TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Computer Science and Engineering

Syllabus

for

2-Years M.Tech

in

Computer Science and Engineering (CSE)

Academic Year: 2024-2025

CURRICULUM

1st Semester

Course Title	Contact Hrs. / Week			Credit
	L	T	P	
Theory				
Advanced Numerical Analysis	3	1	0	4
Advanced Design and Analysis of Algorithms	3	0	0	3
Data Science and Big Data Analytics	3	0	0	3
Elective – I	3	1	0	4
Elective – II	3	1	0	4
Practical				
Advanced Design and Analysis of Algorithm Lab	0	0	3	2
Data Science and Big Data Analytics Lab	0	0	3	2
Sessional				
Entrepreneurship Skill Development	0	0	2	2
Total Credits				**24**

ELECTIVE – I				
Cryptography and Network Security	3	1	0	4
Advanced Theory of Computation (Elective I)	3	1	0	4
Knowledge Representation and Reasoning (Elective I)	3	1	0	4

ELECTIVE – II				
Mobile Computing and Wireless Communication	3	1	0	4
Machine Learning (Elective II)	3	1	0	4
Digital Signal Processing (Elective II)	3	1	0	4

2nd Semester

Course Title	Contact Hrs. / Week			Credit
	L	T	P	
Theory				
High Performance Computer Architecture	3	1	0	4
Elective – III	3	1	0	4
Elective – IV	3	1	0	4
Elective – V	3	1	0	4
Practical				
Technical Seminar-I	2	0	0	2
Sessional				
Entrepreneurship Skill Development	0	0	2	2
Total Credits				**20**

ELECTIVE – III				
Computer Vision (Elective III)	3	1	0	4
Intelligent Systems (Elective III)	3	1	0	4
Internet of Things (Elective III)	3	1	0	4

ELECTIVE – IV				
Bioinformatics (Elective IV)	3	1	0	4
Simulations: Modeling and Analysis (Elective IV)	3	1	0	4
Augmented Reality (AR) and Virtual Reality (VR)	3	1	0	4

ELECTIVE – V				
Cloud Computing and IoT (Elective V)	3	1	0	4
Data Warehousing and Data Mining (Elective V)	3	1	0	4
Data Visualization	3	1	0	4

3rd Semester

Course Title	Contact Hrs. / Week			Credit
	L	T	P	
Theory				
Elective –VI	3	1	0	4
Elective – VII	3	1	0	4
Practical				
Technical Seminar-II	0	0	3	2
Thesis Proposal	0	3	0	8
Sessional				
Entrepreneurship Skill Development	0	0	2	2
Total Credits				**20**

ELECTIVE – VI				
Natural Language Processing and Information Retrieval (Elective VI)	3	1	0	4
Digital VLSI Design (Elective VI)	3	1	0	4
Computational Geometry (Elective VI)	3	1	0	4

ELECTIVE – VII				
Pattern Recognition and Image Processing (Elective VII)	3	1	0	4
Software Project Management and Testing (Elective VII)	3	1	0	4
Data and Knowledge Security (Elective VII)	3	1	0	4

4th Semester

Course Title	Contact Hrs. / Week			Credit
	L	T	P	
Practical				
Final Thesis	0	12	0	14
Grand Viva	0	0	2	4
Sessional				
Entrepreneurship Skill Development	0	0	2	2
Total Credits				20

DETAIL SYLLABUS

SEMSTER 1

Design and Analysis of Algorithm (TIU-PCS-T101)

Program: M. Tech. in CSE	**Year, Semester: 1st Year, 1st Semester**
Course Title: AdvancedDesign and Analysis of Algorithm	**Subject Code:** TIU-PCS-T101
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

COURSE OBJECTIVE:

Enable the student to:

1. Gain a deep understanding of advanced algorithmic paradigms such as dynamic programming, greedy algorithms, backtracking, divide-and-conquer, and network flow algorithms, and apply them to complex problems.
2. Develop the ability to perform rigorous time and space complexity analysis of algorithms, using tools such as recurrence relations, amortized analysis, and big-O notation
3. Master advanced graph algorithms such as shortest path algorithms (Dijkstra, Bellman-Ford), network flow algorithms (Ford-Fulkerson, Edmonds-Karp), and minimum spanning tree algorithms (Kruskal, Prim).
4. Explore advanced data structures, such as segment trees, binary indexed trees, Fibonacci heaps, and disjoint-set structures
5. Analyze Algorithm Efficiency in Different Scenarios
6. Apply Algorithm Design to Real-world Problems.

COURSE OUTCOME:

The student will be able to:

CO1	Evaluate the time and space complexity of algorithms using best-case, worst-case, and average-case complexity functions. Understand problem complexity and select appropriate algorithms based on these analyses.	K3
CO2	Demonstrate a solid understanding of basic and advanced data structures (arrays, lists, stacks, queues, trees, heap,hash table,disjoint-set etc) and apply algorithm design principles such as divide-and-conquer, greedy algorithms, amortized analysis and dynamic programming.	K3
CO3	Tackle NP-complete and NP-hard problems by using approximation algorithms, heuristics, and randomized algorithms to design efficient solutions	K3
CO4	Implement and compare different sorting algorithms such as selection sort, merge sort, and quicksort, and understand their performance based on complexity analysis and various string handling algorithms	K4

CO5	Apply advanced graph algorithms (e.g., shortest path, minimum spanning trees, and network flows) to real-world graph problems and analyze their complexity.	K4
CO6	Implement and analyze binary search trees (BST) and construct optimal weighted binary search trees. Understand the role of self-balancing trees such as AVL trees in maintaining efficient operations.	K2

COURSE CONTENT:

MODULE 1:	**Introduction and basic concepts**	**6 Hours**
Introduction and basic concepts: Complexity measures, best case, worst-case and average-case complexity functions, problem complexity, review of basic data structures and algorithm design principles.		
MODULE 2:	**Sorting**	**4 Hours**
Finding maximum and minimum, k largest elements in order; Sorting by selection, examples of different sorting algorithms.		

MODULE 3:	**Searching and set manipulation**	**6 Hours**
Review of binary search, binary search trees, construction of optimal weighted binary search trees, B-Tree, Introduction to Hashing and its associated concepts.		
MODULE 4:	**Advanced Data Structures**	**6 Hours**
Basic concepts of Fibonacci Heaps and the operations on these heaps, Introduction to Data Structures for Disjoint Sets and Disjoint-set operations, Analysis of union by rank with path compression, Priority Queue.		
MODULE 5:	**Advanced Algorithm design techniques**	**7 Hours**
Introduction to the Divide and conquer programming paradigm along with examples, Overview of Greedy algorithms and related problems, The Dynamic programming approach to problem solving along with relevant examples, Overview of the Amortized Analysis technique to measure algorithm efficiency		
MODULE 6:	**Graphs and flow networks**	**8 Hours**

Review of graph concepts and traversals, Overview of algorithms to construct minimum spanning trees, Introduction and overview of Shortest path algorithms, Network flows – Introduction to flow networks and overview of algorithms to compute maximum and minimum flows, Applications of network flow algorithm.

MODULE 7:	**String processing algorithms**	**4 Hours**
Introduction to String searching and Pattern matching, Overview of standard string matching algorithms.		

MODULE 8:	**Computational Intractability**	**4 Hours**
Introduction to NP-Hard and NP-Completeness, Polynomial-time verification, NP-completeness and reducibility, NP-completeness proofs, Cook's theorem, Discussion of some standard NP-complete problems		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3	2	-	1	2	-	-	-	-	-	-	2	3	-	-
CO2		3	3	2	2	-	-	-	-	-	-	-	2	3	-	-
CO3		3	3	2	2	-	-	-	-	-	-	-	2	3	2	-
CO4		3	3	3	2	-	-	-	-	-	-	-	2	3	3	-
CO5		3	3	2	3	-	-	-	-	-	-	-	2	3	3	-
CO6		3	3	3	2	-	-	-	-	-	-	-	2	3	3	-
		3	2.833	2.4	2	2							2	3	2.75	

Text Books:

T1. Introduction to Algorithms- Thomas H. Cormen Charles E. Leiserson Ronald L. Rivest Clifford Stein, The MIT Press

Reference Books:

R1.Fundamentals of computer algorithms by Satroj Sahani and Ellis Horowitz.

Data Science and Big Data Analytics (TIU-PCS-T111)

Program: M. Tech. in CSE (MCS)	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Data Science and Big Data Analytics	**Subject Code:** TIU-PCS-T111
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

COURSE OBJECTIVE:

1. Make a student familiar with basics of Data Science, big data, its relevance and its application.
2. Make a student familiar with different python tools for big data and data science.
3. Make a student familiar with different analytical methods (both theory and application) for big data. Also make a student familiar with different preprocessing techniques for big data.
4. A student should be able to apply different machine learning methods for big data and able to evaluate the performance of different machine learning methods for given data.

COURSE OUTCOMES:

CO-1	A student should be familiar with: the basis of data science, its relation with other domains.	K1
CO-2	A student should be able to understand: data science life cycle, skills and technologies required, data Analysis and pre-processing, data visualization, Exploratory Data Analysis, different steps for data pre-processing, big data architecture, lambda architecture, kappa architecture, Internet Of Things (IoT), different Python Libraries, NumPy and Pandas, different supervised learning algorithms (linear regression, logistic regression, naive Bayes Classifier, nearest neighbour), unsupervised learning algorithms (K-means, association rule mining, Principal Component Analysis (PCA)).	K2
CO-3	A student should be able to apply: different pre-processing and processing techniques for a given data, Different supervised and unsupervised machine learning methods in areas connected with big data.	K2
CO-4	A student should be able to carry out experiment/s on: given data using the methods stated in CO1 and CO2.	K3
CO-5	A student should be able to evaluate: the performance of different machine learning methods for given data.	K3
CO-6	A student should be able to create new model for given data.	K2

COURSE CONTENT:

MODULE 1:	**INTRODUCTION**	**4 Hours**
Introduction to Data Science: a. Relation with other domains and subjects. b. Data Science Life Cycle. c. Skills and technologies required.		
MODULE 2:	**FAMILIARIZATION WITH PYTHON LIBRARIES**	**5 Hours**
Usage and implementation of Python Libraries. Introduction to Numpy. Introduction to Pandas.		
MODULE 3:	**DATA ANALYSIS AND PRE-PROCESSING**	**4 Hours**
Data Analysis and pre-processing. Data Visualization. Exploratory Data Analysis (EDA). Different steps for data pre-processing.		
MODULE 4:	**IMPLEMENTATION OF DIFFERENT MACHINE LEARNING ALGORITHMS**	**15 Hours**
Implementation of different machine learning algorithms. a. Supervised learning algorithms - linear regression, logistic regression, Naive Bayes Classifier, Nearest neighbor. b. Unsupervised learning algorithms -- K-means, association rule mining, Principal Component Analysis (PCA).		
MODULE 5:	**INTRODUCTION TO BIG DATA AND CLOUD COMPUTING**	**5 Hours**
a. What is big data? b. Types and Characteristics of big data. c. Basics and advantages of Cloud Computing.		
MODULE 6:	**BIG DATA ARCHITECTURE**	**5 Hours**
Big Data Architecture: a. Components of a big data architecture. b. Lambda Architecture. c. Kappa Architecture. d. Internet of Things (IoT).		
MODULE 7:	**PROCESSING TECHNIQUES FOR BIG DATA**	**7 Hours**
Processing techniques for Big Data: a. Batch processing. b. Real time processing c. Different steps and technologies used for big data processing.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	-	2	-	-	-	-	-	-	-	-	3	2	-
CO-2	2	2	2	3	-	-	-	-	-	-	3	2	-
CO-3	2	2	2	2	-	-	-	-	-	-	3	2	-
CO-4	-	2	2	-	-	-	-	-	-	-	3	2	-
CO-5	-	2	2	2	-	-	-	-	-	-	3	2	-
CO-6	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	-	2	-	-	-	-	-	-	-	-	3	2	-

Textbooks:

T1. Subhashini Chellappan, Seema Acharya. Big Data and Analytics, WILEY.

T2. Andreas Muller. Introduction to Machine Learning with Python. A Guide for Data Scientist, O'REILLY'.

T3. Bart Baesens. Analytics in a Big Data world: The Essential Guide to Data Science and its Applications, WILEY.

Cryptography and Network Security (TIU-PCS-E101)

Program:MTech in CSE	**Year, Semester:** 3rd, 6thSem
Course Title: Cryptography and Network Security	**Subject Code:**TIU-PCS-E101
Contact Hours/Week: 3-1-0 (L-T-P)	**Credit:** 4

Course Objectives:

1. Understand the Core Principles of Cryptography.
2. Develop Mathematical Proficiency in Cryptographic Systems.
3. Examine Cryptographic Algorithms and their Security Aspects.
4. Study Cryptographic Protocols and their Practical Applications.

Course Outcomes:

CO-1	Conceptual Mastery of Cryptographic Terminology.	K2
CO-2	Proficiency in Mathematical Tools for Cryptography.	K1
CO-3	Application of Number Theory to Cryptography.	K2
CO-4	Evaluation of Encryption Schemes and Security.	K2
CO-5	Design and Implementation of Secure Hash Functions and MACs.	K1
CO-6	Secure Key Establishment and Digital Signatures.	K2

Course Content:

MODULE 1:	**INTRODUCTION TO CRYPTOGRAPHY**	**5 Hours**
Terminology, Security Aspects, Attack Models, Classical Cryptography, Shift Cipher, Substitution Cipher, Vigenère Cipher, Basic Cryptanalysis		
MODULE 2:	**MATHEMATICS OF CRYPTOGRAPHY**	**10 Hours**
Groups, Rings, and Fields, Integer Arithmetic, Modular Arithmetic, The Euclidean Algorithm, Finite Fields of The Form GF(p), Polynomial Arithmetic, Finite Fields of the Form GF(2n), Linear Congruence.		
MODULE 3:	**INTRODUCTION TO NUMBER THEORY**	**6 Hours**
Prime Numbers, Primality Testing, Factorization, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms		
MODULE 4:	**CONVENTIONAL ENCRYPTION**	**8 Hours**
Attacks on Encryption Schemes, Perfect Security, Cipher Machines, Modes of Operation (ECB, CBC, CFB, OFB), Multiple Encryption, DES, Triple-DES, AES, RC4 Stream Cipher, Attacks on DES.		
MODULE 5:	**PSEUDO-RANDOM NUMBER GENERATORS (PRNGS)**	**6 Hours**
Random and Pseudorandom Numbers, Next-bit Test, Removing Biases, ANSI X9.17 Generator Blum-Blum-Shub Generator, Statistical Tests		

MODULE 6:	**HASH FUNCTIONS AND MAC**	**3 Hours**
Standard hashes (MD5, SHA-1, SHA-256/384/512, RIPEMD-160), Birthday Attack, Collision freeness and recent attacks, Message Authentication Code (MAC) Algorithms, Authenticated Encryption.		
MODULE 7:	**KEY ESTABLISHMENT AND PUBLIC-KEY CRYPTOGRAPHY**	**6 Hours**
Key Management, Diffie-Hellman Key Exchange, Attacks on Diffie Hellman, RSA, Attacks on RSA, ElGamal, Attacks on ElGamal, Semantic Security and Chosen-cipher text Security, Provably Secure Schemes.		
MODULE 8:	**INTEGRITY AND DIGITAL SIGNATURE**	**6 Hours**
Message Integrity, Digital Signature, Authentication Protocol, Digital Signature Standards, Attacks on Digital Signature, Variation and Applications		
TOTAL LECTURES		**50 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	-	2	-	-	-	-	-	-	-	-	3	2	-
CO-2	2	2	2	3	-	-	-	-	-	-	3	2	-
CO-3	2	2	2	2	-	-	-	-	-	-	3	2	-
CO-4	-	2	2	-	-	-	-	-	-	-	3	2	-
CO-5	-	2	2	2	-	-	-	-	-	-	3	2	-
CO-6	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	-	2	-	-	-	-	-	-	-	-	3	2	-

Main Reading:

1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI.
2. Douglous Stinson, Cryptography Theory and Practice, CRC Press.
3. Neal Koblitz, A course in number theory and cryptography, Springer.
4. B. Preneel, C. Paar and J. Pelzl, "Understanding Cryptography: A Textbook for Students and Practitioners".

Advanced Theory of Computation(TIU-PCS-E111)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Advanced Theory of Computation (Elective I)	**Subject Code:** TIU-PCS-E111
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

1. To understand the foundational concepts of automata theory, including regular languages, deterministic finite automata (DFA), non-deterministic finite automata (NFA), and minimization techniques, with a special focus on the Myhill-Nerode theorem.
2. To explore the concepts of computability and undecidability, covering key topics such as Turing machines, the enumeration of Turing machines, the Rice-Myhill-Shapiro theorem, and resource-bounded computation, including tape reduction and speedup theorems.
3. To develop a comprehensive understanding of time complexity theory, examining P vs NP, time complexity classes, the notion of completeness, and reductions with a detailed study of the Cook-Levin theorem.
4. To delve into space complexity theory, focusing on space as a computational resource, Savitch's theorem, inductive counting, and the relationships between complexity classes such as PSPACE, L, and NL.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand and apply the concepts of regular languages	K2
CO2:	Analyze the fundamental concepts of computability	K2
CO3:	Examine time complexity theory	K1
CO4:	Explore space complexity theory	K2
CO5:	Investigate the concept of computational resources and their limitations in the context of Turing machines	K2
CO6:	Apply complexity theory concepts to real-world problems	K2

COURSE CONTENT:

MODULE 1	**Review of Regular Languages and Automata**	**9 Hours**
- Regular Languages: Definition, Properties, and Examples. - Deterministic Finite Automata (DFA): Definitions, Construction, and Applications. - Non-Deterministic Finite Automata (NFA): Concept, Equivalence to DFA. - NFA Minimization: Techniques and Algorithms. - Myhill-Nerode Theorem: Statement, Proof, Applications.		
MODULE 2	**Introduction to Computability**	**9 Hours**
- Turing Machines: Formal Definition, Variants, and Examples. - Enumeration of Turing Machines: Concept and Examples. - Undecidability: Examples, Halting Problem, and Other Undecidable Problems. - Rice-Myhill-Shapiro Theorem: Statement, Proof, and Applications.		

MODULE 3	**Resource-Bounded Computation**	**9 Hours**
- Concept of Computational Resources: Time, Space, and Other Resources. - Tape Reduction in Turing Machines: Definition and Applications. - Speedup Theorems: Concept and Examples.		
MODULE 4	**Time Complexity**	**9 Hours**
- Crossing Sequences: Definition and Applications. - Hierarchy Theorems: Time Hierarchy Theorem, Space Hierarchy Theorem. - P vs NP Problem: Definitions, Importance, and Key Questions. - Time Complexity Classes: P, NP, NP-Complete, and their Relationships. - Notion of Completeness and Reductions. - Cook-Levin Theorem: Proof and Implications.		
MODULE 5	**Space Complexity**	**9 Hours**
- Space as a Computational Resource: Definition, Importance, and Examples. - Savitch’s Theorem: Statement and Proof. - Inductive Counting: Definition and Applications. - PSPACE, L, and NL: Definitions, Examples, and Relationships.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	2	3
CO-2	3	3	2	2	-	-	-	-	-	-	-	2	3
CO-3	3	3	3	2	-	-	-	-	-	-	-	2	3
CO-4	3	3	2	3	-	-	-	-	-	-	-	2	3
CO-5	3	3	2	3	-	-	-	-	-	-	-	2	3
CO-6	3	2	3	2	3	-	-	-	-	-	-	2	3
Average	3	2.66	2.4	2.4	3							2	3

Main Reading:

1. Mishra and Chandrasekaran, Theory of Computer Science, PHI
2. John E. Hofcroft, Formal Language and Automata Theory, Pearson
3. Dexter Kozen, Automata and Computability, Springer

Supplementary Reading:

1. Michael Sipser, Introduction to the Theory of Computation, PWS
2. Sanjeev Arora, Computational Complexity - A Modern Approach, Cambridge University Press

Knowledge Representation and Reasoning (TIU-PCS-E113)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Knowledge Representation and Reasoning (Elective I)	**Subject Code:**TIU-PCS-E113
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Understand foundational concepts in knowledge representation and reasoning, including logic, set theory, and problem-solving using formal methods in artificial intelligence (AI).
2. Apply first-order logic and modal logic to model knowledge and reason about different domains, focusing on their interpretation, inference, and computational properties.
3. Explore advanced topics in knowledge representation, such as non-monotonic reasoning, description logics, and temporal logic, with practical applications in AI and the Semantic Web.
4. Analyze and implement reasoning mechanisms in knowledge representation systems, using logic-based formalisms and applying them to real-world problems like automated theorem proving and reasoning under uncertainty.

COURSE OUTCOME:

The student will be able to:

CO1:	Recall and define the basic concepts of knowledge representation, including set theory, relations, and functions.	K1
CO2:	Apply propositional logic and first-order logic to represent and reason about problems, using tools such as truth tables and inference rules.	K2
CO3:	Analyze and compare various knowledge representation formalisms, such as frame-based systems, inheritance networks, and description logics.	K2
CO4:	Synthesize reasoning techniques from modal and description logics to solve complex problems in artificial intelligence, including agent-based reasoning and semantic web applications.	K3
CO5:	Evaluate the computational complexity and decidability of reasoning tasks in first-order logic and modal logics, focusing on un-decidability and semi-decidability.	K2
CO6:	Create reasoning systems based on description logics and temporal logic for applications in automated reasoning, semantic web, and agent-based systems.	K2

COURSE CONTENT:

MODULE 1	**Introduction to Knowledge Representation and Reasoning**	**6 Hours**
- Overview of Knowledge Representation (KR) and its significance in AI. - Example problems in knowledge representation (e.g., puzzles, problem-solving). - Problem representation via logic: How logic is used for representing problems in AI. - Computer-assisted reasoning in mathematics: Automated theorem proving, reasoning with symbolic logic.		
MODULE 2	**Elementary Set Theory and Relations**	**6 Hours**

- Basic concepts of set theory: What is a set, relation, and function? - Set operations: Union, intersection, difference, complement, etc. - Properties of binary relations: Reflexivity, symmetry, transitivity, equivalence relations, partial orders. - Function properties: Injectivity, surjectivity, bijectivity.		
MODULE 3	**Propositional Logic**	**6 Hours**
- Introduction to propositional logic: Syntax, semantics, and models. - Validity and satisfiability: Understanding the truth assignments and logical formulas. - Inference rules: Modus ponens, Modus tollens, and other logical inference rules. - Soundness and completeness: Overview of logical proofs and the conditions for their correctness. - Reasoning methods: Truth tables, proof by contradiction.		
MODULE 4	**First-Order Logic (FOL)**	**6 Hours**
- Introduction to first-order logic: Syntax, semantics, and models. - First-order logic formulae: Structure and interpretation. - Validity and satisfiability in FOL. - Translating between natural language and first-order logic. - Quantifiers: Universal and existential quantification.		
MODULE 5	**Early Knowledge Representation Formulations**	**6 Hours**
- Non-monotonic inheritance networks: Representation of defaults and non-monotonic reasoning. - Frame-based systems: Conceptual structures for knowledge representation. - FOL: Reasoning problems, useful normal forms (prenex form, Skolemization), and inference calculi. - Undecidability and semi-decidability in first-order logic.		
MODULE 6	**Modal Logic and Applications**	**7 Hours**
- Introduction to Modal Logic: Syntax, semantics, and possible worlds semantics. - Model checking, satisfiability, and validity in modal logic. - Correspondence theory: The relationship between modal operators and frame properties. - Agent-based reasoning: Logically omniscience, belief logic, and epistemic logic. - Deduction in Hilbert systems: Translation of modal logic to first-order logic for agent reasoning.		
MODULE 7	**Description Logics and Temporal Logic**	**8 Hours**
- Introduction to Description Logics (DL): Syntax, semantics, and basic operations. - Meaning of description logic statements: Concepts, roles, and individuals. - Reasoning in description logics: Concept satisfiability, subsumption, and instance checking. - Applications in Semantic Web and Ontologies using description logics. - Temporal logic (LTL): Syntax, semantics, and temporal reasoning. - Extensions of temporal logic to modal and description logics, and their applications. - Defaults in logic: Understanding ordered defaults and their applications in propositional and first-order logic.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	1	2	3
CO-1	3	2	-	-	1	-	-	-	-	-	-	2	3
CO-2	2	2	2	2	2	-	-	-	-	-	-	1	3
CO-3	3	3	1	2	2	-	-	-	-	-	-	1	3
CO-4	2	2	-	2	3	-	-	-	-	-	-	1	3
CO-5	1	1	-	-	1	-	-	-	2	3	-	1	2
CO-6	2	-	-	-	-	2	-	2	-	2	-	1	2
Average	2.166	2	1.5	2	1.8	2		2	2	2.5		1.1666 67	2.666

Main Reading

1. J. Hendler, H. Kitano, Handbook of Knowledge Representation, Elsevier
2. R.J. Brachman, H.J. Levesque, Knowledge Representation and Reasoning, Elsevier

Mobile Computing and Wireless Communication (Elective II) (TIU-PCS-E103)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Mobile Computing and Wireless Communication (Elective II)	**Subject Code:**TIU-PCS-E103
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamentals, challenges, and evolution of mobile computing systems and cellular architectures.
2. Explore mobility management techniques, mobile IP protocols, and data dissemination models in mobile environments.
3. Analyze wireless communication principles including channel models, diversity techniques, and MIMO systems.
4. Evaluate wireless standards, multiuser communication strategies, and protocols for mobile transactions and commerce.

COURSE OUTCOME:

The student will be able to:

CO1:	Describe the challenges of mobile computing and explain cellular architectures and multiple access techniques.	K2
CO2:	Explain mobility management concepts including handoffs, location tracking, and mobile IP protocols.	K2
CO3:	Apply data dissemination and indexing techniques for efficient mobile data access.	K3

CO4:	Illustrate distributed file systems and mobile transaction models for supporting mobility.	K3
CO5:	Analyze various ad hoc routing protocols and their effectiveness in dynamic mobile networks.	K3
CO6:	Evaluate wireless channel models, diversity schemes, and capacity analysis for multiuser wireless systems.	K5

COURSE CONTENT:

Module 1	**Introduction to Mobile Computing**	**9 Hours**
- Challenges in Mobile Computing: Resource Poorness, Uncertainty, Bandwidth Limitations. - Cellular Architecture: Frequency Reuse, Co-channel Interference, Cell Splitting. - Evolution of Mobile Systems: FDMA, TDMA, CDMA, GSM – Architecture and Comparisons.		
MODULE 2	**Mobility Management**	**9 Hours**
- Cellular Architecture Review. - Handoff Mechanisms: Hard and Soft Handoff, Types of Handoff. - Location Management: HLR-VLR, Hierarchical Schemes, Predictive Location Management. - Mobile IP and Cellular IP.		
MODULE 3	**Data Dissemination and File Support**	**9 Hours**
- Data Delivery Models: Push vs. Pull. - Broadcast Disks and Directory Services in Air. - Energy-efficient Indexing Schemes. - Distributed File Sharing Systems: Coda File System, Mobility-Oriented Storage Managers.		
MODULE 4	**Ad Hoc Networks and Mobile Transactions**	**9 Hours**
- Ad Hoc Routing Protocols: DSDV, DSR, AODV, LAR, ZRP, FSR. - Cluster-based and Gateway Routing Schemes. - Mobile Transaction Models: Kangaroo, Joey, Team Transactions. - Recovery Mechanisms and Electronic Payment Protocols.		
MODULE 5	**Wireless Communication Techniques**	**9 Hours**
- Wireless Systems and Standards Overview. - Wireless Channel Models: Path Loss, Fading, MIMO. - Diversity Techniques: Time, Frequency (DSSS, OFDM), Receiver, Transmit Diversity (STC). - Information Theory: Capacity of Fading Channels, Water-Filling, MIMO Capacity. - Multiuser Access: FDMA, TDMA, CDMA, SDMA, Power Control, Multiuser MIMO.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	1	0	1	1	0	1	0	1	0	2	3
CO-2	3	3	2	1	2	0	0	1	1	1	0	2	3
CO-3	2	2	2	1	3	0	0	0	1	1	1	2	3
CO-4	2	2	2	0	2	1	1	1	0	1	0	2	2

CO-5	3	2	3	1	3	1	1	1	0	1	1	3	3
CO-6	3	2	3	1	3	1	1	1	1	1	1	3	3
Average	2.67	2.17	2.17	0.67	2.33	0.67	0.5	0.83	0.5	1	0.5	2.33	2.83

Main Reading:

1.Jochen Schiller, Mobile Communications, Addison-Wesley.
2. Theodore S. Rappaport, Wirelass Communications – Principles and Practice, Prentice Hall
3. Stojmenovic and Cacute, Handbook of Wireless Networks and Mobile Computing, Wiley
4. A. J. Goldsmith, Wireless Communications, Cambridge University Press
5. A. F. Molisch, Wireless Communications, John Wiley
6. S. Haykin and M. Moher, Modern Wireless Communications, Pearson

Machine Learning (TIU-PCS-E105)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Machine Learning	**Subject Code:** TIU-PCS-E105
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** Theory–4

COURSE OBJECTIVE :

Enable the student to:
1. Introduce the fundamental concepts, paradigms, and applications of Machine Learning.
2. Explain different learning methodologies, including supervised, unsupervised, semi-supervised, reinforcement, and transfer learning.

COURSE OUTCOME :

The student will be able to:

CO1	Understand the fundamental concepts, types, and paradigms of Machine Learning.	K2
CO2	Apply regression techniques to model data and analyze bias-variance trade-offs.	K3
CO3	Analyze probabilistic models, statistical methods, and gradient descent algorithms for learning.	K4
CO4	Evaluate classification models, including Bayesian classifiers, decision trees, and discriminant functions.	K5
CO5	Implement artificial neural networks, including perceptron’s, MLP, CNN, RNN, and SVM models for real-world applications.	K6
CO6	Apply clustering and unsupervised learning techniques for data classification and pattern recognition.	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**5 Hours**
What is machine learning, Overview, Major types of learning paradigms: Supervised, Unsupervised, Semi-supervised, Active, Reinforcement and Transfer Learning. Membership Query Synthesis, Stream-based Selective Sampling, Pool-based Sampling. Query Strategies: Least Confidence, Margin Sampling, Entropy-based Sampling.		
MODULE 2:	**REGRESSION**	**5 Hours**
Objective of Regression, Simplest Linear Model, Linear Model of Non-linear Observations, Bias-Variance Trade-off, Over-fitting and Under-fitting, Regularization, Ridge/Shrinkage Regression, Lasso regression, Basis-function Model for Regression.		
MODULE 3:	**FUNDAMENTALS OF PROBABILITY AND STATICS**	**5 Hours**
Probability Densities, Expectation and Co-variances, Gaussian Distribution- Univariate, Bivariate, Multivariate, Maximum Likelihood and Least Squares, ML Estimate of Regression Parameters, Gradient Descent Algorithm for Regression Parameters.		
MODULE 4:	**DECISION THEORETIC MODEL FOR CLASSIFICATION**	**5 Hours**
Bayes Theorem, Bayesian Probability, ML Estimate and Bootstrap estimate, Naïve Bayes Approach for Classification, Expected Loss for C-Class classification Problem, Bayes Risk, Two-Category Classification.		
MODULE 5:	**DISCRIMINATING FUNCTIONS FOR CLASSIFICATION**	**4 Hours**
Discriminating Functions, Fisher's Linear Discriminant Model for Classification, Fisher's Model for Multiple Classes, Building a Linear Discriminant Model, PCA and its Uses in Face Recognition. Computational Cost for Eigen Decomposition		
MODULE 6:	**DECISION TREE CLASSIFIER**	**4 Hours**
Entropy and Information Gain, How to design a Decision Tree, ID3 Algorithm.		
MODULE 7:	**NEURAL MODEL**	**6 Hours**
Neurons, McCulloch-Pitts Model for Artificial Neuron, Neuron with Hebbian Learning Abiity, Thresholds and Activation Function, Discrete and Continuous Activation Function, Relu, Perceptron and Minksy Problem, Network of Single Layer Perceptron, MLP Networks, Analysis of MLP Networks, Linear Gradient Descent and Stochastic Gradient Descent, ANN Learning and Back-Propagation, Impact on Data Size and GPU Machine, Radial Basis Function Networks (RBFN), Algorithm, Classification of XOR Problem, Kohonen's Self-Organizing Map (SOM), SOM Algorithm, Amari Model of Recurrent Neural Networks, Hopfield Network Model.		
MODULE 8:	**SUPPORT VECTOR MACHINE (SVM)**	**3 Hours**
Meaning of Supports, Margins, Classification of linearly separable data, Classification of Data with Overlap.		
MODULE 9:	**CNN AND RNN MODELS**	**4 Hours**
Convolution, Activation Layer, Pooling Layer, Fully Connected Layer, CNN-Architecture. RNN Model Recurrent Neural networks and its Application, Gated RNN or LSTM model and its applications.		
MODULE 10:	**CLUSTERING TECHNIQUES**	**4 Hours**
Different Clustering Algorithms and Unsupervised learning for Classification.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	1	2	3
CO-1	3	2	2	-	1	-	-	-	-	-	-	2	3
CO-2	2	3	2	2	2	-	-	-	-	-	-	2	3
CO-3	2	2	3	2	2	-	-	-	-	-	-	1	3
CO-4	2	2	3	2	3	-	-	-	-	-	-	1	3
CO-5	1	2	2	2	3	-	-	-	-	-	-	1	3
CO-6	2	3	2	3	2	-	-	-	-	-	-	2	3
Average	2	2.333333	2.3333	2.2	2.166							1.5	3

Main Reading

1. Pattern Classification., Richard, Duda, Peter Hart and David Stork, Wiley Interscience.
2. Machine Learning., Tom Mitchell, Tom, McGraw-Hill
3. Neural Networks for Pattern Recognition, Oxford University Press

Digital Signal Processing (Elective II) (TIU-PCS-E109)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Digital Signal Processing(Elective II)	**Subject Code:** TIU-PCS-E109
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

1. Understand the principles of multirate signal processing, including sampling rate conversion, interpolation, and decimation.
2. Explore modern spectral estimation and prediction techniques for discrete random signals using statistical and adaptive methods.
3. Examine the architecture and internal components of digital signal processors, including parallelism and memory organization.
4. Apply DSP concepts in real-world applications and implement DSP algorithms using VLSI design and programming.

COURSE OUTCOME:

The student will be able to:

CO1:	Explain the concepts of sampling rate conversion using interpolation and decimation techniques.	K2
CO2:	Apply and analyze filter implementations for multirate signal processing and frequency domain transforms.	K3

CO3:	Develop estimation and prediction models for random signals using AR, MA, ARMA models and Wiener filters.	K2
CO4:	Evaluate parameter estimation techniques and implement Kalman filtering for signal prediction.	K2
CO5:	Illustrate the architecture and functionality of digital signal processors including MAC and pipelining.	K1
CO6:	Design DSP applications and implement signal processing algorithms using VLSI and hardware description languages.	K1

COURSE CONTENT:

MODULE 1	Multirate Signal Processing	**8 Hours**
Mathematical description of sampling rate change; Decimation and Interpolation; Polyphase implementation; Filter design for rate conversion; Direct-form FIR structures; Applications in subband coding and data compression.		
MODULE 2	Frequency Domain Analysis	**7 Hours**
Review of DTFT and DFT; FFT algorithms (Radix-2 DIT/DIF); Spectral leakage and windowing; Wavelet transforms; Introduction to filter banks and implementation of wavelet signal decomposition.		
MODULE 3	Statistical Signal Processing	**8 Hours**
Discrete random processes, ensemble averages, stationarity, autocorrelation, covariance matrices; Parseval's theorem; Wiener-Khintchine relation; Power Spectral Density estimation using AR, MA, ARMA models; Parameter estimation techniques.		
MODULE 4	Prediction and Adaptive Filtering	**7 Hours**
Linear prediction models (forward and backward); LMS algorithm and least mean square criterion; Wiener filters for filtering and prediction; Discrete Kalman filter – concepts, equations, and practical implementations in DSP.		
MODULE 5	Digital Signal Processor Architecture	**7 Hours**
Basic architecture of DSPs; Computational blocks (MAC, ALU); Bus architecture. Memory hierarchy and interfacing; Parallelism and pipelining; DMA and		
MODULE 6	DSP Applications and VLSI Implementation	**8 Hours**
Applications: Decimation and interpolation filters, FFT algorithm, PID controller, serial interfacing, DSP-based power meters, position control; Basics of DSP system design using VHDL; Mapping DSP algorithms to hardware; Realization of MAC and filter structures.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	-	-	-	2	-	-	-	-	-	-	-	1
CO-2	2	3	-	-	2	-	-	-	-	-	-	-	-
CO-3	2	3	-	-	1	-	-	-	-	-	-	-	-
CO-4	2	-	3	-	1	-	-	-	-	-	-	-	1
CO-5	2	-	3	-	-	-	-	-	-	-	-	-	-
CO-6	-	-	-	-	3	-	-	-	-	-	-	2	2
Average	2.2	3	3		1.8							2	1.3333

Main Reading:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modelling”, JohnWiley and Sons, Inc.
2. John G.Proaks, Dimitris G. Manolakis, “DigitalSignal Processing”, Pearson Education.

SEMSTER 2

High Performance Computer Architecture (TIU-PCS-T108)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title:High Performance Computer Architecture	**Subject Code:TIU-PCS-T108**
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** Theory–3

COURSE OBJECTIVE :

1. Enhanced the knowledge in the areas of database management that go beyond traditional (relational) database management systems.
2. Comprehend the query processing efficient information management for Distributed , Parallel and Object Oriented DBMS
3. To understand and implement of web-enabled applications with different programming languages
4. To enhance the knowledge about spatial data storage and management. To understand storage and management issues of the unstructured data.

COURSE OUTCOME :

The student will be able to:

CO-1:	learn concepts, issues and limitations related to parallel computing.	K1
CO-2:	be able to understand and explain different parallel models of computation, parallel architectures, interconnections and various memory organizations in modern high-performance architectures.	K2
CO-3:	be able to map algorithms onto parallel architectures for parallelism.	K2
CO-4:	be able to analyze and evaluate the performance of different architectures and parallel algorithms.	K1
CO-5:	be able to design and implement parallel programs for shared-memory architectures and distributed-memory architectures using modern tools like OpenMP and MPI, respectively.	K2
CO-6:	Explore real-world applications of parallel computing, addressing challenges like load balancing, fault tolerance, and scalability in large-scale systems.	K2

COURSE CONTENT :

MODULE 1:	Parallel Processing Concepts	9 Hours
Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, and Demand-driven Computation etc.), Architectures: N-wide superscalar architectures, multi-core, multi-threaded, GPU systems, performance clusters.		
MODULE 2:	**Design Issues and Challenges in Parallel Computing**	**9 Hours**
Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms, Bandwidth and Latency Limitations, Power-aware computing and communication, software power management.		
MODULE 3:	**Parallel Programming with OpenMP and MPI**	**9 Hours**
Programming languages and extensions for HPC, Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with OpenMP and (Posix) threads, Message passing with MPI, Thread Management, Job Schedulers.		
MODULE 4:	**Parallel Programming with CUDA**	**9 Hours**
Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in HPC architectures (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee, Intel Nehalem), Memory hierarchy, Thread Organization, OpenCL.		
MODULE 5:	**Advanced Topics**	**9 Hours**
Peta scale Computing, Optics in Parallel Computing, Quantum Computers, exploring future directions of parallel computing, and their societal impact.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	-	2
CO-2	3	2	2	-	-	-	-	-	-	-	-	-	2
CO-3	3	2	-	-	1	-	-	-	-	-	-	-	2
CO-4	3	-	2	-	1	-	-	-	-	-	-	-	2
CO-5	3	2	2	-	-	-	-	-	-	-	-	-	2
CO-6	3	2	-	-	-	-	-	-	-	-	-	-	2
Average	3	2	2		1								2

Text Books:

1. John L. Hennessy and David A. Patterson "Computer Architecture -- A Quantitative Approach", 4th Ed., Morgan Kaufmann Publishers, 2017, ISBN 13: 978-0-12-370490-0.
2. Barbara Chapman, Gabriele Jost and Ruud van der Pas, "Using OpenMP: portable shared memory parallel programming", The MIT Press, 2008, ISBN-13: 978-0-262-53302-7.
3. Marc Snir, Jack Dongarra, Janusz S. Kowalik, Steven Huss-Lederman, Steve W. Otto, David W. Walker, "MPI: The Complete Reference", Volume2, The MIT Press, 1998, ISBN: 9780262571234.

Computer Vision (TIU-PCS-E102)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Computer Vision	**Subject Code:** TIU-PCS-E102
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To introduce fundamental concepts of computer vision, including image formation and projection models.
2. To equip students with image processing and feature extraction techniques for meaningful analysis.
3. To develop skills in 3D vision, motion analysis, and advanced vision techniques for real-world applications.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the fundamental concepts of computer vision, including image sensing, projection models, and noise analysis.	K2
CO-2:	Analyze binary images and extract geometric properties such as area, position, orientation, and equivalent ellipses.	K3
CO-3:	Apply fundamental image processing techniques, including convolution, Fourier transforms, and noise filtering for image enhancement.	K4
CO-4:	Evaluate reflectance models, radiometry concepts, and photometric stereo methods for surface property estimation.	K5
CO-5:	Implement shape-from-shading techniques and optical flow estimation methods to infer object structure and motion.	K6
CO-6:	Develop stereo vision-based depth estimation models using disparity mapping, epipolar geometry, and absolute/relative orientation.	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**3 Hours**
What is Computer Vision and its Objective, Perspective Projection, Orthographic Projection, Radiance and Irradiance, Image Sensing and Random Noise.		
MODULE 2:	**Binary Images and Its Properties**	**7 Hours**
Geometric Properties: Area, Position and Orientation, Projections, Discrete Binary Images, Equivalent Ellipse.		
MODULE 3:	**Fundamentals of Image Processing**	**7 Hours**
Linear Shift-Invariant System, Convolution, Point-Spread Function, One and Two-dimensional Impulse Functions, Modulation Transfer Function, Fourier Transform and Filtering, Fourier Transform of Convolution, Generalized Functions and Unit Impulses, Rotational Symmetry and Isotropic Operators, Hankel Transform, Defocusing and Motion Smear, Correlation and Power Spectrum, Optimal Filtering and Noise Suppression. Image Processing and Discrete Images :Finite Image Size, Sampling Theorem, Discrete Fourier Theorem		
MODULE 4:	**Reflectance Map**	**8 Hours**
Image Brightness, Radiometry, Image Formation, Radiance-Irradiance Relation, BRDF, Extended Light Sources, Surface Reflectance Properties, Surface Brightness for Lambertian Surfaces, Surface Orientation and Reflectance Map, Reflectance Map for the Moon's Surface, Shading in Images, Shaded Graphics, Photometric Stereo, Albedo and its Recovering		
MODULE 5:	**Shape from Shading**	**8 Hours**
Recovering Shape from Shading using: Linear and Rotationally Symmetric Reflectance Maps, Generalized Approach for shape from Shading, Occluding Boundary and Stereographic Projection, Relaxation Method for Recovering shape from shading, Application of Photometric Stereo.		
MODULE 6:	**Motion Vision**	**8 Hours**
Optical Flow: Meaning, Optical Constraint Equation, Smoothness of Optical Flow Field, Determination of Optical Flow: in Continuous case, Discrete case, Motion Parameters Estimation for small Motion.		
Module 7:	**Stereo-Vision**	**4 Hours**
Introduction, Geometry of Stereo vision, Conjugate Points, Epipolar line, Disparity, Absolute Orientation, Relative Orientation, Solving Over-determined Systems, Finding the Depth Values to Compute Shape of an Object.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	-	-	-	2	-	-	-	-	-	-	-	1
CO-2	2	3	-	-	2	-	-	-	-	-	-	-	-
CO-3	2	3	-	-	1	-	-	-	-	-	-	-	-
CO-4	2	-	3	-	1	-	-	-	-	-	-	-	1
CO-5	2	-	3	-	-	-	-	-	-	-	-	-	-
CO-6	-	-	-	-	3	-	-	-	-	-	-	2	2
Average	2.2	3	3		1.8							2	1.333333

Main Reading

1. BKP Horn , Robot Vision, Mit Press
2. Dana Harry Ballard, Christopher M. Brown, Computer vision, Prentice-Hall.

INTELLIGENT SYSTEMS (TIU-PCS-E110)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: INTELLIGENT SYSTEMS	**Subject Code:**TIU-PCS-E110
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Explain key problem characteristics and effectively design both uninformed and heuristic search algorithms.

2. Analyze single and multi-player game strategies using minimax with alpha-beta cutoffs and related search efficiency techniques.

3. Represent and infer knowledge through propositional and predicate calculus, including resolution and unification methods.

4. Develop and apply models in expert systems, neural networks, and fuzzy logic to solve complex, real-world problems.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand and analyze different problem characteristics and formulate intelligent search strategies.	K2
CO2:	Apply uninformed, heuristic, and evolutionary search techniques to solve complex computational problems.	K3
CO3:	Evaluate game-playing algorithms such as Minimax and alpha-beta pruning for decision-making in AI.	K5
CO4:	Demonstrate knowledge representation using propositional and predicate logic with resolution and inference techniques.	K4
CO5:	Design and analyze expert systems using probabilistic reasoning, Bayesian networks, and logical chaining.	K5
CO6:	Explore the fundamentals of neural networks and fuzzy logic for intelligent decision-making and pattern recognition.	K3

COURSE CONTENT:

MODULE 1	**Introduction to Intelligent Systems**	**9 Hours**
Overview of Intelligent Systems and Problem Characteristics, Issues in the Design of Search Algorithms, Introduction to AI Problem Solving, Types of Problems: Well-defined and Ill-defined Problem Formulation and State Space Representation		
MODULE 2	**Search Techniques**	**9 Hours**
Uninformed Search: BFS, DFS, Iterative Deepening, Heuristic Search: Greedy Best First, A* Algorithm Constraint Satisfaction Problems (CSP),Means-Ends Analysis, Evolutionary Search: Genetic Algorithms, Simulated Annealing		
MODULE 3	**Game Playing and Knowledge Representation**	**9 Hours**
Game Playing: Single and Two-Player Games, Minmax Procedure and Alpha-Beta Pruning, Quiescent Search and Efficiency Considerations, Propositional Calculus: Resolution, Entailment, PSAT, Predicate Calculus: Quantification, Unification, Horn Clauses		
MODULE 4	**Expert Systems and Probabilistic Reasoning**	**9 Hours**
Introduction to Expert Systems, Knowledge Representation in Expert Systems, Reasoning Under Uncertainty: Bayesian Networks, D-Separation, Probabilistic Inference and Inexact Reasoning Forward and Backward Chaining ,Monotonic and Non-Monotonic Reasoning		
MODULE 5	**Neural Networks and Fuzzy Logic**	**9 Hours**
Introduction to Artificial Neural Networks, Perceptron's: Linearly Separable and Non-Separable Problems, Supervised and Unsupervised Learning, Backpropagation Algorithm, Introduction to Fuzzy Logic and Fuzzy Sets, Membership Functions, Defuzzification, and Fuzzy Arithmetic		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	1	-	1	3
CO-2	2	2	-	-	-	-	-	-	-	-	-	1	2
CO-3	2	3	-	-	1	-	-	-	-	-	-	1	2
CO-4	2	2	-	-	-	-	-	-	-	-	-	-	2
CO-5	2	2	-	-	1	-	-	-	-	1	-	-	2
CO-6	2	2	3	2	1	-	-	-	-	-	1	2	3
Average	2.1666	2.166667	3	2	1					1	1	1.25	2.333333

Main Reading:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice-Hall.
2. Rajasekharan, S. Pai, G.A Vijaylakshmi, Neural Neyworks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications

Internet of Things (Elective III) (TIU-PCS-E#)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Internet of Things (Elective III)	**Subject Code:** TIU-PCS-E#
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

1. To provide a comprehensive understanding of IoT architecture, protocols, and communication models.
2. To explore sensor technologies, embedded systems, and wireless communication in IoT environments.
3. To equip students with skills to design, develop, and deploy IoT-based applications using modern tools and platforms.
4. To analyze security, scalability, and data management challenges in IoT systems and propose viable solutions.

COURSE OUTCOME:

The student will be able to:

CO1	Explain the fundamental concepts, architecture, and enabling technologies of IoT systems.	
CO2	Describe the role of sensors, actuators, and embedded devices in IoT environments.	
CO3	Apply networking protocols and data communication methods in IoT applications.	
CO4	Analyze system-level components including device connectivity, cloud integration, and IoT middleware.	
CO5	Evaluate security, privacy, and scalability issues in IoT and propose effective countermeasures.	
CO6	Design and prototype a complete IoT solution using platforms like Arduino, Raspberry Pi, or ESP32.	

COURSE CONTENT:

MODULE 1	Introduction to IoT	9 Hours
- Overview of IoT systems and their evolution - IoT architecture and components (Devices, Network, Cloud, Application Layer) - Enabling technologies: Sensors, Actuators, Embedded Systems, Cloud computing, Big Data - IoT Protocols: MQTT, CoAP, HTTP, etc. - Applications of IoT in smart homes, healthcare, agriculture, and industrial automation.		
MODULE 2	Sensors, Actuators, and Embedded Systems	9 Hours
- Role of sensors and actuators in IoT systems: Types and working principles (Temperature, Pressure, Proximity, etc.) - Embedded systems for IoT: Overview of microcontrollers (Arduino, ESP32, Raspberry Pi) - I/O interfacing for IoT applications - Embedded programming basics: C, Python, and platform-specific tools.		
MODULE 3	IoT Communication Protocols	9 Hours
- IoT networking: Basics of networking, IP addressing, and communication protocols. - Wired vs. Wireless communication in IoT: Zigbee, Wi-Fi, Bluetooth, LoRa, 5G. - Networking models: OSI Model, TCP/IP Stack - Data communication methods in IoT: HTTP, MQTT, CoAP - Performance analysis of different communication protocols.		
MODULE 4	Cloud and Middleware for IoT	9 Hours
- IoT cloud platforms: AWS IoT, Microsoft Azure IoT, Google Cloud IoT - Cloud integration with IoT devices - Middleware for IoT: Data processing, storage, and analytics - IoT platforms for device management: ThingsBoard, Node-RED, Home Assistant - Integration of IoT with data analytics and AI.		
MODULE 5	Security and Privacy in IoT	9 Hours

- Security challenges in IoT systems: Threat models, attack vectors - Privacy issues: Data confidentiality, integrity, and authentication - Security protocols for IoT: TLS, VPN, IPSec - IoT security standards and frameworks - IoT Scalability: Handling large-scale IoT deployments.	
TOTAL LECTURES	45 Hours

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	1	-	1	3
CO-2	2	2	-	-	-	-	-	-	-	-	-	1	2
CO-3	2	3	-	-	1	-	-	-	-	-	-	1	2
CO-4	2	2	-	-	-	-	-	-	-	-	-	-	2
CO-5	2	2	-	-	1	-	-	-	-	1	-	-	2
CO-6	2	2	3	2	1	-	-	-	-	-	1	2	3
Average	2.1666	2.166667	3	2	1					1	1	1.25	2.333333

Books:

1. “Internet of Things: A Hands-On-Approach” by Arshdeep Bahga& Vijay Madisetti
2. “Internet of Things (IoT): Architecture and Design Principles” by Raj Kamal
3. “Architecting the Internet of Things” by Dieter Uckelmann et al.
4. “Designing Connected Products: UX for the Consumer Internet of Things” by Claire Rowland et al.

Bioinformatics (TIU-PCS-E106)

Program: M. Tech. in CSE	Year, Semester: 1st Year, 2nd Semester
Course Title: Bioinformatics	Subject Code: TIU-PCS-E106
Contact Hours/Week: 3–0–0 (L–T–P)	Credit: Theory – 3

COURSE OBJECTIVE:

1. Understand the fundamentals of bioinformatics: Gain a solid understanding of the core principles and concepts in bioinformatics, including biological data analysis and computational tools.
2. Learn sequence analysis techniques: Develop skills in DNA, RNA, and protein sequence alignment, sequence assembly, and similarity searching.
3. Explore bioinformatics databases: Understand how to utilize and navigate biological databases, such as GenBank, PDB, and UniProt, for retrieving biological data.

4. Analyze gene expression and functional genomics data: Learn methods for analyzing high-throughput data, including gene expression, microarray, and RNA-Seq data.
5. Apply computational algorithms in bioinformatics: Gain proficiency in using computational algorithms for biological sequence analysis, structural predictions, and functional annotation.
6. Understand molecular evolution and phylogenetics: Study evolutionary concepts and techniques for building phylogenetic trees, understanding genetic variation, and analyzing evolutionary relationships.
7. Use bioinformatics tools for protein structure prediction: Learn about the use of computational tools to predict protein structure, function, and interactions.
8. Study systems biology and pathway analysis: Understand the integration of biological data to study cellular pathways, networks, and systems biology approaches.
9. Apply bioinformatics in personalized medicine and drug discovery: Explore the application of bioinformatics in fields like personalized medicine, drug design, and genomics-based research.

COURSE OUTCOME

The student will be able to:

CO1	Understand the genesis of Bioinformatics, comparison with its allied disciplines, theoretical and computational models and its significance in biological data analysis.	K2
CO2	Explain nucleic acid and protein sequence databases, structural databases, literature databases, genome and organism-specific databases.	K1
CO3	Describe retrieval tools of biological data, database similarity searching, biological file formats	K2
CO4	Analysis and development of models for better interpretation of biological data to extract knowledge. .	K1
CO5	Apply machine learning and statistical techniques for biological data analysis	K2
CO6	Develop bioinformatics applications using computational tools and programming.	K2

COURSE CONTENT:

MODULE 1	Introduction to bioinformatics	6 Hours
- Bioinformatics Applications; Central Dogma of Molecular Biology; Genome projects; Sequence analysis, Homology and Analogy;		
MODULE 2	**Protein Information Resources**	6 Hours
Introduction; Biological databases; Primary Sequence Databases; Composite Protein Sequence Databases; Secondary Databases; Composite protein pattern databases; Structure classification databases		
MODULE 3	**Genome Information Resources**	6 Hours
Introduction; DNA sequence databases; Specialized Genomic Resources;		
MODULE 4	**DNA sequence analysis**	6 Hours

Introduction; Gene structure and DNA sequence; Features of DNA sequence analysis; Issues in interpretation of EST searches; Different approaches to EST analysis; Effects of EST data on DNA databases		
MODULE 5	**Pairwise Sequence Alignment**	6 Hours
Introduction; Database searching; Alphabet and Complexity; Algorithms and Programs; Comparing two sequences; Identity and Similarity; Local and global similarity; Global alignment: the Needleman and Wunsch algorithm; Local alignment: the Smith-Waterman algorithm; Dynamic Programming; Pairwise database searching; Basic Local Alignment Search Tool (BLAST).		
MODULE 6	**Multiple Sequence alignment**	6 Hours
Introduction; Goal of Multiple Sequence Alignment (MSA); Purpose of MSA. Dynamic programming solution for multiple alignment; Methods of alignment.		
MODULE 7	**Protein Secondary Structure Predictions**	6 Hours
Structure of protein; Different level of protein structure; Basics of machine learning; Methods for predicting secondary structure: Chou-Fasman method, Garnier-Osguthorpe-Robson method, Neural Network based method.		
MODULE 8	**Biomedical Text Mining**	6 Hours
Introduction; Named entity recognition; Document classification and clustering; Relationship discovery; Information extraction; Information retrieval and question answering, Applications of biomedical text mining.		
TOTAL LECTURES		45 Hours

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	1	2
CO-2	2	1	-	-	-	-	-	-	-	-	-	-	2
CO-3	2	2	-	-	1	-	-	-	-	-	-	1	2
CO-4	3	2	-	2	-	-	-	-	-	-	-	2	2
CO-5	2	3	-	2	1	-	-	-	-	-	-	2	2
CO-6	2	2	2	-	2	-	-	-	1	-	-	2	3
Average	2.3333	2	2	2	1.333				1			1.6	2.166667

Text Books:

1. T K Attwood, D J Parry-Smith, Samiron Phukan; Introduction to bioinformatics, Pearson
2. S. C. Rastogi, P. Rastogi, N. Mendiratta; Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery, PHI.
3. Bryan Bergeron, Bioinformatics Computing, Pearson

SIMULATIONS: MODELING AND ANALYSIS (TIU-PCS-E112)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: SIMULATIONS: MODELING AND ANALYSIS	**Subject Code:** TIU-PCS-E112
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamental concepts of probability theory, stochastic processes, and their application in simulation.
2. Learn the methodology and structure of discrete-event simulation and apply it to model real-world systems.
3. Analyze simulation output data using statistical techniques to assess system performance and behavior.
4. Explore and compare simulation tools and software for modeling, analyzing, and interpreting simulation experiments.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand the basic principles of probability theory and stochastic processes relevant to simulation.	K2
CO2:	Learn to estimate statistical parameters such as means, variances, and confidence intervals in simulation data.	K3
CO3:	Develop discrete-event simulation models for analyzing systems such as single-server queues and job-shop models.	K3
CO4:	Examine the behavior of simulation models through transient and steady-state output analysis.	K4
CO5:	Apply statistical techniques for performance evaluation and hypothesis testing in simulation studies.	K3
CO6:	Compare and use various simulation software tools, including MATLAB and NS2, for modeling and analysis of complex systems.	K2

COURSE CONTENT:

MODULE 1	**Review of Basic Probability Theory**	**9 Hours**
- Random Variables and Stochastic Processes. - Simulation Output Data Characteristics. - Estimation of Means, Variances, and Correlations. - Confidence Intervals and Hypothesis Testing. - Strong Law of Large Numbers.		
MODULE 2	**Basic Simulation Modeling**	**9 Hours**

- Introduction to Systems, Models, and Simulation. - Discrete-Event Simulation Concepts. - Modeling a Single-Server Queuing System. - Advantages and Disadvantages of Simulation. - Pitfalls and Misconceptions in Simulation Modeling.		
MODULE 3	**Modeling Complex Systems**	**9 Hours**
- List Processing in Simulation. - Modeling a Time-Shared Computer System. - Modeling a Job-Shop Manufacturing System. - Challenges in Modeling Large-Scale Systems.		
MODULE 4	**Output Data Analysis**	**9 Hours**
- Transient and Steady-State Behavior. - Statistical Analysis of Terminating Simulations. - Statistical Analysis of Steady-State Parameters. - Multiple Measures of Performance. - Time-Series Plots and Visualization of Output Data.		
MODULE 5	**Simulation Software**	**9 Hours**
- Simulation Packages vs. General Programming Languages. - Classification and Features of Simulation Software. - Introduction to General-Purpose Simulation Tools. - Overview of MATLAB Simulator. - Introduction to NS2 Network Simulator.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	2	1	2	3	1	2	1	2	1	3	2
CO-2	3	3	3	2	3	3	2	2	2	3	3	3	3
CO-3	2	3	2	3	2	3	2	3	3	3	2	3	3
CO-4	3	2	3	3	3	3	2	3	2	2	3	3	3
CO-5	2	3	3	2	3	3	2	3	2	3	2	3	2
CO-6	3	3	2	3	3	3	3	3	2	3	3	3	3
Average	2.7	2.7	2.5	2.3	2.7	2	2.7	2.3	3	2.7	2.3	3	2.7

Main Reading:

1. Sheldon M. Ross: Introduction to Probability Models 7th Edition, Academic Press.

2. M. Law and W. D. Kelton: Simulation Modeling and Analysis, 3rd Edition, Mc-Graw Hill, New York, USA.

Augmented Reality and Virtual Reality (Elective IV) (TIU-PCS-E#)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Augmented Reality and Virtual Reality (Elective IV)	**Subject Code:** TIU-PCS-E106C
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

1. To introduce the theoretical foundations of Augmented Reality and Virtual Reality systems, including their evolution and distinguishing features.
2. To develop in-depth knowledge of system components such as display technologies, tracking mechanisms, and interaction models.
3. To analyze AR/VR architectures and the underlying algorithms for spatial awareness, rendering, and user engagement.
4. To evaluate real-world AR/VR applications across various domains and identify key challenges and trends in immersive system design.

COURSE OUTCOME:

The student will be able to:

CO1	Explain the fundamental concepts, evolution, and differences between Augmented and Virtual Reality.	K2
CO2	Describe the architecture of AR/VR systems, including input/output devices, sensors, and display types.	K1
CO3	Analyze spatial tracking techniques, sensor fusion algorithms, and rendering pipelines in AR/VR.	K2
CO4	Compare different interaction models and evaluate their usability in immersive systems.	K2
CO5	Evaluate performance parameters of AR/VR systems such as latency, frame rate, and field of view.	K3
CO6	Critically review and propose enhancements to AR/VR applications in areas such as healthcare, gaming, or education.	K3

COURSE CONTENT:

MODULE 1	Introduction to AR and VR	7 Hours

- Evolution and history of immersive technologies - Key differences between AR, VR, and MR - Fundamental concepts and terminology - Applications across domains		
MODULE 2	System Architecture of AR/VR	8 Hours
- Hardware architecture: HMDs, input/output devices, motion sensors - Software architecture: SDKs (ARKit, ARCore, Vuforia) - Display technologies: LCD, OLED, stereoscopic displays		
MODULE 3	Tracking and Rendering Techniques	8 Hours
- Spatial tracking methods: marker-based, markerless, inside-out, outside-in - Sensor fusion (IMU, GPS, camera inputs) - Real-time rendering and graphics pipelines		
MODULE 4	Interaction and User Experience Design	7 Hours
- Interaction models: gesture-based, controller-based, gaze-based - Usability evaluation methods - Human factors in AR/VR - Presence and immersion concepts		
MODULE 5	System Performance and Evaluation Metrics	7 Hours
- Latency, frame rate, refresh rate, motion-to-photon delay - Field of view, resolution, depth perception - Techniques for performance benchmarking and testing		
MODULE 6	Applications and Future Trends in AR/VR	8 Hours
- Domain-specific case studies: healthcare (AR surgery assist), education (VR labs), gaming (immersive gameplay) - Ethical and social considerations - Future trends and challenges		
TOTAL LECTURES		45 Hours

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	2	2	2	1	2	2	2	2	2	1	3
CO-2	2	2	3	2	3	1	3	2	2	2	3	2	3
CO-3	3	3	2	3	3	1	3	2	2	2	3	2	3
CO-4	3	3	2	3	3	2	3	2	2	3	2	2	3
CO-5	3	2	3	3	3	2	3	2	3	2	3	2	3
CO-6	3	3	3	2	3	3	3	2	2	3	2	2	3
Average	2.83	2.5	2.5	2.5	2.83	1.66	2.83	2	2.16	2.33	2.5	1.83	3

Books:

1. "Augmented Reality: Principles and Practice" by Dieter Schmalstieg, Tobias Hollerer
2. "Virtual Reality" by Steven M. LaValle
3. "Fundamentals of Wearable Computers and Augmented Reality" by Woodrow Barfield
4. "Understanding Virtual Reality: Interface, Application, and Design" by William R. Sherman, Alan B. Craig

Cloud Computing and Internet Of Things (TIU-UCS- E416)

Program: M. Tech. in CSE	**Year, Semester:** 1st year
Course Title: Cloud Computing and Internet Of Things	**Subject Code: TIU-UCS- E416**
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

COURSE OBJECTIVE:

1. Develop a strong foundation in cloud computing architectures, services (IaaS, PaaS, SaaS), virtualization, and IoT ecosystems, including sensors, actuators, and communication protocols.
2. Learn to design, deploy, and manage IoT applications using cloud platforms such as AWS, Microsoft Azure, or Google Cloud, ensuring scalability and efficiency.
3. Analyze security risks, data privacy concerns, and best practices in cloud computing and IoT networks to protect sensitive information and maintain system integrity.

COURSE OUTCOME:

The students will be able to:

CO-1:	Demonstrate a clear understanding of cloud computing models, IoT architectures, and their applications in real-world scenarios.	K2
CO-2:	Design, implement, and integrate IoT-enabled systems with cloud platforms for data storage, processing, and analytics.	K1
CO-3:	Apply cloud computing techniques, such as virtualization, containerization, and distributed computing, to optimize resource management and scalability.	K2
CO-4:	Analyse security threats and implement best practices for securing IoT devices, cloud infrastructure, and data privacy.	K2
CO-5:	Develop innovative cloud-based IoT applications for smart homes, healthcare, agriculture, and industrial automation, demonstrating problem-solving and critical thinking skills.	K3

CO-6:	Utilize cloud-based big data and machine learning tools to analyze IoT-generated data for decision-making and predictive analytics.	K3

COURSE CONTENT:

MODULE 1:	**Basics of Cloud Computing and IOT**	**7 Hours**
NIST Cloud Reference Model, Cloud Cube Model, Deployment Models (Public, Private, Hybrid and Community Clouds), Service Models – Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)Characteristics of Cloud Computing – a shift in paradigm, Benefits and Advantages of Cloud Computing. IoT, The Internet of Things Today		
MODULE 2:	**Services and Applications & Cloud Security**	**13 Hours**
IaaS – Basic Concept, Workload, Partitioning of Virtual Private Server Instances, Pods, Aggregations, Silos, PaaS – Basic Concept, Tools and Development Environment with examples SaaS - Basic Concept and Characteristics, Open SaaS and SOA, examples of SaaS Platform. Identity as a Service (IDaaS), Compliance as a Service (CaaS). Virtualization: Taxonomy of Virtualization Techniques. Cloud security concerns, security boundary, security service boundary, Overview of security mapping, Security of data: cloud storage access, storage location, tenancy, encryption.		
MODULE 3:	**IoT Architecture**	**19 Hours**
Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.IoT Architecture -State of the Art – Introduction, State of the art, Architecture. Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.		
MODULE 4:	**Cloud Management using IOT**	**6 Hours**
An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle).		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	0	0	2	1	1	1	0	2	0	2	3
CO-2	3	3	2	1	2	1	1	1	1	2	1	2	3
CO-3	3	2	1	1	3	1	1	1	0	2	1	2	3
CO-4	3	3	3	2	3	0	1	0	1	2	2	3	3
CO-5	3	2	1	1	2	2	2	2	0	2	1	2	3
CO-6	3	3	3	2	3	1	1	1	2	3	2	3	3
Average	3	2.5	1.67	1.17	2.5	1	1.17	1	0.67	2.17	1.17	2.33	3

Textbooks:

Service Oriented Architecture, Concepts Technology and Design, Thomas Erl, Pearson Education, 2008

DATA WAREHOUSING AND DATA MINING (TIU-PCS-E108)

Program: M. Tech. in CSE	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: DATA WAREHOUSING AND DATA MINING	**Subject Code:** TIU-PCS-E108
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamental concepts and components of data warehousing, including architecture, metadata, and ETL processes.
2. Explore business analysis tools and techniques such as OLAP, multidimensional modeling, and reporting for effective decision support.
3. Learn the core concepts, functionalities, and techniques of data mining including data preprocessing, classification, and association rule mining.
4. Analyze advanced data mining methods such as clustering, outlier detection, and apply them to real-world applications across domains.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand the key components of data warehousing including architecture, data extraction, transformation, and loading (ETL).	K2
CO2:	Identify and explain various DBMS schemas and tools used in decision support systems.	K2
CO3:	Apply OLAP operations and multidimensional data models for efficient business analysis and reporting.	K3
CO4:	Describe the basic principles, tasks, and system architecture of data mining and its integration with data warehouses.	K2
CO5:	Develop classification and association rule mining techniques using algorithms like decision trees, SVMs, and rule-based approaches.	K3
CO6:	Analyze clustering techniques and evaluate their applications in discovering patterns and outliers in large datasets.	K4

COURSE CONTENT:

MODULE 1	**Data Warehousing Concepts**	**9 Hours**
- Components of Data Warehousing. - Building a Data Warehouse. - Mapping Data Warehouse to Multiprocessor Architecture. - DBMS Schemas for Decision Support. - ETL: Data Extraction, Cleanup, and Transformation Tools. - Metadata Management.		
MODULE 2	**Business Analysis and OLAP**	**9 Hours**
- Reporting and Query Tools – Categories and Applications. - Introduction to OLAP – Need and Advantages. - Multidimensional Data Model. - OLAP Guidelines and Tool Categories. - Multidimensional vs. Multirotational OLAP. - OLAP Tools and Internet Applications.		
MODULE 3	**Introduction to Data Mining**	**9 Hours**
- Introduction to Data Mining and Types of Data. - Functionalities and Interestingness of Patterns. - Classification of Data Mining Systems. - Data Mining Task Primitives. - Integration with Data Warehousing. - Data Preprocessing Techniques.		
MODULE 4	**Association Rule Mining and Classification**	**9 Hours**
- Mining Frequent Patterns, Associations, and Correlations. - Methods and Constraints in Association Rule Mining. - Classification Basics – Decision Tree Induction. - Bayesian and Rule-Based Classification. - Classification using Backpropagation and SVMs. - Associative Classification, Lazy Learners, and Prediction.		
MODULE 5	**Clustering and Applications**	**9 Hours**
- Cluster Analysis – Types of Data and Categorization of Methods. - K-Means and Partitioning Methods. - Hierarchical, Density-Based, and Grid-Based Methods. - Model-Based Clustering and Clustering High-Dimensional Data. - Constraint-Based Cluster Analysis and Outlier Detection. - Applications of Data Mining in Real-World Scenarios.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	1	-	-	-	-	-	-	2	3
CO-2	2	2	2	2	2	-	-	-	-	-	-	1	3
CO-3	3	3	1	2	2	-	-	-	-	-	-	1	3
CO-4	2	2	-	2	3	-	-	-	-	-	-	1	3
CO-5	1	1	-	-	1	-	-	-	2	3	-	1	2
CO-6	2	-	-	-	-	2	-	2	-	2	-	1	2
Average	2.1666	2	1.5	2	1.8	2		2	2	2.5		1.166667	2.666667

Main Reading:

1. Data Warehousing, Data Mining & OLAP, Alex Berson and Stephen J. Smith, Tata McGraw–Hill Edition.
2. Data Mining Concepts and Techniques, Jiawei Han and Micheline Kamber, Jian Pei, Third Edition, Elsevier.
3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction To Data Mining, Pearson Education.

SEMESTER 3

Technical Seminar-II (TIU-PCS-S201)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Technical Seminar-II	**Subject Code:** TIU-PCS-S201
Contact Hours/Week: 0–3–0 (L–T–P)	**Credit:** 8

COURSE OBJECTIVE:

Enable the student to:

1. Identify a relevant and innovative research problem in the domain of Computer Science and Engineering.
2. Understand the theoretical and practical background necessary to approach the selected problem through literature review and analysis.
3. Develop a structured thesis proposal with clearly defined objectives, scope, methodology, and expected outcomes.
4. Communicate research ideas effectively through written documentation and oral presentation.

COURSE OUTCOME:

The student will be able to:

CO1:	Identify and formulate a research problem relevant to current trends and challenges in CSE.	K2
CO2:	Review and synthesize scholarly literature to frame research context and justify the problem.	K2
CO3:	Design research objectives, scope, and methodology aligned with the problem statement.	K3
CO4:	Analyze technical feasibility, potential impact, and ethical considerations of the proposed research.	K3
CO5:	Prepare a structured, well-documented thesis proposal.	K2
CO6:	Present and defend the research proposal effectively before a review committee.	K2

COURSE CONTENT:

MODULE 1	Introduction to Research in CSE	**6 Hours**
Overview of research in computer science and engineering; types of research (theoretical, applied, experimental); identifying grand challenges; problem formulation basics.		
MODULE 2	Literature Review and Gap Analysis	**8 Hours**

Systematic literature review techniques; using digital libraries (IEEE, ACM, Springer, etc.); identifying gaps and formulating research questions; plagiarism and citation tools (Zotero, Mendeley).		
MODULE 3	Research Design and Methodology	**9 Hours**
Research paradigms (quantitative, qualitative, mixed methods); hypothesis development; designing experiments; data collection methods; tool selection; feasibility study.		
MODULE 4	Technical and Ethical Evaluation	**7 Hours**
Assessing technical feasibility, innovation, impact; understanding research ethics, intellectual property rights (IPR), data privacy, and publication ethics.		
MODULE 5	Proposal Writing	**8 Hours**
Components of a thesis proposal: Title, abstract, objectives, methodology, expected outcomes, timeline, and references; formatting and academic writing style.		
MODULE 6	Presentation and Defense	**7 Hours**
Techniques for effective research presentations; designing technical slides; anticipating questions; oral defense strategies; peer and instructor feedback.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	2	3
CO-2	2	2	-	2	-	-	-	-	-	-	-	2	3
CO-3	3	2	2	2	-	-	-	-	-	-	-	2	3
CO-4	2	2	2	-	-	-	-	-	-	-	-	2	2
CO-5	2	-	2	2	1	-	-	-	-	-	2	2	2
CO-6	-	-	-	-	-	-	-	-	2	3	-	2	2
Average	2.4	2	2	2	1				2	3	2	2	2.5

Books:

1. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar
2. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams
3. Technical Writing: Process and Product by Sharon J. Gerson, Steven M. Gerson

NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL (TIU-PCS-E209)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL	**Subject Code:** TIU-PCS-E209
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** Theory–4

COURSE OBJECTIVE :

Enable the student to:

1. Understand the fundamental concepts of Natural Language Processing (NLP) and Information Retrieval (IR).
2. Analyze various machine translation approaches and their challenges.

COURSE OUTCOME :

The student will be able to:

CO-1:	Understand the fundamentals of NLP and IR, including language models and applications.	K2
CO-2:	Apply classical NLP techniques such as text preprocessing, parsing, and semantic analysis.	K3
CO-3:	Analyze statistical models like HMM, MEM, MEMM, and Conditional Random Fields	K4
CO-4:	Evaluate machine translation approaches and their applications in different languages.	K5
CO-5:	Assess information retrieval models and evaluate IR system performance.	K5
CO-6:	Implement NLP applications in search engines, text summarization, sentiment analysis, and BioNLP.	K6

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**7 Hours**
Introduction to Natural Language Processing (NLP), Language and Grammar, NLP Applications, Information Retrieval (IR), Grammar Based Language Models, Statistical Language Model, Basic Mathematics for NLP and IR.		
MODULE 2:	**CLASSICAL APPROACHES**	**7 Hours**

Introduction, Text Preprocessing, Corpus Creation, Word Level Analysis, Lexical Analysis, Syntactic Parsing, Semantic Analysis, Discourse Processing, Natural Language Generation.		
MODULE 3:	**STATISTICAL APPROACHES**	**7 Hours**
Treebank Annotation, Probabilistic models of Information Extraction, Hidden Markov Models (HMM), Maximal Entropy Modeling (MEM), Maximum Entropy Markov Models (MEMM), Conditional Random Fields.		
MODULE 4:	**MACHINE TRANSLATION**	**8 Hours**
Problems in Machine Translation (MT), MT Approaches, Knowledge based MT Systems, Machine Translation for Indian Languages.		
MODULE 5:	**INFORMATION RETRIEVAL**	**8 Hours**
Introduction, Information Retrieval Models, Classical Information Retrieval Models, Non-classical models of IR, Alternative Models of IR, Evaluation of the IR System, Natural Language Processing in IR, Relation Matching, Knowledge-based Approaches, Conceptual Graphs, Cross-lingual Information Retrieval.		
MODULE 6:	**APPLICATIONS**	**8 Hours**
Information Extraction, Search Engines, Searching the Web, Clustering Documents, Text Categorization, Automatic Text Summarization, Question-Answering System, NLP applications in Education and Healthcare, BioNLP: Biomedical NLP, Sentiment analysis and subjectivity.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	1	-	-	-	-	-	-	2	3
CO-2	2	2	-	2	3	-	-	-	-	-	-	1	3
CO-3	3	3	2	2	2	-	-	-	-	-	-	1	3
CO-4	2	3	1	2	2	-	-	-	-	-	-	1	3
CO-5	2	2	2	2	3	-	-	-	-	-	-	1	3
CO-6	2	2	-	-	-	2	-	2	-	1	-	1	3
Average	2.3333	2.333333	1.6666	2	2.2	2		2		1		1.166667	3

Textbooks:

T1. U.S. Tiwary, Tanveer Siddiqui, Natural Language Processing and Information Retrieval, OUP
T2. M Kanchadu, Text Mining Application Programming, Charls River Media
T3. D. Jurafsky, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistic and Speech Recognition, Pearson Education
T4. Raghavan, Introduction to Information Retrieval, Cambridge University Press

Digital VLSI Design (Elective VI) (TIU-PCS-E211)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Digital VLSI Design (Elective VI)	**Subject Code:** TIU-PCS-E211
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamentals of digital VLSI design, including CMOS logic styles, fabrication techniques, and device modeling.
2. Analyze performance parameters such as power, delay, and area in VLSI circuits and optimize them for advanced applications.
3. Apply HDL-based modeling and simulation techniques to design and verify digital systems at various levels of abstraction.
4. Design and implement complex digital circuits using modern VLSI CAD tools and evaluate their practical applicability in embedded and computing systems.

COURSE OUTCOME:

The student will be able to:

CO1	Explain the principles of CMOS technology, fabrication process, and logic gate design.	K1
CO2	Analyse the performance metrics of VLSI circuits including timing, power, and area.	K2
CO3	Apply CMOS logic design techniques for implementing combinational and sequential digital circuits.	K2
CO4	Develop HDL-based models for digital subsystems and verify them using simulation tools.	K3

CO5	Evaluate the trade-offs in VLSI design with respect to scalability, reliability, ar manufacturability.	K3
CO6	Design and synthesize digital systems using VLSI CAD tools and demonstrate functional verification.	K2

COURSE CONTENT:

MODULE 1	CMOS Technology and Fabrication	**7 Hours**
Introduction to IC design flow, VLSI design styles, MOS transistor operation, CMOS inverter, Fabrication steps (NMOS, CMOS, BICMOS), Layout design rules, Stick diagrams, Mask layout.		
MODULE 2	Performance Metrics and Analysis	**8 Hours**
Delay models (RC delay, logical effort), Dynamic and static power dissipation, Power–delay trade-offs, Noise margins, Interconnect effects, Area estimation and optimization.		
MODULE 3	Combinational and Sequential Circuit Design	**8 Hours**
CMOS logic styles: Static, dynamic, pass-transistor logic; Combinational circuit design: Multiplexers, Encoders, Decoders; Sequential circuit design: Latches, Flip-flops, Registers.		
MODULE 4	HDL Modeling and Simulation	**7 Hours**
Introduction to HDL (VHDL/Verilog), Behavioural and structural modelling, FSM modelling, Testbenches, Simulation workflows using ModelSim/Xilinx/other tools		
MODULE 5	Design Trade-offs and Reliability	**7 Hours**
Design for testability (DFT), Fault models and ATPG basics, Scalability issues (PVT variations), Yield and manufacturability, Reliability and aging effects in VLSI circuits.		
MODULE 6	Synthesis and Verification using CAD Tools	**8 Hours**
RTL to GDSII flow, Logic synthesis using CAD tools (e.g., Synopsys), Static timing analysis, Floorplanning, Placement and routing, Design verification and sign-off techniques.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	3	2	3	2	1	1	3	2	3	2	3
CO-2	3	3	3	2	3	2	1	1	3	2	3	2	3
CO-3	2	3	3	3	3	2	1	1	3	2	3	2	3
CO-4	2	3	3	3	3	1	1	1	3	2	3	3	3
CO-5	3	3	3	2	3	2	1	1	3	3	3	2	3

CO-6	3	3	3	3	3	2	1	1	3	2	3	3	3
Average	3	2	3	2	3	2	1	1	3	2	3	2	3

Books:

1. "CMOS VLSI Design: A Circuits and Systems Perspective by Neil H.E. Weste, David Harris
2. Digital Integrated Circuits by Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolić
3. Basic VLSI Design by Douglas A. Pucknell, Kamran Eshraghian
4. Digital VLSI Design and Simulation with Verilog by Rogério de Lemos

Computational Geometry (Elective VI) (TIU-PCS-E213)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Computational Geometry (Elective VI)	**Subject Code:** TIU-PCS-E213
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamental concepts and techniques used in computational geometry, including geometric data structures, geometric algorithms, and problem-solving approaches.
2. Develop the ability to implement and apply geometric algorithms for solving various computational geometry problems, including convex hulls, Voronoi diagrams, and geometric intersection problems.
3. Analyze the time and space complexity of geometric algorithms, with a focus on optimization techniques to improve the efficiency of geometric computations.
4. Explore advanced topics in computational geometry, such as 3D geometry, motion planning, geometric graph theory, and their applications in areas like robotics, computer graphics, and computer-aided design (CAD).

COURSE OUTCOME:

The student will be able to:

CO1:	Define and recall key concepts in computational geometry, such as convex hulls, Voronoi diagrams, and geometric intersections.	K2
CO2:	Explain the principles and techniques behind geometric algorithms for solving problems in 2D and 3D spaces, such as line segment intersection and Voronoi diagrams.	K2
CO3:	Apply geometric algorithms to real-world problems, including finding the convex hull and determining the closest pair of points in a set.	K3

CO4:	Analyze the computational complexity of geometric algorithms and optimize them for better performance.	K2
CO5:	Evaluate the efficiency of geometric algorithms in terms of time complexity, space complexity, and practical applicability.	K2
CO6:	Design and develop advanced geometric algorithms and data structures to solve complex problems in computational geometry.	K3

COURSE CONTENT:

MODULE 1	Introduction to Computational Geometry	**7 Hours**
- Introduction to computational geometry: Overview, history, and applications. - Key concepts in computational geometry: Points, lines, polygons, and other basic geometric objects. - Basic geometric transformations (translation, scaling, rotation). - Representation of geometric objects (e.g., using data structures like arrays, trees). - Overview of geometric problem types: intersection, visibility, proximity.		
MODULE 2	Convex Hulls and Polygon Triangulation	**8 Hours**
- Convex hull problem: Definition and applications. - Algorithms for computing convex hulls: Graham's scan, Jarvis's march, and QuickHull. - Properties of convex hulls. - Polygon triangulation: Definition and importance. - Algorithms for triangulation: Ear-clipping method, Divide-and-conquer. - Applications in computer graphics and geometric modeling.		
MODULE 3	Geometric Intersection and Voronoi Diagrams	**8 Hours**
- Line segment intersection: Definition, algorithm design, and applications. - Sweep line algorithm for geometric intersections. - Voronoi diagrams: Definition, properties, and applications. - Construction of Voronoi diagrams: Fortune's algorithm. - Delaunay triangulation and its relation to Voronoi diagrams. - Applications in mesh generation, nearest neighbor search.		
MODULE 4	Geometric Optimization and Closest Pair Problems	**7 Hours**
- Closest pair of points problem: Problem definition and applications. - Divide-and-conquer algorithm for closest pair. - Plane sweep technique for geometric problems. - Geometric optimization techniques for solving minimum spanning tree, nearest neighbor search. - Applications in robotics, computer vision, and geographic information systems (GIS).		
MODULE 5	Computational Complexity and Algorithmic Analysis	**8 Hours**

K

- Time complexity and space complexity in computational geometry.
- Analyzing geometric algorithms using Big-O notation.
- Lower bounds for geometric problems.
- Optimizing geometric algorithms: Trade-offs between time and space complexity.
- Advanced geometric algorithmic paradigms: Randomization, approximation algorithms.
- Practical applicability of geometric algorithms.

MODULE 6	Advanced Topics and Applications	**7 Hours**

- 3D Computational Geometry: Convex hulls, Voronoi diagrams, and Delaunay triangulation in 3D.
- Motion planning: Robot path planning using computational geometry techniques.
- Geometric graphs and their applications: Planar graphs, visibility graphs, Steiner trees.
- Advanced algorithms: Approximation algorithms in geometric optimization.
- Real-world case studies: CAD, robotics, and computer graphics.

TOTAL LECTURES	**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	3	-	-	1	-	-	-	-	-	-	1	2
CO-2	3	2	-	-	2	-	-	-	-	-	-	-	2
CO-3	2	3	-	-	1	-	-	-	-	-	-	-	2
CO-4	2	2	-	-	3	-	-	-	-	-	-	-	2
CO-5	2	3	-	-	2	-	-	-	-	-	-	-	1
CO-6	3	2	2	-	3	-	-	-	-	-	1	-	2
Average	3	3	-	-	1	-	-	-	-	-	-	1	2

Books:

1. Computational Geometry: Algorithms and Applications by Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars
2. Algorithms in Combinatorial Geometry by Herbert Edelsbrunner
3. Computational Geometry in C by Joseph O’Rourke
4. Geometric Algorithms and Combinatorial Optimization by Martin Grötschel, László Lovász, Alexander Schrijver
5. Handbook of Computational Geometry by Jörg-Rüdiger Sack, Jorge Urrutia

6. Discrete and Computational Geometry by Satyan L. Devadoss, Joseph O'Rourke
7. Computational Geometry: An Introduction by Franco P. Preparata, Michael Ian Shamos

Pattern Recognition and Image Processing (TIU-PCS-E215)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Pattern Recognition and Image Processing	**Subject Code:**TIU-PCS-E215
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** Theory–4

COURSE OBJECTIVE :

Enable the student:

1. To develop a strong foundation in pattern recognition and classification techniques by understanding the fundamental principles, various distance metrics, and classification methods used in pattern recognition.

2. To equip students with practical knowledge of clustering, feature selection, and trainable classifiers through algorithms like K-means, ISO-data, Bayes classifier, and perceptron models for effective pattern analysis and classification.

3. To enable students to apply image processing techniques for segmentation, texture analysis, and classification by using edge detection, region-growing methods, and multispectral image analysis in real-world applications.

COURSE OUTCOME :

The student will be able to:

CO1	Understand the fundamental problems in pattern recognition system design and the representation of patterns and classes.	K2
CO2	Apply various distance metrics and classification techniques, including minimum distance and likelihood-based classifiers.	K3
CO3	Perform clustering using K-means and ISO-data algorithms and implement feature selection techniques.	K4
CO4	Implement and evaluate trainable classifiers such as Bayesian classifiers and perceptron-based models.	K5
CO5	Process digital images, analyze histograms, and apply segmentation techniques such as edge detection and region growing.	K3

CO6	Analyze and classify multispectral images, perform supervised classification, and extract texture features.	K4

COURSE CONTENT :

Module 1	Introduction to Pattern Recognition	**6 Hours**
Fundamental Concepts of Pattern Recognition, Pattern Recognition System Design, Representation of Patterns and Classes, Metric and Non-Metric Proximity Measures (Euclidean, Mahalanobis, Hausdorff Distance), Pattern Classification by Distance Function (Minimum Distance, Single Prototype, Multi-Prototype), Cluster Seeking Techniques		
Module 2	Clustering and Feature Selection	**7 Hours**
Introduction to Clustering, K-Means Algorithm, ISO-Data Algorithm, Feature Extraction Techniques, Different Approaches to Feature Selection (Exhaustive Search, Branch and Bound)		
Module 3	Trainable Classifiers and Bayes Decision Theory	**7 Hours**
Pattern Classification by Likelihood Functions, Bayesian Decision Theory, Trainable Pattern Classifiers, Deterministic Approach, Perceptron Model and its Learning Rule, Reward-Punishment Concept in Classification		
Module 4	Fundamentals of Image Processing	**8 Hours**
Introduction to Digital Image Processing, Digitization of Images, Image Analysis Problems, Gray-Level Image Segmentation, Histogram Analysis for Image Segmentation, Edge Detection Techniques (Laplacian Operator, Sobel Operator), Region Growing Techniques		
Module 5	Texture Analysis and Classification	**8 Hours**
Introduction to Texture Analysis, Co-Occurrence Matrix for Texture Description, Feature Extraction for Texture Classification, Supervised Classification of Images, Application of Texture Classification		
Module 6	Multispectral Image Processing and Applications	**9 Hours**
Introduction to Multispectral Imaging, Remote Sensing Imagery Concepts, Preprocessing of Multispectral Images, Classification of Multispectral Images, Application of Image Processing in Real-world Scenarios, Case Studies and Research Trends in Pattern Recognition & Image Processing		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	2	3
CO-2	3	3	2	2	2	-	-	-	-	-	-	2	3
CO-3	3	3	3	2	2	-	-	-	-	-	-	2	3
CO-4	3	2	3	3	3	-	-	-	-	-	-	2	3
CO-5	3	3	2	3	3	-	-	-	-	-	-	2	3
CO-6	3	2	3	3	3	-	-	-	-	-	-	2	3
Average	3	2.5	2.6	2.6	2.6							2	3

Main Reading

1. R. O Duda, P E Hart and D G Stork , Pattern Classification, Wiley publisher, 2001
2. J T Tou and R C Gonzalez, Pattern recognition principles, Addison Wesley Publishing co.

Software Project Management and Testing (Elective VII) (TIU-PCS-E217)

Program: M. Tech. in CSE	**Year, Semester:** 2^{nd} Yr., 3^{rd} Sem.
Course Title: Software Project Management and Testing (Elective VII)	**Subject Code:** TIU-PCS-E217
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Understand the fundamental concepts of software project management, including project life cycle, project planning, scheduling, and cost estimation techniques.
2. Analyze the various software development models, methodologies, and processes such as Agile, Waterfall, and Spiral, and their applicability in different project environments.
3. Evaluate the different types of software testing techniques, including functional and non-functional testing, and develop strategies for effective testing in software development projects.
4. Gain proficiency in project risk management, quality assurance, and the use of tools and techniques for managing software projects efficiently and effectively.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand and apply project planning, scheduling, and cost estimation techniques.	K1
CO2:	Analyze and apply software development models (Agile, Waterfall, Spiral, etc.).	K2
CO3:	Evaluate testing strategies for software applications, including functional and non-functional testing.	K2
CO4:	Understand and apply risk management techniques and project quality assurance practices.	K3
CO5:	Use project management tools to monitor and control software development projects effectively.	K3
CO6:	Evaluate and manage project teams and client relationships in the context of software project development.	K2

COURSE CONTENT:

Module 1	Introduction to Project Management	**6 Hours**
- Introduction to Project Management: Scope, objectives, and importance of project management in software development. - Project Planning: Defining project goals, establishing a work breakdown structure (WBS), and how to break down complex projects into manageable tasks. - Scheduling Techniques: Overview of Gantt charts, network diagrams, and the Critical Path Method (CPM) to schedule tasks, monitor progress, and track project milestones. - Cost Estimation: Methods like COCOMO model and function point analysis to estimate costs and project effort. Understanding the role of cost estimation in project management. - Resource Allocation and Time Management: Techniques for resource allocation, balancing workloads, and managing time efficiently throughout the project lifecycle. - Case Study: Real-world application of project planning and cost estimation, focusing on developing a project plan using WBS, scheduling, and cost estimation.		
MODULE 2	Software Development Life Cycle (SDLC)	**6 Hours**
- Introduction to SDLC: Overview of SDLC concepts, stages, and methodologies used in software development. Importance of SDLC for project management. - Waterfall Model: Detailed explanation of the Waterfall model, including phases (requirements, design, implementation, testing, maintenance) and its limitations. - Agile Methodology: Principles of Agile, Scrum framework, Kanban boards, and iterative development. Focus on how Agile methodologies improve flexibility and responsiveness in project management. - Spiral Model: Explanation of the Spiral model and its iterative approach to risk-driven software development. - V-Model: Advantages and application of the V-Model, focusing on verification and validation in the software development process. - Comparative Analysis of SDLC Models: Comparing the strengths, weaknesses, and applicability of different SDLC models to various types of software projects.		
MODULE 3	Software Testing Strategies	**9 Hours**

- Introduction to Software Testing: The importance of software testing, types of testing (manual vs. automated), and objectives of quality assurance. - Functional Testing: Techniques such as unit testing, integration testing, and system testing that ensure the software meets functional requirements. - Acceptance Testing: Discussion on Alpha, Beta, and User Acceptance Testing (UAT) to validate the software from the user's perspective. - Non-Functional Testing: Techniques for performance testing (load, stress, scalability), security testing, and usability testing. - Test Case Design: Methods for designing effective test cases using boundary value analysis and equivalence partitioning techniques. - Regression Testing: Importance of regression testing and methodologies used to ensure that new changes do not introduce bugs. - Automation in Testing: Introduction to test automation tools and techniques, and benefits of automating repetitive testing tasks. - Performance Testing: Detailed explanation of performance testing strategies, including load, stress, and scalability testing. - Test Metrics and Reporting: Understanding how to measure the effectiveness of tests and report findings to project stakeholders.		
MODULE 4	Risk Management and Quality Assurance	**6 Hours**
- Introduction to Risk Management: Identifying and assessing risks in the software project lifecycle. Risk classification and prioritization. - Risk Mitigation Strategies: Contingency planning, avoiding risks, and mitigating known risks. - Quality Assurance: Concept of quality assurance, its importance in software development, and best practices. - Six Sigma, CMMI Models for Process Improvement: Exploring Six Sigma and Capability Maturity Model Integration (CMMI) as frameworks for process improvement in software projects. - Risk Response and Monitoring: Strategies for tracking, monitoring, and reviewing risks throughout the project lifecycle. - Case Study: Application of risk management and quality assurance techniques in real-world software development projects.		
MODULE 5	Project Management Tools	**6 Hours**
- Introduction to Project Management Tools: Overview of popular project management tools like MS Project, JIRA, and their role in tracking project progress, managing resources, and improving communication. - Gantt Charts: How to create, schedule, and manage tasks using Gantt charts, and the importance of this tool for visualizing project timelines. - Critical Path Method (CPM): Understanding CPM, its use in determining the longest path of dependent tasks, and how it helps in project schedule management. - Earned Value Management (EVM): Using EVM to assess cost performance and schedule performance, key concepts like Planned Value (PV), Earned Value (EV), and Actual Cost (AC). - Resource Management Tools: Tools for resource allocation, utilization, and tracking to ensure optimal use of available resources. - Using JIRA for Task Management: Practical session on using JIRA for creating issues, tracking task progress, managing project sprints, and improving team collaboration.		
MODULE 6	Managing Software DevelopmentTeams and Client Relationships	**6 Hours**

- Managing Software Development Teams: Defining roles and responsibilities, establishing collaborative work environments, and managing team dynamics in the software development process.
- Communication within Teams: Importance of communication in team collaboration, strategies for effective communication, and tools for remote communication.
- Client Relationship Management: Managing client expectations, delivering project reports, and maintaining strong relationships with stakeholders.
- Conflict Management in Teams: Identifying and resolving conflicts within development teams to maintain a productive and collaborative environment.
- Motivating Teams: Leadership theories, understanding team development stages, and strategies to keep the team motivated throughout the project lifecycle.
- Managing Stakeholders: Techniques for identifying stakeholders, understanding their needs, and ensuring that project deliverables satisfy stakeholder expectations.

MODULE 7	Testing Tools and Automation	**6 Hours**

- Introduction to Testing Tools: Overview of different types of testing tools, their features, and how they contribute to the efficiency of the testing process.
- Test Automation Tools: In-depth introduction to test automation tools such as Selenium, QTP, JUnit, and their benefits in reducing manual testing efforts.
- Performance Testing Tools: Practical knowledge of tools like LoadRunner and JMeter for conducting performance testing to evaluate load, stress, and scalability.
- Security Testing Tools: Introduction to security testing tools like OWASP ZAP and Burp Suite for identifying vulnerabilities and ensuring secure software development.
- Continuous Integration and Continuous Testing: Understanding the role of tools like Jenkins and Travis CI in Continuous Integration (CI) and Continuous Testing (CT) for faster development cycles and higher software quality.
- Case Study: Practical case study on applying various testing tools in real-world software projects, including automation and performance testing techniques.

TOTAL LECTURES	**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	1	-	1	3
CO-2	2	3	-	1	-	-	-	-	-	1	-	-	2
CO-3	2	2	3	-	1	-	-	-	-	1	-	-	2
CO-4	2	2	3	-	1	-	-	-	-	-	-	-	2
CO-5	2	2	1	3	1	-	-	-	-	-	1	-	2
CO-6	-	-	-	-	-	1	-	1	3	2	2	-	1
Average	2.2	2.2	2.3333	2	1	1		1	3	1.25	1.5	1	2

Books:

1. "Software Engineering: A Practitioner's Approach" by Roger S. Pressman and Bruce R. Maxim
2. "Software Project Management" by Bob Hughes and Mike Cotterell
3. "The Art of Project Management" by Scott Berkun
4. "Software Testing: Principles and Practices" by Naresh Chauhan
5. "The Art of Software Testing" by Glenford J. Myers
6. "Foundations of Software Testing: ISTQB Certification" by Rex Black, Erik van Veenendaal, Dorothy Graham

Data and Knowledge Security (Elective VII) (TIU-PCS-E219)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Data and Knowledge Security (Elective VII)	**Subject Code:** TIU-PCS-E219
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. To provide an understanding of the fundamental principles of data and knowledge security, including cryptographic techniques, security protocols, and key management.
2. To introduce students to various models and frameworks for securing data, both at rest and in transit, along with techniques for ensuring data privacy and integrity.
3. To explore advanced topics in knowledge security such as access control, digital rights management (DRM), and secure multi-party computation.
4. To equip students with practical skills in applying security mechanisms to real-world applications, including secure communication, data encryption, and secure database systems.

COURSE OUTCOME:

The student will be able to:

CO1:	Define key concepts in data security, including cryptography, encryption algorithms, digital signatures, and access control mechanisms.	K1
CO2:	Explain the principles and techniques of symmetric and asymmetric encryption, hashing, and public-key infrastructure (PKI) for securing data in communication systems.	K2
CO3:	Demonstrate how to implement security protocols (such as SSL/TLS) to secure data transmission and assess their effectiveness in mitigating threats	K2
CO4:	Analyze different types of security breaches, including man-in-the-middle attacks and denial-of-service attacks, and evaluate the effectiveness of various countermeasures.	K3

CO5:	Evaluate the strengths and weaknesses of various encryption algorithms, such as RSA and AES, based on their performance, security guarantees, and vulnerability to attacks.	K2
CO6:	Design and develop secure data storage systems that ensure confidentiality, integrity, and availability of sensitive information using advanced encryption and access control techniques.	K3

COURSE CONTENT:

MODULE 1	Introduction to Data and Knowledge Security	**7 Hours**
- Overview of data and knowledge security concepts - Importance and objectives of data protection - Security goals: Confidentiality, Integrity, Availability (CIA Triad) - Types of security threats and vulnerabilities - Key concepts: Cryptography, Digital signatures, Authentication, Access control		
MODULE 2	Cryptographic Basics and Encryption Algorithms	**8 Hours**
- Introduction to cryptography and its role in data security - Types of encryption: Symmetric vs. Asymmetric - Block ciphers (AES, DES, etc.) - Stream ciphers - Public key cryptography basics (RSA, Diffie-Hellman) - Digital signatures and key management strategies		
MODULE 3	Symmetric Encryption, Hashing, and PKI	**8 Hours**
- Symmetric encryption techniques (AES, DES) - Hashing algorithms (SHA-256, MD5, HMAC) - Message Authentication Code (MAC) - Public Key Infrastructure (PKI) and its role in securing communications - Digital certificates, certificate authorities (CA) and their use in secure communication		
MODULE 4	Security Protocols and Data Transmission	**8 Hours**
- Overview of security protocols (SSL/TLS, IPsec, HTTPS) - Working principles of SSL/TLS protocol: Handshake, Record, Alert protocols - Implementing secure communication (e.g., HTTPS) - VPNs and their role in securing communication - Evaluating the effectiveness of SSL/TLS and IPsec in mitigating threats		
MODULE 5	Security Breaches, Attacks, and Countermeasures	**7 Hours**
- Overview of common security breaches (Man-in-the-middle, DoS, DDoS) - Analysis of attack vectors and mechanisms - Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS) - Case studies: Heartbleed, Stuxnet, and others - Countermeasures for network attacks and data breaches		

MODULE 6	Designing Secure Data Storage Systems	7 Hours
- Principles of data storage security (confidentiality, integrity, availability) - Designing secure database systems: encryption techniques for data storage - Implementing access control models (RBAC, ABAC) - Data backup and recovery techniques - Secure multi-party computation and advanced encryption methods (homomorphic encryption)		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	1	-	-	-	-	-	-	2	3
CO-2	2	2	2	2	2	-	-	-	-	-	-	1	3
CO-3	3	3	1	2	2	-	-	-	-	-	-	1	3
CO-4	2	2	-	2	3	-	-	-	-	-	-	1	3
CO-5	1	1	-	-	1	-	-	-	2	3	-	1	2
CO-6	2	-	-	-	-	2	-	2	-	2	-	1	2
Average	2.1666	2	1.5	2	1.8	2		2	2	2.5		1.166667	2.666667

Books:

1. "Cryptography and Network Security: Principles and Practice" by William Stallings
2. "Introduction to Modern Cryptography" by Jonathan Katz and Yehuda Lindell
3. "Computer Security: Principles and Practice" by William Stallings and Lawrie Brown
4. "Network Security Essentials: Applications and Standards" by William Stallings
5. "Database Security: Concepts, Approaches, and Challenges" by Bertino, Sandhu, and Sandhu
6. "Security Engineering: A Guide to Building Dependable Distributed Systems" by Ross Anderson
7. "Applied Cryptography: Protocols, Algorithms, and Source Code in C" by Bruce Schneier
8. "Digital Rights Management: Technology, Issues, Challenges and Solutions" by Marson, Bellini, and Catalano

SEMESTER 4

Final Thesis (TIU-PCS-D298)

Program: M. Tech. in CSE	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Final Thesis	**Subject Code:** TIU-PCS-D298
Contact Hours/Week: 0–3–0 (L–T–P)	**Credit:** 8

COURSE OBJECTIVE:

Enable the student to:

1. Identify a relevant and innovative research problem in the domain of Computer Science and Engineering.
2. Understand the theoretical and practical background necessary to approach the selected problem through literature review and analysis.
3. Develop a structured thesis proposal with clearly defined objectives, scope, methodology, and expected outcomes.
4. Communicate research ideas effectively through written documentation and oral presentation.

COURSE OUTCOME:

The student will be able to:

CO1:	Identify and formulate a research problem relevant to current trends and challenges in CSE.	K1
CO2:	Review and synthesize scholarly literature to frame research context and justify the problem.	K2
CO3:	Design research objectives, scope, and methodology aligned with the problem statement.	K2
CO4:	Analyse technical feasibility, potential impact, and ethical considerations of the proposed research.	K3
CO5:	Prepare a structured, well-documented thesis proposal.	K3
CO6:	Present and defend the research proposal effectively before a review committee.	K2

COURSE CONTENT:

MODULE 1	Introduction to Research in CSE	**6 Hours**
Overview of research in computer science and engineering; types of research (theoretical, applied, experimental); identifying grand challenges; problem formulation basics.		

MODULE 2	Literature Review and Gap Analysis	**8 Hours**
Systematic literature review techniques; using digital libraries (IEEE, ACM, Springer, etc.); identifying gaps and formulating research questions; plagiarism and citation tools (Zotero, Mendeley).		
MODULE 3	Research Design and Methodology	**9 Hours**
Research paradigms (quantitative, qualitative, mixed methods); hypothesis development; designing experiments; data collection methods; tool selection; feasibility study.		
MODULE 4	Technical and Ethical Evaluation	**7 Hours**
Assessing technical feasibility, innovation, impact; understanding research ethics, intellectual property rights (IPR), data privacy, and publication ethics.		
MODULE 5	Proposal Writing	**8 Hours**
Components of a thesis proposal: Title, abstract, objectives, methodology, expected outcomes, timeline, and references; formatting and academic writing style.		
MODULE 6	Presentation and Defense	**7 Hours**
Techniques for effective research presentations; designing technical slides; anticipating questions; oral defense strategies; peer and instructor feedback.		
TOTAL LECTURES		**45 Hours**

CO-PO MATRIX:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO-1	3	2	-	-	-	-	-	-	-	-	-	2	3
CO-2	2	2	-	2	-	-	-	-	-	-	-	2	3
CO-3	3	2	2	2	-	-	-	-	-	-	-	2	3
CO-4	2	2	2	-	-	-	-	-	-	-	-	2	2
CO-5	2	-	2	2	1	-	-	-	-	-	2	2	2
CO-6	-	-	-	-	-	-	-	-	2	3	-	2	2
Average	2.4	2	2	2	1				2	3	2	2	2.5

Books:

4. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar
5. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams
6. Technical Writing: Process and Product by Sharon J. Gerson, Steven M. Gerson