



Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
(Autonomous College affiliated to University of Mumbai)



CURRICULUM STRUCTURE

FINAL YEAR UG: B.E.

COMPUTER ENGINEERING

REVISION: FRCRCE-3-26

Effective from Academic Year 2026-27
Board of Studies Approval: 04/03/2026
Academic Council Approval: 16/03/2024



Dr. Deepak Bhoir
Dean Academics

Dr. Sujata P. Deshmukh
HOD (Computer)

Dr. Sapna Prabhu
Principal



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INSTITUTE VISION

Moulding Engineers Who Can Build The Nation

INSTITUTE MISSION

- M1:** Create an excellent scholastic ambiance for students and faculty, by providing facilities with state-of-the-art technologies and continuously updating based on the needs of user organizations.
- M2:** Attract, develop and retain teaching faculty of academic excellence, dedication and commitment.
- M3:** Design the academic administration system to ensure effective teaching-learning process facilitating participation from students and teachers and enabling continuous improvement through evaluation and feedback.
- M4:** Provide avenues for the holistic development of students to become competent engineers with interpersonal skills, leadership qualities, and social concern.
- M5:** Maintain economic discipline, continuously work for optimal utilization of resources and resource generation through consultancy to make quality education affordable. Everybody in the organization to be a role model for integrity, upholding ethical values, fairness, and transparency in all dealings.

DEPARTMENT VISION

To be a center of excellence in Computer Engineering education that will produce self-motivated, and globally competent individuals through holistic development.

DEPRATMENT MISSION

- M1:** Build state-of-the-art infrastructure that can accommodate cutting-edge technology and is constantly updated in response to the needs.
- M2:** To emphasize on experiential learning and holistic development in order to pursue academic excellence and inculcate research aptitude through high-quality research publications
- M3:** Enable the students to foster innovative ideas in pace with the emerging technologies
- M4:** Encourage faculty members to pursue higher education/research and stay abreast with the latest technology.



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PROGRAMME EDUCATIONAL OBJECTIVES

- PEO1:** Apply Computer Science principles and techniques to develop engineering projects in order to achieve client business objectives and/or to conduct fruitful research.
- PEO2:** Demonstrate excellent interpersonal skills and leadership qualities at their workspace and in the society
- PEO3:** Successfully work in diverse and multidisciplinary teams, communicate effectively, and find innovative solutions to problems.

PROGRAMME SPECIFIC OUTCOMES

The student will have the ability to

- PSO1:** Develop Artificial Intelligence and Machine Learning systems.
- PSO2:** Apply cyber security mechanisms to ensure the protection of information technology assets.



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Structure of Credits to be completed in Final Year (SEM-VII and/or SEM-VIII):

Proposed Scheme for BE Computer 2026-2027

SEM-VII/VIII												
Course Code	Course Vertical	Sub-Vertical	Course Name		Notional Hours	Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE		Total	Points	Total
								Min	Max			
25PEC14CE3X	PCPEC	PEC	Program Elective Course1	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
25PEC14CE3X	PCPEC	PEC	Program Elective Course2	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
25PEC14CE3X	PCPEC	PEC	Program Elective Course3	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
25PEC14CE3X	PCPEC	PEC	Program Elective Course4	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
25MDM06X	MDC	MDM	MDM Course-6	TH	2	20	30	20	50	100	2	2
25MDM07X	MDC	MDM	MDM Course-7	TH	2	20	30	20	50	100	2	2
25RMC14CE01	EL	RM	Essentials of Research Methodology	TH	2	20	30	20	50	100	2	2
25RMC14CE02	EL	RM	Intellectual Property Rights	TH	2	20	30	20	50	100	2	2
25PRJ14CE01	EL	PR	Major Project	PRJ	12	300	-	-	-	300	6	6
25SEM14CE01	PCPEC	PEC	Course Seminar		Online	As per Rubrics for Seminar					2	2
25INT14CE01	EL	INT	Semester long Internship	PR	36-40 hrs	As Per Internship Manual					12	12
HXXXCXXX	HMM/D M	HMM/D M	Honors/Minor Degree Course	TH	Online	As Per SWAYAM					8	8*
HXXXCXXX	HMM/D M	HMM/D M	Honors/Minor Degree Lab (Project)	PR							2	2*
Total					TH:TU:PR+PRJ 16:0:8+ 12=36			-		1200	-	40+*10

Project or Internship is mutually exclusive in SEM-VII or SEM-VIII

Remaining credits can be acquired in SEM-V to SEM-VIII

Online course 1 Credit=4 Week course from SWAYAM can be taken in SEM V or SEM VIII

Online min 8 week course from SWAYAM can be taken in SEM V to SEM VIII to complete 2 credit course (Combination of two 4-week credit courses shall be allowed with prior approval)

* Online min 12 week course from SWAYAM can be taken in SEM V to SEM VIII to complete 3 credit course



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Sem. VII/VIII – PCE – (TH+PR) Credit 3

25PEC14CE31 : Quantum Computing

25PEC14CE32 : Big Data Analytics

25PEC14CE33 : Soft Computing and Optimization Algorithm

25PEC14CE34 : AI for Finance Management

25PEC14CE35 : Blockchain Technology

25PEC14CE36 : IT Service Management

25PEC14CE37 : High Performance Computing
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Course Code	Course Name
25MDM061	Environment Management
25MDM062	Disaster Management
25MDM071	Management Information Systems
25MDM072	Finance Management



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE31	Quantum Computing	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes		25PCC13CE19, 25BSC12CE06
After the successful completion students should be able to:		
Course Outcomes	CO1	Differentiate between classical and quantum computing paradigms.
	CO2	Design and analyze quantum circuits using quantum logic gates.
	CO3	Implement different fundamental quantum algorithms.
	CO4	Apply quantum cryptography concepts for secure communication.
	CO5	Develop quantum programs using Qiskit, Cirq, and IBM Quantum experience
	CO6	Assess the potential of quantum computing in machine learning, optimization, and cloud-based quantum computing.

Module No.	Unit No.	Topics	Ref.	Hrs.
1.		Introduction to Quantum Computing & Industry Trends	1,2,3	4
	1.1	Classical vs. Quantum Computing, Qubits, Entanglement, Superposition and interferences,		
	1.2	Industry Applications: Cybersecurity, AI, Finance, Drug Discovery		
	1.3	Current Quantum Hardware: IBM, Google, Intel, Rigetti, D-Wave		
2		Mathematical Foundations	1,2	4
	2.1	Linear Algebra for Quantum Computing, Probability in Quantum Mechanics		
	2.2	Dirac Notation & State Vectors		
	2.3	Tensor Products and Unitary Transformations, Tensor Products of Matrices		
3		Quantum Gates & Circuits	1,2,3	5
	3.1	Pauli Gates (X, Y, Z), Hadamard (H), Phase (S, T)		
	3.2	Controlled and Multi-Qubit Gates (CNOT, Toffoli, Fredkin)		
	3.3	Quantum Circuit Design for Optimization & AI, Reversible Computing & its Role in Low-Power Design		



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4		Quantum Algorithms	2,3	5
	4.1	Shor's Algorithm (Breaking RSA Cryptography)		
	4.2	Grover's Algorithm (Search Optimization)		
	4.3	Variational Quantum Eigensolver (VQE) for AI/ML		
5		Quantum Cryptography & Security	1,2,4	4
	5.1	Quantum Key Distribution (BB84, E91)		
	5.2	Post-Quantum Cryptography (NIST Standards)		
	5.3	Quantum Secure Cloud Computing, Quantum-Resistant Blockchain Technologies		
6		Quantum Hardware & Programming	4	4
	6.1	Superconducting Qubits vs. Trapped Ions vs. Photonic Qubits		
	6.2	Cloud-Based Quantum Platforms: IBM Quantum, Google Quantum AI		
	6.3	Programming with Qiskit, Cirq, and Braket, Challenges in Scaling Quantum Computers		
Total			26	

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment activities will be conducted during the full semester - 20 Marks.

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Implement $ 0\rangle$, $ 1\rangle$, and superposition states $ +\rangle$ and $ -\rangle$	4	2
2	Implement and visualize X, Y, Z, H, S, T gates	4	2
3	Design a quantum circuit for simple logical operations	4	2
4	Create an entangled Bell pair and measure correlations	4	2
5	Implement quantum teleportation using IBM Quantum	4	2
6	Optimize unstructured search problems using Grover's Algorithm	4	2
7	Factorize small numbers and analyze RSA vulnerability	4	2
8	Implement Quantum Neural Networks (QNNs) for classification	4	2
9	Simulate and test secure quantum key exchange	4	3
10	Prepare case study for any suitable application for Weather Forecasting and Climate Change	4	2
11	Prepare case study for any suitable application for Artificial Intelligence	4	2
Total			22



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Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Michael A. Nielsen, Isaac L. Chuang, “Quantum Computation and Quantum Information”, Cambridge University Press, 2010 (10th Anniversary Edition)
2. Chris Bernhardt, “Quantum Computing for Everyone”, MIT Press
3. Phillip Kaye, Raymond Laflamme, Michele Mosca, “An Introduction to Quantum Computing”, Oxford University Press
4. Eric R. Johnston, NicHarrigan, Mercedes Gimeno-Segovia, “Programming Quantum Computers: Essential Algorithms and Code Samples”, O'Reilly Media
5. “Post-Quantum Cryptography” — by Daniel J. Bernstein, Johannes Buchmann, and Erik Dahmen
6. “Quantum Machine Learning: An Applied Approach” — by Santanu Ganguly

Online Resources:

1. IBM Quantum Experience: <https://quantum-computing.ibm.com/> - Cloud-based quantum computing platform with free access to real quantum computers
2. Qiskit Textbook: <https://qiskit.org/textbook/> - Comprehensive open-source quantum computing textbook with interactive code examples
3. Google Quantum AI: <https://quantumai.google/> - Research papers, Cirq framework documentation, and quantum computing resources
4. Quantum Open Source Foundation (QOSF): <https://qosf.org/> - Community-driven quantum computing resources and projects
5. Quantum Algorithm Zoo: <https://quantumalgorithmzoo.org/> - Comprehensive catalog of quantum algorithms
6. QuTiP (Quantum Toolbox in Python): <http://qutip.org/> - Open-source software for simulating quantum systems

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	--	--	--	--	--	--	--	--	2	3	--	CO1
CO2	3	3	2	--	2	--	--	--	--	--	2	3	2	CO2
CO3	3	3	3	2	2	--	--	--	--	--	2	3	2	CO3
CO4	3	3	3	2	2	3	--	--	--	--	2	3	2	CO4
CO5	3	3	3	2	3	--	--	--	--	--	2	3	3	CO5



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CO6	3	3	3	3	3	2	--	--	--	--	2	3	3	CO6
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Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Bloom's Level:

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE32	Big Data Analytics	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes		25PCC13CE14
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain building blocks of Big Data Analytics.
	CO2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
	CO3	Analyze different NoSQL database systems and evaluate how they manage and process big data efficiently.
	CO4	Apply advanced techniques for emerging applications like stream analytics.
	CO5	Apply big data analytics to recommendation and graph-based systems.
	CO6	Apply feature engineering techniques and distributed processing frameworks to prepare large-scale datasets for machine learning.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Big Data and Hadoop Introduction to Big Data - Big Data characteristics and Types of Big Data -5 V's, Semi-structured and Structured, Sources of data, working with unstructured data	1, 4, 9	2
	1.2	Big Data Analysis Life Cycle, Case Study of Big Data Solutions, Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem	1, 4, 9	2
2	2.1	Hadoop HDFS and MapReduce Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization	1, 4, 7	1
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations	1, 4, 7	2
3	3.1	NoSQL Databases for Big Data	2, 3,	1



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		Introduction to NoSQL, NoSQL Business Drivers	4	
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns, CAP Theorem, ACID vs BASE	2, 3, 4	2
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems	2, 3, 4	2
4	4.1	Mining Data Streams The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing	4, 6	1
	4.2	Sampling Data techniques in a Stream, Filtering Streams: Bloom Filter with Analysis	4, 6	2
	4.3	Counting Distinct Elements in a Stream, Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements, Real time Analytics Platform (RTAP) applications	4,6	3
	4.4	Counting Ones in a Window: The Cost of Exact Counts, The Datar- Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows	4, 6	2
5	5.1	Real-Time Big Data Models A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering	6, 8	1
	5.2	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph	6, 8	2
6	6.1	Big Data and AI Integration Big Data for Machine Learning, Distributed Machine Learning Frameworks, Feature Engineering at Scale, Feature Stores	10, 11	1
	6.2	Big Data in Deep Learning, Distributed Deep Learning, LLM Data Pipelines, Vector Databases and Embeddings, Retrieval Augmented Generation (RAG) Architecture, Ethical Issues in Big Data and AI	12, 13	2
Total				26

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Hadoop HDFS Practical: - HDFS Basics, Hadoop Ecosystem Tools Overview. - Installing Hadoop. - Copying File to Hadoop. - Copy from Hadoop File system and deleting file. - Moving and displaying files in HDFS. - Programming exercises on Hadoop	1, 3	2
2	Experiment on Hadoop Map-Reduce: Write a program to implement a word count program using MapReduce.	3, 7	2
3	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in MapReduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc	3, 7	4
4	To install and configure MongoDB/ Cassandra/ HBase/ Hyper table to execute NoSQL commands	3, 5	2
5	Data Stream Algorithms (any one): - Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language - Implement Flajolet Martin algorithm using any programming language	1, 8	4
6	Exploratory Data Analysis using Spark/ Pyspark	8, 9	2
7	Data Visualization using Hive/PIG/R/Tableau	5, 8	4
8	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). · Streaming data analysis – use flume for data capture, HIVE/PYS park for analysis of twitter data, chat data, weblog analysis etc. · Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) Spatio Temporal Data Analytics	6, 8	6
Total			26

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. CreAnandRajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge University Press
2. Alex Holmes, Hadoop in Practice, Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly —Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.
4. DT Editorial Services, —Big Data Black Book, Dreamtech Press
5. EMC Education Services, Data Science and Big Data Analytics, Wiley



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6. Bill Franks , Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams with Advanced Analytics, Wiley.
7. Chuck Lam, Hadoop in Action, Dreamtech Press.
8. Jared Dean, Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
9. Jiawei Han and MichelineKamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed., 2010.
10. Emmanuel Ameisen, Building Machine Learning Powered Applications, O'Reilly, 2020.
11. LiorRokach and OdedMaimon, Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition, 2010.
12. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006
13. Vojislav Kecman, Learning and Soft Computing, MIT Press, 2010.

SUGGESTED CO-PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	V	2	--	--	--	--	--	--	2	--	--
CO2	3	3	2	2	3	--	--	--	--	--	--	2	2	2
CO3	3	3	2	3	3	--	--	--	--	--	--	2	2	2
CO4	3	3	3	3	3	--	--	--	--	--	--	2	--	--
CO5	3	3	3	3	3	--	--	--	--	--	--	2	--	2
CO6	3	3	3	3	3	--	--	--	--	--	--	2	3	3

Legends :- High: 03, Medium: 02,Low: 01, No Mapping:

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE33	Soft Computing and Optimization Algorithms	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes	25BSC12CE05,25PCC13CE17	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain concepts of soft computing paradigms and optimization.
	CO2	Design and implement fuzzy inference systems for decision-making problems.
	CO3	Apply genetic algorithm concepts to solve optimization problems in search spaces.
	CO4	Apply swarm intelligence algorithms for solving real-world applications.
	CO5	Design and implement hybrid soft computing models for intelligent system applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Soft Computing Concept of Soft Computing vs Hard Computing, Need for Optimization in Computing, Basic tools of soft computing – Fuzzy logic, neural network, evolutionary computing. Application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.	1,2	2
	1.2	Introduction to Learning Rule Introduction to learning and adaptation, Hebbian learning rule, Perceptron learning rule, Delta (Widrow–Hoff) rule, Backpropagation algorithm, Competitive learning rule, gradient descent and error minimization, convergence concepts, comparison of learning rules, and applications of neural network learning mechanisms	1,2	3
2		Fuzzy Sets and Logic Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership	1,2	7



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		functions, interference in fuzzy logic, Fuzzy Systems- fuzzification, defuzzification and fuzzy controllers		
3		Evolutionary Algorithms Biological background and Overview of evolutionary computing, Genetic algorithm and search space, Operators in genetic algorithm- encoding, selection, crossover, and mutation, Classification of GA	3	4
4		Swarm Intelligence Algorithms Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Simulated Annealing (SA), Differential Evolution (Overview), Comparative Study of Swarm Methods, Industrial Use Cases (Routing, Robotics, ML Tuning)	4	6
5		Hybrid Soft Computing & Case Studies Neuro-Fuzzy systems, GA-ANN hybrid models, hybrid soft computing architectures. Case study of hybrid computing systems.	4,5	4
Total			26	

Course Assessment:

Theory:

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MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	1.1 Implement optimization of an objective function using Hard and Soft Computing Techniques 1.2 Implementation of Hebbian Learning Rule / Delta (Widrow-Hoff) Learning Rule	T3,R4	2
2	2.1 Develop a fuzzy logic-based decision support system to evaluate and classify outcomes based on multiple input criteria. 2.2 Implement a multi-parameter evaluation system using fuzzy set theory and fuzzy relations to assess overall system performance.	T1,T2	2
3	3.1 Implement a Fuzzy Inference System (FIS) to dynamically adjust system output based on varying input conditions. 3.2 Implement a fuzzy logic system and compare different defuzzification methods to analyse their impact on the final output.	T1,T2	4



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4	4.1 Implement a Genetic Algorithm to determine the optimal sequence of tasks or operations in order to minimize overall completion time or system cost. 4.2 Apply a Genetic Algorithm to select an optimal subset of features from a given dataset to improve the performance of a predictive or classification model.	T3,T4, R3	4
5	5.1 Apply a Genetic Algorithm to optimize key model parameters in order to enhance the performance and accuracy of a machine learning system.	T3,T4, R3	2
6	6.1 Implement Particle Swarm Optimization to minimize or maximize an objective function in a constrained optimization problem. 6.2 Apply Ant Colony Optimization to determine an optimal solution for a combinatorial optimization problem involving path or sequence selection.	T4	4
7	Implement a Neuro-Fuzzy system by integrating fuzzy inference mechanisms with neural network learning capabilities to model and solve nonlinear prediction or classification problems.	T4,T5	4
8	Implement a hybrid soft computing framework by integrating two or more soft computing techniques (e.g., Fuzzy Logic, Neural Networks, Genetic Algorithms, or Swarm Intelligence) to solve complex optimization or decision-making problems.	T4,T5	4
Total			26

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

Textbooks:

1. S.Rajasekaran and G.A.VijayalakshmiPai ,Neural Networks, Fuzzy Logic and Genetic Algorithms PHI Learning.
2. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley publications, 2nd Edition.
3. David E. Goldberg , Genetic Algorithms - Pearson Education, 2006
4. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Pearson Education.
5. J.-S. R. Jang et al., Neuro-Fuzzy and Soft Computing, Pearson Education.

References:



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1. Andries P. Engelbrecht, “Computational Intelligence: An Introduction”, 2nd Edition- Wiley India- ISBN: 978-0-470-51250-0
2. N.P.Padhy, “Artificial Intelligence and Intelligent Systems” Oxford University Press, ISBN 10: 0195671546 .
3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” , Wiley India, ISBN: 978-0-470-74376-8
4. Eiben and Smith, “Introduction to Evolutionary Computation”, Springer, ISBN-10: 3642072852

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	--	--	--	--	--	--	--	--	--	--	--	--
CO2	3	3	3	--	3	--	--	--	--	--	--	--	3	--
CO3	3	3	2	--	3	--	--	--	--	--	--	2	3	--
CO4	3	3	3	--	3	--	2	--	--	--	--	2	3	1
CO5	3	3	3	--	3	--	--	2	2	2	--	2	3	1

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE34	AI for Finance Management	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
		ISE		MSE	ESE		Total	
					Min	Max		
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes		25PCC13CE17, 25PEC13CE22, 25MDMBM1, 25MDMBM2, 25MDMBM3
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the structure and functioning of the Indian Financial System.
	CO2	Apply concepts of time value of money, risk and return for financial decision making.
	CO3	Analyze corporate finance decisions using financial ratios and capital budgeting techniques.
	CO4	Evaluate investment, financing and dividend decisions using appropriate financial models.
	CO5	Design algorithmic trading strategies and risk management techniques using backtesting methods.
	CO6	Develop and implement AI-based financial models for risk analysis, trading strategies and fraud detection.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.	1,3	2
	1.2	Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	1,2	3
2	2.1	Financial Statistics and The Sharpe Ratio Probability, Combinatorics, Mathematical Expectation, Sample Mean, Standard Deviation and Variance, Sample Skewness and Kurtosis, Sample Covariance and Correlation, Financial Returns, Capital Asset Pricing Model, Sharpe Ratio Formula	1,2	3
	2.2	Time Periods and Annualizing, Ranking Investment Candidates, The Quantmod Package, Measuring Income	1,2	2



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		Statement Growth, Sharpe Ratios for Income Statement Growth.		
3	3.1	Cluster Analysis K-Means Clustering, Dissecting the K-Means Algorithm, Sparsity and Connectedness of Undirected Graph Covariance and Precision Matrices, Visualizing Covariance, The Wishart Distribution, Glasso Penalization for Undirected Graphs,	1,2	2
	3.2	Running the Glasso Algorithm, Tracking a Value Stock through the Years, Regression on Yearly Sparsity, Regression on Quarterly Sparsity, Regression on Monthly Sparsity.	1,2	2
4	4.1	Gauging the Market Sentiment Markov Regime Switching Model, Reading the Market Data, Bayesian Reasoning, The Beta Distribution, Prior and Posterior Distributions, Examining Log Returns for Correlation, Momentum Graphs, Simulating Trading Strategies,	1,2	2
	4.2	Foreign Exchange Markets, Chart Analytics Initialization and Finalization, Momentum Indicators, Bayesian Reasoning within Positions, Entries, Exits, Profitability, Short-Term Volatility, The State Machine.	1,2	2
5	5.1	Trading Algorithms Vectorized Backtesting, Backtesting an SMA-Based Strategy, Backtesting a Daily DNN-Based Strategy, Backtesting an Intraday DNN-Based Strategy,	1,2	2
	5.2	Risk Management: Trading Bot, Vectorized Backtesting, Event-Based Backtesting, Assessing Risk, Backtesting Risk Measures, Stop Loss, Trailing Stop Loss, Take Profit.		3
6	6.1	Fraud Analytics Introduction, The Analytical Fraud Model Life Cycle, Model Representation, Traffic Light Indicator Approach, Decision Tables, Selecting the Sample to Investigate, Fraud Alert and Case Management, Visual Analytics, Backtesting Analytical Fraud Models: Backtesting Data Stability, Backtesting Model Stability, Backtesting Model Calibration, Model Design and Documentation.	1,2,3	3
Total				26

Course Assessment:

Theory:



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ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE- Will be written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Setting up a Digital Money Transfer System	1,2	2
2	Calculating Sharpe Ratios for Investment Portfolios	1,2	2
3	Cluster Analysis of Financial Data for Market Segmentation	1,2	2
4	Analyzing Market Sentiment using the Markov Regime Switching Model.	1,2	2
5	Developing and Backtesting a Simple Trading Algorithm	1,2	2
6	Implementing Advanced Risk Management Techniques in Trading Algorithms	1,2	2
7	Fraud Detection using Machine Learning Algorithms	1,2	2
8	Visualizing Fraud Patterns and Analytics	1,2	3
9	Designing and Backtesting Complex Trading Strategies	1,2	4
10	Evaluating and Enhancing the Performance of Trading Algorithm	1,2	3
	Total		26

Course Assessment: - (Lab)

ISE- : Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.



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SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	--	2	--	--	--	--	--	--	--	2	1
CO2	2	2	--	--	3	--	--	--	--	--	--	--	2	--
CO3	2	3	--	3	2	--	--	--	--	--	--	--	3	--
CO4	3	3	2	2	3	--	--	--	--	--	--	--	3	--
CO5	2	3	-	2	2	--	--	--	--	--	2	2	3	--
CO6	2	--	--	--	--	--	--	--	2	--	--	2	1	2

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze(✓)	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE35	Blockchain Technology	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes		25PCC13CE19
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the fundamental concepts of blockchain technology and distributed ledger systems.
	CO2	Analyze the role of crypto currencies, consensus algorithms, and mining in ensuring block chain security.
	CO3	Explain the working principles and architecture of the Ethereum platform.
	CO4	Design and implement smart contracts using Solidity for decentralized applications.
	CO5	Apply Hyperledger Fabric architecture for enterprise blockchain solutions.
	CO6	Apply block chain components and processes to develop solutions for real-world problems.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Blockchain Technology: Issues with centralized systems, Distributed Ledger Technology (DLT), Decentralization, What is a blockchain, Origin of blockchain, Foundation of blockchain: Genesis block, Merkle trees, Components of blockchain, Block in blockchain. Limitations and applications of blockchain	1,3	3
	1.2	Transactions creation and verification, Mempool, Types of blockchain: Public, Private, and Consortium, Consensus protocols: Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Mining in blockchain	1,3	3
2	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Transactions in Bitcoin, UTXO and double spending	1,3	3



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		problem , The Halving policy		
	2.2	Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transactions, Accounts, Architecture and Workflow, Gas, Gas Limit, Gas Price, Ethereum frameworks	1,2	3
3	3.1	Programming for Blockchain 2.0 Introduction to Smart Contracts, Types of Smart Contracts	1	1
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Strings, Structure, Mapping, Inheritance, Error handling, Events	Useful Link 5	4
4		Need of Private Blockchain, Consensus Algorithms for Private Blockchain - PAXOS, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	1	3
5		Enterprise Blockchain: Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric Architecture, Components of Hyperledger Fabric, Transaction Flow.	1, Ref.3	3
6		Application Blockchain Technology Government & Identity: E-governance solutions, voting systems, decentralized identity management. Finance & Banking: Cryptocurrencies, cross-border payments, decentralized finance (DeFi), and asset tokenization. Supply Chain Management: Real-time tracking of goods, provenance, reducing fraud, and increasing transparency. Healthcare: Secure sharing of electronic health records (EHR), medical data integrity. Digital Assets & Web 3.0: Non-fungible tokens (NFTs), Metaverse		3
Total				26

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Construction of Merkle tree and verification of transaction	1,3	2
2	MetaMask installation and transfer of ethers	Useful Links: 6	2
3	Create a simple blockchain using Proof of Work (PoW)	1.3	2
4	Solidity program: voting application	Useful Links: 5	2
5	Solidity program: crowd funding	Useful Links: 5	2
6	Solidity program: Transactions using Remix IDE and MetaMask	Useful Links: 5	2
7	Implementation of PAXOS/PBFT algorithm	6	2
8	Block mining and reward transfer to the account	2	2
9	Smart contract execution using Ganache	Useful Links: 5	2
10	Genesis block creation using Geth	Useful Links: 8	2
11	Hyperledger installation and execution of application on Hyperledger platform.	6 and Useful Links: 7	2
12	Mini project – Development of smart contract for Dapps	-	4
	Total		26

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and MeenaKarthikeyen, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing.
4. Blockchain for Beginners, Yathish R and Tejaswini N, SPD
5. Blockchain Basics, A non-Technical Introduction in 25 Steps, Daniel Drescher, Apress



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6. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Useful Links:
1. https://www.blockchain.com/explorer/assets/btc
2. https://etherscan.io/
3. https://bitcoin.org/bitcoin.pdf
4. https://ethereum.org/en/whitepaper/
5. https://docs.soliditylang.org/
6. https://metamask.io/
7. https://intellipaat.com/blog/tutorial/blockchain-tutorial/hyperledger/
8. https://www.youtube.com/watch?v=qcjfrUclfyw https://geth.ethereum.org/docs/fundamentals/private-network
9. https://www.geeksforgeeks.org/computer-networks/ethereum-block-structure/
10. https://www.blockchain-council.org/dao/daos-vs-traditional-organizations/
11. https://www.geeksforgeeks.org/blogs/top-applications-of-blockchain-in-the-real-world/ https://mcrhrdi.gov.in/splfc2-2022/week9/Blockchain-Casestudies%20-%20Rukma%20Rekha.pdf https://www.linkedin.com/pulse/real-world-blockchain-case-studies-roland-rust
12. https://www.geeksforgeeks.org/ethical-hacking/blockchain-interoperability/

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	--	--	--	2	--	--	--	--	--	--	1	2
CO2	3	3	--	--	--	2	2	--	--	--	--	--	1	2
CO3	3	2	--	--	3	--	--	--	--	--	--	--	1	2
CO4	3	2	3	2	3	2	--	--	--	--	--	--	1	2
CO5	2	2	2	--	2	--	--	--	--	--	--	--	1	2
CO6	3	3	3	2	--	2	2	2	3	--	3	3	1	2

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply √	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE36	IT service Management	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes	25PCC13CE16, 25PCC12CE010, 25PCC13CE11
After the successful completion students should be able to:	
Course Outcomes	CO1 Apply the concepts of IT Service management in Product and Service lifecycle
	CO2 Analyze the underlying components (Infrastructure and Applications) of products and services
	CO3 Design the value co-creation process to improve the overall customer and user experience
	CO4 Apply modern tools, automation, and emerging technologies to manage and improve IT service operations

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Overview of Products and IT Services: Introduction to industrial revolutions from 1.0 to 5.0, overview of products, services, and their underlying components, IT Infrastructure, Data Centre and Cloud computing, Application management (Development to maintenance)	2	6
2	2.1	IT Service Management and delivery of IT Services: Introduction to IT Service Management, the standards and frameworks in the industry and its evolution, concepts Value management, 4 Ps of IT service management, Principles and guidelines, IT Service management process and procedures overview	1	5
3	3.1	IT Service Management best practices: Application of IT service management best practices in IT Service delivery,	1,3	5
	3.2	Portfolio, Program and Project Management while delivering IT Product and Services: Introduction to Portfolio, Program and Project Management structure and its importance while delivering IT products and services. Methodologies and		



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		industry practices, Agile overview, Concepts of Scrum, Kanban and Lean, use of Agile mindset, principles and methods in IT products and service delivery		
4	4.1	Everything as a Service: Different types of Cloud based computing models (IaaS, PaaS, SaaS), Role of service management in service-based cloud model, importance of service integration and management in multi supplier environment	1, 2	5
	4.2	DevOps and IT Service management: Introduction to DevOps, management of deployment and releases, improve resilience and reliability of products and IT services, understanding service mindset		
5	5.1	Use of technology to manage services: How technology enables management of services, tools for IT service management, IT operations management (event monitoring and integration), Toil reduction using automation, Artificial Intelligence infused IT service operations	1,2	5
Total			26	

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Study of ITIL 4 Service Value System Identify components of Service Value System and map them to a real IT service	1	2
2	IT Service Lifecycle Mapping - Map an IT service (e.g., online learning platform) to ITSM lifecycle stages	1	2
3	Infrastructure Analysis of an IT Service -Analyze infrastructure and application components of a given IT service	2	2
4	Cloud Service Model Comparison -Compare IaaS, PaaS, and SaaS with respect to service management challenges	2	2
5	Value Co-Creation Analysis -Identify stakeholders and design a value co-creation model for an IT service	1	2
6	DevOps Pipeline & ITSM Study -Analyze how CI/CD pipelines integrate with IT service operations	1,3	3



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7	ITSM Tool Exploration Hands-on study of ticketing, incident, and change management using an ITSM tool	1	3
8	Automation & Toil Reduction -Identify repetitive IT operations tasks and propose automation strategies	2	3
9	AI-enabled IT Operations (AIOps) -Study AI-based incident prediction and monitoring use cases	2	3
Total			26

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Axelos, ITIL Foundation: ITIL 4 Edition (ITIL 4 Foundation), 2nd edition, Axelos UK, 2024.
2. Nikhilesh Mishra, Mastering IT Infrastructure Management: Concepts, Techniques, and Applications, Independently Published (Amazon), 2023.
3. Rahul Shah, Agile Essentials: From Concepts to Customer Delight, Notion Press Media Pvt. Ltd., 2025.

Useful Links

1. <https://www.udemy.com/course/agile-fundamentals-scrum-kanban-scrumban/?couponCode=CP130525>
2. <https://www.udemy.com/course/certmike-comp:a-it-fundamentals-i/?couponCode=CP130525>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	--	--	--	--	--	--	--	2	2	1	--
CO2	2	3	--	2	2	--	--	--	--	--	-	2	1	--
CO3	2	-	3	--	-	--	--	--	--	--	2	2	1	--
CO4	--	--	--	--	3	--	--	--	--	--	2	3	1	--

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC14CE37	High Performance Computing	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
		ISE		MSE	ESE		Total	
					Min	Max		
		Theory		20	30	20	50	100
		Lab		50	--	--	--	50

Pre-requisite Course Codes		25PCC12CE010, 26PEC13CE18, 25PCC12CE05
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the fundamental concepts of High Performance Computing and modern processor architectures used in parallel systems.
	CO2	Analyze communication models and communication patterns used in parallel programming environments.
	CO3	Apply parallel programming techniques using APIs such as OpenMP and MPI.
	CO4	Implement GPU-based parallel programs using CUDA architecture and programming model.
	CO5	Optimize the performance of parallel algorithms using metrics, benchmarking, and data access techniques in High Performance Computing.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Module Name-Introduction to High Performance Computing (HPC) and Parallel Programming Introduction to High Performance Computing (HPC), Need and applications of HPC, Basic concepts of parallel computing, Types of parallelism: data parallelism, task parallelism, pipeline parallelism, Classification of parallel computers using Flynn's Taxonomy (SISD, SIMD, MISD, MIMD), Recent parallel system classifications: multicore systems, manycore processors, GPU computing, cluster computing.	1,2	2
	1.2	Modern Processor Architectures in Parallel Systems: Shared memory vs distributed memory architectures, Shared memory systems: Uniform Memory Access (UMA), Cache coherence, Cache-coherent Non-Uniform Memory Access (ccNUMA), Distributed memory computers and interconnection networks, Overview of modern processors: multicore processors and	1,2	2



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		GPU-based parallel systems		
2	2.1	Module Name-Communication Models in Parallel Systems Role of communication in parallel computing systems, Communication mechanisms used in modern HPC and data center environments, Shared memory communication model used in multicore processors and enterprise servers, Message passing communication model used in clusters and supercomputers	1,2,4	2
	2.2	Point-to-point communication, Collective communication patterns (broadcast, scatter, gather, reduce), Synchronization and coordination mechanisms, Communication overhead and latency in parallel systems, Analysis of communication performance in parallel programs	1,2,4	2
3	3.1	Module Name-Introduction to parallel programming using OpenMP and MPI Shared memory parallel programming using OpenMP: directives, parallel regions, work-sharing constructs for loops, synchronization mechanisms, reductions, loop scheduling, and tasking.	3,4	4
	3.2	Distributed memory programming using MPI: basic communication routines and collective communication operations, Programs using MPI: process creation, rank identification, program execution, and advanced communication routines.	3,4	3
4	4.1	Module Name-GPU Architecture and Programming CUDA architecture and execution model: grids, blocks, and threads, CUDA memory hierarchy: global memory, shared memory, constant memory, and registers, Kernel programming in CUDA: writing and launching CUDA kernels, Thread hierarchy and synchronization mechanisms in CUDA, Basic CUDA programming examples (vector addition, matrix operations), Performance optimization techniques for GPU programs.	2,4,5	3
	4.2	OpenCL platform model: host, devices, compute units, and processing elements, OpenCL execution model: kernels, work-items, and work-groups, OpenCL memory model: global, local, constant, and private memory, Writing and executing simple OpenCL kernel programs	2,4,5	3
5	5.1	Module Name-Performance and Optimization Performance metrics and Benchmarking techniques, Hardware scaling via Moore's Law, Theoretical limits using Amdahl's Law, Scalable performance using Gustafson's Law.	1,2,4	2
	5.2	Data Access Optimization: Balance analysis and lightspeed estimates, Storage order, Case studies: The Jacobi algorithm, Dense matrix transpose	1,2,4	3



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	Total	26
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Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Experiments			
	Topics	Ref.	Hrs.
1	Simulation of Flynn's Taxonomy Using Vector/Matrix Tasks	1,2	2
2	Implementation of MPI_Send and MPI_Recv between two processes; measure communication latency and overhead	1,2,3	2
3	Implementation of MPI collective communication operations (broadcast, scatter, gather, reduce) and analyze their performance in a single program.	1,2,3	2
4	Implementation of OpenMP Directives and Work Sharing Constructs for parallelizing loops	1,2,3	2
5	Implementation of OpenMP synchronization mechanisms and reductions	1,2,3	2
6	Writing and Launching CUDA Kernels for Matrix Operations	2,3,5	2
7	OpenCL Kernel Programming on Host-Device Model	1,2,4	2
8	Amdahl's Law Simulation and Speedup Analysis	1,2	2
9	Gustafson's Law Simulation on Scalable Problems	1,2	2
10	Implementation of parallel row-major vs column-major matrix transpose; measure execution time.	1,2	4
11	Solve linear system in parallel: Implement OpenMP tasking for different rows.	1,2,3	4
Total			26

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.
2. Gene Wagenbreth and John Levesque, High performance Computing: Programming and



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Application, CRC press, Taylor and Francis group, 2010.

3. Michael J Quinn, Parallel programming in C with MPI and Open MP, McGraw Hill, International Editions, Computer Science Series, 2004
4. Michael J Quinn, Maciej Brodowicz, Matthew Anderson, and Thomas Sterling, High Performance Computing: Modern Systems and Practices, Morgan Kaufmann publishers, 2017.
5. Jason Sanders, Edward Kandrot, “CUDA by Example”, Addison-Wesley, ISBN-13: 978-0-13-138768-3

Useful Links:

1. <https://hpc.llnl.gov/documentation/tutorials/introduction-parallel-computing-tutorial>
2. <https://www.nvidia.com/en-us/glossary/high-performance-computing/>
3. https://onlinecourses.nptel.ac.in/noc22_cs21/preview

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	--	--	--	--	--	--	--	--	--	2	2	2	2
CO2	3	3	--	--	--	--	--	--	--	--	2	2	2	2
CO3	3	--	--	--	3	--	--	--	--	--	2	2	2	2
CO4	3	--	--	--	3	--	--	--	--	--	2	2	2	2
CO5	3	1	3	--	--	--	--	--	--	--	2	2	2	2

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25RMC14CE01	Essentials of Research Methodology	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100

Pre-requisite Course Codes	25BSC11CE01, 25ESC11CE03, 25PCC11CE01, 25PCC13CE16	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the basic concepts and types of research
	CO2	Formulate research problems and research design.
	CO3	Apply statistical tools including ANOVA and basic DOE.
	CO4	Interpret multivariate data analysis concepts at introductory level.
	CO5	Analyze ethical issues in research and publication.
	CO6	Prepare structured research report and presentation.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	Introduction to Research Meaning and objectives of research. Characteristics of research. Research process. Types of research – Basic, Applied, Exploratory, Descriptive, Experimental. Research problem identification and formulation. Concept of hypothesis, variables and research gap	1,2	4
2	2	Research Design & Sampling Research design types. Measurement & scaling (Nominal, Ordinal, Interval, Ratio). Sampling techniques – Probability & Non-probability sampling. Questionnaire design basics (Marketing research perspective). Literature review methods and referencing styles.	1,2,	4
3	3	Statistical Analysis & ANOVA Probability distributions – Normal, Binomial, Poisson (Conceptual). Estimation and hypothesis testing. Z-test, t-test. ANOVA – One way ANOVA, Two way ANOVA Type I and II error.	1,	5



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4	4	Design of Experiments (DOE) Full factorial design Interaction effects. Introduction to Taguchi method. Applications in Engineering & Manufacturing..	4	4
5	5	Introduction to Multivariate Data Analysis Need for multivariate techniques. Multiple regression (concept). Factor analysis (basic idea). Cluster analysis (conceptual verview). Applications in Engineering and Marketing research.	3	4
6	6	Research and Publication Ethics Research integrity and scientific conduct. Falsification – Fabrication – Plagiarism , Plagiarism – types and detection tools. Authorship ethics and conflicts of interest. Predatory journals Indexing databases – Scopus, Web of Science. Research metrics – Impact Factor, h-index. Structure of journal paper and conference .	1,2,6	5
Total				26

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

References

1. Kothari, C.R., *Research Methodology – Methods and Techniques*.
2. Malhotra, Naresh K., *Marketing Research – An Applied Orientation*.
3. Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., *Multivariate Data Analysis*.
4. Montgomery, D.C., *Design and Analysis of Experiments*.
5. Dawson, Catherine, *Practical Research Methods*.
6. UGC – Research & Publication Ethics Guidelines



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SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	--	2	--	2	2	--	--	--	--	--	--	--	1	1
CO2	--	3	2	2	2	--	--	--	--	2	--	--	1	1
CO3	--	2	2	3	2	--	--	--	--	--	--	--	1	1
CO4	--	2	2	3	3	--	--	--	--	--	--	--	1	1
CO5	--	--	--	--	--	2	2	3	--	--	--	--	1	1
CO6	--	2	--	--	--	--	--	--	3	2	2	3	1	1

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25RMC14ME02	Intellectual Property Rights	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
						Min	Max	
		Theory		20	30	20	50	100

Pre-requisite Course Codes	25PCC11CE01, 25PECL13CE14, 25PECL13CE24	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the basic concepts and need of Intellectual Property Rights.
	CO2	Differentiate between patents, trademarks, copyrights and other IP forms.
	CO3	Interpret national and international IPR laws and conventions.
	CO4	Apply procedures for filing patents, trademarks, and copyrights.
	CO5	Analyze infringement issues and legal remedies.
	CO6	Evaluate the role of IPR in innovation, research, and industrial growth.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	Introduction to Intellectual Property Concept and meaning of Intellectual Property. Nature and characteristics of IPR. Importance of IPR in knowledge economy. Types of Intellectual Property. Need for IPR in Engineering and Research.	1,2,3, 5,6	4
2	2	Patents Meaning and objectives of patents. Patentable subject matter. Patentability criteria – novelty, inventive step, industrial applicability. Non-patentable inventions. Patent specification and claims. Patent filing procedure in India. Rights of patentee and infringement.	1,2,3, 5,6	4



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3	3	Trademarks, Copyrights and Industrial Design Trademark: Definition, types, registration process, infringement. Copyright: Subject matter, ownership, duration, infringement. Industrial Design: Meaning, registration procedure, rights and protection.	1,2,3, 5,6	6
4	4	Geographical Indications, Trade Secrets and Semiconductor IC Layout Design GI: Concept, registration, protection. Trade Secrets: Meaning, protection strategies. Semiconductor Integrated Circuit Layout Design protection.	1,2,3, 5,6	4
5	5	International Treaties and Agreements TRIPS Agreement. WIPO conventions. Paris Convention and Berne Convention. Patent Cooperation Treaty (PCT). Role of WTO in IPR regulation	4	4
6	6	IPR Management and Case Studies Technology transfer and licensing. IPR in academic institutions and research organizations. Patent search and documentation. Case studies on infringement and litigation. IPR strategy for startups and MSMEs.	1,2,3, 5,6	4
Total				26

Course Assessment:

Theory:

ISE- Based on Self Learning / Formative Assessment - activities will be conducted during the full semester (20 Marks).

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE- Examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

References

1. P. Narayanan, Intellectual Property Law, Eastern Law House.
2. W.R. Cornish, Intellectual Property: Patents, Copyright, Trademarks and Allied Rights.
3. B.L. Wadhwa, Law Relating to Intellectual Property.
4. WIPO Publication on Intellectual Property Handbook.
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property.
6. Bare Acts: Indian Patent Act 1970, Trademark Act 1999, Copyright Act 1957.

SUGGESTED CO - PO articulation Matrix



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Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	--	--	--	--	--	2	--	--	--	--	--	1	1
CO2	2	--	--	--	--	2	--	--	--	--	--	--	1	1
CO3	2	--	--	--	--	2	--	--	--	--	--	--	1	1
CO4	2	--	--	--	--	2	--	--	--	--	--	--	1	1
CO5	2	--	--	--	--	2	--	2	--	--	--	--	1	1
CO6	2	--	--	--	--	--	--	--	--	--	--	2	1	1

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PRJ14CE01	Major Project	--	--	12		--	6	6
		Examination Scheme						
				ISE	ESE		Total	
		Theory		--	--		--	
		Lab		300	--		300	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify and define real-world engineering problems through literature review and data analysis.
	CO2	Analyze existing literature to determine problem scope, research gaps, and feasibility of identified real world problem.
	CO3	Design and implement engineering solutions using appropriate techniques and modern tools.
	CO4	Evaluate the prototype/working model using appropriate validation metrics, considering societal, environmental, and sustainability aspects.
	CO5	Demonstrate effective written and oral communication, teamwork, and leadership skills.
	CO6	Exhibit professional ethics, and commitment to lifelong learning in engineering practice.

Project Guidelines

1. Project Topic Selection and Allocation

1.1 Project Orientation

- Project orientation shall be begin at the end of Semester VI.
- Students shall be informed about available domains and domain experts for guidance.
- Students should be encouraged to refer to problem statements from Digital India Portal, Smart India Hackathon (SIH), INPASS patent database and other hackathon portals.

1.2 Topic Finalization Criteria

Projects should satisfy the following criteria:



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- **Novelty:**
Topics should be product-based, application-based, or research-based and preferably address gaps in existing systems.
- **Relevance:**
Should align with current industrial trends and specialization area. Also address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact.
- **Technology:**
Use of modern tools and latest technologies is encouraged.
- **Originality:**
Work should not repeat projects carried out in the last three years.
- **Literature Review:**
Students must refer to recent papers (preferably within last 3 years) from reputed sources such as IEEE, Elsevier, ACM, Springer, etc.
- Students may take inspiration from existing ideas but must evolve them uniquely to suit their project requirements.
- Student's projects may be undertaken in research institutes, industries, or business establishments.

1.3 Group Formation

- Project must be carried out in a group of **minimum 2 and maximum 4 students**.

1.4 Approval Process

- Proposal presentations shall be scheduled domain-wise.
- Evaluation shall be carried out by faculty experts in the respective domain.
- Final approval shall be granted by the Head of Department, internal domain wise faculty members, and project coordinators.
- Guide allocation shall be done after topic approval.

2. Monitoring and Progress Tracking

- Students are required to meet their assigned guide regularly, discuss their progress, and submit a weekly progress report (log book) to the internal guide for review and monitoring.
- Internal guide shall:
 - Monitor technical progress
 - Maintain attendance records
 - Evaluate contribution of each student
- Progress reports shall be considered as continuous assessment.



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3. Project Implementation Framework

The Capstone Project is structured into two sequential stages: Phase I, conducted during the 7th semester, and Phase II, completed in the 8th semester.

Phase I: Research & Methodology (Semester VII)

Target Outcomes: CO1, CO2, CO3

Phase I focuses on the foundational stages of the engineering lifecycle. Students will conduct a comprehensive literature review, identify critical research gaps, and assess the feasibility of a real-world problem. Emphasis is placed on designing engineering solutions through the application of modern tools and appropriate technical methodologies.

- **In-Semester Evaluation (ISE):** 100 Marks

ISE-phase1- Literature review and Methodology (50M)

ISE-phase2- Design and Implementation (50M)

- **End-Semester Evaluation (ESE):** 50 Marks

Phase II: Implementation & Professional Practice (Semester VIII)

Target Outcomes: CO4, CO5, CO6

Phase II transitions into the execution and validation of the project. This stage involves evaluating the prototype or working model against performance benchmarks. Furthermore, students must demonstrate proficiency in technical communication, collaborative teamwork, and leadership. The phase concludes with a focus on professional ethics and a commitment to continuous lifelong learning.

- **In-Semester Evaluation (ISE):** 100 Marks

ISE-phase1- Full demonstration of Project and Draft of Publication/Patent (50M)

ISE-phase2- Black book and Evidence of outcome (50M)

End-Semester Evaluation (ESE): 50 Marks

Evaluation Components:

1. Weekly Log Report
2. Project Work Contribution
3. Completeness of Work



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4. Mid-term Presentations (ISE- (100 Marks) With well-defined rubrics)
5. The End Semester Examination (ESE) shall be conducted in the presence of both an internal and an external examiner. The ESE shall be evaluated based on the demonstration of the project, quality of the final report, and submission of a technical paper to a reputed journal or an international conference/ Publication of patent.

Evaluation shall be based on department-defined rubrics.

Final certification of Project Work ensures satisfactory performance in the above components.

4. Project Report Format

At the end of the semester, each group must submit:

- **Hard Copy (Black Book)**
- **Soft Copy** including:
 - Report
 - Source Code
 - Executable
 - Required utilities/software
 - User Manual
 - Documentation
 - Submission on GitHub

The Report Shall Contain:

1. Abstract
2. Introduction
3. Literature Survey / Existing System
4. Limitations / Research Gap
5. Problem Statement and Objectives
6. Proposed System
7. Analysis / Framework / Algorithm
8. Design Details
9. Methodology
10. Experimental Setup
11. Database / Input Details
12. Performance Evaluation Parameters (Validation)
13. Software and Hardware Setup
14. Results and Discussion
15. Conclusion and Future Scope
16. Timeline Chart (Project Management Tools)
17. Implementation details
18. References
19. Appendix (Publications / Certifications if any)



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5. Desirable Activities

Students should be encouraged to:

- Complete relevant certification courses aligned with project domain.
- Participate in project competitions and hackathons.
- Publish at least one technical paper in a reputed journal/Present work at National / International Conferences.
- Submission of GitHub repository

6. Suggested Quality Evaluation Parameters:

- Quality and relevance of problem selected
- Clarity of problem definition and feasibility
- Relevance to specialization / industrial trends
- Address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact
- Originality and innovation
- Use of modern tools
- Quality of analysis and design
- Implementation completeness
- Validation of results
- Impact on society/environment and business value
- Quality of written and oral presentation
- Individual contribution and teamwork
- Participation in hackthons and project competitions

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	1	1	1						3	3
CO2	3	3	1	-	2	1	1						3	3
CO3	3	3	3	1	3	1	1	1	1	1	1	2	3	3
CO4	1	3	1	1	3		3	3	2		1	2	3	3
CO5								1	3	3		2	-	-
CO6								3				3	-	-

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze	Evaluate	Create √
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25SEM14CE01	Course Seminar	L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
		Examination Scheme						
			ISE		MSE	ESE	Total	
		Lab	100		--	--	100	

Pre-requisite Course Codes		25MDM05
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify a real-world engineering advancements across diverse domains.
	CO2	Analyze research literature and technical data to determine problem scope and feasibility.
	CO3	Demonstrate awareness of advanced engineering developments and emerging technologies.
	CO4	Exhibit professional ethics, independent learning ability, and commitment to lifelong learning.
	CO5	Present structured technical reports with effective written and oral communication skills.

1. Seminar Guidelines

1.1 Topic Finalization Criteria

The selected seminar topic must satisfy the following criteria:

- **Novelty:** The topic should address emerging trends, innovative ideas, or recent technological advancements.
- **Relevance:** The selected topic should align with current industrial trends, address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact, and be closely related to the student's area of specialization.
- **Technology Orientation:** Usage of modern tools, platforms, frameworks, and latest technologies is encouraged.
- **Literature Review:**
 - Students must refer to recent research papers (preferably within the last 3 years).
 - References should be from reputed sources such as IEEE, Elsevier, ACM, Springer, etc.
 - A maximum number of quality research papers should be reviewed and critically analyzed.



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1.2 Group Formation

- The seminar shall be carried out as an **individual (single student) activity** to encourage independent research and learning.

1.3 Approval Process

- Topic presentations shall be conducted domain-wise.
- Evaluation shall be carried out by faculty experts in the respective domain.
- Final approval shall be granted by the Head of Department and panel wise domain internal faculty members.
- Guide allocation shall be done after formal topic approval.

2. Internal Assessment (ISE)

2.1 Evaluation Components

- Fortnightly Log Report (Progress Monitoring)
- Mid-term Presentation (ISE) as per department-defined rubrics for 100 marks
- Completeness and Quality of Work

3. Suggested Quality Evaluation Parameters

Evaluation shall be based on the following:

- Quality and relevance of topic selected
- Clarity of problem definition and feasibility
- Relevance to specialization and industrial trends
- Address relevant Sustainable Development Goals (SDGs) with consideration for environmental and societal impact
- Use of modern tools and technologies
- Quality of analysis
- Societal and environmental impact
- Quality of written report
- Effectiveness of oral presentation

4. Seminar Report Structure

The seminar report must include the following sections:

1. Abstract
2. Introduction
3. Literature Survey / Existing System



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4. Comparative study of different technical papers
5. Analysis / Framework / Algorithm of the study
6. Design Details studied
7. Methodologies used in the study
8. Proposal for the new concept/solution/algorithm etc.
9. Conclusion
10. References (in standard citation format)
11. Appendix (Publications / Certifications / Additional Documents if any)

5. Desirable Academic Enrichment Activities

Students are encouraged to:

- Complete relevant certification courses aligned with their seminar domain.
- Present their seminar findings to junior students to promote awareness of emerging technologies.
- Publish e-content related to their seminar topic on the department's official YouTube channel.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes* (PSOs)	
	PO 1	PO2	PO 3	PO 4	PO5	PO6	PO 7	PO 8	PO9	PO 10	PO 11	PO1 2	PSO1	PSO 2
CO1	3	2	2	--	2	2	2	--	--	2	--	2	3	3
CO2	3	3	2	--	2	2	2	--	--	2	--	2	3	3
CO3	3	2	2	--	2	2	2	--	--	2	--	3	3	3
CO4	2	--	--	--	--	--	--	3	2	2	--	3	1	1
CO4	2	--	--	--	2	--	--	2	2	3	--	2	1	1

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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