Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Udumalai Road, Pollachi, Coimbatore District 642003
Estd. 1998 | AICTE Approved | Affiliated to Anna University
An Autonomous Institution
NAAC A++ GRADE
Cycle 3 (2023-2030)
The Highest Grade

Curriculum and Syllabi

M.E. Computer Science and Engineering

Semesters I to IV

Regulations 2024

Dr.Mahalingam College of Engineering and Technology

Department of Computer Science and Engineering

Vision

To develop engineers with global employability, entrepreneurship capability, research focus and social responsibility

Mission

- To develop internationally competent engineers in dynamic IT field by providing state-of-art academic environment and industry driven curriculum
- To motivate and guide students to take up higher studies and establish entrepreneurial ventures
- To enrich the department through committed and technically sound faculty team with research focus in thrust areas
- To undertake societal problems and provide solutions through technical innovations and projects in association with the industry, society and professional bodies

Dr.Mahalingam College of Engineering and Technology

Programme: M.E. Computer Science and Engineering

Programme Educational Objectives (PEOs) - Regulations 2024

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Domain Expertise and Leadership: Exhibit sustained knowledge in the field of Computer Science and Engineering and possess leadership capability in their professional careers.

PEO2. Problem Solving: Design optimal computing solutions for engineering problems to meet the needs of individuals, organizations and society.

PEO3. Lifelong Learning and Research: Engage in lifelong learning and contribute towards independent and collaborative scientific research

Programme Outcomes (POs) - Regulations 2024

On successful completion of the programme the graduates will be able to:

PO1. Scholarship of Knowledge: Acquire in-depth knowledge in Computer Science and Engineering with an ability to discriminate, evaluate, analyse and synthesize knowledge.

PO2. Research Skill: Investigate suitable literature and conduct experiments apply appropriate research methodologies, techniques and tools to demonstrate higher order skill and contribute to the development of technological knowledge in Computer Science and Engineering.

PO3. Usage of Modern Tools: Develop and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities.

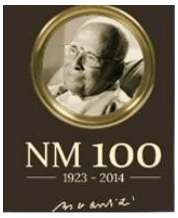
PO4. Communication: Communicate effectively regarding complex engineering activities, write effective reports and design documentation by adhering to appropriate standards and make effective presentations

Programme Specific Outcomes (PSOs) - Regulations 2024

On successful completion of the programme the graduates will be able to:

PSO1. Data Management: Analyze large scale data and provide scalable solutions for real world problems.

PSO2. Computing and Communication: Design and evaluate techniques for secure computing and communication.



MCET | Dr. MAHALINGAM COLLEGE OF ENGINEERING AND TECHNOLOGY

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NAAC A++ GRADE
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Department of Computer Science and Engineering
M.E - Computer Science and Engineering
2024 Regulations – Curriculum for Semesters I to IV

Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24MAT102	Applied Probability and Statistics	3	0	0	3	100	-
24CPT101	Data Structures and Algorithms	3	0	0	3	100	-
24CPT102	Network Design and Management	3	0	0	3	100	-
XXXXXXX	Professional Elective - I	3	0	0	3	100	-
24CCT101	Research Methodology and IPR	3	0	0	3	100	All
24CPL101	Data Structures Laboratory	0	0	4	2	100	-
24CPL102	Networks Laboratory	0	0	4	2	100	
24SHA101	English for Research Paper Writing	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24CPT201	Data Analytics	3	0	0	3	100	-
24CPT202	Machine Learning	3	0	0	3	100	-
24CPT203	Modern Operating Systems	3	0	0	3	100	-
XXXXXXX	Professional Elective - II	3	0	0	3	100	-
XXXXXXX	Professional Elective – III	3	0	0	3	100	-
24CPL201	Data Analytics and Machine Learning Laboratory	0	0	4	2	100	-
24CPL202	Research Paper Seminar	0	0	2	1	100	-
24SHA201	Teaching and Learning in Engineering	0	0	4	-	100	All
Total		**15**	**0**	**10**	**18**	**800**	

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
XXXXXXX	Professional Elective – IV	3	0	0	3	100	-
XXXXXXX	Professional Elective – V	3	0	0	3	100	-
XXXXXXX	Open Elective/ Online Course	3	0	0	3	100	-
24CPP301	Project – I	0	0	20	10	200	-
Total		**9**	**0**	**20**	**19**	**500**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24CPP401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 72

Professional Electives (Semesters I to III)

Course code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24CPE001	Advanced Computer Architecture	3	0	0	3	100
24CPE002	Advanced Databases	3	0	0	3	100
24CPE003	Compiler Optimization Techniques	3	0	0	3	100
24CPE004	Digital Media Processing Techniques	3	0	0	3	100
24CPE005	Soft Computing	3	0	0	3	100
24CPE006	Cloud Computing and IoT	3	0	0	3	100
24CPE007	GPU Architectures and Computing	3	0	0	3	100
24CPE008	Security in Computing	3	0	0	3	100
24CPE009	Natural Language Processing	3	0	0	3	100
24CPE010	Information Retrieval	3	0	0	3	100
24CPE011	Social Network Mining	3	0	0	3	100
24CPE012	Blockchain	3	0	0	3	100
24CPE013	Embedded System Design	3	0	0	3	100
24CPE014	Extended Reality	3	0	0	3	100
24CPE015	Advanced Software Engineering	3	0	0	3	100

Course code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24CPE016	Nature Inspired Computing	3	0	0	3	100
24CPE017	Wireless Security	3	0	0	3	100
24CPE018	Industrial IOT	3	0	0	3	100
24CPE019	Deep Learning Techniques	3	0	0	3	100
24CPE020	Reinforcement Learning	3	0	0	3	100

List of Open Electives

Course code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24CPO301	Business Analytics	3	0	0	3	100
24CPO302	Cyber Security and Forensics	3	0	0	3	100

Syllabus - Semester I

Course Code: 24MAT102		Course Title: Applied Probability and Statistics	
Course Category: Foundation Course		Course Level: Introductory	
L:T:P(Hours/Week) 3 : 0 : 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on Probability and random variables. The course intends to provide exposure the small / large sample tests through tests of hypothesis. To enable the students to use the concepts of multivariate analysis.

Module I **23 Hours**

Probability Distributions: Random variables - Moments, Moment generating function - Probability distributions: Binomial, Poisson, Exponential and Normal distributions - Functions of one Random variable. **Two Dimensional Random Variables:** Joint distributions - Marginal and Conditional distributions - Covariance - Correlation Regression - Functions of two random variables Central limit theorem. **Estimation Theory:** Point Estimation: Properties of estimators-Unbiased Estimators-Curve fitting by Principle of least squares.

Module II **22 Hours**

Testing of Hypothesis: Sampling distributions - Statistical hypothesis - Small sample test: I test for single mean and difference of means - F test. Chisquare test for goodness of fit and independence of attributes - ANOVA: One way and Two way classification – Latin Square Design. **Multivariate Analysis:** Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate a thorough understanding of the principles of probability theory and distributions	Apply
CO2: Calculate the marginal and conditional distributions of bivariate random variable	Apply
CO3: Compute point estimation of parameters and fit a curve to the given duly.	Apply
CO4: Formulate and test hypotheses using small and large sample tests.	Apply
CO5: Apply multivariate analysis techniques in the analysis of data	Apply

Text Books:

T1. Irwin Miller, Marylees Miller, “John E. Freund's Mathematical Statistics with Applications", 7th Edition, Pearson Education Limited, 2014.

T2. Johnson, R.A. Miller and Freund's, “Probability and Statistics for Engineers", 7th Edition, Prentice Hall of India, 2005.

Reference Books:

R1. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, 8th Edition, Cengage Learning, 2012.

R2. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 8th Edition, Pearson Education, Asia, 2002.

R3. Anderson. T.W, “An introduction to Multivariate Statistical Analysis", John Wiley and Sons, 2003.

Web References:

1. https://archive.nptel.ac.in/courses /111/105/111105090/
2. https://archive.nptel.ac.in/courses /111/105/111105041/

Course Code: 24CPT101		Course Title: Data Structures and Algorithms	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3 : 0 : 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on advanced data structures and algorithm design strategies. The course aims to enable the learners to identify the suitable data structure and design algorithms for problem solving.

Module I **22 Hours**

Lists: Linked lists - Skip lists - Self-organizing lists. **Balanced Trees:** AVL Trees – Treaps - Multiway Search Trees: B-Trees - B+ Trees. **Search Trees:** k-d Trees - R-Trees – Tries - Suffix Trees and Arrays.

Module II **23 Hours**

Theory of NP Completeness - Satisfiability problem – Cooks Theorem – NP Complete problems. **Randomized Algorithms:** Primality Testing - Closest pair problem - Pattern matching. **Approximation Algorithms:** Node cover problem - Bin-packing - Polynomial Time Approximation Schemes: 0/1 Knapsack problem. **Online Algorithms:** k-server problem - Bipartite matching - Convex Hull problem.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Implement various operations on advanced data structures	Apply
CO2:Solve search problems using the appropriate data structure	Apply
CO3:Choose the best suited algorithm design paradigm for solving a problem.	Evaluate
CO4:Design efficient algorithms for real world applications.	Create

Text Books:

T1. Adam Drozdek, “Data Structures and Algorithms in Java”, 4th Edition, Cengage Learning, 2013.

T2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, “Introduction to the Design and Analysis of Algorithms A Strategic Approach”, Tata McGraw Hill, 2012.

Reference Books:

R1. Charles E. Leiserson, Ronald Rivest, Thomas H. Cormen and Clifford Stein, “Introduction to Algorithms”, 4th Edition, MIT Press, 2022.

R2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran “Fundamentals of Computer Algorithms”, 2nd Edition, Universities press, 2008.

R3. Mark A. Weiss, “Data Structures and Algorithm Analysis in Java”, 3rd Edition, Pearson Education, 2012.

Web References:

1.https://www.coursera.org/specializations/data-structures-algorithms

2.http://visualalgo.net

Course Code: 24CPT102		Course Title: Network Design and Management	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on network management and quality of service. The course intends to provide exposure on designing reliable networks, virtualization and effective management techniques.

Module I **22 Hours**

TCP/IP Network Architecture – Routers and Switches – Reliable Data Service – Sliding Window Protocol – Congestion Control and Avoidance Algorithms – Measuring and Managing Network Congestion – Internet Addressing – IPv4 and IPv6 Addressing scheme – Classless Interdomain Routing – DHCP – Routing Protocols: Distance Vector, Link State Routing – Error and Control Messages – Wireless Networks – IEEE 80.2.11 – Zigbee – Mobility and Mobile IP – Wireless Sensor Networks.

Module II **23 Hours**

QoS Tools – Queuing and Scheduling Algorithms – Random Early Detection – Differentiated Services – QoS in LTE and 5G Networks – Network Virtualization – Virtual LANs – Open Flow Technology – Tunneling and Encapsulation – Network Address Translation – Software Defined Networks – Network Management – MIB – SNMP and Security.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the working of various TCP congestion control techniques in wired and wireless networks	Analyze
CO2: Design wired/ wireless network with suitable IP addressing using appropriate routing protocol	Create
CO3: Analyze the quality of service offered in various real time applications	Analyze
CO4: Compare the performance of a network after applying virtualization concepts and network management protocols	Analyze

Text Books:

T1. James F. Kurose, Keith W. Ross, "Computer Networking – A top down Approach Featuring the Internet", 8th Edition, Pearson Education, 2021.

T2. Miguel Barreiros, Peter Lundqvist, "QoS Enabled Networks: Tools and Foundations", 2nd Edition, John Wiley & Sons, 2016

Reference Books:

R1. Christos N Houmkozlis, George A Rovithakis, "End-to-End Adaptive Congestion Control in TCP/IP Networks", CRC Press, 2017.

R2. Douglas E. Comer, "Internetworking with TCP/IP: Principles, Protocol and Architecture Volume I", 6th Edition, Pearson Education, 2014.

R3. Larry Peterson, Carmelo Cascone, Bruce Davie, "Software-Defined Networks: A Systems Approach", Systems Approach LLC, 2021.

Web References:

1. https://archive.nptel. ac.in/courses/106/105/106105183/
2. https://nptel.ac.in/courses /106106091

Course Code: 24CCT101		Course Title: Research Methodology and IPR	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to describe the attitude measurements, scales and sampling methods and to apply hypotheses testing in research problem. Elucidate the research report writing and presentation effectively to encourage applying for patent and copyrighting for their innovative works.

Module I **22 Hours**

Overview of Research Methodology: Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

Attitude Measurements, Scales and Sampling Methods: Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified, sampling, cluster sampling. Non- probability sampling method– convenience.

Module II **23 Hours**

Hypotheses Testing: Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests).

Report Writing and Presentation: Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

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

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the attitude measurements, scales and sampling methods	Apply
CO2: Apply hypotheses testing in research problem	Apply
CO3: Apply the patent and copyright for their innovative works	Apply

Reference Books:

R1. Panneerselvam, R, “Research Methodology”, Prentice-Hall of India, 2004.

R2. Kumar, Ranjit, “Research Methodology: A Step by Step Guide for beginners”, London Sage Publications, 2005.

R3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Publications,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, Clause 8 Publishing, 2016

R5. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publications, 2008

Course Code: 24CPL101		Course Title: Data Structures Laboratory	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:4	Credits:2	Total Contact Hours:60	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on problem solving by choosing the ideal data structure and algorithm design paradigm.

List of Experiments:

1. Implementation of lists
2. Implementation of AVL Tree
3. Implementation of Treaps
4. Implementation of B-Trees
5. Implementation of k-d trees
6. Implementation of Tries
7. Implementation of Suffix Trees

Problem solving using:

8. Randomized algorithms
9. Approximation algorithms
10. Online algorithms

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Develop algorithms to implement operations on various data structures	Apply
CO2:Design efficient algorithms using suitable algorithm design paradigm for solving real-world problems	Create

Reference Books:

R1. Adam Drozdek, “Data Structures and Algorithms in Java”, 4th Edition, Cengage Learning, 2013.

R2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, “Introduction to the Design and Analysis of Algorithms A Strategic Approach”, Tata McGraw Hill, 2012.

R3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran “Fundamentals of Computer Algorithms”, 2nd Edition, Universities press, 2008.

Web References:

1. https://www.coursera.org/specializations/data-structures-algorithms
2. http://visualalgo.net

Course Code: 24CPL102		Course Title: Networks Laboratory	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:4	Credits: 2	Total Contact Hours: 60	Max Marks: 100

Course Objective:

The course is intended to impart knowledge with hands on experience in designing and implementing networking concepts with quality of services and management techniques.

List of Experiments:

1. Application development using socket programming
2. Performance analysis of transport layer protocols
3. Implementation of congestion control algorithms
4. Design local area network with IP address configuration
5. Design multi-router network and testing using simulation tools
6. Implementation of Routing protocols
7. Design of network virtualization using simulation tools
8. Demonstration of network management using SNMP
9. Implementation of Queuing and Scheduling policies
10. Analysis of LAN traffic using simulation tools

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design network applications using appropriate socket programming.	Create
CO2: Design IP LAN and WAN network using subnetting and IP address configuration.	Create
CO3: Implement network virtualization and management protocols using simulation tools.	Apply
CO4: Analyze real time network and monitor the performance.	Analyze

Reference Books:

R1. James F. Kurose, Keith W. Ross, "Computer Networking – A top down Approach Featuring the Internet", 8th Edition, Pearson Education, 2021.

R2. Miguel Barreiros, Peter Lundqvist, "QoS Enabled Networks: Tools and Foundations", 2nd Edition, John Wiley & Sons, 2016.

Web References:

1. https://archive.nptel. ac.in/courses/106/105/106105183/
2. https://nptel.ac.in/courses /106106091

Course Code: 24SHA101		Course Title: English for Research Paper Writing (Common to all PG Programme)	
Course Category: Audit Course		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Credits:-	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to enhance the language skills concerning research paper writing and to explain the crucial role of technology in enhancing the quality and credibility of research.

Module I **15 Hours**

Foundations of Academic English in Research: Academic English - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References. **Effective Writing Style for Research Papers:** Word Order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Paraphrasing Skills. **Advanced Reading and Research Vocabulary Development:** Critical Reading Strategies - Analysing Research Articles - Identifying Arguments - Evaluating Findings - Formulaic Expressions - Academic Phrase Bank - Discipline-Specific Vocabulary - Commonly Misused Words.

Module II **15 Hours**

Presentation Language Skills: Written vs. Spoken English - Dynamic Vocabulary for Presentations -Expressive Language for Audience Engagement- Language for Clear and Impactful Slides - Adapting Language Style to Different Audiences. **Grammar Refinement for Research Writing:** Advanced Punctuation Usage- Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences. **Technology and Language for Research:** Technology and Role of AI in Research Writing - Citations and References - Plagiarism and Ethical Considerations - Tools and Awareness - Fair Practices.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Enhance their English Language Skills concerning research paper writing.	Understand
CO 2: Develop a comprehensive set of linguistic skills essential for academic research.	Apply
CO 3: Produce well-structured research papers using a variety of research and presentation technologies.	Apply

Reference Books:

R1. Craswell, G. 2004. Writing for Academic Success. Sage Publications. Springer, New York.
R2. Wallwork, Adrian. 2015. English for Academic Research: Grammar, Usage and Style.
R3. Swales, J. & C. Feak. 2012. Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press.
R4. English for Writing Research Papers, Springer, New York, 2011.

Web References:

1. https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf
2. https://libguides.usc.edu/writingguide/grammar
3. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview

Assessment Pattern:

	Assessment Component	Co. No.	Marks	Total
Continuous Comprehensive Evaluation (Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

Student will be finally awarded with three levels based on the score as follows:

Marks Scored	Levels
70% & above	Good
30-69 %	Average
< 30 %	Fair

Syllabus - Semester II

Course Code: 24CPT201		Course Title: Data Analytics	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on various models and algorithms used for the analyzing the given datasets. The course intends to provide in-depth knowledge on the methods used for descriptive and predictive analysis of real time data.

Module I **22 Hours**

Descriptive Analytics: Big Data and Data Science – KDD Process – Descriptive Statistics – Univariate and Multivariate Analysis – Data Quality and Preprocessing – Data Transformation Methods – Clustering Techniques – Distance Measures – K-means – DBSCAN – Agglomerative Hierarchical Clustering Technique – Frequent Pattern Mining – Case Study: Descriptive Analytics on Breast Cancer Dataset.

Module II **23 Hours**

Predictive Analytics: Regression – Classification – Distance-based Learning Algorithms – Probabilistic Classification Algorithms – Search-based Algorithms – Optimization-based Algorithms – Ensemble Learning – Algorithm Bias – Non-binary Classification Tasks – Advanced Data Preparation Techniques for Prediction – Performance Evaluation Techniques – Applications: Text Analytics – Recommender Systems – Social Network Analysis – Case Study: Predictive Analytics on Movie Dataset

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Perform exploratory data analysis on the given datasets using similarity based algorithms	Apply
CO2: Extract hidden patterns and perform descriptive analysis of dataset using appropriate model	Analyze
CO3: Develop Predictive data analytics based solutions for real world problems using inductive learning algorithms	Create
CO4: Build solutions for Text, Web and Social Media problems using suitable data analytic models	Create

Text Book:

T1. Joao Mendes Moreira, Andre Carvalho, Tomas Horvath, “A General Introduction to Data Analytics”, John Wiley & Sons, 2019

Reference Books:

R1. John D. Kelleher, Brian Mac Namee, and Aoife D’Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics”, 2nd Edition, MIT Press, 2020

R2. Thomas A. Runkler, “Data Analytics Models and Algorithms for Intelligent Data Analysis”, 3rd Edition, Springer, 2020

Web References:

1. https://archive.nptel.ac.in/courses/ 110/106/110106072/#
2. https://onlinecourses.nptel.ac.in/ noc21_cs45/preview
3. https://www.coursera.org/ learn/introduction-to-data-analytics

Course Code: 24CPT202		Course Title: Machine Learning	
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to impart knowledge on machine learning, supervised and unsupervised learning techniques.

Module I **22 Hours**

Machine Learning- History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

Module II **23 Hours**

Clustering Algorithms: K-Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning- Markov Models – Hidden Markov Model- Deep Learning- Building blocks of Neural Networks– Convolutional Neural Networks (CNN) – Recurrent Neural Networks (RNN).

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design a supervised learning model that can learn and predict output in real time.	Apply
CO2: Implement and evaluate Probabilistic, Discriminative and Generative algorithms for an application.	Analyze
CO3: Apply unsupervised learning techniques on real-world dataset for clustering and dimensionality reduction.	Apply
CO4: Employ neural network and deep learning algorithms to design learning models for text / speech /image processing application.	Create

Text Books:

T1.Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, 2nd Edition, CRC press, 2014.

T2 Ethem Alpaydin, “Introduction to Machine Learning”, 2nd Edition, MIT Press, 2014.

T3.Seth Weidman, “Deep Learning from Scratch: Building with Python from First Principles”, O'Reilly publication, 2019.

Reference Books:

R1. S.Sridar, M.Vijayalakshmi , “Machine Learning”, Oxford University Press, 2021.

R2. Josh Patterson and Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly, 2017.

Web References:

1. https://nptel.ac.in/courses/106106139
2. https://www.kaggle.com/kanncaa1/ machine-learning-tutorial-for-beginners
3. https://www.coursera.org/learn/machine-learning-duke

Course Code: 24CPT203		Course Title: Modern Operating Systems	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on demonstrating the design and synchronization issues between processes, resource management techniques for Distributed systems, Failure Recovery and Fault Tolerance. The course also intends to describe the different features of real time and Mobile Operating Systems.

Module I **23 Hours**

Architectures of Distributed Systems: System Architecture Types - Distributed Operating Systems- Issues in Distributed Operating Systems- Communication Primitives Distributed Mutual Exclusion- Distributed Deadlock Detection- Agreement Protocols- Distributed File Systems- Distributed Shared Memory- Distributed Scheduling

Module II **22 Hours**

Classification of Failures: Error recovery – Recovery in concurrent systems – Check pointing and recovery. **Fault tolerance:** Issues – Commit protocols – Voting protocols: Static, Dynamic – Failure resilient processes – Reliable communication. **Real Time Systems:** Introduction – Concepts of Real Time Task Scheduling – Scheduling of Real time tasks in Multiprocessor and Distributed Systems-Handling Resource Sharing. **Mobile OS:** Architecture and SDK Framework –Media Layer –Services Layer –Core OS Layer – File System. **Case Study- iOS:** Features of iOS-Architecture of iOS-iOS Kernel Architecture-Processes and Threads Management-Memory Management-File System in iOS.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve communication and synchronization issues between processes in a distributed environment	Apply
CO2: Analyze various resource management techniques for distributed systems.	Analyze
CO3: Design fault-tolerant systems using various failure recovery models and commit protocols in distributed systems	Apply
CO4: Analyze the working principles of Real-Time and Mobile Operating Systems.	Analyze

Text Books:

T1. Mukesh Singhal, Niranjan G. Shivaratri, “Advanced Concepts in Operating Systems: Distributed, Database, and Multiprocessor Operating Systems”, Tata McGraw-Hill, 2011.

T2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson Education India, 2007.

Reference Books:

R1. Pradeep K. Sinha, “Distributed Operating Systems: Concepts and Design”, PHI Learning, 2012.

R2. Phillip A. Laplante Seppo J. Ovaska, “Real-Time Systems Design and Analysis -Tools for the Practitioner”, 4th Edition, John Wiley & Sons Publication, 2012

R3.John Ray, “iOS 9 Application Development in 24 Hours”, Sams Teach Yourself, 2019.

Web References:

1. https://nptel.ac.in/courses/106106168/
2. https://archive.nptel.ac.in/courses/106/105/106105229/
3. https://developer.apple.com/

Course Code: 24CPL201		Course Title: Data Analytics and Machine Learning Laboratory	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:4	Credits: 2	Total Contact Hours: 60	Max Marks: 100

Course Objective:

The course is intended to impart knowledge with hands on experience in designing and implementing data analytics using Machine Learning techniques for providing solutions to real world problems.

List of Experiments:

1. Implement data processing techniques and data analytic functions.
2. Perform exploratory data analysis with simple visualizations using real time data.
3. Cluster the given data using various models and evaluate the performance.
4. Construct linear regression models using the given dataset.
5. Perform Text Analysis operations with the given dataset.
6. Demonstrate sentiment analysis process with the sample dataset.
7. Build a machine learning model to solve real-world problems using kernel machines.
8. Implement Dimensionality reduction technique.
9. Design a Convolutional Network to identify handwriting character recognition.
10. Develop a speech processing application using Recurrent Neural Networks**.**

Identified Tools: Python, R tool, Open Web Analytics, Microsoft Power BI Desktop, Apache Spark

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate the data pre-processing and data analysis concepts for the given dataset and visualize the results	Apply
CO2: Identify the patterns in the given dataset and organize them based on similarity	Apply
CO3: Develop prediction based algorithms and evaluate their performance	Analyze
CO4: Build efficient Machine Learning models to provide data analytic solutions for real time problems.	Create

Reference Books:

R1. Avinash Navlani, Armando Fandango, Ivan Idris, "Python Data Analysis: Perform Data Collection, Data Processing, Wrangling, Visualization, and Model Building Using Python", 3rd Edition, Packt Publishing, 2021.

R2. Sayan Mukhopadhyay, "Advanced Data Analytics Using Python With Machine Learning, Deep Learning and NLP Examples", Apress, 2018.

R3. Abdulhamit Subasi, "Practical Machine Learning for Data Analysis Using Python", Elsevier Science, 2020.

Web References:

1. https://ifacet.iitk.ac.in/professional-certificate-course-in-data-analytics/
2. https://www.pluralsight.com/courses/data-analytics-hands-on

Course Code: 24CPL202		Course Title: Research Paper Seminar	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:2	Credits: 1	Total Contact Hours: 30	Max Marks: 100

Course Objective:

The course is intended to develop critical analysis, presentation, and research communication skills by engaging students in the study, review, and presentation of contemporary research papers in Computer Science and Engineering domain.

Assessment Methodology:

1. Internal Assessment: 75 Marks
    - Three Reviews – Each carrying 25 marks (3 × 25 = 75 marks)
2. Final Review: 25 marks

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze research papers and identify key contributions, methodologies, and limitations in the context of current advancements of the research domain.	Analyze
CO2: Communicate the technical content, demonstrating clarity of thought, depth of understanding, and engage in scholarly discussion.	Apply

Course Code: 24SHA201		Course Title: **Teaching and Learning in Engineering** (Common to all PG Programmes)	
Course Category: Audit Course		**Course Level: Introductory**	
L:T:P(Hours/Week) 0: 0: 4	**Credits:-**	**Total Contact Hours:30**	**Max Marks:100**

Course Objective:

The course is intended to impart knowledge on an outcome-based approach, employing active learning methods in lecture/practical/tutorial sessions. Assessments will be conducted using rubrics, focusing on higher-order thinking skills.

Module I **15 Hours**

Outcome Based Approach

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

Active Learning Methods

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods

Module II **15 Hours**

Assessments

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Use outcome based approach in teaching courses in engineering Programmes.	Apply
CO2:Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO3: Conduct higher order assessments by using rubrics.	Apply

Reference Books:

R1. William G. Spady and Francis Aldrine A. Uy, “Outcome-Based Education: Critical Issues and Answers”, Maxcor Publishing House, 2014

R2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy, “Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices”, 2018

R3. Richard M. Felder, Rebecca Brent, “Teaching and Learning STEM: A Practical Guide”, John Wiley & Sons, 2016

Syllabus - Semester III

Course Code: 24CPP301		Course Title: Project I	
Course Category: Project		Course Level: Mastery	
L:T:P(Hours/Week) 0:0:20	Credits: 10	Total Contact Hours: 150	Max Marks: 200

Course Objective:

The objective of this course is to provide students with the opportunity to initiate independent research by identifying a relevant problem statement, conducting an in-depth literature review, and understanding existing methodologies. The course aims to develop analytical, technical, and problem-solving skills through the implementation and evaluation of a base system, thereby preparing students for the subsequent phases of their research project.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Identify a research problem, review relevant literature, and formulate clear research objectives aligned with current trends and technological advancements.	Analyze
CO2: Implement and evaluate an existing system or methodology, analyze its performance, and identify potential gaps or areas for further research.	Evaluate

Syllabus - Semester IV

Course Code: 24CPP401		Course Title: Project II	
Course Category: Project		Course Level: Mastery	
L:T:P(Hours/Week) 0:0:32	Credits: 16	Total Contact Hours: 240	Max Marks: 400

Course Objective:

The objective of this course is to enable students to design, develop, and implement innovative solutions to the identified problem, analyze results using appropriate methodologies, and effectively communicate their findings through technical documentation and presentations, demonstrating readiness for professional practice or further research.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop comprehensive solutions to defined engineering problem using appropriate tools, technologies, and methodologies.	Create
CO2: Analyze, interpret, validate results, and effectively communicate the research outcomes through well-structured documentation and oral presentations.	Evaluate

List of Professional Electives

Course Code: 24CPE001		Course Title: Advanced Computer Architecture	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on principles and design of Instruction Set Architectures, Memory Hierarchy and aspects related to various levels of parallelism. The course also provides awareness on the working of Domain Specific Architectures.

Module I Memory Hierarchy, Instruction Level Parallelism **23 Hours**

Fundamentals of Quantitative Design and Analysis-Memory Hierarchy Design: Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies - Instruction Level Parallelism and its Exploitation – Concepts and Challenges –Exposing ILP - Advanced Branch Prediction - Dynamic Scheduling - Hardware-Based Speculation - Exploiting ILP - Instruction Delivery and Speculation - Limitations of ILP -Cross-Cutting Issues.

Module II Data level and Thread Level Parallelism **22 Hours**

Data level Parallelism – Vector Architecture- SIMD Instruction Set Extensions for Multimedia- Graphics Processing Units- Detecting and Enhancing Loop-Level Parallelism- Cross-cutting issues

Thread level parallelism - Centralized Shared Memory Architecture- Performance of Symmetric- Shared Memory Multiprocessors- Distributed Shared Memory and Directory-Bases Coherence- Basics of Synchronization- Models of Memory Consistency –Cross-cutting issues.

Case Study: Domain-specific architectures: Deep Neural Networks-Google’s Tensor Processing Unit.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the design and functioning of memory hierarchies, including caches, main memory, and virtual memory systems	Analyze
CO2: Analyze structural, data and control hazards and exploit the various aspects of Instruction level parallelism	Analyze
CO3: Predict the challenges of realizing data and thread level parallelism for performance advancement	Apply
CO4: Analyze the working principles of domain specific architectures to accelerate data processing	Analyze

Text Book:

T1. John L. Hennessey and David A. Patterson, “Computer Architecture – A Quantitative Approach”, 6th Edition, Morgan Kaufmann, 2019.

Reference Books:

R1. Richard Y. Kain, “Advanced Computer Architecture - A Systems Design Approach”, Pearson, 2015.

R2. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture”, 3rd Edition, Tata McGraw-Hill, 2017

Web References:

1. https://nptel.ac.in/courses/106105033/
2. https://archive.nptel.ac.in/courses/106/103/106103206/

Course Code: 24CPE002		Course Title: Advanced Databases	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on database management systems. The course intends to provide exposure on advanced concepts such as parallel & distributed systems, object oriented, Spatial and Temporal databases.

Module I **23 Hours**

Relational Model: ER and Relational Data Model – Relational Algebra – Structured Query Language – Database Normalization – Concurrency control mechanisms – Deadlock Handling. **Parallel and distributed databases:** Centralized and Client-Server architectures – Parallel and Distributed systems – Distributed transactions – Locking and Commit protocols – Distributed Concurrency control – Distributed Query Processing - Parallel Databases. Database Recovery: Failures – Recovery techniques – Advanced Database Security.

Module II **22 Hours**

Object oriented Databases and XML: OODBMS – XML Data Model – DTD – XML Schema – XML Querying – Web Databases. **Spatial and Temporal Databases:** Spatial Data Types and Models – Spatial Operators and Spatial Queries – Spatial Data Indexing – Temporal Database forms and Architecture – Temporal Data Model – Querying Temporal databases – Graph Databases. **Performance Optimization:** Profiling and Performance Monitoring – Query Optimization – Indexing Strategies.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Implement parallel and distributed database management concepts for enterprise applications.	Apply
CO2: Design normalized relational database model for real time applications.	Create
CO3: Apply advanced database management technique suitable for spatial and temporal applications.	Apply
CO4: Enhance the performance of database systems using optimization techniques.	Apply

Text Books:

T1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, 7th Edition, McGraw-Hill, 2019

T2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, 7th Edition, Pearson Education, 2017.

Reference Books:

R1. Ian Robinson, Jim Webber, Emil Eifrem, “Graph Databases”, O'Reilly, 2013

R2. “Mastering Database Performance Optimization and Scalability”, Cybellium, 2023

Web References:

1. https://nptel.ac.in/courses/106105175
2. https://opencourse.inf.ed.ac.uk/adbs

Course Code: 24CPE003		Course Title: Compiler Optimization Techniques	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3 : 0 : 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on program analysis and compiler optimizations for code performance enhancement. The course will enable learners to develop high performance software.

Module I Program Analysis and preliminary optimizations — 23 Hours

Structure of Optimizing Compilers – Intermediate Language representations. Control Flow Analysis - Data Flow Analysis: Reaching Definitions – Lattices, Flow functions and fixed points - Iterative Data Flow Analysis - Static Single Assignment. Dependence Analysis and Dependence Graphs – Alias Analysis. Early Optimizations - Redundancy Elimination - Loop Optimizations.

Module II Procedure and Memory optimization — 22 Hours

Procedure Optimizations - Code Scheduling - Control-Flow and Low-Level Optimizations – Inter-procedural analysis and optimizations. Register Allocation - Optimization for Memory hierarchy.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Analyze code to determine information necessary for optimization.	Analyze
CO2:Apply common code optimization techniques to enhance the performance of software.	Apply
CO3:Optimize code for specific target architectures by utilizing advanced features and instruction sets.	Apply
CO4:Assess the impact of code optimization techniques on code performance and resource utilization.	Evaluate

Text Books:

T1. Steven. S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kaufman, 1997.
T2. Randy Allen, Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence based Approach”, Morgan Kaufman, 2005.

Reference Books:

R1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools”, 2nd Edition, Pearson Education, 2014.
R2. Y. N. Srikant, Priti Shankar, “The Compiler Design Handbook – Optimizations and Machine Code Generation”, 2nd Edition, CRC Press, 2007.

Web References:

1. https://nptel.ac.in/courses/106108052
2. https://www.cs.cornell.edu/courses/cs6120/2020fa/self-guided/

Course Code: 24CPE004		Course Title: Digital Media Processing Techniques	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on Image transforms, Enhancement, Compression, Segmentation, Color image and video processing.

Module I Image Transforms, Enhancement and Restoration 23 Hours

Introduction: Steps in Digital Image processing – Elements of visual Perception – Image Sensing and Acquisition-Image Sampling and Quantization-Pixel relationships. **Image Transforms:** Discrete and Fast Fourier Transform and Discrete Cosine Transform-Wavelet Transform and Multi-resolution Processing. **Image Enhancement and Restoration:** Spatial Domain – Gray-level Transformations Histogram Processing – Spatial Filtering – Smoothing and Sharpening - Frequency Domain: Filtering in Frequency Domain – Smoothing and Sharpening filters – Homomorphic Filtering, Noise models, Constrained and Unconstrained restoration models. **Image Compression:** Redundancies, Image compression standards, Lossy and Loss-less predictive coding

Module II Color image and Video Processing , Segmentation 22 Hours

Color Image Processing: Color fundamentals – Color models. **Image Segmentation:** Detection of isolated points, Line, edge linking and boundary – Thresholding: global and adaptive – Region based segmentation. **Feature Extraction:** Boundary feature descriptors - Region feature descriptors - Principal Component as feature descriptors - Whole image features: Harris-Stephens Corner detector - Scale Invariant Feature Transform (SIFT). **Video Processing:** Digital Video and its applications – 2D Apparent Motion Models and its Estimation– Video Segmentation: Change detection, Motion segmentation and tracking-– Video Compression standards: MPEG-1, MPEG-2 and H.26X

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Apply appropriate image processing methods to solve real world problems	Apply
CO2:Critically analyze different approaches to image processing applications.	Analyze
CO3:Design and implement algorithms for image processing applications	Create
CO4:Design appropriate motion models and segmentation for video processing in implementing video based applications	Create

Text Books:

T1. R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, 4th Edition, Pearson Education, 2018.
T2. Murat Tekalp , “Digital Video Processing”, 2nd Edition, Prentice Hall, 2015.

Reference Books:

R1. Anil K Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India 2003.
R2. Milan Sonka , “Digital Image Processing and Computer Vision”, 2nd Edition, Thomson publication, 2007.

Web References:

1. https://www.coursera.org/learn/digital
2. https://archive.nptel.ac.in/courses/117/105/117105135/

Course Code: 24CPE005		Course Title: Soft Computing	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on Fuzzy logic, Knowledge based Systems, Neural networks and optimization techniques for various predictive models

Module I Intelligent System, Fuzzy Logic and Supervised Learning Network **23 Hours**

Intelligent system – Knowledge based system - Expert systems – Knowledge representation processing – Soft computing.

Fuzzy logic system: Fundamentals - Fuzzy set - Fuzzy logic operations – Fuzzy resolution - Fuzzy relations - Composition and inference: Projection, Cylindrical Extension, Join, Composition, Composition rule of inference – Fuzzy Decision Making – Fuzzy Logic Control Architecture.

Neural Networks: Machine Learning Basics - Activation functions - Supervised Learning Neural Networks: Perceptron Network, Adaline, Back propagation Network.

Module II Unsupervised Learning Network and Evolutionary Computing **22 Hours**

Unsupervised Learning Neural Networks: Maxnet – Kohonen - Self-Organizing Feature Maps - Adaptive Resonance Theory Network – Reinforcement Learning.

Evolutionary Computing: Origins – Evolutionary Algorithm - Components of Evolutionary Algorithms – Representation – Mutation - Recombination – Fitness, Selection and Population Management – Popular Evolutionary Algorithm.

Genetic algorithm and Optimization – Genetic algorithm operators – Integration of genetic algorithm with Neural network & Fuzzy logic –ES Applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Use knowledge and rules for solving real world problems.	Apply
CO2:Analyze various fuzzy reasoning approaches for decision making effectively in engineering problems.	Analyze
CO3:Choose appropriate neural network architectures to encounter the challenges in the world.	Analyze
CO4:Design evolutionary algorithm for optimize problems	Create

Text Books:

T1. Fakhreddine O. Karray, "Soft Computing and Intelligent Systems Design: Theory, Tools and Applications", Pearson Education India, 2004.

T2. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", 3rd Edition, John Wiley & Sons, New Delhi, 2019.

T3. A.E. Eiben J.E. Smith, "Introduction to Evolutionary Computing", Natural Computing Series, Springer, New York, 2015.

Reference Books:

R1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2015.

R2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 4th Edition, Wiley, 2016.

R3. Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Prentice Hall, 2009.

Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105173/

2. https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-641j-introduction-to-neural-networks-spring-2005/

3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/lecture-videos/lecture-13-learning-genetic-algorithms/

Course Code: 24CPE006		Course Title: Cloud Computing and IoT	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart the knowledge of applying Cloud Computing and IoT on diverse applications.

Module I CLOUD COMPUTING **23 Hours**

Understanding Cloud Computing: Origins and influences-Basic concepts-Goals and Benefits-Roles and Boundaries-Cloud Characteristics- Cloud Delivery Models-Cloud Deployment Models. **Cloud –Enabling Technology:** Cloud Data Center Technology-Multitenant Technology-Service Technology and Service APIs. **Cloud Computing Mechanisms:** Virtual Server-Hypervisor-Cloud Storage Device-Cloud Usage Monitor-Resource Replication-Ready-Made Environment. **Cloud Security Mechanisms:** Security Terminology-Cloud Based Security Groups-Firewall-Virtual Private Network-Biometric Scanner-IDS-Data Backup and Recovery System-Traffic Monitor. **Cloud Management Mechanisms:** Remote Administration system-Resource Management System-SLA Management System-Billing Management System. **Cloud Computing Architecture:** Resource Pooling Architecture-Dynamic Scalability Architecture-Hypervisor Clustering Architecture-Resilient Disaster Recovery Architecture-Virtual private Cloud Architecture-Cloud Usage Cost Metrics-Virtualization and Containerization-Service Quality Metrics.

Module II INTERNET OF THINGS **22 Hours**

INTRODUCTION: Genesis of IoT- Digitization-Impact-Convergence of IT and IoT- IoT Challenges- Network Architecture and Design- Comparing IoT Architectures - Core IoT Functional Stack-Data Management. **IoT NETWORKS AND PROTOCOLS:** Sensors-Actuators-Smart Objects-Sensor Networks-Connecting Smart Objects-Communication Criteria- IoT Access Technologies- IoT Network Layer-Business care for IP-Optimizing IP for IoT-Profiles and Compliances-Application protocols for IoT-Transport Layer-IoT Application Transport Methods-Securing IoT **APPLICATION:** Manufacturing-Smart and Connected Cities-Transportation-Mining-Public Safety.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply cloud computing technology for computing resources to solve real time problems.	Apply
CO2: Choose the appropriate architecture for resource provisioning to solve performance issues.	Apply
CO3: Create different connectivity technologies for IoT to arrive at suitable conclusions.	Create
CO4: Evaluate control measures to offer appropriate solutions for IoT related Industry applications	Evaluate

Text Books:

T1. Thomas Erl, Zaigham Mahood, Ricardo Puttini, "Cloud Computing, Concept, Technology & Architecture", Pearson Education, 2024.

T2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017.

Reference Books:

R1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw-Hill, 2013.

R2. Toby Velte, Anthony Velte, Robert C. Elsenpeter, "Cloud Computing, A Practical Approach", Tata McGraw-Hill Edition, 2010.

R3. Olivier Hersent, David Boswarthick, Omar Elloum, "The Internet of Things – Key applications and Protocols", Wiley, 2012.

R4. Michael Miller, "The Internet of Things", Pearson Education, 2015.

Web References:

1. https://nptel.ac.in/courses/106105167
2. https://www.udemy.com/topic/cloud-computing
3. https://nptel.ac.in/courses/10610566
4. https://www.coursera.org/learn/iot?specialization=iot

Course Code: 24CPE007		Course Title: GPU Architectures and Computing	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on GPU architectures and development of programming models for GPU processors.

Module I GPU architecture, Algorithms **23 Hours**

GPU Architecture: Evolution of GPU Architectures- Understanding Parallelism with GPU- CUDA Hardware Overview- Grids, Blocks Threads- Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory. **Algorithms on GPU:** Parallel Patterns: Convolution-Prefix Sum – Sparse Matrix – Vector Multiplication

Module II CUDA Programming, OpenCL **22 Hours**

CUDA Programming: Multi-CPU and Multi-GPU Solutions - Optimizing CUDA Applications: Problem Decomposition-Memory Considerations- Transfers-Thread Usage-Resource Contentions. **Programming Issues:** CUDA Error Handling -Parallel Programming Issues-Algorithmic Issues-Finding and Avoiding Errors. **OpenCL Basics**: OpenCL Standard - Kernels - Host Device Interaction- Execution Environment- Memory Model- Basic OpenCL Examples.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Analyze efficient parallel programming patterns to provide efficient solutions for real world applications.	Analyze
CO2:Design optimized algorithms for common GPU application kernels	Apply
CO3:Analyze CUDA code using suitable tools and techniques to enhance application performance.	Analyze
CO4:Develop programming models that leverage the parallel compute engine in GPUs.	Create

Text Books:

T1.Shane Cook, “CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs”, Morgan Kaufman, 2013

T2.David R Kaeli , Perhaad Mistry, Dana Schaa , Dong Ping Zhang ,”Heterogeneous Computing with OpenCL 2.0” , 3rd Edition, Morgan Kaufman, 2015

T3.David B. Kirk and Wen-mei W. Hwu ,“Programming Massively Parallel Processors A Hands-on Approach,” 2nd Edition, Morgan Kaufman, 2016

Reference Books:

R1.Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison Wesley, 2013

R2.Jasan Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison Wesley, 2011

Web References:

1. https://developer.nvidia.com/language-solutions
2. https://www.khronos.org/opencl/

Course Code: 24CPE008		Course Title: Security In Computing	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is designed to impart knowledge on computer security fundamentals and cryptographic techniques. The course is also intended to address the real-world security challenges in database and networks .

Module I Symmetric and Asymmetric Ciphers 22 Hours

Symmetric Ciphers: Introduction – Security Attacks- Security Services – Security Mechanisms- Classical Encryption Techniques: Substitution Techniques, Transposition Techniques – Data Encryption Standard – Advanced Encryption Standard. **Asymmetric Ciphers:** Mathematical Concepts: Modular Arithmetic, Fermat's and Euler's Theorem, Chinese Remainder Theorem– Public Key Cryptography – RSA Algorithm - Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Message Authentication and Hash Function: Authentication Requirements- Authentication Functions- Message Authentication Codes – Two Simple Hash Functions- Secure Hash Algorithm (SHA-1).

Module II Database and Network Security 23 Hours

Digital Threats: Malware: Viruses, Trojan Horses, Worms and Malicious Code, Unintentional (Non-malicious) Programming Oversights: Buffer Overflow, Off-by-One Error - Counter Measures for Users and Developers. **Database and Data Mining Security:** Database Security Requirements – Reliability and Integrity – Sensitive Data- Security in Data Mining and Big Data. **Security in Networks:** Threats to Network Communications-Wireless Network security – Firewalls. **Legal Issues and Ethics:** Protecting programs and Data - Information and the Law – Rights of Employees and Employers- Computer Crime - Ethical Issues in Computer Security

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Utilize various encryption techniques to enhance security in real-world scenarios	Apply
CO2: Design and implement secure authentication mechanisms and encryption schemes to protect sensitive data	Apply
CO3: Analyze vulnerabilities within computing systems and devise effective security solutions	Analyze
CO4: Develop solutions to protect organizations and people from cyber-crime.	Create

Text Books:

T1. William Stallings, "Cryptography and Network Security", 8th Edition, Pearson Education, 2020

T2. Charles P. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", 5th Edition, Prentice Hall, 2018

Reference Books:

R1. Behrouz A.Forozan and Debdeep Mukhopadhyay, "Cryptography And Network Security", 3rd Edition, Tata McGraw Hill, 2015

R2. Bernard L. Menezes," Network Security and Cryptography", Cengage Learning India, 2010

R3. Marjie T. Britz, "Computer Forensics and Cyber Crime-An Introduction", 3rd Edition, Pearson Education, 2013.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2. https://archive.nptel.ac.in/courses/106/105/106105031/
3. http://williamstallings.com/Cryptography/Crypto8e-Student/

Course Code: 24CPE009		Course Title: Natural Language Processing	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on implementing Natural Language Processing functionalities and language models. The course will enable learners to develop simple NLP applications.

Module I – NLP Functionalities **23 Hours**

Regular Expressions – Text Normalization - Minimum Edit Distance; **N-gram Language Models:** N-grams – Evaluating Language Models – Generalization– Smoothing; **Naive Bayes and Sentiment Classification**: Naive Bayes Classifiers - Other text classification tasks - Naive Bayes as a Language Model - Evaluation: Precision, Recall, F-measure; **Vector Semantics**: Lexical Semantics - Vector Semantics - Words and Vectors - Cosine for measuring similarity- TF-IDF; Sequence Labeling: English Word Classes - Part-of-Speech Tagging - Named Entities and Named Entity Tagging - HMM POS Tagging - Evaluation of NER; **Constituency Grammars:** Constituency - Context-Free Grammars - Grammar Rules for English – Treebanks - Grammar Equivalence and Normal Form - Lexicalized Grammars

Module II – Language Models **22 Hours**

Feed-Forward Neural Networks - Neural Language Models - Deep Learning Architectures - Recurrent Neural Networks - LSTMs and GRUs; **Constituency Parsing:** CKY Parsing - Span-Based Neural Constituency Parsing - Evaluating Parsers - Partial Parsing - CCG Parsing; **Dependency Parsing:** Transition-Based Dependency Parsing - Graph-Based Dependency Parsing – Evaluation; **Logical Representations of Sentence Meaning:** Computational Desiderata for Representations - Model-Theoretic Semantics - First-Order Logic - Event and State Representations - Description Logics; **Word Senses and WordNet:** Word Senses - Relations Between Senses – WordNet, A Database of Lexical Relations - Word Sense Disambiguation. Case studies: Factoid Question Answering, Chatbots, Dialogue systems

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Implement language models using suitable programming language	Apply
CO2. Analyze the performance of parsers and taggers with appropriate evaluation metrics	Analyze
CO3. Identify the appropriate sequence of NLP techniques required for solving a given research problem	Apply
CO4. Create real time applications using NLP functionalities	Create

Text Book:

T1. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, 3rd Edition, Prentice Hall, 2020.

Reference Books:

R1. U. S. Tiwary and Tanveer Siddiqui, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.

R2. Richard M Reese, “Natural Language Processing with Java”, Packt Publishing, 2015.

Web References:

1. https://nptel.ac.in/courses/106101007/
2. https://nlp.stanford.edu/software/

Course Code: 24CPE010		Course Title: Information Retrieval	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3 0 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on evaluating IR models, applying text processing and web search operations.

Module I Information Retrieval Process 22 Hours

Basic Concepts – Retrieval Process – Modeling – Classic Information Retrieval – Set Theoretic, Algebraic and Probabilistic Models – Structured Text Retrieval Models – Retrieval Evaluation- Languages – Key word based Querying – Pattern Matching – Structural Queries – Query Operations – User Relevance Feedback – Local and Global Analysis – Text and Multimedia languages- Data Models – Query Languages

Module II Text Operations and Web Searching 23 Hours

Document Preprocessing – Clustering – Text Compression - Indexing and Searching – Inverted files – Boolean Queries – Sequential searching –User relevance Judgment - Spatial Access Methods – Generic Approach – One Dimensional Time Series – Two Dimensional Color Images – Feature Extraction. Searching the Web – Characterizing the Web – Search Engines – Parallel Information Retrieval – Distributed Information Retrieval.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Implement various information retrieval models including set theoretic, algebraic, and probabilistic models to efficiently retrieve relevant information from complex data collections.	Apply
CO2: Analyze the strengths and weaknesses of different data models using query languages and relevance feedback mechanisms for real time applications	Analyze
CO3: Conduct a comparative analysis of document preprocessing pipelines, examining the effectiveness of tokenization, stemming, and document vectorization techniques in optimizing information retrieval systems	Evaluate
CO4: Design a comprehensive multimedia retrieval system, outlining the architecture, data flow, and components required for efficient searching and retrieval of multimedia data	Create

Text Book:

T1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, “Modern Information Retrieval”, 2nd Edition, ACM Press Books, 2011

Reference Books:

R1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “Introduction to Information Retrieval”, Cambridge University Press, 2012

R2. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, “Information Retrieval Implementing and Evaluating Search Engines”, MIT Press, 2010

Web References:

1. http://cse.iitkgp.ac.in/~pawang/courses/IR18.html
2. http://web.stanford.edu/class/cs276/

Course Code: 24CPE011		Course Title: Social Network Mining	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3 : 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective:

The course is intended to impart knowledge on relationships in social networks and analyze dynamic changes within social networks.

Module I Graph Theory and Social Networks 22 Hours

Aspects of networks - Graph - Paths and Connectivity – Distance and Breadth First Search - Network Datasets - Triadic Closure - Strength of Weak Ties - Network Structure –Social Media - Passive Engagement - Closure - Structural Holes - Social Capital - Betweenness Measures - Graph Partitioning. Homophily - Selection and Social Influence - Affiliation - Spatial Model of Segregation - Positive and Negative Relationships - Structure of the web - Link Analysis using Hubs and Authorities - PageRank - Applying Link Analysis in Web Search .

Module II Social Network Dynamics 23 Hours

Information Cascades - Power Laws - Rich-Get-Richer Phenomena and Unpredictability - Effect of Search Tools and Recommendation Systems-Cascading Behavior in Networks - Small-World Phenomenon - Six Degrees of Separation Epidemics - Structure and Randomness- Decentralized Search - Modeling the Process of Decentralized Search - Empirical Analysis and Generalized Models- Branching Processes –SIR Epidemic Model – SIS Epidemic Model- Synchronization- Transient Contacts and Dangers of Concurrency.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Develop social network analysis model using graph theory to identify influential nodes, communities, patterns of homophily, social influence, and affiliation within real-world social networks.	Apply
CO2. Demonstrate web-based social network analysis in real-time scenarios, applying techniques such as link analysis and PageRank.	Apply
CO3: Analyze the effects of network dynamics such as information cascades, power laws, and cascading behavior on real-world networks	Analyze
CO4: Create real time predictive models for epidemic spread within networks.	Create

Text Book:

T1. David Easley and Jon Kleinberg , “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.

Reference Books:

R1. Przemyslaw Kazienko, Nitesh Chawla, “Applications of Social Media and Social Network Analysis”, Springer,2015

R2. Guandong Xu ,Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and Applications”, Springer, 2012

R3. Charu.C.Aggarwal, “Social Network Data Analytics”, Springer, 2011

Web References:

1. https://nptel.ac.in/courses/106106169/
2. https://archive.nptel.ac.in/courses/106/106/106106239/

Course Code: 24CPE012		**Course Title: Blockchain**	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3:0:0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objective:

The course is intended to impart knowledge on blockchain technologies for various security applications.

Module I Blockchain and Bitcoin **23 Hours**

Blockchain basics: History – Types – Consensus - CAP Theorem

Decentralization: Methods – Routes - Full eco system - Organizations – platform.

Cryptographic primitives: Symmetric ciphers, DES, AES.

Bitcoin basics: Digital keys and addresses - transaction: life cycle, data structure, Types, mining – bitcoin networks: wallets, payments, innovation - Alt coins: Lite coin. Prime coin.

Module II Ethereum and Smart contract **22 Hours**

Ethereum: Stages of Development – Components- MetaMask - EOAs and contracts - Test Ether faucet, Creating contract - interacting with contract - Ethereum Virtual Machine.

Smart Contracts and Solidity: Life cycle - Ethereum high level language - Building a Smart Contract with Solidity - Programming with solidity.

Hyperledger: Projects under Hyperledger - Hyperledger as a Protocol - Distributed Ledger - Fabric - Sawtooth Lake - Corda**.**

Blockchain applications: KYC using blockchain in industry 4.0 - Blockchain for securing HER - Blockchain based Food supply chain management.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate proficiency in selecting appropriate blockchain types for specific use cases and requirements	Apply
CO2: Develop bitcoin payment module integrating with wallet for real time e-commerce applications	Apply
CO3: Examine the implications of deploying contracts and interacting with them in real-world scenarios,	Analyze
CO4: Evaluate the practical applications of blockchain technology across different industries.	Evaluate

Text Books:

T1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, 2nd Edition, Packt Publishing, 2018.

T2. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.

T3. E. Golden Julie, J. Jesu Vedha Nayahi, and Noor Zaman Jhanjhi ,” Blockchain Technology : Fundamentals, Applications, and Case Studies”, CRC Press, 2021.

Reference Books:

R1. D. Drescher, “Blockchain Basics”, Apress, 2017.

R2. Antonopoulos, “Mastering Bitcoin”, O’Reilly Publishing, 2015.

R3. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.

Web References:

1. https://archive.nptel.ac.in/courses/106/104/106104220/
2. https://www.udemy.com/course/build-your-blockchain-az/
3. https://www.ibm.com/topics/blockchain

Course Code: 24CPE013		Course Title: Embedded System Design	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective

The course is intended to impart knowledge on embedded system architecture and designs for diverse socio-economic applications.

Module I **23 Hours**

Embedded Computing: Embedded Computers - Characteristics of Embedded Computing Applications - Challenges and performance in system design - Design Process: Requirements, Specification, Architectural Design, Designing hardware and software components, System Integration, Formalism for System Design, Structural and Behavioral Description - Design Example: Model Train Controller. **ARM processor:** Memory organization - Data operations – Features - Flow of Control. **TI C55x DSP:** Memory organization - Addressing modes - Data operations - Flow of Control - CPU Bus - Memory devices and systems. Designing with computing platforms - Design Examples: Alarm Clock, Audio player.

Module II **22 Hours**

System Design Techniques: Design Methodologies - Requirement Analysis, Specification - System Analysis and Architecture Design - Quality Assurance. **Automotive and Aerospace Systems:** Networked control systems in cars and airplanes - Vehicular networks - Safety and security - Design example: video accelerator - Application example: optical disk. **Multicore Embedded Wireless Sensor Network:** Architectures, Compute-Intensive Tasks, Application Domains, sensor nodes, Research challenges.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate the process of designing embedded systems to fulfill the requirements of industrial safety applications.	Apply
CO2: Analyze factors, including societal impacts, to decide on the best computing platforms for real-world applications.	Analyze
CO3: Analyze networked control system models for engineering applications employing diverse tools.	Evaluate
CO4: Analyze multicore wireless sensor networks for compute-intensive tasks and research challenges.	Evaluate

Text Books:

T1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman Publishers, 4th Edition 2017.

T2. Arslan Munir, Ann Gordon-Ross, Sanjay Ranka, "Modeling and optimization of parallel and distributed embedded systems", John Wiley & Sons Inc, 2016.

Reference Books:

R1. Rajkamal "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill, 3rd Edition 2014.

R2. Jane.W.S. Liu, "Real-Time systems", Pearson Education, LPE,2018.

R3. Derek Molloy, "Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux", Wiley, 2019.

Web References:

1. https://developer.arm.com/ip-products/processors/classic-processors
2. https://www.analog.com/en/products/processors-dsp/dsp/sharc.html
3. https://microcontrollerslab.com/embedded-systems-basics/
4. https://archive.nptel.ac.in/courses/108/102/108102169/

Course Code: 24CPE014		Course Title: Extended Reality	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objective

The course is intended to impart knowledge on creating 3D objects & AR assets using AR tools. The course aims to enable the learners to develop simple AR applications considering the human and legal factors.

Module I **23 Hours**

Introduction: Fundamentals of AR, VR and MR - XR system - Immersion in XR- MR Devices. **Foundation:** Session Management – 3D Objects – Textures – Surfaces – Adding Physics – Portal – Adding Objects. **AR tools:** Geometry – Textures – Lighting – Place Holders – User Interactions - Location Tracking & Beacons. **AR assets:** Face Tracking Sessions – Face Geometry – Creating Assets – Blend Shapes – Enhancing UX – Vehicle Physics.

Module II **22 Hours**

XR Hardware and Software: Hardware XR systems - VR Headsets - AR display devices, glasses - MR Devices - Software and Development Tools - Unity Game Engine. **Applications:** Gaming and Entertainment – Architecture and Construction – Science and Engineering – Health and Medicine – Education – Information Control and Big Data Visualization – Telerobotics and Telepresence. **Human Factors Considerations:** Physical Side Effects, Visual Side Effects – Legal Considerations – Moral and Ethical Considerations.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Create a 3D object and apply different textures using Unity framework.	Apply
CO2:Create assets using AR tools for face tracking application	Apply
CO3:Develop a Simple XR application under entertainment domain.	Create
CO4:Analyze research directions of Augmented Reality considering the human and legal factors.	Analyze

Text Books:

T1. Steve Aukstakalnis, “Practical Augmented Reality A Guide to the Technologies, Applications and Human Factors for AR and VR”, Pearson Education, Inc., 2017.
T2. Ralf Doerner et al., “Virtual and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR)”, Springer, 2022.

Reference Book:

R1.Julie A.Jacko, “The Human Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications”, 3rd Edition, CRC Press, 2012.

Web References:

1.https://onlinecourses.swayam2.ac.in/ntr24_ ed76/preview
2.https://developers.google.com/ar/develop/java/ quickstart
3.https://learn.unity.com/learn/pathway/ mobile-ar-development

Course Code: 24CPE015		Course Title: Advanced Software Engineering	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on object-oriented software development process and quality measurement. The course also intends to provide exposure on the various stages of software development such as Requirement analysis, design, implementation, testing and management.

Module I **23 Hours**

Requirement Elicitation: Software Development Life cycle models – Requirement Elicitation Techniques – Use case Approach – SRS Document – Requirements Change Management. **Software Estimation:** Lorenz and Kidd Estimation Method – Use Case points Method – Class Point method – Object Oriented Function Point – Risk Management. **Software Development:** Object Oriented Analysis – Class diagrams – Object Oriented Design – Interaction and sequence diagrams – Generating test cases – Implementation – Activity and State chart diagrams – Database access – Coding standards – Refactoring and Reusability. **Case Studies:** Learner Management System – ATM System – Home Automation System.

Module II **22 Hours**

Software Quality and Metrics: Quality Models – Measurement Basics – Analyzing the metric data – Measuring size and Structure – Measuring Quality – Object Oriented Metrics. **Software Testing:** Testing and Verification Techniques – Checklist – Functional, Structural, Class, State-based, Mutation testing – Levels of testing – Testing tools. **Software Maintenance:** Categories of Software Maintenance – Challenges – Software Rejuvenation – Estimation of Maintenance effort – Configuration Management – Regression Testing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Compare the functionalities of traditional and object oriented Software Development Life cycle models	Apply
CO2. Apply Object Oriented analysis and design techniques to develop a software	Apply
CO3. Analyze the quality aspects of the software using various metrics and testing techniques	Analyze
CO4. Formulate appropriate procedure for software maintenance and configuration management.	Create

Text Book:

T1. Yogesh Singh, Ruchika Malhotra, “Object-Oriented Software Engineering”, PHI Learning, 2012.

Reference Books:

R1. Bernd Bruegge and Allen H. Dutoit, “Object-Oriented Software Engineering: Using UML, Patterns and Java”, 4th Edition, Pearson Education Asia, 2013.
R2. Deven N. Shah, G.P. Bherde, “Object Oriented Software Engineering”, Dreamtech Press, 2010.
R3. Ian Holmes, Benjamin Curtis, Kenneth Gu, “Object Oriented Software Engineering”, Kruger Brentt Publishers, 2024.

Web References:

1. https://online.stanford.edu/courses/cs108-object-oriented-systems-design
2. https://onlinecourses.nptel.ac.in/noc22_cs61/preview

Course Code: 24CPE016		Course Title: Nature Inspired Computing	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on various Evolutionary and Swarm Intelligence based optimization techniques to solve computational problems. The course intends to provide exposure on the working principle and applications of nature inspired algorithms in real world scenarios.

Module I **23 Hours**

Introduction: Optimization Techniques – Multi-objective Optimization – Optimization Functions. **Classic Evolutionary Algorithms:** Genetic Algorithms – Genetic Programming – Evolutionary Programming – Evolutionary Algorithm Variations – Direct Search Algorithms – Simulated Annealing. **Recent Evolutionary Algorithms:** Differential Evolution – Biogeography-Based Optimization – Cultural Algorithms – Opposition-Based Learning. **Case Studies:** Traveling Salesman Problem – Music Generation.

Module II **22 Hours**

Introduction: Biological Foundations of Swarm Intelligence – Role of Swarm Intelligence in Optimization. **Classic SI Algorithms:** Ant Colony Optimization – Artificial Bee Colony Optimization – Bat Algorithm – Particle Swarm Optimization – Grey Wolf Optimization. **Recent SI Algorithms:** Bacteria Foraging Algorithm – Firefly based Optimization – Gravitational Search Algorithm – Cuckoo Search Optimization – Elephant Herding Optimization. **Case Studies:** White Blood Cell Classification – Swarm Robotics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Identify appropriate optimization technique for the given research problem.	Apply
CO2. Apply Evolutionary and Swarm Intelligence based optimization techniques to solve computational problems	Apply
CO3. Analyze the performance of nature-inspired algorithms in real world applications	Analyze
CO4. Formulate solutions for Metaheuristic problems using nature inspired algorithms	Create

Text Books:

T1. Dan Simon, “Evolutionary Optimization Algorithms”, Wiley & Sons, 2013.
T2. Adam Slowik, “Swarm Intelligence Algorithms – A Tutorial”, CRC Press, 2nd Edition, 2021.

Reference Books:

R1. Altaf Q. H Badar, “Evolutionary Optimization Algorithms”, CRC Press, 2022.
R2. George Lindfield and John Penny, “Introduction to Nature Inspired Optimization”, Academic Press, 2017.
R3. Xin-She yang, “Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications”, Academic Press, Elsevier, 2020. (Case Studies)

Web References:

1.https://web.itu.edu.tr/~etaner/courses/NIC/
2.https://archive.nptel.ac.in/courses/112/103/112103301/

Course Code: 24CPE017		Course Title: Wireless Security	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to equip students with the knowledge and skills to identify security vulnerabilities in wireless and mobile communication systems.

Module I **23 Hours**

Wireless network - Wireless Threat - wireless security protocols and cryptography - security consideration for wireless network - wireless standards and technologies. Implementing wireless LANs: Security consideration - Enabling secure wireless access to data - Real world Example.

Module II **22 Hours**

Threats, hacking and virus in Mobile communication - Wireless system security – cryptography – cryptosystem - Digital Signature - Authentication-key distribution and management - Security of GSM - GSM Infrastructure - Attacks on GSM - Encryption Algorithm - Security of multimedia system - Security of Adhoc network - Routing protocols - Attacks – Authentication - Key Management.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Analyze the security considerations and vulnerabilities in different wireless network technologies and standards through real-world case studies	Analyze
CO2. Develop a secure wireless LAN system by integrating appropriate wireless security protocols and cryptographic techniques.	Apply
CO3. Apply cryptographic methods and authentication techniques to secure GSM and multimedia systems against common threats.	Apply
CO4. Develop a comprehensive security framework for mobile communication systems, addressing threats, attacks, and key management in GSM and Adhoc networks.	Create

Text Books:

T1. Merritt Maxim David Pollino," Wireless Security", McGraw-Hill, 2002.
T2. Noureddine Boudriga, "Security of Mobile Communications", CRC Press 2010.

Reference Books:

R1. J Minella "Wireless Security Architecture: Designing and Maintaining Secure Wireless " , John Wiley & Sons Inc 2022.
R2. Jim Doherty ,"Wireless and Mobile Device Security" Jones and Bartlett Publishers, Inc, 2021.

Web References:

1.https://nptel.ac.in/courses/106/105/ 106105160/
2.https://www.tutorialspoint.com/ wireless_security/index.htm

Course Code: 24CPE018		Course Title: Industrial IOT	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on basic concepts of Industrial Internet of Things.

Module I **23 Hours**

Introduction and Architecture of IoT: Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack. **Industrial IoT**: IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking. **IIOT Analytics**: Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

Module II **22 Hours**

IoT Security: Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT. **Case Study**: Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the basic concepts, architecture, and communication models of IoT, including challenges	Analyze
CO2: Apply Industrial IoT business models and analytics techniques to solve real-world problems.	Apply
CO3: Construct secure solutions for Industrial IoT using cloud and fog computing technique	Apply
CO4: Analyze case studies of Industrial IoT applications across various industries and UAVs	Analyze

Text Books:

T1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry," IoT Fundamentals: Networking Technologies, Protocols, and Use cases for the Internet of Things", Pearson Education, 2017.

T2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things-Key Applications and Protocols", Wiley, 2021.

Reference Books:

R1. Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT", Packt, 2018.

R2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2017.

Web References:

1. https://nptel.ac.in/courses/106105166
2. https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Course Code: 24CPE019		Course Title: Deep Learning Techniques	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course aims to provide a comprehensive foundation in deep learning, covering essential concepts and techniques. By the end of the course, students will develop practical skills in designing, training, and applying these models to real-world data and problems.

Module I **23 Hours**

Introduction to Deep Learning: Basic concept of Neurons – Linear Perceptrons as Neurons – Feed-Forward Neural Networks – Linear Neurons and their Limitations – Multilayer Perceptrons - Forward Propagation, Backward Propagation, and Computational Graphs-Generalization in Deep Learning-Dropout. **Convolution Neural Networks**: Convolutions, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, LeNet. **Pre-Trained CNN Models:** Self-Supervised Pretraining, AlexNet, VGG, NiN, GoogleNet, ResNet, DenseNet, Transfer Learning. **Region-Based CNNs:** R-CNN, Fast R-CNN, Faster R-CNN, Mask RCNN, Sequence modeling using recurrent nets, Deep Generative Models. **Case Study:**Image segmentation using CNNs.

Module II **22 Hours**

Recurrent Neural Networks: Long Short-Term Memory (LSTM)- Gated Recurrent Units (GRU)- Deep Recurrent Neural Networks-Bidirectional Recurrent Neural Networks-Machine Translation and the Dataset-The Encoder−Decoder Architecture-Sequence-to-Sequence Learning for Machine Translation. **Generative Adversarial Networks:** Generator, Discriminator, Training, GAN variants. **Optimization Algorithms:** Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, RMSProp, Adadelta, Adam, Common Image Augmentation Methods. **Case Study**: Text generation with LSTM , Speech Processing and Image Captioning using RNNs- Image generation with Generative Adversarial Networks.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the principles of neurons, perceptron, and neural networks, to design and train multilayer models for solving real-world deep learning problems.	Apply
CO2: Apply CNN architectures and techniques to design and optimize convolutional networks for addressing complex practical challenges across various domains	Apply
CO3: Analyze the performance of different Recurrent Neural Network (RNN) by comparing their effectiveness in solving sequential data tasks across various domains.	Analyze
CO4: Develop deep generative models for real-world applications.	Create

Text Book:

T1. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, “Dive into Deep Learning”, Cambridge University Press, 2023.
T2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2021.

Reference Books:

R1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
R2. Nikhil Buduma, Nicholas Locascio, “Fundamentals of Deep Learning: Designing Next- Generation Machine Intelligence Algorithms”, O’Reilly Media, 2017.
R3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017

Web References:

1. https://nptel.ac.in/courses/106106184

Course Code: 24CPE020		Course Title: Reinforcement Learning	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on a type of machine learning where agents learn to make decisions by interacting with an environment. The course intends to provide exposure reinforcement learning techniques to real-world problems such as game AI, robotics, and autonomous decision-making systems.

Module I **23 Hours**

Introduction: Introduction to Reinforcement Learning–Elements of Reinforcement Learning–Limitations and Scope – History of Reinforcement Learning– The Agent-Environment Interface - An-Armed Bandit Problem. **Markov Decision Process and Dynamic Programming:** Markov Decision Process – Action Space – Policy – Episode – Return and Discount Factor - The Markov Property – Markov Decision Processes – Bellman Equation – Dynamic Programming – Value Iteration and Policy Iteration. **Monte Carlo Methods and Temporal Methods:** Understanding Monte Carlo Method – Prediction and Control Tasks – Monte Carlo Prediction – First and Every Visit – Monte Carlo Control – Understanding Temporal Difference Learning – TD Prediction – On-Policy TD Control – SARSA – Off-Policy TD Control – Q-Learning.

Module II **22 Hours**

Deep Q Networks and its Variants: DQN – replay Buffer – Loss functions – Target Function – Architecture of DQN – Double DQN - DQN with prioritized Experience replay – Dueling DQN – Deep Recurrent Method.**Function Approximation:** Getting Started with Policy Gradient Methods – Policy Gradient Intuition – Variance Reduction Methods – Actor – Citic Methods – A2C , A3C , A3C – Deep Gradient Policy Gradient – Twin Delayed DDPG – Trust Region Policy Approximation – TRPO -Proximal Policy Optimization.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Illustrate Markov Decision Process and Bellman Equation for learning	Apply
CO2. Apply to optimize and fine-tune RL agents in different environments.	Apply
CO3. Implement and analyze Time difference learning for real world problems.	Analyze
CO4. Develop Approximation methods of learning techniques.	Create

Text Books:

T1. Richard S. Sutton and Andrew G. Barto, Introduction to Reinforcement Learning, 2nd Edition, MIT Press. 2018.

T2. Sudharsan Ravichandiran, "Deep Reinforcement Learning with Python", 2nd Edition, Packet Publishing, 2020.

Reference Books:

R1. Kevin P Murphy, "Machine Learning: A Probabilistic Perspective", 2nd Edition, MIT Press, 2022.

R2. Laura Graesser and Wah Loon Keng, "Foundations of Deep Reinforcement learning: theory and Practice in Python", Pearson, 2022.

R3. Csaba Szepesvari, "Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning)", Morgan & Claypool Publishers, 2010.

Web Reference:

1. http://cse.iitkgp.ac.in/~adas/courses/rl_aut2021/syllabus.html/

Course Code: 24CPO301		Course Title: Business Analytics	
Course Category: Open Elective		Course Level: Practice	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on various data analysis techniques to solve business problems. The course intends to provide exposure to develop skills in data-driven decision-making.

Module I **23 Hours**

Introduction: Data-Analytic Thinking - Data Science, Engineering, and Data-Driven Decision Making - Business Problems and Data Science Solutions - Introduction to Predictive Modeling: From Correlation to Supervised Segmentation. **Prescriptive Analytics:** Testing retail analytics-Simulating the future pension analytics-: Optimizing complex decisions sales force analytics-Optimizing with multiple objectives portfolio analytics. **Data Analytics:** Visual representations of data in Excel- Define and calculate descriptive statistics-Create scatter plots and calculate the correlation coefficient- Deep Analytics and visualization.

Module II **22 Hours**

Introduction: Web Mining -AWS Elastic Map Reduce - AWS CLI -Sentiment analysis-Applications of web mining. **Operational Analytics:** Operational Analytics Vs Traditional Analytics-Challenges of Operational Analytics - Cloud ware house-Operational Analytics in Modern Data stack-Use cases- benefits.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Apply the various optimizations for prescriptive analytics in different scenarios.	Apply
CO2. Design the data representations and calculate statistics, correlation coefficient.	Apply
CO3. Analyze the big data and web mining in various applications.	Analyze
CO4. Investigate the Operational Analytics in modern data stack.	Evaluate

Text Books:

T1. Foster Provost, Tom Fawcett, “Data Science for Business”, O’Reilly 2013.
T2. Peter C. Bruce Galit, Shmueli, Nitin R. Patel, “Data Mining for Business Intelligence, Concepts, Techniques and Applications”, Wiley India Pvt Ltd, 2008.

Reference Books:

R1. Stephen G. Powell, Kenneth R. Baker, “Management Science: The Art of Modeling with Spreadsheets”, 4th edition, John Wiley & Sons, 2013.
R2. Rajkumar Buyya, S. Thamarai Selvi, "Big Data: Principles and Paradigms”, Morgan Kaufmann Publishers In, 2016.

Web References:

1. https://web.stanford.edu/~hastie/ElemStatLearn/
2. https://hightouch.com/blog/what-is-operational-analytics

Course Code: 24CPO302		Course Title: Cybersecurity and Forensics	
Course Category: Open Elective		Course Level: Practice	
L:T:P (Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on cybersecurity and computer forensics through an in-depth study of security principles, forensic methodologies, and best practices for managing and analyzing cyber threats.

Module I **23 Hours**

Introduction: Basics of Cyber Security – Cyber Security policy – Domain of Cyber Security Policy: Laws and Regulations, Enterprise Policy, Technology Operations, Technology Configuration - Strategy Versus Policy – Cyber Security Evolution: Productivity, Internet, E-commerce, Counter Measures, Challenges. **Cybersecurity Objectives and Guidance**: Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks: E-Commerce Systems, Industrial Control Systems, Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers - Cyber Security Management – Catalog Approach. **Cyber Governance Issues:** Net Neutrality, Internet Names, and Numbers, Copyright and Trademarks, Email and Messaging. **Cyber User Issues:** Malvertising, Impersonation, Appropriate Use, Cyber Crime, Geolocation, Privacy

Module II **22 Hours**

Cyber Conflict Issues: Intellectual, property Theft, Cyber Espionage, Cyber Sabotage, Cyber Welfare. **Scope of computer forensics:** Introduction, Types of Evidence, Investigator skills, Importance, History of Computer Forensics, Law Enforcement Training-Computer Forensics Lab Requirements. **Network Forensics:** Tools, Networking Devices, Understanding the OSI Model, Advanced Persistent Threats, Investigating a Network Attack. **Mobile Forensics:** Cellular Network, Handset Specifications, Mobile Operating Systems, Standard Operating Procedures for Handling Handset Evidence, Handset Forensics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the evolution of cybersecurity and its policies for engineering applications.	Analyze
CO2: Choose appropriate cybersecurity metrics and frameworks to enforce cybersecurity policies	Analyze
CO3: Analyze cybersecurity issues faced by decision makers to interpret the cybersecurity environment	Analyze
CO4: Investigate the knowledge requirements for careers in forensics.	Evaluate

Text Books:

T1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss, “Cyber Security Policy Guidebook”, John Wiley & Sons, 2017.

T2. Darren R. Hayes, “A Practical Guide to Computer Forensics Investigations”, 2nd Edition Pearson, 2020.

Reference Books:

R1. Bill Nelson, Amelia Phillips, Christopher Steuart, “Computer Forensics and Investigations”, 3rd Edition, Cengage learning, 2020.

R2. Eugene H. Spafford, Leigh Metcalf , Josiah Dykstra. “Cybersecurity Myths and Misconceptions”, Pearson Education, 2024

Web References:

1. https://www.coursera.org/learn/introduction-to-cybersecurity-fundamentals
2. https://www.udemy.com/course/2021-beginners-guide-to-cyber-security