regularization methods used in deep learning
- To familiarize students with deep learning architectures for computer vision, sequence learning, and transfer learning
- To develop knowledge of transformer models, large language models, graph neural networks, and generative AI techniques
- To familiarize students with emerging approaches such as federated learning, edge AI, TinyML, and multimodal learning
- To provide an understanding of explainable, trustworthy, and reinforcement learning techniques for advanced intelligent applications

COURSE OUTCOMES:

CO 1:	Demonstrate the implementation of neural network architectures, optimization techniques, and regularization methods for deep learning tasks	**Apply**
CO 2:	Compare deep learning architectures for computer vision and sequence learning applications	**Analyze**
CO 3:	Implement transformer models and large language models for natural language processing and sequence learning applications	**Apply**
CO 4:	Compare graph-based, generative, and federated learning approaches for intelligent computing applications	**Analyze**
CO 5:	Examine explainable and trustworthy AI techniques and reinforcement learning approaches for intelligent applications	**Apply**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	3	-	3	2
CO 2	3	-	3	-	3	2
CO 3	3	-	3	-	3	2
CO 4	3	-	3	-	3	2
CO 5	3	-	3	-	3	2

SYLLABUS:

UNIT I: INTRODUCTION 9

Introduction to Artificial Intelligence, Machine Learning and Deep Learning – Artificial Neurons and Deep Neural Networks – Perceptron and Multilayer Perceptron – Feedforward and Backpropagation – Activation Functions – Loss Functions – Gradient Descent Optimization – Regularization Techniques – Introduction to Convolutional Neural Networks (CNN) – Basic CNN Architecture and Applications

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UNIT II: ADVANCED DEEP LEARNING ARCHITECTURES 9

Convolutional Neural Networks – LeNet – AlexNet – VGGNet – GoogLeNet – ResNet – DenseNet – – Vision Transformer (ViT) – Swin Transformer – Recurrent Neural Networks – Long Short-Term Memory (LSTM) – Gated Recurrent Unit (GRU) – Attention Mechanism – Transformer Architecture – Transfer Learning – Fine-Tuning

UNIT III: TRANSFORMERS AND LARGE LANGUAGE MODELS 9

Transformer Models – Bidirectional Encoder Representations from Transformers (BERT) – Generative Pre-trained Transformer (GPT) – Text-to-Text Transfer Transformer (T5) – Large Language Models (LLaMA) – Prompt Engineering – Fine-Tuning Large Language Models – Retrieval-Augmented Generation (RAG) – AI Agents – Model Context Protocol (MCP) – Applications of Large Language Models

UNIT IV: EMERGING DEEP LEARNING MODELS 9

Graph Neural Networks – Graph Convolutional Networks (GCN) – Graph Attention Networks (GAT) – Autoencoders – Variational Autoencoders (VAE) – Generative Adversarial Networks (GAN) – Diffusion Models – Self-Supervised Learning – Contrastive Learning – Federated Learning – Edge AI – TinyML – Multimodal Learning

UNIT V: EXPLAINABLE AI, REINFORCEMENT LEARNING AND APPLICATIONS 9

Explainable AI (XAI) – SHAP – LIME – Grad-CAM – Trustworthy AI – Fairness and Bias Mitigation – Adversarial Machine Learning – Reinforcement Learning Fundamentals – Markov Decision Process (MDP) – Q-Learning – Deep Q Network (DQN) – Policy Gradient – Proximal Policy Optimization (PPO) – Applications in Healthcare, Cybersecurity, Smart Agriculture, Intelligent Transportation Systems, and Autonomous Systems

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016
2. Simon J. D. Prince, "Understanding Deep Learning", 1st Edition, MIT Press, 2023
3. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, "Dive into Deep Learning", Cambridge University Press, 2023

REFERENCES:

1. François Chollet, "Deep Learning with Python", 2nd Edition, Manning Publications, 2021
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 3rd Edition, O'Reilly Media, 2022
3. Lewis Tunstall, Leandro von Werra and Thomas Wolf, "Natural Language Processing with Transformers: Building Language Applications with Hugging Face", O'Reilly Media, 2022

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PROFESSIONAL ELECTIVE COURSES

		Category: PEC				
P26CSP02	Quantum Cryptography	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the principles of quantum information, quantum states, and quantum computation for secure communication
- To develop an understanding of quantum algorithms and their implications for classical cryptographic systems
- To familiarize students with quantum random number generation and randomness certification techniques
- To provide knowledge of quantum key distribution protocols and their security considerations
- To familiarize students with post-quantum cryptography and emerging quantum-secure communication technologies

COURSE OUTCOMES:

CO 1:	Make use of quantum information and quantum computation principles for secure communication	**Apply**
CO 2:	Examine quantum algorithms and their implications for classical cryptographic systems	**Analyze**
CO 3:	Implement quantum random number generation techniques for cryptographic applications	**Apply**
CO 4:	Compare quantum key distribution protocols based on their security mechanisms and practical considerations	**Analyze**
CO 5:	Demonstrate post-quantum cryptographic techniques for securing communication against quantum-enabled attacks	**Apply**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	2	-	2	2
CO 2	2	-	2	-	3	2
CO 3	3	-	2	-	2	2
CO 4	3	-	2	-	3	2
CO 5	3	-	2	-	2	2

SYLLABUS:

UNIT I: FUNDAMENTALS OF QUANTUM INFORMATION 9

Introduction to Classical and Quantum Cryptography – Qubits and Quantum States – Dirac Notation – Quantum Operators – Quantum Measurements – Quantum Entanglement and Bell States – Quantum Teleportation – Superdense Coding – Quantum Gates (Pauli, Hadamard, Phase and CNOT Gates) – Quantum Circuits

UNIT II: QUANTUM ALGORITHMS AND CRYPTANALYTIC IMPLICATIONS 9

Introduction to Quantum Algorithms – Deutsch–Jozsa Algorithm – Simon's Algorithm – Grover's Search Algorithm – Shor's Factoring Algorithm – Impact of Quantum Computing on Symmetric Key Cryptography – Impact on Public Key Cryptography (RSA, Diffie–Hellman and Elliptic Curve Cryptography) – Quantum Complexity Overview

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UNIT III: QUANTUM TRUE RANDOM NUMBER GENERATORS 9

Randomness in Classical and Quantum Systems – Principles of Quantum True Random Number Generators – Design of Quantum Random Number Generators – Quantum Randomness Certification – Statistical Testing of Randomness – Commercial QTRNG Products – Applications of QTRNG in Cryptography and Secure Communications

UNIT IV: QUANTUM KEY DISTRIBUTION 9

Principles of Quantum Key Distribution – BB84 Protocol – B92 Protocol – E91 (Ekert) Protocol – Semi-Quantum Key Distribution – Device-Independent Quantum Key Distribution (Overview) – Security Analysis of QKD – Practical Challenges in QKD – Commercial QKD Implementations

UNIT V: POST-QUANTUM CRYPTOGRAPHY AND EMERGING QUANTUM SECURITY 9

Introduction to Post-Quantum Cryptography – Lattice-Based Cryptography – Code-Based Cryptography – Hash-Based Digital Signatures – NIST Post-Quantum Cryptography Standards: FIPS 203 (ML-KEM), FIPS 204 (ML-DSA) and FIPS 205 (SLH-DSA) – Quantum Secret Sharing – Secure Multiparty Computation – Future Trends in Quantum-Secure Communication

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2010
2. Gilles Van Assche, Quantum Cryptography and Secret-Key Distillation, Cambridge University Press, 2006

REFERENCES:

1. Mark M. Wilde, Quantum Information Theory, 2nd Edition, Cambridge University Press, 2017
2. Bhawana Rudra, Quantum Computing and Quantum Cryptography in Future Computers, IGI Global, 2024
3. National Institute of Standards and Technology (NIST), Post-Quantum Cryptography Standards: FIPS 203, FIPS 204 and FIPS 205, 2024

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PROFESSIONAL ELECTIVE COURSES

		Category: PEC				
P26CSP03	AI in IoT	L	T	P	J	C
		3	0	0	0	0

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce AIoT architectures, sensor networks, edge devices, and edge-to-cloud communication technologies
- To familiarize students with machine learning techniques for processing and analyzing IoT sensor data
- To develop knowledge of lightweight deep learning models and optimization techniques for resource-constrained edge devices
- To provide an understanding of TinyML and Federated Learning for distributed and privacy-aware AIoT applications
- To familiarize students with AIoT applications, security threats, and secure deployment practices across diverse domains

COURSE OUTCOMES:

CO 1:	Use AIoT system architectures, edge-to-cloud topologies, IoT hardware components, and communication protocols in AIoT applications	**Apply**
CO 2:	Compare machine learning classifiers and preprocessing techniques for IoT sensor data analysis and spatial anomaly detection	**Analyze**
CO 3:	Utilize lightweight deep learning models and optimization techniques for resource-constrained edge intelligence	**Apply**
CO 4:	Examine TinyML and federated learning approaches considering resource constraints, heterogeneous data distributions, connectivity limitations, and privacy requirements	**Analyze**
CO 5:	Formulate security solutions for AIoT systems using threat models, cryptographic techniques, secure boot, and secure firmware update mechanisms	**Create**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	1	-	-
CO 2	1	-	2	2	1	-
CO 3	1	-	2	2	2	-
CO 4	1	-	2	2	2	1
CO 5	-	-	1	3	2	2

SYLLABUS:

UNIT I: FOUNDATIONS OF AIOT AND SYSTEM ARCHITECTURES **9**

Introduction to the AIoT paradigm – System layers: sensing, computing, and application interfaces – Edge-to-Cloud topology – Physical IoT infrastructure: SoCs, microcontrollers – ESP32 – Raspberry Pi – sensor arrays – power envelopes – Serialization and low-power application protocols: MQTT – CoAP – LoRaWAN

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UNIT II: MACHINE LEARNING FOR IOT SENSOR DATA 9

Classical machine learning classifiers optimized for tabular data – SVM – Random Forests – Naive Bayes – Preprocessing time-series data – Data imputation – Windowing techniques – Fast Fourier Transforms – Unsupervised learning for spatial anomalies – K-Means – DBSCAN – Centralized vs. localized data splitting topologies

UNIT III: DEEP LEARNING AND EDGE INTELLIGENCE 9

Deep architectures for sequential IoT arrays – 1D-CNNs – LSTMs – Lightweight Transformers – Model optimization principles – Structural pruning – Weight clustering – Post-Training Quantization – Edge runtime frameworks – TensorFlow Lite – ONNX Runtime – OpenVINO – Hardware execution using Edge TPUs – Neural Processing Units

UNIT IV: TINYML AND DISTRIBUTED FEDERATED LEARNING 9

TinyML concepts – Engineering model inference under extreme ultra-low power and memory budgets – Distributed training paradigm – Federated Learning – Global orchestration via Federated Averaging – Dealing with Non-IID data distribution – Intermittent client connectivity – On-device privacy – Differential privacy constraints

UNIT V: INDUSTRY CASE STUDIES AND SECURITY 9

Domain implementations – Industry 4.0 – Predictive maintenance – Defect detection – Healthcare – IoMT wearables – Vital alerting systems – Smart Infrastructure – IoT attack surfaces and threat models – Security abstractions – Cryptography for constrained nodes – Hardware-based secure boots – Secure Firmware-Over-The-Air update loops

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Amita Kapoor and Hector Duran Lopez-Velarde, Hands-On Artificial Intelligence for IoT: Expert Machine Learning and Deep Learning Techniques for Developing Smarter IoT Systems, 2nd Edition, Packt Publishing, 2025
2. Pete Warden and Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, 1st Edition, O'Reilly Media, 2020

REFERENCES:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, 2022
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 1st Edition, Cisco Press, 2017

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PROFESSIONAL ELECTIVE COURSES

		Category: PEC				
P26CSP08	Digital Image Processing and Computer Vision (Common to PCS, PHDIC)	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the fundamental concepts and operations of digital image processing and computer vision
- To familiarize students with image enhancement, transformation, and restoration techniques for improving image quality
- To develop knowledge of image segmentation, morphological processing, feature extraction, and image classification techniques
- To provide an understanding of advanced image analysis methods for computer vision applications
- To familiarize students with deep learning models and tools for image classification, object detection, and semantic segmentation

COURSE OUTCOMES:

CO 1:	Make use of digital image representations and basic image operations for image processing tasks	**Apply**
CO 2:	Choose appropriate enhancement and restoration techniques for improving image quality	**Apply**
CO 3:	Implement segmentation, morphological, and feature extraction techniques for image analysis	**Apply**
CO 4:	Examine image representations, features, and classification techniques for computer vision applications	**Analyze**
CO 5:	Distinguish deep learning models for image classification, object detection, and semantic segmentation	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	2	-	-	1
CO 2	2	-	2	-	-	1
CO 3	2	-	2	1	1	1
CO 4	3	-	3	1	1	1
CO 5	3	-	3	1	1	1

SYLLABUS:

UNIT I: IMAGE PROCESSING FUNDAMENTALS 9

Introduction – Elements of visual perception, Steps in Image Processing Systems – Digital Imaging System – Image Acquisition – Sampling and Quantization – Pixel Relationships – File Formats – colour images and models – Image Operations – Arithmetic, logical, statistical and spatial operations

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UNIT II: IMAGE ENHANCEMENT AND RESTORATION 9

Image Transforms –Discrete and Fast Fourier Transform and Discrete Cosine Transform; Spatial Domain – Gray-level Transformations, Histogram Processing; Spatial Filtering – Smoothing and Sharpening. Frequency Domain: Filtering in the Frequency Domain – Smoothing and Sharpening filters – Homomorphic Filtering, Noise models, Constrained and Unconstrained restoration models

UNIT III: IMAGE SEGMENTATION AND MORPHOLOGY 9

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region-Based Segmentation – Motion Segmentation, Image Morphology: Binary and Gray-level morphology operations – Erosion, Dilation, Opening and Closing Operations, Distance Transforms –Basic Morphological Algorithms. Features – Textures – Boundary representations and Descriptions –Component Labeling – Regional descriptors and Feature Selection Techniques

UNIT IV: IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation – pixel based, edge based, region-based segmentation. Active contour models and Level sets for medical image segmentation, Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and statistical image classification

UNIT V: DEEP LEARNING FOR COMPUTER VISION 9

Introduction to deep learning and neural networks – Convolutional Neural Networks (CNNs) for image classification –Transfer learning and pre–trained models – Object detection using CNNs – Faster R-CNN, SSD Semantic segmentation using CNNs – FCN, U-Net – Familiarity with popular libraries such as OpenCV and PyTorch

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2018
2. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer, 2022
3. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson, 2012

REFERENCES:

1. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016
3. Adrian Kaehler and Gary Bradski, Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, 1st Edition, O'Reilly Media, 2017

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PROFESSIONAL ELECTIVE COURSES

		Category: PEC				
P26CSP11	Cybersecurity Practices	L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce advanced concepts, threats, vulnerabilities, and security principles for modern computing systems
- To familiarize students with network, cloud, infrastructure, and IoT security mechanisms
- To develop knowledge of secure software development, identity management, security operations, and incident response
- To provide knowledge of applied cryptography, digital forensics, and incident investigation techniques
- To familiarize students with privacy, risk management, security governance, and emerging cybersecurity technologies

COURSE OUTCOMES:

CO 1:	Utilize system security mechanisms to mitigate threats, address vulnerabilities, and enforce access control in computing systems	**Apply**
CO 2:	Implement network, cloud, and infrastructure security mechanisms to protect computing environments	**Apply**
CO 3:	Examine secure software development, identity management, security governance, and security operations practice	**Analyze**
CO 4:	Solve information security problems using cryptographic techniques and digital forensic procedures	**Apply**
CO 5:	Differentiate privacy principles, risk assessment methods, security auditing practices, and cybersecurity frameworks for organizational information security	**Analyze**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	-	-
CO 2	2	-	2	2	-	-
CO 3	3	-	3	3	2	2
CO 4	2	-	2	2	-	-
CO 5	-	-	-	-	2	2

SYLLABUS:

UNIT I: ADVANCED SYSTEM SECURITY **9**

Cyber Security Fundamentals – Threats, Vulnerabilities and Risk Management – System Security Principles – Operating System Security – Access Control Models – Authentication and Authorization – Malware and System Intrusion – Intrusion Detection and Prevention Systems – Secure System Design – Virtualization Security

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UNIT II: NETWORK, CLOUD AND INFRASTRUCTURE SECURITY 9

Network Security Architecture – Firewalls – Virtual Private Networks (VPN) – Wireless Network Security – Web Security – Email Security – Cloud Computing Security – Identity and Access Management – Internet of Things (IoT) Security – Security in Virtualized Environments

UNIT III: APPLICATION SECURITY AND SECURITY OPERATIONS 9

Secure Software Development Life Cycle (SSDLC) – Secure Coding Principles – Web Application Security – OWASP Top 10 Overview – Security Policies – Security Governance – Security Information and Event Management (SIEM) – Security Operations Centre (SOC) – Incident Response and Business Continuity Planning

UNIT IV: APPLIED CRYPTOGRAPHY AND DIGITAL FORENSICS 9

Symmetric Key Cryptography – Public Key Cryptography – Hash Functions – Digital Signatures – Public Key Infrastructure (PKI) – Key Management – Transport Layer Security (TLS) – Digital Forensics – Network Forensics – Incident Investigation and Evidence Collection

UNIT V: PRIVACY, GOVERNANCE AND EMERGING TRENDS 9

Privacy Principles – Privacy Enhancing Technologies – Risk Assessment – Risk Management – Security Auditing – ISO/IEC 27001 Information Security Management – NIST Cybersecurity Framework Overview – Cloud Security Best Practices – Artificial Intelligence in Cyber Security – Emerging Trends in Cyber Security

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. William Stallings and Lawrie Brown, Computer Security: Principles and Practice, 5th Edition, Pearson, 2024
2. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 7th Edition, Cengage Learning, 2022
3. Joseph Migga Kizza, Guide to Computer Network Security, 6th Edition, Springer, 2024

REFERENCES:

1. Charles Pfleeger, Shari Lawrence Pfleeger and Lizzie Coles-Kemp, Security in Computing, 6th Edition, Addison-Wesley Professional, 2023
2. Nina Godbole and Sunit Belapure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, 1st Edition, Wiley India, 2011
3. OWASP Foundation, OWASP Top 10: The Ten Most Critical Web Application Security Risks, OWASP Foundation, 2021

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Learn Beyond

PROFESSIONAL ELECTIVE COURSES

P26CSP17	Large Language Models	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

QP PATTERN: B

COURSE OBJECTIVES:

- To introduce the foundations of natural language processing and Transformer-based language models
- To develop knowledge of pretraining and fine-tuning techniques for adapting large language models
- To apply prompting and retrieval-augmented techniques for LLM-based applications
- To examine evaluation and alignment techniques for large language models
- To explore safety, bias, ethical considerations, and emerging applications of LLMs

COURSE OUTCOMES:

CO 1:	Use text preprocessing, word embeddings, sequence models, and language modelling techniques to process textual data	**Apply**
CO 2:	Examine transformer architecture, attention mechanisms, positional encoding, and encoder–decoder models used in large language models	**Analyze**
CO 3:	Develop pretraining and fine-tuning workflows using full fine-tuning and parameter-efficient techniques for adapting large language models	**Apply**
CO 4:	Examine prompting strategies, retrieval-augmented generation, and agentic workflows for developing LLM-based applications	**Analyze**
CO 5:	Assess large language models using evaluation metrics and benchmarks, considering alignment, bias, fairness, safety, and ethical and regulatory considerations.	**Evaluate**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	2	1	-	-
CO 2	-	-	3	2	1	-
CO 3	2	-	3	2	2	-
CO 4	2	-	2	2	2	-
CO 5	2	-	2	2	1	1

SYLLABUS:

UNIT I: FOUNDATIONS OF NLP AND LANGUAGE MODELLING **9**

Introduction to NLP – Text preprocessing and tokenization basics–Word embeddings (Word2Vec, GloVe, FastText– N-gram language models – sequence models – RNN, LSTM – Basics of attention mechanism. Evolution from statistical → neural → large language model – Overview of the LLM landscape

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UNIT II: TRANSFORMER ARCHITECTURE **9**

Limitations of RNNs –Self-attention and scaled dot-product attention – Multi-head attention – Positional encoding – Encoder–decoder architecture – Transformer model – Encoder-only models–Decoder-only models (GPT) – Encoder–decoder models (T5, BART) – tokenization schemes – BPE, WordPiece, SentencePiece

UNIT III: PRETRAINING AND FINE-TUNING OF LLMS **9**

Pretraining objectives – Masked Language Modeling – Causal Language Modeling–Span Corruption Transfer learning for NLP–Full fine-tuning vs. parameter-efficient fine-tuning (PEFT) – LoRA, adapters, prefix tuning, prompt tuning, instruction tuning

UNIT IV: PROMPTING, IN-CONTEXT LEARNING, AND RETRIEVAL-AUGMENTED GENERATION **9**

Prompt engineering principles– zero-shot, few-shot, and chain-of-thought prompting –In-context learning behavior of LLMs–Retrieval-augmented generation (RAG) architecture–Embeddings and vector databases–semantic search. Introduction to LLM-based agents and agentic workflows

UNIT V: EVALUATION, ALIGNMENT, SAFETY, AND APPLICATIONS **9**

Evaluation metrics – perplexity, BLEU, ROUGE, BERTScore, human evaluation; benchmark suites – GLUE, SuperGLUE–Bias and fairness in LLM –Alignment techniques – RLHF – Direct Preference Optimization (DPO) – safety, red-teaming, and ethical/ regulatory considerations

CONTACT PERIODS:

Lecture: 45 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 45 Periods

TEXTBOOKS:

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing, 3rd Edition (draft), Stanford University, 2026
2. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, Natural Language Processing with Transformers: Building Language Applications with Hugging Face, Revised Edition, O'Reilly Media, 2022

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
2. Denis Rothman, Transformers for Natural Language Processing: Build, Train, and Fine-Tune Deep Neural Network Architectures for NLP with Python, Hugging Face, and OpenAI's GPT-3, ChatGPT, and GPT-4, 2nd Edition, Packt Publishing, 2022
3. Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin, "Attention Is All You Need," Advances in Neural Information Processing Systems (NeurIPS), 2017

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