



CURRICULUM STRUCTURE
FOURTH YEAR UG: BE
ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REVISION: FRCRCE-3-26

Effective from Academic Year 2026-27
Board of Studies Approval: 4/3/2026
Academic Council Approval: 27/3/2026



Dr. DEEPAK BHOIR
Dean Academics

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HOD (CSE)

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Principal



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)

Institute Vision

To be a leading institution in education, transforming students into globally competent professionals with strong ethical values, innovation capabilities, and a commitment to sustainable societal development.

Institute Mission

- Develop industry-ready engineers with strong academic foundations, practical skills, and an entrepreneurial mindset capable of addressing industry and societal needs.
- Cultivate a culture of innovation and research to address real-world challenges through interdisciplinary approaches and sustainable practices.
- Foster a vibrant industry–academia ecosystem by actively engaging faculty and students in knowledge exchange, collaborative learning and professional skill development.

Department Vision

To achieve excellence in Computer Science education by nurturing technically competent and socially responsible professionals who solve real-world problems.

Department Mission

1. Facilitate an excellent scholastic environment for students and faculty to promote research, innovation and interdisciplinary learning.
2. Foster a culture of experiential learning and sustainable practices through projects, internships and industry engagement.
3. Promote participation in co-curricular and extra-curricular activities to build integrity, communication, teamwork and leadership.



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Program Educational Objectives (PEO)

Graduates will be able to

1. Design, develop and implement innovative computing solutions that promote sustainable development and socio-economic growth.
2. Pursue lifelong learning and advanced education by adapting to evolving technologies and diverse career opportunities.
3. Exhibit ethical conduct, leadership, and effective interpersonal skills in their professional domain.

Program Specific Outcomes (PSO)

Students will be able to

1. Apply computational thinking, algorithmic design and software development principles to build efficient computing solutions.
2. Develop scalable and intelligent computing solutions using emerging technologies such as Artificial Intelligence, Data Science and Distributed Systems to solve complex problems.



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Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

Government of Maharashtra has also directed Autonomous Colleges to revise their curriculum in line with National Education Policy (NEP) 2020 through Government Resolution dated 4th July 2023. We commit to ourselves to the effective implementation of UGC Regulations and NEP 2020 in its spirit.

Based on recent recommendations of the GR, we are pleased to offer our holistic curriculum for 2024-28, a “**H-Tree Model**” of Engineering Education. A unique “**H-Tree Model**” of Engineering Education Curriculum is carefully designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient) and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an **all-rounded** personality with **holistic** approach to education in which learner receives **25% teacher-led learning, 25% peer learning, 25% self-learning and 25% experiential learning**. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to learner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science, and mathematics foundation and program core, sequel of electives, Multidisciplinary Minor courses, humanities & management courses and sufficient experiential learning through projects and semester-long industry / research internship along with employable skill-based courses. Learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. Learner also gets additional option to choose the kind of degree i.e. Honors or Double Minor or Honors with Research.

Various steps are taken to transform teaching learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units.



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Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2026-27

Nomenclature of the courses in the curriculum	
Abbreviation	Title
BSESC	Basic Science & Engineering Science Courses
PCPEC	Program Core and Program Elective Courses
MDC	Multidisciplinary Courses
SC	Skill Courses
HSSM	Humanities, Social Sciences and Management
EL	Experiential Learning
LLC	Liberal Learning Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC	Program Elective Courses
MDM	Multidisciplinary Minor
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
VSC	Vocational Skill Courses
SEC	Skill Enhancement Courses
AEC	Ability Enhancement Course
EEMC	Entrepreneurship, Economics and Management Course
IKS	Indian Knowledge System
VEC	Value Education
RM	Research Methodologies
CEFP	Community Engagement or Field Project
ELC	Experiential Learning Courses
PRJ	Project
INT	Internship
CC	Cocurricular Courses
HMM	Honors and Multidisciplinary Minor
DM	Double Minor
BC	Bridge Course

Credit Specification:

- ❖ Theory: 1 credit=13 to 15 hrs of teaching
- ❖ Lab: 1 Credit=26 to 30 hrs of lab work
- ❖ Studio Activities: 1 Credit= 26 to 30 hrs of creative activities
- ❖ Workshop Based Activities: 1 Credit=26 to 30 hrs of hands-on activities related to vocation/professional practice/skill based
- ❖ Seminar/Group Discussion: 1 Credit=13 to 15 hrs of participation
- ❖ Internship: 1 Credit=Per 2 weeks OR 36 to 40 hrs of engagement
- ❖ Field Based Learning/Practices: 1 Credit=26 to 30 hrs of learning activities
- ❖ Community Engagement Projects: 1 Credit=26 to 30 hrs of contact time along with 13 to 15 hrs of activities preparation, report writing, independent reading etc.



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Credit requirements for different options of the Degrees:

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B.E	18	20	22+ 4#	23+5 #	20	20	20	20	163+9#=172
B.E with Honors/Minors	18	20	22+ 4#	23+5 #	20+4*	20+4*	20+6*	20+4*	163+9#+18*= 190

Bridge courses

*Optional Credits

1. Learners who earn a minimum of total **172 credits** will be awarded “**Bachelor of Engineering**” degree.
2. Learners will have the following options to earn **B. E. in(regular) Engineering with Honours/Minor in (specialization)**

Sr. No.	Honors/Minor degree programs	Programs who can offer this Honours Degree Program	Programs who can offer this as Minor Degree program
1	Internet of Things	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science 4. Mechanical Engineering	--
2	Artificial Intelligence and Machine Learning	1. Computer Engineering 2. Electronics and Computer Science	Mechanical Engineering
3	Data Science	1. Computer Engineering 2. Electronics and Computer Science 3. Mechanical Engineering	
4	Blockchain	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
5	Cyber Security	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
6	Robotics	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science
7	3D Printing	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science



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3. **Honours and Minor Degree Eligibility Criteria for Students:**
 - a. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:
 - i. Students with no backlog in semester I, II, and III
 - ii. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above
 - iii. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above
 - b. ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.
 - c. iii) However, it is optional for learners to take Honours/Minor degree program.
 - d. iv) The Honours/ Minor degree program can be opted only during regular engineering studies
 - e. v) The student shall complete the Honours/ Minor degree program in stipulated four semesters only.
4. Courses offered during internship semester shall be in online mode
5. Learner can earn additional credits by enrolling to skill courses offered in summer.
College shall explore feasibility to offer NSDC aligned skill-based courses to the learners
6. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

Salient Features of Curriculum:

- ✓ Framed as per Government Resolution dated 4th July 2023 in line with National Education Policy (NEP) 2020.
- ✓ Minimum 172 choice-based credit structure with options of Degrees earning additional credits
- ✓ Unique 'H-Tree' Model of Curriculum: Hybrid model for holistic development with happy learning environment having bridge connecting verticals providing unique path for each learner for 3-dimensional growth, Life Long Learning, bridge courses, inclusive model indicating equal distribution of central resources
- ✓ More emphasis on laboratory based and experiential learning
- ✓ More weightage to continuous assessment to reduce examination stress
- ✓ Mandatory Semester-long internship, courses with emotional & spiritual learning and skill-based learning aligned with NSDC framework
- ✓ Well balanced curriculum to attain Program Outcomes and skills of 21st century learner
- ✓ Curriculum is designed to create excitement among learners for education through stories, activities, collaboration, hackathon, contest, case studies, creative art etc.
- ✓ Curriculum is designed to make graduates responsible citizens of country with future ready skills to handle challenges of 21st Century



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Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2026-27
FOURTH YEAR Artificial Intelligence & Data Science Program

SEM-VII/VIII													
Course Code	Course Vertical	Sub-Vertical	Course Name		Contact Hours	Examination Marks (1 Credit=50 Marks)					Credits		
						ISE	MSE	ESE		Total	Points	Total	
								Min	Max				
25PEC4CSX	PCPEC	PEC	Program Elective Course 1	TH	2	20	30	20	50	100	2	3	
				PR	2	50	-	-	50	1			
25PEC4CSX	PCPEC	PEC	Program Elective Course 2	TH	2	20	30	20	50	100	2	3	
				PR	2	50	-	-	50	1			
25PEC4CSX	PCPEC	PEC	Program Elective Course 3	TH	2	20	30	20	50	100	2	3	
				PR	2	50	-	-	50	1			
25PEC4CSX	PCPEC	PEC	Program Elective Course 4	TH	2	20	30	20	50	100	2	3	
				PR	2	50	-	-	50	1			
25MDM6X	MDC	MDM	MDM Course 6	TH	2	20	30	20	50	100	2	2	
25MDM7X	MDC	MDM	MDM Course 7	TH	2	20	30	20	50	100	2	2	
25RMC14CS01	EL	RM	Essentials of Research Methodology	TH	2	20	30	20	50	100	2	2	
25RMC14CS02	EL	RM	Intellectual Property Rights	TH	2	20	30	20	50	100	2	2	
25PRJ14CS01	EL	PR	Capstone Project	PR	12	200	-	40	100	300	6	6	
25SEM14CS01	EL	PR	Course Seminar	PR	2	100	-	-	-	100	2	2	
25INT14CS01	EL	INT	Semester long Internship	PR	36-40 hrs.	As Per Internship Manual					12	12	
HXXXCXXX	HMM/DM	HMM/DM	Honors/Minor Degree Course	TH	Online	As Per SWAYAM					8	8*	
HXXXCXXX	HMM/DM	HMM/DM	Honors/Minor Degree Lab (Project)	PR							2	2*	
Total						TH:TU:PR+PRJ 16:0:(10+12)=38			-	-	1400	-	40+*10

- MDM should be non-technical courses e.g. Principles of Management
- Internship is mutually exclusive in SEM-VII or SEM-VIII
- The remaining required credits may be earned during Semester V to Semester VIII through SWAYAM/NPTEL courses or through courses offered by the Department.
 - 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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List of Program Elective Courses (SEM VII/VIII)

The Department offers the following Program Elective courses. Students are required to select any four of these courses.

- **25PEC4CS1** - Natural Language Processing
- **25PEC4CS2** - Software Engineering
- **25PEC4CS3** - Quantum Computing
- **25PEC4CS4** - Big Data Analytics
- **25PEC4CS5** - Blockchain Technologies
- **25PEC4CS6** - Optimization Algorithm
- **25PEC4CS7** - IT Service Management

List of Program MDM Courses (SEM VII/VIII)

The Department offers the following two tracks for MDM courses. Students are required to select one course from each track.

Track 1:

- 25MDM61:** Environmental Management
- 25MDM62:** Disaster management

Track 2:

- 25MDM71:** Management Information System
- 25MDM72:** Finance Management



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PEC4CS1	Natural Language Processing	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	Basic Mathematics, Machine Learning, Python Programming	
After the successful completion students should be able to:		
Course Outcomes	CO1	Describe the mathematical and linguistic preliminaries necessary for various processes in NLP.
	CO2	Analyze natural language at word-Level to extract meaningful linguistic features.
	CO3	Analyze natural language at Syntax-Level to determine sentence structure and relationships between linguistic constituents.
	CO4	Analyze the natural language at Semantic Level to understand meaning and identify relationships between words.
	CO5	Explain the role of pragmatics in NLP in interpreting meaning based on context and intent.
	CO6	Apply NLP techniques to design and develop real-world NLP applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Natural Language Processing	1,3	4
	1.1	The need of NLP, Levels of NLP		
	1.2	Stages in building a Natural Language Processing System		
	1.3	Challenges and ambiguities in NLP Design		
	1.4	Mathematical preliminaries required for NLP: Probability Theory, Conditional Probability and Independence, Bayes Rule, Probability Distributions, Statistics: Counting, Frequency, Mean and Variance.		
2		Word Level Analysis	1,3	5
	2.1	Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer.		
	2.2	N-gram Language Model, Evaluating N-gram Model: Perplexity, Smoothing.		
	2.3	Morphological Analysis, Derivational and Reflectional Morphology		
3		Syntax Level Analysis	3,4	5



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	3.1	Tag set for English (Penn Tree bank), Introduction to Parts of Speech Tagging (POST), Types of POS tagging: Rule –based, stochastic and Transform based.		
	3.2	Markov Processes, Hidden Markov Models (HMM), Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm.		
		Semantic Analysis		
4	4.1	Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma	3,4	4
	4.2	Study of Various language dictionaries: WordNet (gloss, synset, sense relations in WordNet), Babelnet.		
	4.3	Cosine distance between documents.		
	4.4	Word sense disambiguation: Knowledge based approach (Lesk's Algorithm), Supervised (Naïve Bayes, Decision List), Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)		
5		Pragmatics & Discourse Processing and Applications of NLP	5,6	4
		Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference, Anaphora Resolution using Hobbs and Canterling Algorithm.		
		Applications of NLP and Ethical Considerations	1,3	4
6	6.1	Applications of NLP: Machine Translation, Text Summarization, Sentiment Analysis, Named Entity Recognition, Information Retrieval, Question Answer System.		
	6.2	Bias and Fairness in NLP: Sources of bias in language data, Fairness metrics in NLP models. Data Privacy and Consent: Data collection ethics, Web scraping and ethical concerns, Data anonymization techniques Transparency and Explainability: Black-box nature of large language models, Explainable AI (XAI) techniques, Model interpretability and trust		
Total				26

Course Assessment - Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)



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To be Taught in laboratory			
S.N.	Topics	Ref.	Hrs.
1	Preprocessing of text (Tokenization, Filtration, Lower casing, Stop Word Removal etc.)	7,8	2
2	Perform Stemming and Lemmatization on a given Text	7,8	2
3	Study different POS taggers and Perform POS tagging on the given text.	7,8	2
4	Implement N-Gram model for the given text input.	7,8	2
5	Implement Chunking and Named Entity Recognition	7,8	2
6	Implement POS tagging using HMM	7,8	2
7	To extract word senses in a given sentence using WordNet	7,8	2
8	Implement Text Similarity Recognizer for the chosen text documents (TF-IDF)	7,8	2
9	a. To implement coreference resolution using the spaCy library in order to identify and resolve pronouns in a given text. b. Implementation of Intent Recognition using Machine Learning for Pragmatic Analysis.	7,8	2
10	Mini project implementation for real-world problems		8
Total			26

Course Assessment - Lab

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

Recommended Books:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
3. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
4. Daniel M Bikel and Imed Zitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
5. Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
6. Nitin Indurkha and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
7. Steven Bird, Ewan Klein & Edward Loper,” Natural Language Processing with Python, OREILLY.
8. Rohan Chopra,” Natural Language Processing with Python, Packt Publications.



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Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	3	-	-	-	-	-	-	-
CO3	3	3	2	-	3	-	-	-	-	-	-	-
CO4	3	3	2	-	3	-	-	-	-	-	-	-
CO5	3	2	-	-	3	-	-	-	-	-	-	-
CO6	3	3	3	3	3	-	-	-	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			
		L	T	P	L	T	P	Total
25PEC4CS2	Software Engineering	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	Object Oriented Programming
After the successful completion students should be able to:	
Course Outcomes	CO1 Apply appropriate software engineering process models for effective software project development.
	CO2 Analyze and specify software requirement of a software system in an SRS document.
	CO3 Apply strategies to effectively plan, schedule, and monitor project progress.
	CO4 Apply software design concepts to create architectural, user interface, and component-level designs using appropriate patterns and styles.
	CO5 Identify risks and manage the change to assure quality in software projects.
	CO6 Apply testing strategies and techniques to a software system.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction To Software Engineering and Process Models:	1,2,5,6	6
	1.1	Software engineering- a layered technology, Process Framework and Umbrella Activities, Capability Maturity Model (CMM)		
	1.2	Prescriptive Process Models: Waterfall model, Incremental Process Models, Evolutionary Process Models: RAD, Spiral, Prototyping		
	1.3	Agile process model: Agile Principles, Scrum, Kanban, Extreme Programming (XP)		
2		Software Requirements Analysis and Modelling:	1,2,4	4
	2.1	Types of requirements- Functional and Nonfunctional requirements, system and user requirements, requirement elicitation methods, Requirement Engineering process.		
	2.2	Software Requirement Specification document format (IEEE)		
	2.3	Requirement Modelling: Scenario based Models, Behavioral models, Data flow diagram.		
3		Project estimation, Tracking and Scheduling:	1,6	5
	3.1	Project Estimation techniques-LOC, FP, COCOMO II		
	3.2	Project Scheduling and Tracking: Defining a Task Set for the Software Project, Gantt Chart, Program Evaluation Review Techniques (PERT), Tracking the Schedule		
4		Design Engineering	1,3,6	6
	4.1	Software design concepts, design model		



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	4.2	Architectural Design, User interface design, Component level design, Architectural styles and Patterns.		
5		Software Risk & Quality Management	1,2,5 ,6	5
	5.1	Software Risk, Types of Risk, Risk Identification, Risk Assessment, Risk Projection, RMMM Plan.		
	5.2	Software Quality Assurance Task, SCM process, change and version control, Formal Technical Review (FTR), Walkthrough.		
6		Software Testing	1,2,6	4
	6.1	Unit testing, Integration testing, Validation testing, System testing		
	6.2	Testing Techniques: white-box testing- Basis path, Control structure testing Black-box testing: Graph based, Equivalence partitioning, Boundary value analysis		
	6.3	Types of Software Maintenance, Re-Engineering, Reverse Engineering		
Total			30	

Course Assessment - Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

To be Taught in laboratory			
S.N.	Topics	Ref.	Hrs.
1	Apply different process models (Waterfall, Iterative, Incremental and Spiral) to a selected case study and compare their effectiveness in terms of time, flexibility, and quality.	1,2	2
2	Gather requirements for a sample software system using requirement elicitation methods and document them in IEEE format. (SRS document)	1,2,4	3
3	Develop UML diagrams (use case, activity, sequence, DFD etc.) for a selected case study.	1,2,4	3
4	Estimate size, cost and effort for a selected case study using function point method.	1,6	2
5	Estimate size, cost and effort for a selected case study using COCOMO Model.	1,6	2
6	Create a project plan using Gantt and PERT for a software development project and track progress.	1,6	2
7	Use any project management tool like JIRA, Trello, Asana etc. to learn project management principles and manage the lifecycle of a selected case study.	1,6	3
8	Design the architecture of a selected case study using architectural styles and patterns.	1,4	2



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9	Design a user interface for a selected case study focusing on usability and accessibility	1,4	3
10	Create a component level design of a chosen software system.	1,4	2
11	Conduct a risk assessment for a software project and create a Risk Mitigation and Management Plan (RMMM).	1	2
12	Experiments based on manual and automated software testing		
Total			26

Course Assessment – Lab:

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

Recommended Books:

1. Roger Pressman, “Software Engineering: A Practitioner’s Approach”, 9th edition , McGraw-Hill Publications, 2019
2. Ian Sommerville, “Software Engineering”, 9th edition, Pearson Education, 2011
3. Ali Behfroz and Fredeick J. Hudson, "Software Engineering Fundamentals", Oxford University Press, 1997
4. Grady Booch, James Rumbaugh, Ivar Jacobson, “The unified modeling language user guide”, 2nd edition, Pearson Education, 2005
5. Pankaj Jalote, "An integrated approach to Software Engineering", 3rd edition, Springer, 2005
6. Rajib Mall, "Fundamentals of Software Engineering", 5th edition, Prentice Hall India, 2014
7. Jibitesh Mishra and Ashok Mohanty, “Software Engineering”, Pearson, 2011
8. Ugrasen Suman, “Software Engineering – Concepts and Practices”, Cengage Learning, 2013
9. Waman S Jawadekar, “Software Engineering principles and practice”, McGraw Hill Education, 2004

Online Resources:

1. Software Engineering specialization by the Hong Kong university of Science and Technology <https://www.coursera.org/specializations/software-engineering>
2. <https://nptel.ac.in/courses/106/105/106105182/>
3. https://onlinecourses.nptel.ac.in/noc19_cs69/preview
4. <https://www.mooc-list.com/course/software-engineering-introduction-edx>
5. <https://www.geeksforgeeks.org/software-engineering/>
6. <https://www.atlassian.com/software/jira>



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Suggested CO – PO articulation Matrix

Course Outcomes	Programme Outcomes (Pos)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	-	-	3	-	-	-	-	-	-	-
CO4	3	3	3	3	3	-	-	-	3	3	3	3
CO5	3	3	-	-	-	-	-	-	3	3	3	3
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			
		L	T	P	L	T	P	Total
25PEC4CS3	Quantum Computing	2	--	2	2	--	1	3
		Examination Scheme						
				ISE	MSE	ESE		Total
				Min	Max	Min	Max	
		Theory		20	30	20	50	100
Lab		50	--	--	--	50		

Pre-requisite Course		Physics, Mathematics (Linear Algebra)
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the fundamental differences between classical and quantum computing paradigms
	CO2	Design and analyze quantum circuits using quantum logic gates.
	CO3	Implement fundamental quantum algorithms, including Shor's algorithm and Grover's algorithm, using quantum-computing frameworks.
	CO4	Analyze quantum cryptography techniques, such as quantum key distribution, to evaluate their role in secure communication systems.
	CO5	Evaluate the potential and limitations of quantum computing applications 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.		
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		



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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: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

To be Taught in laboratory			
	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	2
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

Course Assessment: - (Lab)

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

Recommended Books:

1. Michael A. Nielsen, Isaac L. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 2010 (10th Anniversary Edition)



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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, Nic Harrigan, 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)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	-	-	-
CO3	2	2	3	2	2	-	-	-	-	-	-	-
CO4	2	3	2	2	2	3	-	-	-	-	-	-
CO5	2	3	2	2	3	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			
		L	T	P	L	T	P	Total
25PEC4CS4	Big Data Analytics	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	Data base Management System	
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	Analyse different NoSQL systems and evaluate how they manage and process big data efficiently
	CO4	Apply advanced techniques for emerging applications like stream analytics.
	CO5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Big Data and Hadoop	1,3	4
	1.1	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, Big Data Analysis Life Cycle, Case Study of Big Data Solutions		
	1.2	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem		
2		Hadoop HDFS and MapReduce	2	6
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization		
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures, Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce		
	2.3	Hadoop Technology Stack: Hive, Pig, Zookeeper, Swoop, oozie, flume etc., Hadoop Limitations		



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3		NoSQL databases for Bigdata	2,3	6
	3.1	Introduction to NoSQL, NoSQL Business Drivers		
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study		
	3.3	NoSQL solution for big data, Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Big data for E-Commerce Big data for blogs, Case Studies MongoDB and Cassandra, Graph Databases-Neo4j.		
4		Mining Data Streams	1,3	6
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data techniques in a Stream		
	4.2	Filtering Streams: Bloom Filter with Analysis, Counting Distinct Elements in a Stream, Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements, Real time Analytics Platform (RTAP) applications		
	4.3	Counting Ones in a Window: The Cost of Exact Counts, The Datar- Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows, Case Studies as Spark, Kafka.		
5		Real-Time Big Data Models	1,3	4
	5.1	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Case Study: Product Recommendation		
	5.2	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph		
Total				26

Course Assessment Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)



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To be Taught in laboratory			
	Topics	Ref.	Hrs.
1	Case Study-on big data and big data analysis (Walmart, Uber, Netflix, eBay, Zomato etc.)	2,3	2
2	Install Hadoop and Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files and directories.	2,3	3
3	<ul style="list-style-type: none"> • Develop a MapReduce program to implement Matrix Multiplication • Develop a Map Reduce program that mines weather data and displays appropriate messages indicating the weather conditions of the day. 	2,3	3
4	<ul style="list-style-type: none"> • Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data. • Implement a word count program in Hadoop and Spark. • Use Hive to create, alter, and drop databases, tables, views, functions, and indexes. 	2,3	2
5	Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB	2,3	2
6	Case Studies on Cassandra or Graph Databases-Neo4j	2,3	2
7	<ul style="list-style-type: none"> • Implementation of Matrix algorithms in Spark Sql programming, • Building Spark Streaming application 	2,3	2
8	Implement bloom filter technology	2,3	2
9	Finding Communities in a social network graph	2,3	2
10	Build recommendation system	2,3	6
Total			26

Course Assessment – Lab:

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

Recommended Books:

1. Cre Anand Rajaraman 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.



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Online Resources:

1. <https://nptel.ac.in/courses/106104189>
2. <https://www.coursera.org/specializations/big-data#courses>
3. <https://www.digimat.in/nptel/courses/video/106106169/L01.html>
4. <https://www.coursera.org/learn/nosql-databases#syllabus>
5. <https://www.coursera.org/learn/basic-recommender-systems#syllabus>

Suggested CO - PO articulation Matrix

Course Outcome	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	1	2
CO2	3	3	2	-	2	-	-	-	-	-	1	2
CO3	3	3	3	2	2	-	-	-	-	-	1	2
CO4	3	3	3	2	2	3	-	-	-	-	1	2
CO5	3	3	3	2	3	-	-	-	-	-	2	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			
		L	T	P	L	T	P	Total
25PEC4CS5	Blockchain Technologies	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	Python, Data structure	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the Fundamental Concepts of Blockchain Technology
	CO2	Examine consensus algorithms and analyse security challenges in blockchain systems.
	CO3	Analyse cryptocurrency and bitcoin mechanisms to interpret digital transaction processes.
	CO4	Evaluate public and private blockchain platforms to select suitable platforms for different applications.
	CO5	Develop smart contracts using Solidity to build blockchain-based applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Introduction to Blockchain		1,2	5
	1.1	What is a blockchain, Centralization vs. Decentralization, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, The Structure of a Block, Block header, Genesis block, Mining, Rewards, Foundation of blockchain: Merkle trees		
	1.2	Components of blockchain, Types: Public, Private, and Consortium, Consensus Protocol- Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Limitations and Challenges of blockchain		
2	Bitcoin and Cryptocurrency		1,2	5
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem in Bitcoin		
	2.2	Mining difficulty, Mining pool, Private keys in Bitcoin, Public Keys in Bitcoin, Addresses in Bitcoin		



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3	Public Blockchain		4	4
	3.1	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum		
	3.2	Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure		
4	Programming for Blockchain		2	8
	4.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts		
	4.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling		
5	Private Blockchain		1,3,5	4
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT		
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies		
	5.3	Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger		
Total				26

Course Assessment – Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)



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To be Taught in laboratory			
Sr. No.	Topics	Ref.	Hrs.
1	<p>Blockchain Implementation in Supply Chain Management</p> <p>Objective: To analyze how blockchain enhances transparency and traceability in supply chains.</p> <p>Experiments:</p> <ul style="list-style-type: none"> • Examine how blockchain is used for tracking goods in real-world supply chains (e.g., Walmart, IBM Food Trust). • Identify the advantages of using blockchain in logistics, including fraud prevention and efficiency. • Propose a simplified blockchain-based model for a supply chain and explain its working. 	1,2	2
2	<p>Cryptocurrency Adoption and Financial Systems</p> <p>Objective: To explore the role of cryptocurrencies in modern financial systems.</p> <p>Experiments:</p> <ul style="list-style-type: none"> • Investigate the adoption of Bitcoin and other cryptocurrencies as legal tender (e.g., El Salvador's Bitcoin initiative). • Discuss the impact of decentralized finance (DeFi) on traditional banking. • Analyze risks such as volatility, regulatory challenges, and security issues in cryptocurrency transactions. 	1,2	2
3	<p>UTXO Model and Double-Spending in Bitcoin</p> <p>Objective: To understand the security model of Bitcoin transactions.</p> <p>Experiments:</p> <ul style="list-style-type: none"> • Analyze a real-world Bitcoin transaction using blockchain explorers. • Explain how the UTXO model prevents double-spending. • Investigate historical double-spending attacks and how Bitcoin's consensus mechanism mitigates them. 	3,4	2
4	<p>Smart Contract Vulnerabilities and Security Breaches</p> <p>Objective: To study real-world smart contract failures and security risks.</p> <p>Experiments:</p> <ul style="list-style-type: none"> • Examine high-profile smart contract vulnerabilities (e.g., The DAO hack, Parity wallet bug). • Identify common security issues such as reentrancy attacks and integer overflow. • Propose security best practices for developing secure smart contracts. 	2	2
5	<p>Implementation of Private Blockchains in Enterprises</p> <p>Objective: To explore how private blockchain networks are used in business applications.</p>	1,2,3	2



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	<p>Experiments:</p> <ul style="list-style-type: none"> Investigate Hyperledger Fabric's role in enterprise blockchain solutions. Compare Hyperledger Fabric with public blockchains like Ethereum in terms of security and scalability. Analyze a real-world use case of Hyperledger Fabric in healthcare or finance. 		
6	<p>Hyperledger Fabric in Supply Chain Management</p> <p>Objective: To understand how Hyperledger Fabric optimizes supply chain operations.</p> <p>Experiments:</p> <ul style="list-style-type: none"> Examine case studies where Hyperledger Fabric is used for tracking goods (e.g., IBM Food Trust). Explain how smart contracts (chaincode) enforce rules in supply chain transactions. Propose a simplified architecture for implementing Hyperledger Fabric in logistics. 	2,3	2
7	<p>Future Trends in Blockchain Technology</p> <p>Objective: To explore emerging innovations in blockchain technology.</p> <p>Experiments:</p> <ul style="list-style-type: none"> Analyze new blockchain developments such as Ethereum 2.0, Layer 2 solutions, and interoperability protocols. Discuss the potential of quantum-safe cryptography in blockchain. Explore the impact of blockchain on industries like IoT, AI, and digital identity management. 	1,3	2
8	<p>Smart Contracts in Decentralized Finance (DeFi)</p> <p>Objective: To analyze how smart contracts enable decentralized financial services.</p> <p>Experiments:</p> <ul style="list-style-type: none"> Study the working of DeFi platforms like Uniswap, Aave, or Compound. Examine how smart contracts automate lending, borrowing, and trading without intermediaries. Identify security vulnerabilities in DeFi smart contracts and suggest improvements. 	2,3	4
9	<p>Ethereum's Role in NFTs and Digital Ownership</p> <p>Objective: To explore how Ethereum powers the NFT (Non-Fungible Token) ecosystem.</p> <p>Experiments:</p> <ul style="list-style-type: none"> Analyze real-world NFT marketplaces like OpenSea and Rarible. Explain how ERC-721 and ERC-1155 standards work for NFT creation and ownership. 	1,2,3	4



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	<ul style="list-style-type: none"> Discuss challenges such as high gas fees, copyright issues, and NFT sustainability. 		
10	<p>Web3.js for Blockchain Interaction</p> <p>Objective: To understand how Web3.js enables interaction with Ethereum smart contracts.</p> <p>Experiments:</p> <ul style="list-style-type: none"> Demonstrate how Web3.js connects a front-end application to an Ethereum smart contract. Implement basic Web3.js functions like fetching blockchain data and executing transactions. Explore real-world applications of Web3.js in dApps (Decentralized Applications). 	4	4
Total			26

Course Assessment- Lab:

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyan, 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 with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing
5. Blockchain enabled Applications, Vikram Dhillon, DevidMetcalf, Max Hooper, Apress

Online Resources:

1. <https://ethereum.org/en/>
2. <https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.html>
3. <https://www.blockchain.com/>
4. <https://docs.soliditylang.org/en/v0.7.4>



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Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	1	2
CO2	3	3	2	-	2	-	-	-	-	-	1	2
CO3	3	3	3	2	2	-	-	-	-	-	1	2
CO4	3	3	3	2	2	3	-	-	-	-	1	2
CO5	3	3	3	2	3	-	-	-	-	-	2	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			
		L	T	P	L	T	P	Total
25PEC4CS6	Optimization Algorithms	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	Data Structures, Analysis of Algorithms, Applied Mathematics
After the successful completion students should be able to:	
Course Outcomes	CO1 Identify and classify optimization problems and solution approaches.
	CO2 Apply stochastic optimization techniques to solve optimization problems.
	CO3 Apply convex optimization techniques to solve optimization problems.
	CO4 Solve optimization problems using evolutionary algorithms.
	CO5 Evaluate optimization algorithms based on performance and convergence.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction and Background to Optimization Theory	1,2	4
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization		
2		Stochastic Methods	1,2	6
	2.1	Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation		
3		Convex Optimization	1,2	6
	3.1	Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems, Geometric programming, Overview of Generalized inequality constraints and Vector optimization		
4		Evolutionary Methods	1,2,3	8
	4.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions		
	4.2	Canonical Genetic Algorithm, Binary Representations of		



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		Crossover and Mutation: Binary Representations, Control Parameters		
5		Advanced Evolutionary Methods	1,2,3	6
	5.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures		
	5.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone, Simple Ant Colony Optimization, Ant System, Ant Colony System		
Total				30

Course Assessment - Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

To be Taught in laboratory			
S.N.	Topics	Ref.	Hrs.
1	To implement Newton method to solve optimization problem.	1, 4	2
2	To implement Mesh Adaptive Direct Search for the given problem.	1,2,4	2
3	To implement Geometric Programming Optimization for the given problem.	1,2,5	4
4	To implement Vector Optimization for the given problem.	1,2, 5	2
5	To apply genetic algorithm to solve given optimization problem.	1,2,3	2
6	To implement different selection mechanism and mutation and crossover mechanisms in genetic algorithm and perform analysis of the results.	1,2,3	2
7	To implement Particles Swarm optimization for the given problem.	1,2,3	4
8	To implement Ant colony optimization	1,2,3	4
	Mini Project		6
Total			28

Course Assessment - Lab

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks



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Recommended Books:

1. Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, Optimization for Machine Learning, The MIT Press
2. Xin-She Yang Middlesex ,Optimization techniques and applications with examples, Wiley
3. A.E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc26_cs78/preview
2. https://onlinecourses.nptel.ac.in/noc24_ce122/preview

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	3	-	2	2	-	-	-	-	-	-	1
CO3	3	3	2	2	2	-	-	-	-	-	-	1
CO4	3	3	3	2	3	-	-	-	-	-	-	2
CO5	2	3	-	3	2	-	-	-	2	2	-	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			
		L	T	P	L	T	P	Total
25PEC4CS7	IT service management	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	Cloud Computing, Operating Systems, Computer Networks		
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	6
3	3.1	IT Service Management best practices: Application of IT service management best practices in IT Service delivery,	1,3	6
	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 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	1, 2	6



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		environment		
	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	6
Total			30	

Course Assessment -Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

Suggested List of Experiments			
	Topics	Ref.	Hrs.
Activities to be Completed in ISE			
A1	Study of ITIL 4 Service Value System -Identify components of Service Value System and map them to a real IT service	1	2
A2	IT Service Lifecycle Mapping - Map an IT service (e.g., online learning platform) to ITSM lifecycle stages	1	2
A3	Infrastructure Analysis of an IT Service -Analyze infrastructure and application components of a given IT service	2	2
A4	Cloud Service Model Comparison -Compare IaaS, PaaS, and SaaS with respect to service management challenges	2	2
A5	Value Co-Creation Analysis -Identify stakeholders and design a value co-creation model for an IT service	1	2
A6	DevOps Pipeline & ITSM Study -Analyze how CI/CD pipelines integrate with IT service operations	1,3	2
A7	ITSM Tool Exploration -Hands-on study of ticketing, incident, and change management using an ITSM tool	1	2



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A8	Automation & Toil Reduction -Identify repetitive IT operations tasks and propose automation strategies	2	2
A9	AI-enabled IT Operations (AIOps) -Study AI-based incident prediction and monitoring use cases	2	4
Total			24

Course Assessment – Lab:

ISE:

- a. Based on all experiments using predefined rubrics carrying 40 Marks.
- b. Mini-project carrying 10 Marks

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.

Online Resources:

1. [hZps://www.udemy.com/course/agile-fundamentals-scrum-kanban-scrumban/?couponCode=CP130525](https://www.udemy.com/course/agile-fundamentals-scrum-kanban-scrumban/?couponCode=CP130525)
2. [hZps://www.udemy.com/course/certmike-comp:a-it-fundamentals-i/?couponCode=CP130525](https://www.udemy.com/course/certmike-comp:a-it-fundamentals-i/?couponCode=CP130525)

Suggested CO - PO articulation Matrix

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

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

Blooms Level

Remember	Understand	Apply✓	Analyse✓	Evaluate✓	Create ✓
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25MDM61	Environmental Management	2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
					Min	Max		
		Theory	20	30	20	50	100	
Lab	--	--	--	--	--			

Pre-requisite Course		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain major global environmental issues, ecological concepts, biodiversity loss, and Sustainable Development Goals (SDGs).
	CO2	Interpret environmental laws, regulatory frameworks, and governance mechanisms in India and globally.
	CO3	Analyse environmental impact assessment procedures and corporate environmental responsibilities.
	CO4	Apply Environmental Management Systems (EMS), ISO 14001 standards, and environmental auditing principles.
	CO5	Evaluate the role of digital tools (AI, GIS, IoT, blockchain, carbon credits) in modern environmental management.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Environmental Management		7
	1.1	Global Environmental concerns: - Global Warming, Acid Rain, Ozone Depletion, Chemical smog, Hazardous Wastes.	1,2	
	1.2	Endangered life-species, Loss of Biodiversity, Ecology and Ecological successions and its types, Population as a global problem.	3,4,5	
	1.3	Significance of UN 17 Sustainable Development Goals (SDGs), Natural Circular economy frameworks	2	
2		Environmental Laws and Governing Policies		6
	2.1	Environmental policy frameworks, Major environmental laws in India (Salient Features of: - Air Act, Water Act, EPA, Forest & Wildlife Acts), Regulatory agencies and enforcement,	1,2	
	2.2	Central and State Pollution control boards—Powers and Functions. International conventions and protocols	1,2	
3		Environmental Impact Analysis		5



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	3.1	Role and functions of Government as a planning and regulating agency, Environment Quality Management and Corporate Environmental Responsibility	4,5	
	3.2	Objectives of environmental impact Analysis, Impact prediction, evaluation and mitigation measures, Environmental clearance	4,5	
4		Environmental Management		4
	4.1	Environmental Management Systems (EMS) and ISO 14001, Implementation steps and certification processes	6,7	
	4.2	Environmental auditing: purpose & process, Waste audits and pollution prevention assessment, Role of EMS in corporate sustainability	6,7	
5		Digital Tools & Emerging Technologies in Environmental Management		4
	5.1	AI and machine learning in pollution prediction, GIS & Remote sensing applications,	1,3,7	
	5.2	IoT-based environmental monitoring, Smart cities and environmental dashboards, Blockchain in carbon trading, Role of Carbon credits in solving environmental problem.	1,3,7	
			Total	26

Course Assessment-Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

Recommended Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha - Oxford University Press.
2. Environmental Studies: From Crisis to Cure by R. Rajagopalan - Oxford University Press,
3. A Textbook of Environmental Studies by D.K. Asthana - S. Chand Publishing.
4. A Text Book of Environmental Studies by Dr. G.R. Chatwal & Dr. Harish Sharma - Himalaya Publishing House.
5. Perspectives in Environmental Studies –Anubha Kaushik, C P Kaushik Third Edition, New age International Publis.hers
6. Environmental Studies- Benny Joseph, Second Edition the McGraw Hill Publishers.
7. Textbook of Environmental Studies, Deeksha Dave, S S Katewa, Second Edition Cengage Publishers.



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Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	3	-	-	-	-	-
CO2	3	2	-	-	-	-	3	-	-	-	-	-
CO3	3	2	-	-	-	-	3	-	-	-	-	-
CO4	3	2	-	-	-	-	3	-	-	-	-	-
CO5	3	2	-	-	-	-	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			
		L	T	P	L	T	P	Total
25MDM62	Disaster Management	2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
					Min	Max		
		Theory	20	30	20	50	100	
Tutorial	--	--	--	--	--			

Pre-requisite Course	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Analyze disaster risk, vulnerability, and hazard assessment frameworks
	CO2	Explain types, causes, and impacts of natural and anthropogenic disasters
	CO3	Apply national and international disaster management policies and institutional mechanisms.
	CO4	Evaluate institutional frameworks in disaster management
	CO5	Measure the importance of Financing Relief and Risk mapping

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Disaster Management	1,2	5
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters		
	1.2	Climate change and disaster linkages, global warming, Sea level rise and Ozone layer depletion		
2		Natural and Manmade disasters	2,3,4	6
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge		
	2.2	Manmade disaster: Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization		
3		Disaster Management, Policy and Administration	3,4	4
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.		
	3.2	Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to		



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		proceed in due course of time, study of flowchart showing the process.		
4		Institutional Framework for Disaster Management in India	5,6	7
	4.1	Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.		
	4.2	Methods and measures to avoid disasters, Management of casualties. set up of emergency facilities, importance of effective Communication amongst different agencies in such situations		
	4.3	Use of Internet and software for effective disaster Management. Applications of GIS, Remote sensing and GPS in this regard		
5		Financing Relief Measures and Risk mapping	5.6.7	4
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters International relief aid agencies and their role in extreme events.	1,3,7	
	5.2	Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis		
			Total	26

Course Assessment -Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

Recommended Books:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by
3. Centre for land warfare studies, New Delhi, 2011.
4. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann, Elsevier Publications.
5. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
6. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.



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7. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications .
8. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	3	-	-	-	-	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-
CO3	3	2	-	-	3	-	-	-	-	-	-	-
CO4	3	2	-	-	3	-	-	-	-	-	-	-
CO5	3	2	-	-	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			
		L	T	P	L	T	P	Total
25MDM71	Management Information Systems	2	--	--	2	--	--	2
		Examination Scheme						
		Theory	Lab	ISE	MSE	ESE		Total
						Min	Max	
		20	30	20	50	100		
--	--	--	--	--	--			

Pre-requisite Course	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Examine the impact of information systems in transforming Businesses.
	CO2	Analyse the ethical, social, and security considerations in the management and governance of information systems.
	CO3	Evaluate the major tools, technologies, and data management approaches used to support business intelligence and managerial decision-making.
	CO4	Assess the influence of social media platforms on business strategy, marketing practices, and customer engagement.
	CO5	Compare and critique the methodologies involved in the development and implementation of information systems within business organizations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Foundations of Information Systems (IS): Computer Based Information Systems, Components of IS: People, Process, Technology, Data, Role of IS in organizational efficiency. Organizational Strategy and Competitive Advantages using IS	1,2	4
	1.2	Digital Transformation and Platform Economy: Digital transformation strategy, Platform-based business models and digital ecosystems, Case discussions: Platform enterprises		
2	2.1	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management	1	7
	2.2	Business Intelligence (BI): Managers and Decision Making, Descriptive, predictive and prescriptive analytics, Data visualization and data storytelling BI for Data analysis and Presenting Results.		
	2.3	Artificial Intelligence in Business: AI-powered Decision Support Systems, Generative AI in enterprises, Intelligent automation and robotic process automation (RPA), AI-driven personalization and forecasting		
3	3.1	Information Security and Risk Management: Threats to Information Systems, Security controls and cyber resilience, Zero-trust security model.	1,3	6
	3.2	Ethical and Social Implications: Ethical issues in information systems, Algorithmic bias and explainable AI, Responsible AI principles, Societal impacts of automation and digital platforms		



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	3.3	Social Computing (SC): Web 2.0 and 3.0, SC in business, shopping, Marketing, Operational and Analytic CRM, E-business, E-commerce & M-commerce		
4	4.1	Enterprise Systems: Transaction Processing Systems (TPS), Functional Area Information Systems, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Analytics	1,3	6
	4.2	Cloud Computing and Emerging Technologies: Cloud computing models: IaaS, PaaS, SaaS, Blockchain applications in business, Digital twins and automation.		
5	5.1	System Development, Agile Methods and Organizational Implementation: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	1,3	3
Total				26

Course Assessment Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

Recommended Books:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. Tom Taulli, Artificial Intelligence Basics: A Non-Technical Introduction.
4. Lindsay Herbert: Digital Transformation: Build Your Organization's Future for the Innovation Age
5. Thomas Erl, Ricardo Puttini & Zaigham Mahmood: Cloud Computing: Concepts, Technology & Architecture



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Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	-	-	-	-	-	-	2
CO2	3	-	-	2	-	2	-	2	-	-	-	2
CO3	3	-	-	-	1	-	-	-	-	-	-	2
CO4	3	-	-	2	-	2	-	2	-	-	-	2
CO5	3	-	-	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			
		L	T	P	L	T	P	Total
25MDM72	Finance Management	2	--	--	2	--	--	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
					Min	Max		
Theory	20	30	20	50	100			

Pre-requisite Course Codes	--
Course Outcomes	At the End of the course students will be able to :
	CO1 Understand Indian finance system and corporate finance
	CO2 Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.	1, 2, 4, 5	4
	1.2	Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills 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	2.1	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two- security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	1	4
	2.2	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting	1	
3	3.1	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance Investment Decision, Financing Decision, and Dividend Decision.	1	6



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	3.2	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis	2	
4	4.1	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion - Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	2	6
	4.2	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities	1	
5	5.1	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	1	4
	5.2	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure.		
6	6.1	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches - Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	2	2
			TOTAL	26

Course Assessment Theory:

ISE: Minimum two formative Assessment activities for 20 Marks.

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)



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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.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	-	-	-	-	-	-	-	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			
		L	T	P	L	T	P	Total
25RMC14CS01	Essentials of Research Methodology	2	-	-	2	-	-	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
			Min	Max				
Theory	20	30	20	50	100			

Pre-requisite Course	--	
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.	Topics	Ref.	Hrs.
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	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	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	Design of Experiments (DOE) Full factorial design, Interaction effects. Introduction to Taguchi method. Applications in Engineering & Manufacturing	4	4
5	Introduction to Multivariate Data Analysis Need for multivariate techniques. Multiple regression (concept). Factor analysis (basic idea). Cluster analysis (conceptual overview). Applications in Engineering and Marketing research.	3	4
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

Course Assessment - Theory:

ISE:

- a. It will be conducted for following activities (Any One) (10 Marks)
 (This can be assessed through Group Activity/Debate/Case study presentation)
 - Research Proposal Preparation
 - Questionnaire Design
 - ANOVA based problem solving
 - Literature Review Matrix
 - Ethics Case Study
 - Instructor approved activity.
- b. Mini Project. (10 Marks)
 Suggested topics are as follows: -
 - Small experimental study using DOE
 - Survey-based research study
 - Statistical data analysis using Excel/JASP/JAMOVI.
 - Research publication review with ethics analysis
 - Any other Instructor approved topic

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)



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Recommended Books:

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

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	-	1	1	-	-	1	-	1	-	1
CO2	-	3	2	2	2	-	-	-	-	2	-	1
CO3	-	2	2	3	2	-	-	-	-	-	-	-
CO4	-	2	2	3	3	-	-	-	-	-	-	-
CO5	-	-	-	-	-	2	1	3	-	-	-	-
CO6	-	1	-	-	-	-	-	-	1	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			
		L	T	P	L	T	P	Total
25RMC14CS02	Intellectual Property Rights	2	-	-	2	-	-	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
					Min	Max		
	Theory	20	30	20	50	100		

Pre-requisite Course	--	
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.	Topics	Ref.	Hrs.
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	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
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	Geographical Indications, Trade Secrets and Semiconductor IC Layout Design	1,2,3,5,6	4



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	GI: Concept, registration, protection. Trade Secrets: Meaning, protection strategies. Semiconductor Integrated Circuit Layout Design protection.		
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	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:

- a. It will be conducted for following activities (Any One) (10 Marks)
(This can be assessed through Group Activity/Debate/Case study presentation)
 - Patent Drafting, Copyright Registration Process, GI study
 - Any other Activity suggested by course instructor.
- b. Mini Project (10 Marks)
Suggested topics are as follows: -
 - Prepare IPR strategy for product/start-up
 - Expired Patent as Source of New Business
 - Instructor Approved Topic

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

ESE: 120 minutes 50 Marks written examination based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus)

Recommended Books:

1. P. Narayanan, Intellectual Property Law, Eastern Law House.
2. W.R. Cornish, Intellectual Property: Patents, Copyright, Trademarks and Allied Rights.
3. B.L. Wadhera, 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.



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Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	1	1	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	-	-	-
CO3	-	-	-	-	-	2	-	-	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	2	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	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
25PRJ14CS01	Capstone Project	--	--	12		--	6	6
		Examination Scheme						
			ISE	MSE	ESE		Total	
			Min	Max				
		Theory	--	--	--	--	--	
Lab	200	--	--	100	300			

Pre-requisite Course		--
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:

- **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.



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- **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.

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.



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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
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



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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
CO1	3	3	1	-	1	1	1	-	-	-	-	-
CO2	3	3	1	-	2	1	1	-	-	-	-	-
CO3	3	3	3	1	3	1	1	1	1	1	1	2
CO4	1	3	1	1	3	-	3	3	2	-	1	2
CO5	-	-	-	-	-	-	-	1	3	3	-	2
CO6	-	-	-	-	-	-	-	3	-	-	-	3

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

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
25SEM14CS01	Course Seminar	--	--	2		--	2	2
		Examination Scheme						
			ISE	MSE	ESE		Total	
					Min	Max		
		Theory	--	--	--	--	--	
		Lab	100	--	--	--	100	

Pre-requisite Course	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify 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-I & ISE-II) as per department-defined rubrics for 50 marks each
- 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
4. Comparative study of different technical papers



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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)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	1	1	-	-	1	-	2
CO2	3	3	2	-	2	2	2	-	-	1	-	2
CO3	3	2	1	-	2	2	2	-	-	1	-	3
CO4	1	-	-	-	-	-	-	3	2	2	-	3
CO5	1	-	-	-	1	-	-	1	2	3	-	2

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

Blooms level

Remember	Understand ✓	Apply ✓	Analyse ✓	Evaluate	Create
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