PSGR Krishnammal College for Women

MASTER OF SCIENCE IN COMPUTER SCIENCE

PROGRAMME CODE: MCS

CHOICE BASED CREDIT SYSTEM (CBCS) &
LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF)

SCHEME OF EXAMINATION & SYLLABUS

(w.e.f. 2026-27 onwards)

REGULATIONS 2026

POSTGRADUATE PROGRAMMES

(a) Qualification Descriptors

Aligned with NHEQF Level 9 (Master's Degree Level).

A Master's Degree signifies that a learner has acquired:

- Advanced theoretical and practical knowledge in a specialized discipline
- Ability to conduct independent research and contribute to knowledge
- Competence to solve complex professional or societal problems
- Skills to communicate research findings effectively
- Capacity for autonomous decision making and leadership
- Preparation for doctoral research, policy roles, entrepreneurship or advanced careers

(b) PG Graduate Attributes (Gas)

GA Code	Graduate Attribute (PG Level Meaning)
GA1	Advanced Disciplinary Expertise
GA2	Scholarly & Professional Communication
GA3	Critical & Evaluative Thinking
GA4	Complex Problem Solving
GA5	Advanced Analytical & Quantitative Reasoning
GA6	Independent Research & Innovation
GA7	Professional Collaboration
GA8	Evidence-Based Scientific Reasoning
GA9	Reflective & Meta-Cognitive Ability
GA10	Advanced Digital & Data Competence
GA11	Self-determined Learning
GA12	Global & Multicultural Perspective
GA13	Research Ethics & Professional Integrity
GA14	Academic & Professional Leadership
GA15	Lifelong Learning & Scholarly Growth

(c) GAs – Written Measured

These attributes can be directly assessed through advanced written examinations, analytical assignments, and research documentation.

GA	Attribute	Measure	Assessment Method
GA1	Advanced Disciplinary Expertise	Strongly	Advanced theory examinations, domain-specific problem solving
GA3	Critical & Evaluative Thinking	Strongly	Critical essays, analytical case evaluations
GA4	Complex Problem Solving	Strongly	Multi-layered case studies, applied domain challenges
GA5	Advanced Analytical & Quantitative Reasoning	Strongly	Statistical analysis, modelling, advanced data interpretation
GA6	Independent Research & Innovation	Strongly	Dissertation, research publications, project reports
GA8	Evidence-Based Scientific Reasoning	Strongly	Research justification, hypothesis testing, empirical argumentation
GA9	Reflective & Meta-Cognitive Ability	Partially	Research reflection reports, learning journals
GA10	Advanced Digital & Data Competence	Partially	Data analytics assignments, software-based problem tasks

(d) GAs – Performance based

These require demonstration through professional engagement, leadership roles, applied practice, and real-world interaction.

GA	Attribute	Measure	How Measured
GA2	Scholarly & Professional Communication	Strongly	Research presentations, conference papers, viva voce
GA7	Professional Collaboration	Strongly	Team research projects, interdisciplinary assignments
GA11	Self-determined Learning	Limited	Independent coursework, self-designed research components
GA12	Global & Multicultural Perspective	Partially	International seminars, cross-cultural academic discussions
GA13	Research Ethics & Professional Integrity	Strongly	Ethics-based case analysis, plagiarism checks, research compliance documentation
GA14	Academic & Professional Leadership	Limited	Project leadership, event coordination, mentoring roles
GA15	Lifelong Learning & Scholarly Growth	Limited	Online courses completion, publication engagement, academic memberships

Department of Computer Science (PG)

Vision

To provide high-quality postgraduate education in Computer Science by fostering advanced knowledge, research, innovation, and ethical computing practices, and by developing competent professionals who contribute to technological advancement and societal development.

Mission

- To provide advanced and quality education in Computer Science through innovative and learner-centric teaching methods.
- To promote research, innovation, and development in emerging areas such as Artificial Intelligence, Data Science, Cloud Computing, and advanced computing technologies.
- To develop analytical thinking, problem-solving ability, and technical expertise among postgraduate students.
- To encourage industry collaboration, interdisciplinary learning, and project-based learning for professional growth.
- To nurture ethical values, leadership qualities, and lifelong learning so that graduates contribute effectively to society and the global IT industry.

Master of Science in Computer Science

Programme Objectives, Outcomes and Mapping

Programme Educational Objectives (PEOs)

(Expected career and professional achievements of graduates within three to five years of completing the programme)

PEO1: Build successful careers in computing using advanced knowledge, problem-solving skills, and emerging technologies while adapting to technological changes.

PEO2: Pursue higher studies and research, contributing to innovation in Computer Science and interdisciplinary fields.

PEO3: Demonstrate professional ethics, social responsibility, and respect for diversity and sustainability.

PEO4: Exhibit leadership and entrepreneurial skills to develop innovative, technology-driven solutions for real-world problems.

PEO5: Engage in lifelong learning to enhance competence and support sustainable and socially responsible development.

Programme Learning Outcomes (PLOs)

(Specific abilities, knowledge, and skills that graduates are expected to demonstrate upon Graduation)

PLO1: Apply advanced concepts of algorithms, data structures, artificial intelligence, and distributed systems to solve complex computing problems.

PLO2: Analyze computational problems using appropriate mathematical models, statistical techniques, and algorithmic paradigms.

PLO3: Design and develop efficient, scalable, and secure software systems using modern programming tools and frameworks.

PLO4: Evaluate alternative computing solutions based on performance metrics, feasibility, and real-world constraints.

PLO5: Conduct independent research by formulating problems, reviewing literature, and implementing innovative solutions in emerging areas of Computer Science.

PLO6: Communicate technical concepts, research findings, and solutions effectively through written reports, presentations, and discussions.

PLO7: Collaborate in multidisciplinary teams to plan, execute, and deliver computing solutions addressing societal and industrial needs.

PLO8: Demonstrate ethical practices, professional responsibility, and awareness of sustainability and societal impact in computing solutions.

PLO9: Utilize advanced digital tools, data analytics techniques, and computing platforms to manage and interpret large-scale data.

PLO10: Reflect on personal learning, evaluate performance, and adapt strategies for continuous professional and academic growth.

PLOs with Bloom's Levels, Assessment Methods, and Graduate Attribute Mapping

PLO No	Programme Learning Outcome	Bloom's Level	Assessment Methods	Mapped GAs
PLO1	Apply advanced concepts of algorithms, data structures, artificial intelligence, and distributed systems to solve complex computing problems.	K3	Practical, Viva	GA1, GA4
PLO2	Analyze computational problems using appropriate mathematical models, statistical techniques, and algorithmic paradigms.	K4	Case Study, ESE	GA3, GA5
PLO3	Design and develop efficient, scalable, and secure software systems using modern programming tools and frameworks.	K6	Project, Practical, Viva	GA4, GA10
PLO4	Evaluate alternative computing solutions based on performance metrics, feasibility, and real-world constraints.	K5	Case Study, Seminar, ESE	GA3, GA8
PLO5	Conduct independent research by formulating problems, reviewing literature, and implementing innovative solutions in emerging areas of Computer Science.	K6	Project, Viva	GA6, GA8
PLO6	Communicate technical concepts, research findings, and solutions effectively through written reports, presentations, and discussions.	K3	Seminar, Viva, Project	GA2, GA7
PLO7	Collaborate in multidisciplinary teams to plan, execute, and deliver computing solutions addressing societal and industrial needs.	K3	Project, Internship, Field Work	GA7, GA14
PLO8	Demonstrate ethical practices, professional responsibility, and awareness of sustainability and societal impact in computing solutions.	K2	Case Study, Seminar, Viva	GA13, GA12
PLO9	Utilize advanced digital tools, data analytics techniques, and computing platforms to manage and interpret large-scale data.	K3	Practical, Project	GA10, GA5
PLO10	Reflect on personal learning, evaluate performance, and adapt strategies for continuous professional and academic growth.	K5	Seminar, Viva	GA9, GA11

Programme Specific Outcomes (PSOs)

(Expected knowledge, skills, and competencies that graduates will acquire by the end of the programme)

PSO1: Design and optimize algorithmic solutions for complex and large-scale computational problems using advanced paradigms and parallel processing techniques.

PSO2: Develop and deploy intelligent systems using machine learning, artificial intelligence, and data analytics techniques for real-world applications.

PSO3: Build and manage scalable, secure, and distributed applications using modern programming languages, cloud platforms, and database systems.

PSO4: Implement and evaluate secure computing solutions by applying network security, cyber security, and forensics techniques.

PSO5: Apply advanced computing techniques in emerging interdisciplinary domains such as image processing, IoT, and intelligent automation systems.

PSO6: Conduct and present independent research by integrating research methodology with practical implementation to solve contemporary computing problems.

PSO Alignment with Core Courses and Skill Competencies

PSO No	Programme Specific Outcome	Supporting Core Courses	Skill Competency
PSO1	Design and optimize algorithmic solutions for complex and large-scale computational problems using advanced paradigms and parallel processing techniques.	Advanced Design and Analysis of Algorithm, Parallel Computing, Modern Operating Systems	Algorithm design, computational optimization, parallel programming
PSO2	Develop and deploy intelligent systems using machine learning, artificial intelligence, and data analytics techniques for real-world applications.	Advanced Machine Learning, Artificial Intelligence, Business Intelligence, Big Data Analytics Lab	AI model development, predictive analytics, data-driven decision making
PSO3	Build and manage scalable, secure, and distributed applications using modern programming languages, cloud platforms, and database systems.	Python Programming, Advanced Java Programming, Cloud Computing, ADBMS Lab	Full-stack development, cloud deployment, database management
PSO4	Implement and evaluate secure computing solutions by applying network security, cyber security, and forensics techniques.	Advanced Network Security, Information Security, Cyber Security & Forensics, Cyber Security II	Cybersecurity analysis, threat detection, secure system design
PSO5	Apply advanced computing techniques in emerging interdisciplinary domains such as image processing, IoT, and intelligent automation systems.	Digital Image Processing, Wireless Sensor Networks, Robotic Process Automation Lab, Computer Vision	Domain-specific application development, IoT systems, automation design
PSO6	Conduct and present independent research by integrating research methodology with practical implementation to solve contemporary computing problems.	Conduct and present independent research by integrating research methodology with practical implementation to solve contemporary computing problems.	Conduct and present independent research by integrating research methodology with practical implementation to solve contemporary computing problems.

Scheme of Examination

Sem	Course Code	Course Title	Course Type	Hrs / Week	Credit	Examination			
						Duration in Hours	Maximum Marks		
							CA	ESE	TOTAL
I	MCS2601	Core I: Advanced Design and Analysis of Algorithm	DSC	4	4	3	25	75	100
	MCS2602	Core II: Parallel Computing	DSC	4	4	3	25	75	100
	MCS2603	Core III: Modern Operating Systems	DSC	4	4	3	25	75	100
	MCS2604	Core IV: Advanced Machine Learning	DSC	4	4	3	25	75	100
	MCS26E01	Elective I: Advanced Network Security (OR)	DSE	4	4	3	25	75	100
	MCS26E02	Elective I: Digital Image Processing (OR)							
	MCS26E03	Elective I: Text Analytics (OR)							
	MCS26E04	Elective I: Soft Computing							
	MCS26P1	Core Practical I: Advanced Machine Learning Lab	DSC	5	3	3	25	75	100
	MCS26P2	Core Practical II: Full Stack Development Lab	DSC	5	3	3	25	75	100
I - III	26MONL1	Online Course	ACC						
Semester I Total				**30**	**26**				**700**
II	MCS2605CE	Core V: Python Programming	DSC	4	4	-	-	100	100
	MCS2606	Core VI: Wireless Sensor Networks	DSC	4	4	3	25	75	100
	MCS2607	Core VII : Business Intelligence	DSC	4	4	3	25	75	100
	MCS26E05	Elective II : Information Security (OR)	DSE	4	4	3	25	75	100
	MCS26E06	Elective II: Computer Graphics and Computer Vision (OR)							
	MCS26E07	Elective II : : Social Media Analytics (OR)							

Sem	Course Code	Course Title	Course Type	Hrs / Week	Credit	Examination			
						Duration in Hours	Maximum Marks		
							CA	ESE	TOTAL
	MCS26E08	Elective II : Pervasive Computing							
	MTH26A5	Statistical Techniques in Practice	MDC	4	4	3	25	75	100
	MCS26P3	Core Practical III: ADBMS Lab	DSC	5	3	3	25	75	100
	MCS26P4	Core Practical IV: Big Data Analytics Lab	DSC	5	3	3	25	75	100
Semester II Total				**30**	**26**				**700**
I - III	26MONL1	Online Course	ACC						
III	MCS2608	Core VIII: Agentic Artificial Intelligence	DSC	4	4	3	25	75	100
	MCS2609	Core IX: Advanced Java Programming	DSC	4	4	3	25	75	100
	MCS2610	Core X: Cloud Computing Tools and Techniques	DSC	4	4	3	25	75	100
	MCS26E09	Elective III: Cyber Security and Forensics (OR)	DSE	4	4	3	25	75	100
	MCS26E10	Elective III: Mixed Reality (OR)							
	MCS26E11	Elective III: Health Care Analytics (OR)							
	MCS26E12	Elective III: Quantum Computing							
	MCS26P5	Core Practical V: Advanced Java Programming Lab	DSC	5	3	5	25	75	100
	MCS26P6	Core Practical VI: Robotic Process Automation Lab	DSC	5	3	5	25	75	100
	MCS26S1	Research Methodology	DSE	4	4	3		100[@]	100
	MCS26IST	Summer Internship	SEC	-	Gr.	-	100*	-	100[€]
	NMN26CS2	Cyber Security II	VAC	-	Gr.	-	100*	-	100[€]
	MCS26COM	Comprehensive Examination	DSC	-	Gr.	-	100*	-	100[€]
		Job Oriented Course	DSE	-	-	-	-	-	-
I - III	26MONL1	Online Course	ACC	-	Cr. / St.	-	-	-	-
Semester III Total				**30**	**26**				**700**

Sem	Course Code	Course Title	Course Type	Hrs / Week	Credit	Examination			
						Duration in Hours	Maximum Marks		
							CA	ESE	TOTAL
IV	MCS26AC1	Advance Learner Course I : Block Chain (OR)	ACC	SS	5^	3	25	75	100^
	MCS26AC2	Advance Learner Course II : Augmented Reality							
	MCS26PROJ	Project and Viva Voce	DSE	30	12		25	75	100
Semester IV Total				**30**	**12**				**100**
		Total			**90 + Additional Credits**				**2200 + Marks for Additional Credit Courses**

Hours of Instructions is inclusive of lectures, seminars, presentations, case-studies, etc.

Symbols and Notations

Symbols	Notations
*	Course assessed through Internal Assessment (CIA) only
Gr.	Grade awarded based on CBCS grading system
St.	Course Status (Completed/Not Completed)
^	Advanced Learner Course, Online Courses – Additional Credit Courses
@	Course assessed through End Semester Examination (ESE) only
#	Open Book Examination
$	Evaluation Pattern converted from 25:75:100 to 20:55:75 (CIA:ESE:Total) structure
$$	Evaluation Pattern converted from 25:75:100 to 15:35:50 (CIA:ESE:Total) structure
€	Hours per Week Outside Class Hours

Abbreviation	Course Type
DSC	Discipline Specific Core Courses
DSE	Discipline Specific Elective Courses
MDC	Multidisciplinary Courses
AEC	Ability Enhancement Course
SEC	Skill Enhancement Course
VAC	Value Added Courses
ACC	Additional Credits Courses

Assessment and Evaluation Framework
Continuous Internal Assessment (CIA) – 25%

Component	Activities Included
Internal Tests	Periodic written tests
Assignments / Case Studies	● Written assignments ● Case analysis reports ● Article reviews ● Literature review tasks ● Data interpretation exercises ● Policy analysis (Arts & Humanities) ● Business case studies (Commerce & Management) ● Lab-based analytical reports (Science)
Seminars / Presentations	● PowerPoint presentations ● Poster presentations ● Panel discussions ● Group seminars ● Viva voce ● Digital presentations using multimedia tools ● Peer evaluation rubrics
ICT-based Tasks	● Spreadsheet analysis ● Accounting software / statistical software ● Online quizzes ● Simulation tools ● E-content creation ● Coding platforms (for relevant disciplines)
Projects / Field Reports	● Field surveys ● Industry visits ● Internship reports ● Mini-projects ● Laboratory experiments ● Community-based research ● Data collection & statistical analysis ● Reflective journals

End Semester Examination (ESE) – 75%

Component	Description
Written Examination	3-hour written examination covering all CLOs
Cognitive Levels	Questions aligned with multiple Bloom's Taxonomy (K-levels)
Professional Conduct	Ethical and professional conduct during examination
Academic Compliance	Timely submission and participation as per regulations

Assessment Components Aligned with Blooms Levels

EXAMINATION SYSTEM

Semester system will be followed. A semester consists of a minimum of 90 working days excluding the days of conduct of ESE. There will be Continuous Internal Assessment (CA) to evaluate the performance of students in each course and the End Semester Examination will be held at the end of every semester. Marks for ESE and CA with reference to the maximum marks for the courses will be as follows:

Max. Marks	CA	ESE
100	25	75
75	20	55
50	15	35

A. Bloom's levels are followed in question papers and aligned with CLOs and CA components.

Remember	-	K1
Understand	-	K2
Apply	-	K3
Analyze	-	K4
Evaluate	-	K5
Create	-	K6

B. Continuous Internal Assessment CA
The weightage assigned to various components of the CA is as follows

Postgraduate Programme

a. Core and Elective (Including Course with Open Book Examination)

CA Components	Marks	K Level
CIA Test	5 Marks (conducted for 45 marks after 50 days – 3 units)	K2 to K6 as per QP Pattern
Model Exam	7 Marks (Conducted for 75 marks after 85 days) (Each Unit 15 Marks)	
Seminar	4 Marks	K6
Assignment	4 Marks	K5
ICT (Quiz)	2 Marks	K2
Attendance	3 Marks (Attendance 75% - 80% - 1 Mark, 81% - 90 % - 2 Marks, 91% - 100% - 3 Marks)	
Total	**25 Marks**	

b. Coursera in combination with Core Course:

CA Components	Marks	K Level
Coursera	25 Marks (100 marks from Coursera converted to 25 marks)	K4
CIA Test	25 Marks (conducted for 45 marks from Coursera converted to 25 marks)	K2 to K6 as per QP Pattern
Model Exam	30 Marks (conducted for 75 marks from Coursera converted to 30 marks)	
Assignment	10 Marks	K5
Seminar	10 Marks	K6
Total	**100 Marks**	

c. Practical

CA Components	Marks	K Level
Lab Performance	7 Marks	K4
Internal Viva-Voce	5 Marks	K4
Model Exam	10 Marks	K5
Attendance	3 Marks	
Total	**25 Marks**	

For practical courses with 50 marks as ESE, the split-up is 15 marks as internal and 35 as external. Internal conducted for 25 and converted to 15 marks and external conducted for 75 and converted to 35 marks.

d. Cyber Security II

CA Components	Marks	K Level
ICT (Quiz)	50 Marks	K2
Assignment	25 Marks	K5
Project / Case Study / Poster	25 Marks	K6
Total	**100 Marks**	

e. Advance Learner Course

CA Components	Marks	K Level
Test 1	10 Marks (conducted for 45 marks after 50 days – 3 units)	K2 to K6 as per QP Pattern
Model Exam	15 Marks (Conducted for 75 marks after 85 days (Each Unit 15 Marks)	
Total	**25 Marks**	

f. Comprehensive Examination

Course Title	Marks	K level
Comprehensive Examination	100	K3

g. Project and Viva voce

Components	Marks	K level
Continuous Internal Assessment (CA)	25 Marks	K3, K4, K6
End Semester Examination	75 Marks	K5, K6
Total	**100 Marks**	

Continuous Internal Assessment (CA)

CA Components	Marks	K Level
I Review - Project Proposal Presentation	5 Marks	K3
II Review - Periodic Review-Progress Evaluation	10 Marks	K4
III Review - Project Report Draft Submission	10 Marks	K6
Total	**25 Marks**	

End Semester Examination

Components	Marks	K level
Evaluation of the Project Report	25 Marks	K6
Viva Voce	50 Marks	K5
Total	**75 Marks**	

h. *Summer Internship* / Field Work / Institutional Training

CA Components	Marks	K Level
Work diary	15 Marks	K3
Report	50 Marks	K6
Viva Voce	25 Marks	K5
Attendance	10 Marks	
Total	**100 Marks**	

C. Schedule for CA Tests

One test for Continuous Assessment (3 Units) will be conducted on pre-determined date i.e., commencing on the 50th day from the date of reopening. The model exam (5 units) will be conducted after completing 85th working day.

D. Question Paper Pattern and Distribution of Marks for CA – PG

PG : Core, Elective & ALC - (First 3 Units)

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 2 Marks	3 X 2 = 6		3				
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	3 X 5 = 15			1	1	1	
One question with a weightage of 8 Marks (Internal Choice at the same CLO level)	3 X 8 = 24			1	1		1
Total	**45 Marks**						

E. Model /End Semester Examination – Question Paper Pattern and Distribution of Marks

PG : Core, Elective & ALC

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 2 Marks	5 x 2 = 10		5				
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	5 x 5 =25			2	2	1	
One question with a weightage of 8 Marks (Internal Choice at the same CLO level)	5 x 8 =40			2	1	1	1
Total	**75 Marks**						

PG - IDC and Special Course (Research Methodology):

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	5 x 5 =25		2	1	1	1	
One question with a weightage of 15 Marks (Internal Choice at the same CLO level)	5 x 15 =75			2	1	1	1
Total	**100 Marks**						

ESE Practical Pattern (UG & PG)

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

Practical Components	Marks	K level
Practical Execution	60 Marks	K5
Record	15 Marks	K2
Total	**75 Marks**	

Submission of Record note books for Practical Examinations

Submission of bonafide record note books is mandatory to appear for the practical examination. If a candidate is unable to submit the record note book on valid grounds, she may be permitted to appear for the practical examinations, provided the head of the department certifies that the candidate has performed the experiments prescribed for the course and she will be awarded zero (0) marks for record note book.

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS2601	CORE I : ADVANCED DESIGN AND ANALYSIS OF ALGORITHM	60	55	5	4

Preamble

- Introduces advanced algorithm design paradigms and techniques for solving complex computational problems efficiently
- Explains methods for analyzing time and space complexity to evaluate and compare algorithm performance
- Emphasizes optimization strategies to enhance efficiency and scalability of algorithms
- Develops the ability to critically analyze, design, and refine algorithms for diverse problem domains
- Enables application of algorithmic solutions to real-world scenarios, improving problem-solving and decision-making skills

Prerequisite

- Basic knowledge of data structures and discrete mathematics, along with familiarity with programming and basic algorithm analysis concepts such as time and space complexity.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of algorithm design, computational models, problem-solving strategies, and complexity classifications across algorithmic domains.	K1
CLO2	Understand principles of algorithm correctness, performance analysis, problem classification, and theoretical foundations of computation.	K2
CLO3	Apply algorithmic principles and problem-solving methods to develop solutions for computational and real-world problems.	K3
CLO4	Analyze algorithms in terms of efficiency, correctness, scalability, and computational limitations using formal analytical methods.	K4
CLO5	Evaluate different algorithmic solutions based on performance measures, constraints, and suitability for real-world applications.	K5
CLO6	Design and develop efficient algorithms for complex problems by integrating advanced concepts from various algorithmic domains.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Fundamentals, problem solving, algorithm analysis, max subarray	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Complexity classes, reductions, greedy algorithms	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Approximation, randomized algorithms, backtracking, branch & bound	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Network flow, matching algorithms	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Computational geometry, Voronoi diagrams	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	2	3	1	1	1	1	1	2	1
CLO4	2	3	1	1	2	1	1	1	1	1
CLO5	1	2	1	1	3	1	1	1	2	1
CLO6	2	2	3	1	2	1	1	1	2	1

ADVANCED DESIGN AND ANALYSIS OF ALGORITHM (MCS2601) (55 Hrs)

UNIT I **(11 Hrs)**

Fundamentals of Algorithmic Problem Solving : Understanding the Problem -Ascertaining the Capabilities of the Computational Device -Choosing between Exact and Approximate Problem Solving - Algorithm Design Techniques-Designing an Algorithm and Data Structures-Methods of Specifying an Algorithm-Proving an Algorithm's Correctness -Analyzing an Algorithm-Coding an Algorithm.

Case Study in Algorithm Analysis : Solution to maximum subarray problem, Improved Maximum Subarray Algorithm, Linear-Time Maximum Subarray Algorithm.

Case Study: Stock Market Profit Analysis Using Maximum Subarray Algorithms, Performance Optimization in Signal Processing Using Efficient Subarray Computation.

UNIT II **(11 Hrs)**

Complexity of Problems : NP- Complete Problems – Class co-NP- Class NPI – Relationships between the four classes. **Computational Complexity :** Model of Computation – Relationships between Complexity Classes – Reductions- Completeness. Lower Bounds: Trivial Lower Bounds – Algebric decision Tree Model – Linear Time Reductions. **Greedy Algorithms :** Optimization Problems - Greedy Design Strategy - Interval Selection- Interval Coloring - Wireless Access Points - A House Construction Problem.

Case Study: Wireless Network Coverage Optimization Using Greedy Algorithms, Task Scheduling in Cloud Computing Using Complexity and Greedy Strategies.

UNIT III **(11 Hrs)**

Apporximation Algorithms: Difference Bounds – Relative Performance Bounds- P olynomial Approximation Schemes- Fully Polynomial Approximation scheme. **Randomized Algorithm :** Introduction – Las Vegas Algorithms – Randomized selection – Random Sampling – Testing String Equality **–** Minimum Cuts**. Back tracking :** general back tracking method- Branch and Bound.

Case Study: Approximation Algorithms in E-Commerce Recommendation Systems, Randomized Algorithms in Data Sampling for Big Data Analytics.

UNIT IV **(11 Hrs)**

Iterative Improvement for Domain- Specific Problems : Network Flow: Introduction – Ford-Fulkerson Method- Maximum Capacity Augmentation – Shortest Path Augmentation- Dinic's Algorithm – MPM algorithm. **Matching:** Introduction – Network Flow Method- Hungarian Tree –Maximum Matching in General Graphs. Case Study: Traffic Routing and Congestion Control Using Network Flow Algorithms, Job Assignment Systems Using Matching Algorithms.

UNIT V **(11 Hrs)**

Techniques in Computational Geometry: Geometry Sweeping : Computing the Intersections of Line Segment- Convex Hull Problem – Computing the Diameter of a set of points. **Voronoi Diagrams :** Introduction – Nearest- Point Voronoi diagram- Appications of the Voronoi diagrams – Farthest- Point Voronoi diagram – Applications of the Farthest- Point Voronoi Diagram. Case Study: GPS Navigation Systems Using Convex Hull and Geometric Algorithms, Case Study: Nearest Facility Location Planning Using Voronoi Diagrams.

*** Course Alignment with SDGs: 4, 9**

Text Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Anany Levitin	Introduction to the Design and Analysis of Algorithms	Pearson Education	2012, 3rd Edn
2	Douglas Robert Stinson	Techniques for Designing and Analyzing Algorithms	Pearson Education	2006, 1st Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Anany Levitin	Introduction to the Design and Analysis of Algorithms	Pearson Education	2012, 3rd Edn
2	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	Introduction to Algorithms	MIT Press	2009, 3rd Edn
3	Jon Kleinberg, Éva Tardos	Algorithm Design	Pearson Education	2006, 1st Edn
4	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani	Algorithms	McGraw-Hill	2006, 1st Edn

Related Online References

1. Design and Analysis of Algorithms by NPTEL (IIT Professors).
2. Introduction to Algorithms by MIT OpenCourseWare.
3. Algorithms Specialization by Tim Roughgarden on Coursera.

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Numerical problem-solving exercises
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminars

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS2602	**Core II : Parallel Computing**	**60**	**55**	**5**	**4**

Course Preamble

- Introduces fundamental principles of parallel computing, including architectures and parallel system organization
- Explores parallel programming models and tools such as Pthreads and MPI for developing concurrent applications
- Focuses on performance evaluation techniques to analyze speedup, efficiency, and scalability of parallel systems
- Emphasizes design and optimization of algorithms for efficient parallel execution
- Enables development of scalable parallel solutions for real-world computational problems.

Prerequisite

- Basic knowledge of data structures, computer organization, and programming concepts, along with a fundamental understanding of algorithms and problem solving.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of parallel computing, including computational models, parallel architectures, programming environments, performance metrics, and application domains.	K1
CLO2	Understand the principles of parallel computation, including program execution, communication, memory organization, system architectures, and performance behavior in diverse computing environments.	K2
CLO3	Apply parallel computing concepts to develop solutions for computational problems by utilizing appropriate programming models, system resources, and performance considerations.	K3
CLO4	Analyze parallel programs and systems with respect to performance, scalability, communication overhead, resource utilization, and architectural constraints using formal evaluation methods.	K4
CLO5	Evaluate parallel computing solutions by comparing alternative designs based on efficiency, scalability, load distribution, system limitations, and application requirements.	K5
CLO6	Design and develop efficient parallel computing solutions for complex real-world problems by integrating concepts of computation, architecture, programming, and performance optimization.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Foundations of parallel computing, hardware architectures, programming models, and performance metrics	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Thread-based programming, Pthreads, synchronization, race conditions, and shared-memory performance issues	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	MPI programming, point-to-point and collective communication, process topologies, and parallel program design	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	High-performance computing architectures, memory hierarchy, interconnection networks, and system software	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Performance measurement, benchmarking, optimization, scalability, HPC tools, and emerging HPC applications	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	2	3	1	1	1	1	1	2	1
CLO4	2	3	1	1	2	1	1	1	1	1
CLO5	1	2	1	1	3	1	1	1	2	1
CLO6	2	2	3	1	2	1	1	1	2	1

PARALLEL COMPUTING (MCS2602) (55 Hrs)

UNIT I **(11 Hrs)**

Motivation for parallel computing and limitations of sequential computing - Parallel computing in modern applications and scientific problems - Types of parallelism including task parallelism and data parallelism - Parallel hardware architectures including shared memory systems, distributed memory systems and hybrid systems - Memory organization in parallel systems - Introduction to parallel programming models including shared-memory programming and message-passing programming models - Performance metrics in parallel systems including execution time, speedup, efficiency and scalability.

Case Study: Matrix Multiplication, Parallel Matrix-Matrix Multiplication, Redistribution Costs, A Systolic Algorithm.

UNIT II **(11 Hrs)**

Introduction to distributed memory programming and the message passing paradigm - Overview of the Message Passing Interface (MPI) standard - Structure of MPI programs including initialization and finalization, Shared memory Programming with OpenMP. Parallel Sorting Algorithms. Parallel Program Development : Two n-Body Solvers, Tree Search.

Case Study: Parallel Weather Simulation Using MPI and OpenMP, Parallel Sorting and N-Body Simulation in Scientific Computing Systems.

UNIT III **(11 Hrs)**

Agglomeration: Increasing Granularity, Surface-to-Volume Effects, Replicating Computati on, Avoiding Communication, Preserving Flexibility, Reducing Software, Engineering Costs, Mapping, Load-Balancing Algorithms, Recursive Bisection, Local Algorithms, Probabilistic Methods, Cyclic Mappings, Task-Scheduling Algorithms, Manager/Worker, Hierarchical Manager/Worker, Decentralized Schemes, Termination Detection. Programming using message passing paradigm and shared address space: Threads, OpenMP, Intel TBB, MPI, CUDA, Hybrid parallel programming by combining pThreads and MPI calls.

Case study: Image processing, analog/digital circuit simulation, smart grid. Parallel Performance Analysis: Simple Parallel Model, Bulk-Synchronous Parallel Model, PARM model, Performance Evaluation.

UNIT IV **(11 Hrs)**

Overview and evolution of high performance computing systems - Architecture of modern HPC systems including multicore processors and many-core architectures - Memory hierarchy in HPC systems including cache memories and shared memory - Distributed memory architecture in HPC systems - Interconnection networks used in high performance computers - Communication mechanisms in parallel systems - Parallel I/O subsystems and storage architectures - System software for HPC systems including operating systems, compilers and runtime environments.

Case Study: Weather Forecasting Using High Performance Computing Systems, Case Study: Drug Discovery and Scientific Simulations Using Modern HPC Architectures.

UNIT V **(11 Hrs)**

Performance measurement and benchmarking in high performance computing - Performance analysis techniques for parallel programs - Optimization strategies for parallel programs including improving data locality and minimizing communication overhead - Load balancing strategies in parallel systems - Scalability analysis and performance modeling - Parallel software tools and development environments for HPC applications.

Case Study : HPC in scientific computing, engineering simulations and data analytics - Emerging trends in HPC including exascale computing and energy-efficient computing systems.

Course Alignment with SDGs: 7, 9

Text Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Peter Pacheco, Matthew Malensek	An Introduction to Parallel Programming	Elsevier	2021, 2nd Edn
2	Thomas Sterling, Maciej Brodowicz, Matthew Anderson	High Performance Computing: Modern Systems and Practices	Elsevier	2024, 2nd Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1	William Gropp, Ewing Lusk, Anthony Skjellum	Using MPI: Portable Parallel Programming with the Message Passing Interface	MIT Press	2014, 3rd Edn
2	David B. Kirk, Wen-mei W. Hwu, Izzat El Hajj	Programming Massively Parallel Processors: A Hands-on Approach	Morgan Kaufmann	2022, 5th Edn
3	Michael J. Quinn	Parallel Programming in C with MPI and OpenMP	McGraw-Hill	2004, 1st Edn
4	Georg Hager, Gerhard Wellein	Introduction to High Performance Computing for Scientists and Engineers	CRC Press	2019, 2nd Edn
5	Timothy G. Mattson, Beverly Sanders, Berna Massingill	Patterns for Parallel Programming	Addison-Wesley	2005, 1st Edn

Related Online References

1. Parallel Programming by NPTEL (IIT Professors)
2. Parallel Computing by MIT OpenCourseWare
3. High Performance Computing Specialization by Coursera

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Hands-on programming exercises (Pthreads & MPI)
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminars
- Case studies on real-world HPC applications

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS2603	**CORE III : MODERN OPERATING SYSTEMS**	**60**	**55**	**5**	**4**

Course Preamble

- Introduces distributed operating systems and their architectures for scalable computing environments
- Describes core operating system concepts including process, memory, and file management techniques
- Addresses security mechanisms and protection strategies in modern operating systems
- Discusses real-time and embedded systems with focus on timing constraints and reliability
- Explores platforms such as Linux and Android along with emerging trends like cloud computing and IoT

Prerequisite

- Basic knowledge of computer architecture, programming in C or Java, and fundamental operating system concepts is required.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of modern operating systems, including system structures, process management, communication mechanisms, security aspects, real-time systems, and platform-specific environments.	K2
CLO2	Understand the principles governing operating system functionalities such as process and thread management, resource allocation, communication, security mechanisms, real-time operations, and system architectures.	K2
CLO3	Apply operating system concepts to manage processes, synchronization, communication, security, and resource utilization in diverse computing environments and platforms.	K3
CLO4	Analyze operating system behavior in terms of performance, scheduling, resource management, security, and reliability across distributed, real-time, and modern computing systems.	K4
CLO5	Evaluate different operating system strategies based on efficiency, scalability, security, reliability, and suitability for various application domains and system requirements.	K5
CLO6	Design and develop solutions for complex system-level problems by integrating concepts of process management, communication, security, real-time processing, and modern operating system environments.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Distributed OS systems, middleware, communication, scheduling, and load balancing	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit II	Processes, threads, inter process communication, and scheduling techniques	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit III	Security models, authentication, access control, and intrusion detection	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit IV	Real-Time Operating Systems, multitasking, memory, and inter-task communication	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit V	Linux, Android, modern OS concepts, virtualization, and emerging trends	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	2	1	2	1	2	3	1	1
CLO2	2	3	2	1	1	1	1	2	2	1
CLO3	2	3	2	2	1	1	2	2	2	2
CLO4	2	3	2	2	1	2	2	2	1	1
CLO5	1	2	3	2	1	2	2	2	2	1
CLO6	1	2	3	3	2	2	1	1	2	1

MODERN OPERATING SYSTEMS (MCS2603) (55 Hrs)

UNIT I (11 Hrs)

Distributed OS Systems – Network Hardware - Network Services and Protocols - Document Based Middleware – File system based middleware - Object based middleware - Co-ordination based middleware – Multi computers: User level Communication software – Remote Procedure call - Distributed shared memory – Multicomputer scheduling – Load Balancing. Trends in OS Design: Virtualization and the cloud – Manycore Chip – Large address space OS – Seamless data access – Battery – Powered Computing Embedded systems – OS Structure: Monolithic Structure - Layered System - Virtual Machine - Exo Kernel – Client-Server Model.

Case Study: Load Balancing in Multicomputer System, Remote Procedure Call (RPC) Optimization, Network Flow for Bandwidth Allocation.

UNIT II (11 Hrs)

Processes and Threads: Process model - Process Creation - Process Termination - Process Hierarchies - Process State. Threads: Thread usage - Classical Thread Model - Implementing Threads in userspace and kernel. Interprocess Communication - Semaphores- Message Passing-Scheduling - Scheduling in Batch systems - Interactive Systems - Real Time Systems - Thread Scheduling.

Case Study: Job Sequence Scheduling, Message Passing in Semaphore.

UNIT III (11 Hrs)

Security Environment: Threats – Attackers - Controlling Access to Resources - Protection Domains - Access Control lists – Capabilities - Formal Models of Secure Systems - Multilevel security – Covert Channels - Authentication using a Physical object - Authentication using Biometrics – Defenses – Code Signing – Jailing – Model based intrusion detection – Encapsulating Mobile Code.

Case study: Biometric Authentication in Smartphones (Fingerprint/Face ID) and Intrusion Detection Systems (IDS) in Enterprise Networks

UNIT IV (11 Hrs)

Introduction to RTOS: Purpose of Real Time Operating Systems - Process Management - Memory Management - Interrupts Management – Multitasking - File System Management - I/O Management - Characteristics of RTOS Kernels - Priority Scheduling - Inter task Communication and Resource Sharing - Real Time Signals – Shared Memory -Asynchronous I/O - Memory Locking. Real-Time Embedded Systems - Real-Time Embedded System Characteristics-System Structure-Real-Time Response - Concurrency – Predictability - safety and Reliability - Hard and Soft Real-Time Embedded Systems.

Case study: Real Time Operating Systems in Automotive Airbag Control System. Priority-Based Task Scheduling in RTOS, Inter-Task Communication using Shared Memory, Resource Sharing using Semaphores.

UNIT V **(11 Hrs)**

Linux Overview – Linux Goals - Linux Architecture - Scheduling – Synchronization - Memory Management System calls - Paging – Input – output system calls - File system calls in Linux Introduction to Android - History of Android - Design Goals - Android Architecture -Types of OS– Mobile OS-IOS, Web OS- Smart OS. Embedded OS - Memory Management - Services Layer - Core OS Layer - File System. Practical Issues - Software Reliability - Software Faults – Reliability Measurement – Security - Challenges. Case study: Process Scheduling in Linux Systems. Memory Management using Paging in Linux Security Mechanisms in Android OS. Web OS Architecture in Smart Devices .

*** Course Alignment with SDGs: 4, 9**

Text Books

S. No.	Authors	Title	Publisher	Year & Edition
1.	Andrew S.Tanenbaum, Herbert Bos	Modern Operating Systems	Pearson Education	2023, 5th Edn
2.	Jiacun Wang	Real-Time Embedded Systems	John Wiley & Sons, Inc.	2017,1st Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1.	Shubra Garg	Fundamentals of Distributed Operating Systems	S.K. Kataria & Sons	2022, 1st Edn
2.	Andrew S.Tanenbaum	Distributed Operating System	Pearson Education	2017, 10th Edn

Related online course

1. Distributed Systems – NPTEL – Designed by IIT Madras Professors
2.Operating System Fundamentals – SWAYAM – Designed by UGC/AICTE Faculty
3.Operating Systems and You: Becoming a Power User – Coursera – Designed by Google

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Case study-based learning (GFS, AWS, RTOS, Security systems)
- Problem-solving and analytical exercises
- Group discussions and collaborative learning
- Assignments and tutorials
- Quizzes and continuous assessment
- Peer learning activities
- Student seminars and presentations

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS2604	CORE IV: ADVANCED MACHINE LEARNING	60	55	5	4

Preamble

- Introduces fundamental concepts and principles of machine learning and deep learning
- Describes key algorithms, models, and evaluation techniques used in intelligent systems
- Emphasizes understanding through real-world case studies and practical applications
- Develops the ability to design and implement data-driven intelligent solutions

Prerequisite

- Basic knowledge of mathematics (linear algebra, probability, and statistics) and programming skills (preferably in Python) are required.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of machine learning, including data representation, learning paradigms, model structures, optimization principles, and application domains.	K1
CLO2	Understand the principles underlying machine learning models, including learning theory, classification, clustering, optimization, neural networks, and performance evaluation.	K2
CLO3	Apply machine learning concepts to develop predictive and analytical models for solving real-world problems using appropriate data representations and evaluation methods.	K3
CLO4	Analyze machine learning models with respect to generalization, performance, model complexity, optimization behavior, and suitability for different types of data and applications.	K4
CLO5	Evaluate different machine learning models and solutions based on accuracy, efficiency, scalability, robustness, and applicability to real-world scenarios.	K5
CLO6	Design and develop advanced machine learning solutions by integrating learning theory, model development, optimization strategies, and deep learning concepts for complex applications.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	ML basics, applications, supervised learning, bias-variance, VC dimension, PAC learning	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit II	Pattern mining, classification, decision trees, Bayes, ensemble, lazy learners	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit III	Clustering, PCA/ICA, evaluation metrics, validation, model complexity	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit IV	Convex learning, Lipschitzness, smoothness, learnability	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit V	Deep learning, neural networks, CNN, RNN, applications	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	1	1	1	1	1	1	1	1	1
CLO2	3	2	1	1	1	1	1	1	1	1
CLO3	3	2	2	1	1	1	1	1	2	1
CLO4	2	3	1	2	1	1	1	1	2	1
CLO5	2	2	1	3	2	1	1	1	1	1
CLO6	2	1	3	1	2	1	1	1	2	1

ADVANCED MACHINE LEARNING (MCS2604) (55 Hrs)

UNIT I **(11 Hrs)**

Introduction: Machine learning Basics – Examples of machine Learning Applications.

Variables and Data types- The Bias- Complexity Tradeoff- Learning through uniform Convergence. Supervised Learning: Learning a class from Examples - Vapnik- Chervonenkis Dimension - Probably Approximately Correct Learning – Noise - Learning Multiple Classes – Regression-Model Selection and Generalization - Dimensions of a Supervised Machine Learning Algorithm.

Case Studies: Spam Filter, Predicting House Prices.

UNIT II **(11 Hrs)**

Pattern Growth Algorithm- Classification: Basic Concepts – Decision tree induction: Decision tree induction Attribute selection measures - Tree pruning. Bayes Classification Methods : Bayes' theorem Naïve Bayesian classification. Ensemble Methods – Bagging – Boosting. Lazy learners: k-nearest-neighbor classifiers, Case-based reasoning, Support Vector Machines.

Case Studies: Market basket analysis, Loan Approval, Email Spam Detection

UNIT III **(11 Hrs)**

Clustering – K-means – K-mode- K-median – Hierarchical clustering – DBSCAN – Principal Component Analysis – Independent Component Analysis. Performance Evaluation metrics – ROC Curves – Validation methods – Bias-variance decomposition – Model complexity.

Case Studies: Customer Segmentation using K-Means Clustering, Product Categorization using K-Modes.

UNIT IV **(11 Hrs)**

Convex Learning Problem: Convexity, Lipschitzness and Smoothness – Convexity – Lipschitzness-Smoothness. Learnability of Convex Learning Problem – Convex-Lipschitz/ Smooth-Bounded Learning Problems

Case Studies: Logistic Regression for Disease Prediction, Online Recommendation System (Smooth Convex Optimization), Portfolio Optimization in Finance, Text Classification with Convex-Lipschitz Loss.

UNIT V **(11 Hrs)**

Introduction to deep learning - Feed Forward Neural Networks – Gradient Descent – Back Propagation Algorithm. Convolutional neural networks - Kernel Filters – Multiple Filters - CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning - Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications.

Case Studies: Computer Vision – Speech Recognition-Multi Digit Number Recognition.

*** Course Alignment with SDGs:** 4, 8, 9

Text Books

S.No.	Authors	Title	Publisher	Year & Edition
1	Ethem Alpaydm	Introduction to Machine Learning	The MIT Press	2020,4th Edn
2	Tom M. Mitchell	Machine Learning	Tata McGraw-Hill, New Delhi	2017, 1st Edn
3	Phil Kim	Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence	Apress	2017, 1st Edn
4	Ragav Venkatesan, Baoxin Li	Convolutional Neural Networks in Visual Computing: A Concise Guide	CRC Press	2018, 1st Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Mark A. Hall, Ian H. Witten, Eibe Frank	Data Mining: Practical Machine Learning Tools and Techniques	Morgan Kaufmann Publishers, San Francisco.	2022, 4th Edn
2	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar	Introduction to Data Mining	Pearson Education	2021, 4th Edn
3	Francois Chollet	Deep Learning with Python	Manning Publications	2021, 2nd Edn
4	Phil Kim	Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence	Apress	2017, 1st Edn

Related Online References

1. The course Machine Learning in Coursera by Andrew Ng provides a strong foundation in supervised learning, regression, and model evaluation.
2. The course Machine Learning and Data Mining in NPTEL offer in-depth knowledge of classification, clustering, and association rules.
3. The Deep Learning course in Coursera offers in-depth knowledge of neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and deep learning applications.

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Problem-Based Learning
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminars

Course Code	Course Title	Hours			Credits
		Total	Practical	Examination	
MCS26P1	CORE PRACTICAL 1: ADVANCED MACHINE LEARNING LAB	75	72	3	3

Preamble

- Delivers hands-on experience in machine learning and deep learning using tools such as Python, R, Tableau, and KNIME
- Applies algorithms like Naïve Bayes, SVM, and CNN to real-world datasets for practical understanding
- Explores domain-specific applications, including bioinformatics using datasets such as the Protein Data Bank (PDB)

Prerequisite

- Basic knowledge of programming (Python/R), data structures, and fundamental mathematics including statistics, probability, and linear algebra.

Course Learning Outcomes (CLOs)

- On the successful completion of the course, students will be able to,

CLO Number	CLO Statement	Knowledge Level
CLO1	Identify fundamental concepts of data preprocessing, visualization, machine learning models, data mining tasks, and analytical tools used in data-driven applications.	K1
CLO2	Understand the principles of data handling, similarity measures, classification, clustering, association analysis, dimensionality reduction, and neural network models across different platforms and tools.	K2
CLO3	Apply data preprocessing, visualization, and machine learning methods to implement predictive and analytical solutions using tools such as Python, R, Tableau, and KNIME.	K3
CLO4	Analyze datasets and model outcomes using statistical measures, performance metrics, similarity measures, and visualization techniques to interpret patterns and insights.	K4
CLO5	Evaluate different data analysis and machine learning solutions based on accuracy, efficiency, interpretability, and suitability for real-world applications.	K5
CLO6	Design and develop end-to-end data-driven solutions by integrating preprocessing, modeling, evaluation, and visualization techniques for complex real-world problems.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Program wise

Program	Coverage	Mapped CLOs
Program 1	Focuses on the concepts of data preprocessing, feature identification, and data cleaning techniques.	CLO1, CLO2, CLO3
Program 2	Introduces the concepts of probabilistic supervised learning for email classification.	CLO1, CLO2, CLO3
Program 3	Emphasizes the concepts of similarity computation and distance-based data analysis.	CLO1, CLO2, CLO3
Program 4	Addresses the concepts of hierarchical clustering for unsupervised data grouping.	CLO1, CLO2, CLO3
Program 5	Explores the concepts of cluster formation using the Birch algorithm.	CLO1, CLO2, CLO3

Program 6	Highlights the concepts of text mining and knowledge extraction from corpus data.	CLO4, CLO5, CLO6
Program 7	Presents the concepts of exploratory data analysis and statistical visualization in R.	CLO1, CLO2, CLO3
Program 8	Deals with the concepts of classification using Support Vector Machine (SVM).	CLO1, CLO2, CLO3
Program 9	Provides exposure to the concepts of deep learning and CNN-based sequence classification.	CLO4, CLO5, CLO6
Program 10	Includes the concepts of dimensionality reduction and feature visualization using PCA.	CLO4, CLO5, CLO6
Program 11	Focuses on the concepts of statistical analysis and data visualization using Tableau.	CLO1, CLO2, CLO3
Program 12	Addresses the concepts of decision tree-based classification and prediction.	CLO1, CLO2, CLO3
Program 13	Emphasizes the concepts of association rule mining and frequent pattern analysis.	CLO4, CLO5, CLO6
Program 14	Focuses on the concepts of customer behavior analysis and supervised classification for identifying buying patterns.	CLO4, CLO5, CLO6
Program 15	Addresses the concepts of fraud detection and supervised predictive modeling using credit card transaction data.	CLO4, CLO5, CLO6
Program 16	Emphasizes the concepts of medical data classification and supervised prediction for breast cancer analysis.	CLO4, CLO5, CLO6
Program 17	Explores the concepts of customer grouping and unsupervised learning through clustering techniques.	CLO4, CLO5, CLO6
Program 18	Highlights the concepts of predictive analytics and supervised learning for loan defaulter identification.	CLO4, CLO5, CLO6
Program 19	Presents the concepts of classification and model building using the Iris dataset.	CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	2	1	1	1	1	1	1
CLO2	2	3	1	1	1	2	1	1	1	1
CLO3	2	2	3	3	1	1	1	1	2	1
CLO4	1	3	1	2	2	3	1	1	1	1
CLO5	1	2	1	1	3	2	1	1	1	2
CLO6	1	1	3	2	2	1	1	1	2	3

Syllabus

- Exercises to implement data exploration and visualization techniques in R, Tableau.
- Exercises to perform preprocessing tasks in Python
- Exercises to implement linear regression & logistic regression
- Exercises to perform classification & clustering
- Exercises to perform association rules & text mining

- Exercises to perform Convolutional Neural Network
- Exercises to perform PCA

List of Programs

1. Demonstrate the following data preprocessing tasks using Python libraries.
   a) Loading the dataset b) Identifying the dependent and independent variables
   c) Dealing with missing data
2. Implement a probabilistic model to detect Spam Email with Naive Bayes
3. Demonstrate the following similarity measures using python
   a) Pearson's Correlation b) Euclidean Distance) Manhattan Distance
4. Experiment on hierarchal Data Clustering algorithms on weather data set.
5. Write a Python code to perform Clustering using the Birch algorithm.
6. Write a Python code to implement Text Mining for the corpus data.
7. Perform data exploration and visualization of the iris dataset and implement various statistical operations in R.
8. Perform classification of the iris dataset using support vector machine (SVM) in R.
9. Develop a Convolutional Neural Network (CNN) model to classify protein secondary structures using amino acid sequence data.
10. Apply PCA to visualize tumor vs normal samples.
11. Perform data exploration and visualization of the stock dataset and implement various statistical operations in Tableau.
12. Perform decision tree classification using Knime.
13. Perform Apriori Algorithm (Frequent Itemset Mining) using Knime.

Applications

14. Customer buying patterns using classification methods
15. Credit card Fraud Detection using Supervised algorithm
16. Breast Cancer Prediction using Supervised Algorithm
17. Customer Segmentation using Clustering
18. Loan defaulters Prediction
19. Classification of Iris Dataset

*** Course Alignment with SDGs: 4**

Pedagogy: Demonstrations

Course Code	Course Title	Hours			Credits
		Total	Practical	Examination	
MCS26P2	CORE PRACTICAL II: FULL STACK DEVELOPMENT LAB	75	72	3	3

Course Preamble

- Introduces interactive web development concepts, including client–server architecture and asynchronous communication using AJAX
- Describes front-end technologies such as AngularJS and ReactJS for building dynamic user interfaces
- Focuses on back-end development using NodeJS and PHP for server-side application logic
- Includes database integration using MySQL for data storage and management
- Emphasizes full-stack development using MERN and LAMP stacks for building complete web applications

Prerequisite

- Basic knowledge of HTML, CSS, JavaScript, programming concepts, and databases is required

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of web application development, including client-server architecture, front-end and back-end technologies, asynchronous communication, database connectivity, and full-stack frameworks.	K1
CLO2	Understand the principles of dynamic web development, including user interaction handling, data exchange, authentication mechanisms, state management, and integration of multiple technologies across full-stack environments.	K2
CLO3	Apply web development concepts to build interactive and dynamic applications using technologies such as AJAX, AngularJS, ReactJS, NodeJS, PHP, MySQL, and full-stack frameworks.	K3
CLO4	Analyze web applications in terms of functionality, data flow, responsiveness, security, and performance across client-side and server-side components.	K4
CLO5	Evaluate web-based solutions based on usability, scalability, security, efficiency, and suitability for real-world application requirements.	K5
CLO6	Design and develop complete full-stack web applications by integrating front-end interfaces, back-end services, database systems, and authentication mechanisms for real-world scenarios.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Program wise

Program	Coverage	Mapped CLOs
Program 1	PHP, MySQL, Database Connectivity, CRUD Operations	CLO1, CLO2, CLO3
Program 2	AJAX, Dynamic Search, Client-Server Interaction	CLO1, CLO2, CLO3
Program 3	AJAX, Asynchronous Updates, Web Interaction	CLO1, CLO2, CLO3
Program 4	AJAX, Real-time Suggestions, UI Enhancement	CLO1, CLO2, CLO3
Program 5	AngularJS, Directives, Controllers, UI Interaction	CLO4, CLO5, CLO6
Program 6	AngularJS, Data Binding, Dynamic Updates	CLO4, CLO5, CLO6
Program 7	AngularJS, Data Handling, Display & Count	CLO4, CLO5, CLO6
Program 8	AngularJS, CRUD, UI Interaction	CLO4, CLO5, CLO6
Program 9	AngularJS, CRUD Operations, Validation	CLO4, CLO5, CLO6
Program 10	ReactJS, Authentication, Security Basics	CLO4, CLO5, CLO6
Program 11	ReactJS, State Management, User Interaction	CLO4, CLO5, CLO6
Program 12	ReactJS, Component Design, Logic Implementation	CLO4, CLO5, CLO6
Program 13	ReactJS, CMS Integration, Content Management	CLO4, CLO5, CLO6
Program 14	Full-stack Development, Transactions, UI/UX	CLO4, CLO5, CLO6
Program 15	ReactJS, Scheduling System, User Interaction	CLO4, CLO5, CLO6
Program 16	NodeJS, Transactions, Backend Logic	CLO4, CLO5, CLO6
Program 17	MERN Stack, Full-stack Development	CLO4, CLO5, CLO6
Program 18	MERN Stack, CRUD, Full-stack Application	CLO4, CLO5, CLO6
Program 19	LAMP Stack, E-commerce, Database Connectivity	CLO4, CLO5, CLO6
Program 20	LAMP Stack, Transaction Handling	CLO4, CLO5, CLO6

Alignment of CLO with PLO
3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	1	1	1	1	1	1	1	2	1
CLO2	2	2	1	1	2	2	1	1	2	1
CLO3	3	2	3	1	1	2	2	2	3	2
CLO4	2	3	2	2	2	2	1	1	2	1
CLO5	1	2	2	1	3	2	2	2	2	1
CLO6	2	1	3	2	2	2	2	1	2	3

SYLLABUS

- Exercise to create interactive web pages.
- Exercise to apply AJAX concepts.
- Exercise to implement Inventory operations using AngularJS.
- Exercise to implement the Authentication functions.
- Exercise to create menus, styles, and animation using AJAX.
- Exercise to validate student application using ReactJS.
- Exercise to handle Banking Transaction using NodeJS
- Exercise to implement MERN functions.
- Exercise to create database connectivity using PHP and MySQL
- Exercise using LAMP.
- Exercise using ReactJS

List of Programs

1. Create a PHP script that connects to a MySQL database and provides functionalities to manage employee records, including adding, retrieving, updating, and deleting employee information.
2. Using AJAX Create visual search feature to search using name for practical number 15 which list name, mobile number and email id of matching users.
3. Create a dynamic web application using AJAX to modify content on-the-fly based on user interactions, providing seamless and efficient content updates without page reloads.
4. Develop a web form utilizing AJAX to dynamically suggest options based on user input, enhancing user experience by providing real-time suggestions as they type.
5. Develop a project AngularJS application that displays a list of shopping items. Allow users to add and remove items from the list using directives and controllers.
6. Create AngularJS application that allows users to maintain a collection of items. The application should display the current total number of items, and this count should automatically update as items are added or removed. Users should be able to add items to the collection and remove the mas needed. Note: The default values for items may be included in the program.

7. Develop AngularJS application that displays a detail of students and their CGPA. Allow users to read the number of students and display the count. Note: Student details maybe included in the program.
8. Develop an AngularJS program to create a simple to-do list application. Allow users to add, edit, and delete tasks.
9. Write an AngularJS program to create simple CRUD application (Create, Read, Update, and Delete) for managing users
10. Create a program to confirm authentication using ReactJS.
11. Create a multiple option voting application using ReactJS.
12. Write a program to create a scientific calculator Application using ReactJS.
13. Create a blog using ReactJS Using the CMS.
14. Create a project on Grocery delivery application.
15. Develop a project to schedule doctor appointments using ReactJS.
16. Create a complete bank transaction for banking Credit, debit and update the balance amount Using Nodejs
17. Create a supply concept using mern concept.
18. Create a student application using mern concept.
19. Create an online shopping cart using LAMP.
20. Create a shipping concept using LAMP

Course Alignment with SDGs: 4

Pedagogy

- Concept explanation through lectures on full-stack technologies (MERN & LAMP).
- Demonstration of real-time web application development.
- Practical lab sessions for AJAX, AngularJS, ReactJS, NodeJS, PHP, and MySQL.

ELECTIVES

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS26E01	**ELECTIVE I: ADVANCED NETWORK SECURITY**	**60**	**55**	**5**	**4**

Preamble

- Introduces network security techniques for protecting communication systems and detecting cyber threats
- Describes security protocols and standards used for secure data transmission
- Addresses cryptographic mechanisms for ensuring confidentiality, integrity, and authentication
- Develops the ability to analyze network attacks and vulnerabilities
- Enables design of secure authentication and key exchange solutions for real-world networks

Prerequisite

- Basic knowledge of computer networks and operating systems, along with fundamental understanding of cryptography and programming concepts.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of network security, including protection mechanisms, secure communication protocols, attack models, authentication methods, and cryptographic key management systems.	K1
CLO2	Understand the principles of network security systems, including monitoring and detection, secure protocols, attack methodologies, authentication processes, and key agreement mechanisms.	K2
CLO3	Apply network security concepts to implement secure communication, detect and analyze threats, and manage authentication and key establishment in computing environments.	K3
CLO4	Analyze network security systems and protocols with respect to vulnerabilities, attack impacts, detection effectiveness, authentication strength, and cryptographic robustness.	K4
CLO5	Evaluate network security solutions based on effectiveness, scalability, reliability, and resilience against attacks in diverse network environments.	K5
CLO6	Design and develop secure network systems by integrating protection mechanisms, secure protocols, attack mitigation strategies, authentication techniques, and key management approaches.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Network protection, monitoring, IDS, firewalls, DNS security	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit II	Security protocols, email security, SSO mechanisms	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit III	Attack techniques and tools	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit IV	Authentication protocols and key exchange	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6
Unit V	Advanced key agreement and cryptographic protocols	CLO1, CLO2, CLO3, CLO4,CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	3	3	1	1	1	1	1	2	1
CLO4	1	3	1	3	1	1	1	1	2	1
CLO5	1	2	1	3	2	1	1	1	1	1
CLO6	2	1	3	2	3	1	1	1	2	1

ADVANCED NETWORK SECURITY (MCS26E01) (55 Hrs)

UNIT I **(11 Hrs)**

Techniques for Network Protection, Monitoring and Detection: Firewalls, packet filter and stateful firewalls, application aware firewalls, personal firewalls-IPtables, Proxies, NAT, Intrusion Detection System-Snort, Signature and Anomaly based detection, Honeypots and Honeynets, Network Log management-syslog or SPLUNK; RBAC: Role mining; DNS-Dig tool: DNSSEC-DS and NSEC records.

Case Study: Enterprise Network Breach Detection Using IDS and Firewall Logs.

UNIT II **(11 Hrs)**

Protocols and Standards: SCP, SSH, SSL3.0, TLS 1.2, STARTTLS, IPSec, VPN and Secure HTTP; Encrypting and Signing Emails: PGP- GPG/open PGP, DKIM and SPF; Single Sign On (SSO)-OAUTH and OPENID.

Case Study: HTTPS Deployment and TLS-Based Secure Web Communication.

UNIT III **(11 Hrs)**

Attack Techniques: Network reconnaissance-Nmap and vulnerability audits-openVAS; DNS based attacks, Phishing-DNS Twist; Network based malware attacks: Remote access TrojanPoison Ivy and Domain name generation algorithm based Botnets; LAN attacks: ARP Cache poisoning- Ettercap/arpspoof, MAC flooding, Man in the middle attacks, Port Stealing, DHCP attacks, VLAN hopping; Network Sniffing - Wireshark and Password Cracking-John the Ripper; Attacks on SSL/TLS: SSL stripping, Drown and Poodle attack; Network packet creation and Manipulation using scapy and dpkt libraries.

Case Study: Network Attack Techniques, Vulnerability Assessment, and Packet Manipulation in Cybersecurity

UNIT IV **(11 Hrs)**

Protocols for identification and login: Interactive protocols, ID protocols, Password protocols, Challenge-response protocols, Schnorr's identification protocol, Proving properties in zero knowledge. Authenticated Key Exchange: Goals for authentication and Key Establishment, encryption based protocol and its attacks, Perfect forward secrecy, Protocol based on ephemeral encryption, Attacks on Insecure variations, Identity protection, One-sided authenticated key exchange, Security of protocol AKE1, Password authenticated key exchange - Phishing attacks, Protocol PAKE0, Protocol PAKE1, Protocol PAKE2, Explicit key confirmation.

Case Study: Phishing Attacks and Password Authenticated Key Exchange (PAKE)

UNIT V **(11 Hrs)**

Classes of Key Agreement protocols: Diffie Hellman Key Agreement, MTI Protocols, Diffie Hellman- Based Protocols. Protocols not based on Diffie Hellman. Pairing based cryptographic protocol: ID based encryption schemes, Boneh and Franklin's Scheme, Shamir's encryption and signature schemes. Conference Key protocols: Security goals, Static and dynamic groups, Generalizing Diffie- Hell man key agreement.

Case Study: Man-in-the-Middle Attacks in Diffie–Hellman Key Agreement

*** Course Alignment with SDGs: 9, 16**

Text Books

S.NO	AUTHORS	TITLE	PUBLISHERS	YEAR & EDITION
1	William Stallings	Cryptography and Network Security: Principles and Practice	Pearson	2020, 8th Edn
2	Behrouz A. Forouzan	Cryptography & Network Security	McGraw-Hill	2015, 3rd Edn
3	Colin Boyd, Anish Mathuria, Douglas Stebila	Protocols for Authentication and Key Establishment	Springer	2020, 6th Edn
4	Dan Boneh, Victor Shoup	A Graduate Course in Applied Cryptography	-	2020, 3rd Edn

Reference Books

S.NO	AUTHORS	TITLE	PUBLISHERS	YEAR & EDITION
1	W. Stallings	Network Security Essentials: Applications and Standards	Pearson Prentice Hall	2016, 6th Edn
2	Bryan Sullivan, Vincent Liu	Web Application Security, A Beginner's Guide	McGraw-Hill Education	2012, 2nd Edn
3	C. Kaufman, R. Perlman, M. Speciner	Network Security: Private Communication in a Public World	Prentice Hall PTR	2002, 2nd Edn
4	J. Menezes, P. C. V. Oorschot, S. A. Vanstone	Handbook of Applied Cryptography	CRC Press	1996, 1st Edn
5	J. Pieprzyk, T. Hardjono, J. Seberry	Fundamentals of Computer Security	Springer	2003, 2nd Edn
6	Abhijit Das, Veni Madhavan C. E.	Public-Key Cryptography: Theory and Practice	Pearson Education	2009, 3rd Edn
7	L. Dong, K. Chen	Cryptographic Protocol: Security Analysis Based on Trusted Freshness	Springer	2012, 4th Edn

Related Online References

1. Cyber Security and Privacy – NPTEL – Designed by IIT Professors
2. Network Security – SWAYAM – Designed by UGC/AICTE Faculty
3. Introduction to Cyber Security Specialization – Coursera – Designed by IBM

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Case study-based learning (IDS, Firewall systems, SSL/TLS attacks, VPN security)
- Hands-on exposure to security tools (Wireshark, Nmap, Snort)
- Problem-solving and analytical exercises
- Group discussions and collaborative learning
- Assignments and tutorials
- Quizzes and continuous assessment
- Peer learning activities
- Student seminars and presentations

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS26E02	ELECTIVE II: DIGITAL IMAGE PROCESSING	60	55	5	4

Course Preamble

- Introduces fundamental concepts of digital image processing, including image acquisition, sampling, quantization, and spatial filtering
- Describes techniques for image enhancement, compression, and restoration to improve visual quality and efficiency
- Addresses feature extraction and pattern classification methods for image analysis and recognition
- Presents advanced concepts such as wavelets, multiresolution analysis, and 3D vision
- Emphasizes real-world applications in medical imaging, facial recognition, agriculture, AR/VR, and autonomous systems

Prerequisite

- Basic knowledge of mathematics (linear algebra, probability, statistics), fundamentals of signals and digital electronics, and programming skills in languages such as Python, C, or MATLAB, along with a basic understanding of image representation.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of digital image processing, including image acquisition, representation, enhancement, transformation, analysis, and application domains.	K1
CLO2	Understand the principles of image processing systems, including filtering, transformation, segmentation, feature extraction, compression, and restoration techniques.	K2
CLO3	Apply image processing concepts to perform enhancement, analysis, compression, segmentation, and restoration for real-world image data.	K3
CLO4	Analyze digital images and processing methods with respect to quality, efficiency, feature representation, and performance under various conditions.	K4
CLO5	Evaluate different image processing solutions based on effectiveness, accuracy, computational efficiency, and suitability for diverse applications.	K5
CLO6	Design and develop image processing solutions by integrating acquisition, enhancement, analysis, compression, and restoration methods for complex real-world problems.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Digital image fundamentals, image acquisition, sampling, quantization, spatial filtering, histogram processing, edge detection, thresholding	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit II	Image compression techniques (Huffman, LZW, Arithmetic), transform coding, predictive coding, filtering methods	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit III	Feature descriptors, image restoration, noise models, filtering techniques, pattern and image classification	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit IV	Wavelets, multiresolution processing, image pyramids, descriptors, texture analysis, case studies (medical imaging, AR/VR, etc.)	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6
Unit V	3D vision concepts, camera calibration, stereopsis, 3D modeling, shape from	CLO1, CLO2. CLO3. CLO4. CLO5. CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	3	3	1	1	1	1	1	2	1
CLO4	1	3	1	3	1	1	1	1	2	1
CLO5	1	2	1	3	2	1	1	1	1	1
CLO6	2	1	3	2	3	1	1	1	2	1

DIGITAL IMAGE PROCESSING (MCS26E02) (55 Hrs)

UNIT I (11 Hrs)

Digital Image Fundamentals: Fundamental steps in Digital Image Processing – Components of an image processing system – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels. Smoothing and Sharpening Spatial Filtering. Histogram Processing- Fundamentals- Point, Line and Edge detection- Thresholding.

Case Study: Application of digital image fundamentals in medical image acquisition (X-ray, MRI)

UNIT II (11 Hrs)

Image Compression: Fundamentals-Huffman Coding-Golomd coding - Arithmetic Coding – LZW coding-Block Transform Coding-Predictive Coding -Wavelet coding-Filters – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.

Case Study: Enhancement techniques used in satellite image processing for weather forecasting and land analysis.

UNIT III (11 Hrs)

Image segmentation and Feature extraction: Fundamentals- Point, Line and Edge detection- Thresholding-Segmentation using region growing and by region splitting and Merging.- Region segmentation using clustering and super pixels - Region segmentation using Graph cuts - segmentation using Morphological Watersheds – The use of motion in segmentation - Feature extraction: Boundary preprocessing- Boundary Feature descriptors - Region features descriptors – Principal Component as Feature descriptors.

Case Study: Facial recognition systems where segmentation and feature extraction are used to identify and verify individuals.

UNIT IV (11 Hrs)

Image Compression: Fundamentals-Huffman Coding-Golomd coding - Arithmetic Coding – LZW coding - DCT implementation using FFT Sub-image size selection Coding-Run- length Coding- Symbol-based Coding-Bit-plane Coding-Block Transform Coding-Predictive Coding -Wavelet coding.

Case study: Medical Imaging Analysis, Facial Recognition Technology and Agricultural Applications, Historical Document Restoration and Analysis.

UNIT V (11 Hrs)

Image Restoration: Degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering. Case study: Medical Imaging Analysis, Facial Recognition Technology, Agricultural Applications, Historical Document Restoration and Analysis, Entertainment and Media, Autonomous vehicles AR/VR in image processing.

*** Course Alignment with SDGs: 4, 9**

Text Books

S. No.	Authors	Title	Publisher	Year & Edition
1.	Rafael C. Gonzalez, Richard E.Woods	Digital Image Processing	Pearson Publication	2018, 4th Edn
2.	S.Jayaraman,S.Esakkirajan,T.Veerakumar	Digital Image Processing	Tata Mc Graw Hill	2020,2nd Edn
3.	Steve Marschner, Peter Shirle	Fundamentals of Computer Graphics	CRC Press	2022 5th Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1.	Sandipan Dey	Hands-On Image Processing with Python	O'Reilly Publications	2018, 2nd Edn
2.	Wilhelm Burger, Mark J. Burge	Digital Image Processing An Algorithmic Introduction	Springer	2022, 3rd Edn

Related online course

1. Digital Image Processing – NPTEL – Designed by IIT Kharagpur Professors
2. Image and Video Processing – Coursera – Designed by Duke University
3. Fundamentals of Digital Image and Video Processing – Coursera – Designed by Northwestern University

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Demonstration of image processing algorithms and tools
- Laboratory-based hands-on learning using MATLAB/Python
- Case study-based learning (Medical Imaging, Facial Recognition, AR/VR, Autonomous Systems)
- Problem-solving and analytical exercises
- Group discussions and collaborative learning
- Assignments and tutorials
- Quizzes and continuous assessment
- Peer learning activities
- Student seminars and presentations

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS26E03	ELECTIVE III: TEXT ANALYTICS	60	55	5	4

Course Preamble

- Introduces text mining and natural language processing techniques for extracting meaningful information from unstructured data
- Describes preprocessing methods, text classification, and sentiment analysis for text analytics
- Addresses advanced approaches such as word embeddings, topic modeling, and transformer-based models
- Enables design of intelligent text analytics solutions for real-world applications

Prerequisite

- Basic knowledge of data structures, probability, and programming, along with a fundamental understanding of machine learning concepts.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of text analytics, including text representation, information retrieval, probabilistic modeling, sentiment analysis, and emerging language processing methods.	K1
CLO2	Understand the principles of text processing and analysis, including linguistic preprocessing, feature representation, classification, clustering, probabilistic approaches, and sentiment evaluation techniques.	K2
CLO3	Apply text analytics methods to process, represent, and analyze textual data for tasks such as information extraction, classification, clustering, and sentiment analysis.	K3
CLO4	Analyze textual data and models with respect to performance, representation quality, probabilistic behavior, and effectiveness in handling diverse and complex text sources.	K4
CLO5	Evaluate text analytics solutions based on accuracy, scalability, interpretability, robustness, and ethical considerations in real-world applications.	K5
CLO6	Design and develop advanced text analytics systems by integrating preprocessing, modeling, sentiment analysis, probabilistic methods, and modern language processing approaches for complex applications.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Text mining basics, preprocessing, representation, embeddings	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Information retrieval, classification, clustering, topic modelling	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Probabilistic models and sequence models	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Sentiment analysis techniques and applications	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Advanced sentiment analysis, fake review detection, ethics, BERT	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	2	3	1	1	1	1	1	2	1
CLO4	2	3	1	1	2	1	1	1	1	1
CLO5	1	2	1	1	3	1	1	1	2	1
CLO6	2	2	3	1	2	1	1	1	2	1

TEXT ANALYTICS (MCS26E03) (55 Hrs)

UNIT I **(11 Hrs)**

Text Mining - Definition - General Architecture – Core Text mining Operations. Nature of unstructured and semi-structured text, collecting documents NLP: Text pre-processing-Sentence Segmentation tokenization - lemmatization - stemming - Parsing text - keywords- POS, Bag of Words Model, n-grams, chunking and Named Entity Recognition (NER) Corpus - sentence boundary determination - Textual information to numerical vectors -vector generation for prediction- document standardization and Representation – Inverted Index-term document matrix (TDM)-TDM Frequency. Introduction to word embeddings (Word2Vec, GloVe) – Dimensionality reduction (PCA – basic idea) – Handling multilingual and code-mixed text – Basics of text annotation.

UNIT II **(11 Hrs)**

Information retrieval- keyword search - Vector space scoring, Models - web- based document search matching-inverted lists. Information extraction-Architecture - Co-reference - Named Entity and Relation Extraction-Template filling and database construction –Applications. Inductive -Unsupervised Algorithms for Information Extraction. Text Categorization – Definition – knowledge engineering, Text Classification, Feature Selection for Text Classification, Gini Index, Information Gain. Evaluating model: confusion matrix, class specific measure Classification models: Decision Tree Classifiers -Rule- based Classifiers - Naive Bayes Classifiers - Methods for Text Clustering –Distance and similarities. Introduction to Topic Modeling (LDA – basic idea) – Applications such as spam filtering and document tagging.

UNIT III **(11 Hrs)**

Probabilistic Models: Introduction, Mixture Models, Stochastic Processes in Bayesian Nonparametric Models, Graphical Models, Probabilistic Models with Constraints, Parallel Learning Algorithms. Probabilistic Models for Information Extraction -Hidden Markov Models -Stochastic Context-Free Grammars - Maximal Entropy Modelling -Maximal Entropy Markov Models - Conditional Random Fields. Introduction to neural probabilistic models– Comparison of probabilistic and neural approaches – Applications in machine translation and speech processing.

UNIT IV **(11 Hrs)**

Introduction: Sentiment Analysis Applications - Sentiment Analysis Research - Sentiment Analysis as Mini NLP. The Problem of Sentiment Analysis: Definition of Opinion - Definition of Opinion Summary - Affect, Emotion, and Mood - Different Types of Opinions - Author and Reader Standpoint. Document Sentiment Classification: Supervised Sentiment Classification - Unsupervised Sentiment Classification - Sentiment Rating Prediction - Cross-Domain Sentiment Classification – Cross Language Sentiment Classification - Emotion Classification of Documents. Fine-grained sentiment analysis – Social media sentiment analysis – Introduction to deep learning methods (CNN/RNN – overview) – Real-time sentiment analysis systems.

UNIT V **(11 Hrs)**

Subjectivity - Sentence Subjectivity Classification - Sentence Sentiment Classification - Dealing with Conditional Sentences - Dealing with Sarcastic Sentences - Cross-Language Subjectivity and Sentiment Classification - Using Discourse Information for Sentiment Classification - Emotion Classification of Sentences. Subjectivity classification and Aspect Based sentiment classification. Sentiment Lexicon Generation: Dictionary-Based Approach - Corpus-Based Approach - Desirable and Undesirable Facts. - Use Cases: Detecting Fake or Deceptive Opinions: Different Types of Spam - Supervised Fake Review Detection - Supervised Yelp Data Experiment - Automated Discovery of Abnormal Patterns - Model-Based Behavioural Analysis - Group Spam Detection - Identifying Reviewers with Multiple User ids - Exploiting Business in Reviews - Some Future Research Directions. Trust and credibility analysis – Ethical issues in

sentiment analysis – Bias and fairness in NLP systems – Introduction to transformer models (BERT – basic idea) – Emerging research directions.

*** Course Alignment with SDGs: 4, 9**

Text Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Murugan Anandarajan	Practical Text Analytics: Maximizing the Value of Text Data	Springer	2018, 1st Edn
2	Charu C. Aggarwal	Machine Learning for Text	Springer	2018, 1st Edn
3	Steven Bird, Ewan Klein, Edward Loper	Natural Language Processing with Python	O'Reilly Media	2009, 1st Edn
4	Bing Liu	Sentiment Analysis: Mining Opinions, Sentiments and Emotions	Cambridge University Press	2015, 1st Edn

Reference Books

S. No.	Authors	Title	Publisher	Year & Edition
1	Markus Hofmann, Andrew Chisholm	Text Mining and Visualization: Case Studies Using Open Source Tools	CRC Press, Taylor & Francis	2016, 1st Edn
2	Charu C. Aggarwal, Cheng Xiang Zhai	Mining Text Data	Springer	2012, 1st Edn
3	Dipanjan Sarkar	Text Analytics with Python	Apress	2019, 2nd Edn
4	Bing Liu	Sentiment Analysis and Opinion Mining	Morgan & Claypool Publishers	2012, 1st Edn
5	Erik Cambria, Dipankar Das	A Practical Guide to Sentiment Analysis	Springer	2017, 1st Edn

Related Online Courses

1. Business Analytics & Text Mining Modelling Using Python, IIT Roorkeehttps://swayam.gov.in/
2. Natural Language Processing, IIT Kharagpurhttps://swayam.gov.in/
3. Text Mining and Natural Language Processing in Rhttps://www.udemy.com/

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Case study-based learning (Sentiment analysis, Fake review detection, Topic modeling, Text classification)
- Hands-on exercises using NLP tools and Python libraries (NLTK, spaCy, Scikit-learn)
- Problem-solving and analytical exercises
- Group discussions and collaborative learning
- Assignments and tutorials
- Quizzes and continuous assessment
- Peer learning activities
- Student seminars and presentations

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCS26E04	ELECTIVE IV: SOFT COMPUTING	60	55	5	4

Course Preamble

- Introduces fundamental concepts and techniques of soft computing, including neural networks, fuzzy systems, genetic algorithms, and hybrid intelligent systems
- Focuses on handling uncertainty and solving complex real-world problems using bio-inspired computational approaches
- Emphasizes both theoretical understanding and practical applications through case studies such as prediction, classification, and optimization
- Develops the ability to design adaptive and intelligent systems for diverse application domains

Prerequisite

- Basic knowledge of data structures, discrete mathematics, and programming concepts, along with a fundamental understanding of algorithms and problem solving.

Course Learning Outcomes (CLOs)

On the successful completion of the course, students will be able to,

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Identify fundamental concepts of soft computing, including neural networks, fuzzy systems, evolutionary computation, hybrid models, and their application domains.	K1
CLO2	Understand the principles of soft computing methodologies, including learning mechanisms, reasoning processes, optimization strategies, and integration of multiple computational paradigms.	K2
CLO3	Apply soft computing concepts to develop solutions for real-world problems using learning, reasoning, and optimization frameworks.	K3
CLO4	Analyze soft computing models with respect to performance, convergence behavior, accuracy, adaptability, and suitability for different problem domains.	K4
CLO5	Evaluate alternative soft computing solutions based on efficiency, robustness, scalability, and effectiveness in handling uncertainty and imprecision.	K5
CLO6	Design and develop intelligent systems by integrating neural, fuzzy, evolutionary, and hybrid models to solve complex real-world problems.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
Unit I	Introduction to soft computing, ANN models, learning rules, case study	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Advanced neural networks and applications	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Fuzzy systems and decision making	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Genetic algorithms and optimization	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Hybrid systems and intelligent applications	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO 1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	2	2	1	1	1	1	1	1	1	1
CLO3	2	2	3	1	1	1	1	1	2	1
CLO4	2	3	1	1	2	1	1	1	1	1
CLO5	1	2	1	1	3	1	1	1	2	1
CLO6	2	2	3	1	2	1	1	1	2	1

SOFT COMPUTING (MCS26E04) (55 Hrs)

UNIT I (11 Hrs)

Introduction to Soft Computing - Importance and applications – Comparision with Hard Computing – Future Trends in Soft Computing. Artificial Neural Networks-Fuzzy Systems-Genetic Algorithm and Evolutionary Programming-Swarm Intelligent Systems-Classification of ANNs-McCulloch and Pitts Neuron Model-Learning Rules: Hebbian and Delta- Perceptron Network-Adaline Network-Madaline Network.

Case Study: Weather Prediction using Soft Computing Techniques.

UNIT II (11 Hrs)

Neural Networks Back Propagation Neural Networks - Kohonen Neural Network -Learning Vector Quantization- Hamming Neural Network- Hopfield Neural Network-Bi-directional Associative Memory - Adaptive Resonance Theory Neural Networks- Support Vector Machines-Spike Neuron Models.

Case Study: Handwritten Digit Recognition using Neural Networks.

UNIT III (11 Hrs)

Fuzzy system Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets – Classical Relations and Fuzzy Relations – Membership Functions- Defuzzification – Fuzzy Arithmetic and Fuzzy Measures – Fuzzy Rule Base and Approximate Reasoning - Introduction to Fuzzy Decision Making.

Case Study: Student Grade Evaluation using Fuzzy Logic.

UNIT IV (11 Hrs)

Genetic Algorithm Basic Concepts- Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators- Cross Over – Inversion and Deletion –Mutation Operator - Bit-wise Operators - Convergence of Genetic Algorithm.

Case Study: Travelling Salesman Problem (TSP) using Genetic Algorithm.

UNIT V (11 Hrs)

Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic -GA Based Weight Determination - LR- Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP- Inference by Fuzzy BP- Fuzzy Art Map: A Brief Introduction-Soft Computing Tools- GA in Fuzzy Logic Controller Design - Fuzzy Logic Controller.

Case Study: Adaptive Traffic Signal Control using Neuro-Fuzzy System (GA-Optimized Fuzzy Controller)

*** Course Alignment with SDGs: 4, 9**

Reference Books

S. NO.	AUTHOR	TITLE OF THE BOOK	PUBLISHERS	YEAR OF PUBLICATION / EDITION
1	S.Rajasekaran, G.A.Vijayalakshmi Pai	Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications	PHI Learning Pvt.Ltd	2017, 2nd Edn
2	S.N.Sivanandam S.N.Deepa	Principles of Soft Computing	S.K. Katria &Sons	2017, 3rd Edn
3	Vinoth Kumarand R. Saravana Kumar	Neural Networks and Learning Machines	Prentice Hall of India	2011, 2nd Edn

4	Tang,Tanand Yi	Neural Networks: Computational Models and Application	Springer Verlag Publications	2007, 2nd Edn

Related online course

1. Soft Computing – NPTEL – Designed by IIT Professors
2. Artificial Intelligence – SWAYAM – Designed by UGC/AICTE Faculty
3. Machine Learning Specialization – Coursera – Designed by Andrew Ng

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture – Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Demonstration of image processing algorithms and tools
- Laboratory-based hands-on learning using MATLAB/Python
- Case study-based learning (Medical Imaging, Facial Recognition, AR/VR, Autonomous Systems)
- Problem-solving and analytical exercises
- Group discussions and collaborative learning
- Assignments and tutorials
- Quizzes and continuous assessment
- Peer learning activities
- Student seminars and presentations