Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of

B. Tech. (Information Technology)

Effective from Academic Year 2026-27

Prepared by: Board of Studies in Information Technology

Approved by: Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman–BOS **Chairman–Academic Board**

B. Tech. Information Technology (applicable w.e.f. AY 2026-27)

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List of Coursera courses			
	Structure	**Module V**	
1	MD3101	MD3101:IBM Full Stack Software Developer	
2	MD3102	MD3102:Meta Back-End Developer	
3	MD3106	MD3106:Microsoft Power BI Data Analyst	
4	MD3112	MD3112:Google Cybersecurity	
5	MD3113	MD3113:Google Data Analytics	
6	MD3118	MD3118:IBM Data Science	
7	MD3119	MD3119:Fractal Data Science	
8	MD3121	MD3121:IBM DevOps and Software Engineering	
9	MD3141	MD3141:AWS Cloud Technology Consultant	
10	MD3147	MD3147:DEEP LEARNING.AI DEEP LEARNING	

Institute Vision

"To be globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development".

Institute Mission

- To ensure that 100% students are employable and employed in Industry, HigherStudies, become Entrepreneurs, Civil / Defense Services / Govt. Jobs and other areas like Sports and Theatre.
- To strengthen Academic Practices in terms of Curriculum, Pedagogy, Assessment and Faculty Competence.
- Promote Research Culture among Students and Faculty through Projects and Consultancy.
- To make students Socially Responsible Citizen.

Department Vision

“To provide student-centered state-of-the art academically enriched environment for productivecareers in the world of computing through creativity and innovation art”

Department Mission

- To promote aspiring ethically conscious engineers demonstrating sustainable employability and entrepreneurship.
- To impart quality education with the focus on analytical and problem-solving skill development.
- To foster inspired scholarly environment through active student faculty participation in research and development resulting in new knowledge-base or insights.
- To prepare students to shoulder social responsibilities by application oftheir skill set for betterment of society.

Program Education Objectives (PEO)

PEO	PEO Focus	PEO Statement
PEO1	Preparation	To prepare the students with a commitment towards meeting the needs of users within an organizational and societal context through the selection, creation, application, integration and administration of InformationTechnology projects.
PEO2	Core competence	To facilitate students with foundation of mathematical & engineering fundamentals along with knowledge of Information Technology principles and applications and be able to integrate this knowledge in a variety of business and inter-disciplinary setting.
PEO3	Breadth	To enable student to exercise problem solving capacity with effective use of analysis, design, development that address idea realization.
PEO4	Professionalism	To inculcate students with professional and ethical values with effective skills leading to participative team work having multidisciplinary knowledge useful to the society.
PEO5	Learning Environment	To provide students an academic environment that develops leadership qualities, excellence in subject areas of Information Technology and lifelong learning in every sphere of their life.

List of Program Outcomes [PO]

Graduates will be able

PO	PO Statement
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and Research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5	**Modern tool usage: Create**, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit professional ethics and responsibilities and norms of the engineering practice.
PO9	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO10	**Project management and finance:** Demonstrate knowledge and understanding of The engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO11	**Life-long learning:** Recognize the need for, and have the preparation and ability to Engage in independent and life-long learning in the broadest context of technological change**.**
PSO1	Apply core Information Technology skills—including Operating Systems, IoT, Networking, and Artificial Intelligence—along with problem-solving techniques to analyze, design, and develop efficient solutions using appropriate tools and technologies.
PSO2	Demonstrate research aptitude and entrepreneurial mindset by innovating IT-based solutions, creating engineering artifacts, and adapting to emerging technologies and IT industry standards.

B. Tech. Information Technology Structure(Applicable w.e.f. AY-2026-27)

SY IT Module-III

Subject Head	Course	Credits	CVV	CP	LAB	HA	MSE (W)	MSE (R)	ESE (R)	ESE TH (W)	PRACT + CVV	ESE-Direct Evaluation	Total
IT2301	DATA STRUCTURES	4	20							40	40		100
IT2304	DISCRETE MATHEMATICS	3	20	30	10		40						100
IT2303	DIGITAL ELECTRONICS AND MICROPROCESSOR	3	20	30	10					40			100
IT2305	OPERATING SYSTEM	3	20	30	10					40			100
MM1316	MDM-ROBOTICS	3	20	20		20	40						100
HS2002	HSSM-FROM CAMPUS TO CORPORATE - 1	2						50	50				100
IT2268	VSEC-DT	1										100	100
HS2001	AEC-RAD	1										100	100
IT2272	FP-EDI	2						30	70				100
Total		22											900

FF No.: 654-A

IT2301: Data Structures

Teaching Scheme	Examination Scheme
Credits : 04	ESE(TH): 40 Marks
Lectures : 2 Hrs/week	
Practical : 4 Hrs/week	CVV: 20 Marks
Tutorial : - Hrs/week	Practical Exam: 40 Marks

Prerequisites:	
●	1. Basic programming Skills
Course Objectives:	
●	1. To impart the basic concepts of data structures and algorithms.
●	2. To understand concepts about searching and sorting techniques.
●	3. To construct and implement various data structures and abstract data types including lists stacks, queues, trees, and graphs.
●	4. To make understand about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.
●	5. To emphasize the importance of data structures in developing and implementing efficient algorithms.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Interpret and diagnose the properties of data structures with their memory representations and time complexity analysis. (1)
2.	Use linear data structures like stacks, queues with their applications. (2)
3.	Implement operations like searching, insertion, deletion, traversing mechanism etc. on various data structures with the help of dynamic storage representation. (3)
4.	Demonstrate the use of binary tree traversals and to perform various operations on Non-linear data structures. (5)
5.	Analyze the Graph data structure and to solve the applications of Graph data structures.(4)
6.	To design the appropriate data structure by applying various hashing Techniques.(3)

Section1:	**Introduction**

Introduction: Data and Information, Data Structure, Classification of Data Structures, Primitive Data Types, Abstract Data Types, Data structure vs. File Organization, Operations on Data Structure, Algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Asymptotic Analysis and Notations, Big O Notation, Big Omega Notation, Big Theta Notation

Array: Introduction, One Dimensional Array, Various Operations on Array, Multidimensional Arrays, Advantages and Limitations of Arrays.

Section2:	**Sorting and Searching**
Sorting Techniques: Bubble, Selection, Insertion, Merge, Quick, Heap sort with Analysis. Searching techniques: Linear Search, Binary search with Analysis.	
Section3:	**Linear Data Structures**
Stack: Introduction, Operations on the Stack Memory Representation of Stack, Array Representation of Stack, Applications of Stack, Evaluation of Arithmetic Expression, Matching Parenthesis, infix and postfix operations, Recursion. Queue: Introduction, Queue, Operations on the Queue, Memory Representation of Queue, Array representation of queue, Linked List Representation of Queue, Circular Queue, Deque, Priority Queue, Application of Priority Queue, Applications of Queues. Linked List : Dynamic memory allocation, Singly Linked Lists, Doubly linked Lists, Circular linked lists, Applications of Linked list	
Section4:	**Trees**
Tree: Tree, Binary Tree, Properties of Binary Tree, representation using array and linked lists. Tree Traversals: Recursive and Non recursive, Operations Performed on Binary Tree, Reconstruction of Binary Tree from its Traversals, Binary Search Tree, Operations on Binary Search Tree Advanced Tree Structures: AVL Tree, Operations performed on AVL Tree, Red Black Tree, Operations Performed on Red Black Tree, B-Tree	
Section5:	**Graph**
Graph: Introduction, Graph, Graph Terminology, Memory Representation of Graph, Adjacency Matrix Representation of Graph, Adjacency List or Linked Representation of Graph, Operations Performed on Graph, Graph Traversal, Applications of the Graph, Reachability, Shortest Path Problems and understanding using the tool graphonline	
Section6:	**Hashing**
Hashing Techniques Hash function, Address calculation techniques, Common hashing functions Collision resolution, Linear probing, Quadratic, Double hashing, Bucket hashing, applying tool for visualization of hashing	
Text Books:	
1	E. Horwitz , S. Sahani, Anderson-Freed, " Fundamentals of Data Structures in C", Second Edition, Universities Press.
2	Y. Langsam, M.J. Augenstein, A.M.Tenenbaum, "Data structures using C and C++", Pearson Education, Second Edition. 3. Narasimha karumanchi, "Data Structures and Algorithm Made Easy", Fifth Edition, CareerMonk publication.

3	Narasimha karumanchi, "Data Structures and Algorithm Made Easy", Fifth Edition, CareerMonk publication.
Reference Books:	
1	G. A.V, PAI , "Data Structures and Algorithms ", McGraw Hill, ISBN -13: 978-0-07-066726-6
2	J. Tremblay, P. soresan, "An Introduction to data Structures with applications", TMHPublication, 2nd Edition
Online Resources:	
Virtual Labs: 1. https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html 2. https://cse01-iiith.vlabs.ac.in/List%20of%20experiments.html **Online Tools for Graphs and Hashing:** 1. https://graphonline.top/en/ 2. https://visualgo.net/en/sssp?slide=1 3. https://www.cs.usfca.edu/~galles/visualization/OpenHash.html 4. https://www.cs.usfca.edu/~galles/visualization/ClosedHash.html	

List of Practicals:

1. Assignment on Array
2. Assignment based on Sorting and Searching.
3. Assignment based on Stack Application (Expression conversion etc.)
4. Assignment based on Queue Application (Job scheduling, resources allocation etc.)
5. Assignment based on linked list.
6. Assignment based on BST operations (Create, Insert, Delete and Traversals)
7. Assignment based on various operations on Binary Tree (Mirror image, Height, Leaf node display, Level wise display etc.)
8. Assignment based on AVL and R B tree.
9. Assignment based on DFS and BFS
10. Assignment based on MST using Prim's and Kruskals Algorithm.
11. Assignment based on Finding shortest path in given Graph.
12. Assignment based on Hashing.

List of Project areas:

1. Smart Traffic Route Optimization and Navigation
2. Network Packet Routing and Congestion Detection
3. Online Product Search, Ranking, and Recommendation Engine
4. Social Network Friend Recommendation and Community Detection
5. Real-Time Ride Matching and Driver Allocation
6. Cloud File Deduplication and Fast Data Retrieval
7. Food Delivery Route Optimization and Order Assignment
8. Search Engine Query Processing and Auto-Completion

9. Warehouse Robot Path Planning and Task Scheduling
10. Banking Transaction Fraud Detection Using Transaction Graph Analysis

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Based but not limited for.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	1	1	-	-	-	1	3	2
CO2	3	3	2	-	2	1	1	-	-	-	-	3	2
CO3	3	3	3	1	2	1	1	-	-	-	-	3	2
CO4	3	3	3	2	2	1	1	-	-	-	-	3	2
CO5	3	3	2	2	2	1	1	-	-	-	1	3	2
CO6	3	3	3	1	2	1	1	-	-	-	-	3	2
Avg	3	2.83	2.60	1.50	1.83	1	1	-	-	-	1	3	2

CO – WK Mapping (Knowledge & Attitude Profiles)

' *✓ indicates the knowledge profile drawn upon by the CO.*

CO	WK1	WK2		WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	-		✓	-	✓	-	-	-	-
CO2	✓	✓		✓	-	✓	-	-	-	-
CO3	✓	✓		✓	✓	✓	-	-	-	-
CO4	✓	✓		✓	✓	✓	-	-	-	-
CO5	✓	✓		✓	✓	✓	✓	-	-	-
CO6	✓	✓		✓	✓	✓	✓	-	✓	-

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO1	✓	-	✓	✓	-	-	-
CO2	✓	✓	✓	✓	-	-	-
CO3	✓	✓	✓	✓	-	-	-
CO4	✓	✓	✓	✓	-	-	-
CO5	✓	✓	✓	✓	-	-	✓
CO6	✓	✓	✓	✓	-	-	✓

CO – EA Mapping (Complex Engineering Activities)

' *✓ indicates the activity attribute addressed by the CO*

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓	-	-	✓
CO2	✓	✓	✓	-	✓

CO3	✓	✓	✓	-	✓
CO4	✓	✓	✓	-	✓
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓	-	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	SDG 4 – Quality Education	Develops computational thinking, algorithmic analysis, and problem-solving skills essential for quality computing education.
CO2	SDG 9 – Industry, Innovation and Infrastructure	Enables implementation of fundamental data structures used in software systems, operating systems, and industrial applications.
CO3	SDG 9 – Industry, Innovation and Infrastructure	Builds efficient software solutions through optimized data organization and algorithm implementation for modern digital infrastructure.
CO4	SDG 9 – Industry, Innovation and Infrastructure	Supports the design of scalable databases, search engines, file systems, and intelligent software applications.
CO5	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Graph algorithms enable solutions for transportation networks, smart city applications, communication networks, and navigation systems.
CO6	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 12 – Responsible Consumption and Production**	Efficient hashing improves data retrieval, minimizes computational resources, and promotes energy-efficient software systems and sustainable computing.

IT2304: Discrete Mathematics

Teaching Scheme	Examination Scheme
Credits : 03	CVV: 20 Marks
Lectures : 3 Hrs/week	CP: - 30 Marks
Practical : - Hrs/week	MSE(W): 40 Marks
Tutorial : - Hrs/week	Lab: 10 Marks

Prerequisites:	1. Number Systems — binary, octal, hexadecimal representation and conversions 2. Boolean Algebra basics — gates and logic expressions

Course Objectives:	1. To develop the ability to reason formally using propositional and predicate logic, construct truth tables, evaluate argument validity, and apply set-theoretic operations essential for computer science problem formulation. 2. Understand the mathematical structure of binary relations, equivalence classes, partial orders, and Hasse diagrams, and distinguish between types of functions including injective, surjective, and bijective mappings. 3. Apply systematic counting techniques — permutations, combinations, and inclusion-exclusion — and use discrete probability and Bayes' theorem to model and solve computational problems involving uncertainty. 4. Construct valid mathematical proofs using direct, contrapositive, contradiction, and induction techniques, and classify algebraic structures such as groups, rings, integral domains, and fields. 5. Analyze graph-theoretic properties including connectivity, planarity, Eulerian and Hamiltonian paths, and implement Dijkstra's shortest path algorithm for real-world network optimization problems.

Course Outcomes:	*After completion of the course, student will be able to*
CO1.	Interpret mathematical propositions, apply logical connectives, construct truth tables and evaluate validity of arguments using predicate logic, quantifiers, and set operations.
CO2.	Analyze binary relations, determine equivalence classes and partial orderings, design Hasse diagrams, and classify functions as injective, surjective, or bijective using the Pigeonhole principle.
CO3.	Apply counting principles including permutations, combinations, the inclusion-exclusion principle, and Bayes' theorem to solve discrete probability

	problems.
CO4.	Construct formal proofs using direct, contrapositive, contradiction, and induction methods, and classify algebraic structures such as groups, rings, and fields based on their properties.
CO5.	Examine graph theoretic properties, determine Eulerian and Hamiltonian paths, assess graph planarity, and apply Dijkstra's shortest path algorithm to real-world network problems.
CO6.	Construct spanning trees and Huffman codes, apply the Max-Flow Min-Cut theorem to transport networks, and evaluate tree-based solutions for real-world data compression and network optimization problems.

Section1:	**Propositions and Set Theory (6 Hours)**
Mathematics and the Notion of Abstraction, Significance of Discrete Mathematics in Computer Engineering, Continuous Structures and Discrete Structures. Propositions — Propositions, Logical Connectives, Logical Equivalence, Validity of Arguments by using Truth Tables, Normal Forms, Predicate Logic, Logical Quantifiers and Rules of Inference. Sets — Sets, Types of Set - Finite and Infinite Sets, Countable Sets, Multisets, Power Set, Joint Set, Venn diagram, Set Operations - Cartesian Product, Union, Intersection, Difference, Symmetric Difference, Principle of Mutual Inclusion-Exclusion.	
Section2:	**Relations and Functions (6 Hours)**
Relations: Cartesian Product, Relations, Properties of Binary Relations, Equivalence Relations, Equivalence class, Transitive Closure of Relation, Warshall's Algorithm, Partitions, Partial Ordering Relations, Hasse Diagram, Partial Ordering Set, Chains and Anti Chains, Lattices. Functions: Functions, Types of Function - Injective, Surjective, Bijective, Composite Functions, Invertible Functions, Pigeonhole principle.	
Section3:	**Counting Principles and Probability (4 Hours)**
Permutations and Combinations: Rule of sum and product, Permutations and Combinations, Inclusion-exclusion principle. Probability: Discrete Probability, Conditional Probability, Bayes Theorem, Applications of Discrete Probability.	
Section4:	**Proof Techniques and Algebraic Structures (4 Hours)**
Proof Techniques - Proof, Types, Direct, Contrapositive, Contradiction, Counter example, Principle of mathematical induction. Basic Terminologies: Algebraic Structure, Semigroup, Monoid, Group, Abelian Group, Ring, Integral Domain, Field.	
Section5:	**Graph Theory (4 Hours)**

Basic Terminologies: Graph, Multi-Graphs, Weighted Graphs, Sub Graphs, Isomorphic graphs, Complete Graphs, Regular Graphs, Bipartite Graphs, Operations on Graphs, Paths, Circuits, Hamiltonian and Eulerian graphs, Planar Graphs. Dijkstra's Shortest Path Algorithm, Real world applications.	
Section6:	**Trees (4 Hours)**
Basic Terminologies: Tree, Weighted Trees, Height and Depth of Tree, Spanning Trees and Minimum Spanning Trees, Isomorphism of Trees and Subtrees, Path Length in Rooted Trees, Prefix Codes, Huffman Algorithm, Fundamental Cut Sets and Circuits, Max Flow-Min Cut Theorem (Transport Network), Real world applications.	

Text Books: (As per IEEE format)	
1	Kenneth H. Rosen, "Discrete Mathematics and Its Applications", 8th Edition, McGraw-Hill Education, 2018, ISBN: 978-1259676512.
2	J. P. Tremblay and R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Reprint 2017, Tata McGraw-Hill, New Delhi, ISBN: 978-0070647374.
3	C. L. Liu, "Elements of Discrete Mathematics", 4th Edition, 2011, Tata McGraw-Hill, ISBN: 978-0071077743.

Reference Books / MOOC / E-Resources: (As per IEEE format)	
1	NPTEL / SWAYAM: nptel.ac.in/courses/106106183
2	MIT OpenCourseWare: ocw.mit.edu/courses/6-1200j-mathematics-for-computer-science-spring-2024/
3	Mathematics for Computer Science — Lehman, Leighton & Meyer (MIT, CC BY-SA): ocw.mit.edu/courses/6-1200j-mathematics-for-computer-science-spring-2024/pages/readings/ — full free textbook, covers all units.
4	Discrete Mathematics: An Open Introduction — Oscar Levin: discrete.openmathbooks.org/dmoi3.html — open-access, interactive; excellent for logic, counting, and graph theory.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2

CO1	3	3	1	-	-	-	-	-	-	-	-	2	1
CO2	3	3	2	-	1	-	-	-	-	-	-	2	2
CO3	3	3	2	1	1	-	-	-	-	-	-	2	1
CO4	3	2	1	-	-	-	-	-	-	-	-	1	1
CO5	3	3	3	2	2	-	-	-	1	-	-	3	2
CO6	3	3	3	2	2	-	-	-	1	-	-	3	2
Avg	3.0	2.8	2.0	1.7	1.5	-	-	-	1.0	-	-	2.2	1.5

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓ indicates the knowledge profile drawn upon by the CO. WK2 = Mathematics, WK3 = Engineering fundamentals, WK4 = Specialist knowledge, WK5 = Engineering design. Draft mapping — please review against the program's WK definitions.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	-	✓	✓	-	-	-	-	-	-
CO2	-	✓	✓	-	-	-	-	-	-
CO3	-	✓	✓	-	-	-	-	-	-
CO4	-	✓	✓	-	-	-	-	-	-
CO5	-	✓	✓	✓	✓	-	-	-	-
CO6	-	✓	✓	✓	✓	-	-	-	-

CO – WP Mapping (Complex Engineering Problems)

' ✓ indicates the problem-solving attribute addressed by the CO. WP1 = Depth of knowledge required, WP3 = Depth of analysis required, WP7 = Interdependence. Draft mapping — please review.

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓	-	✓	-	-	-	-

CO2	✓	-	✓	-	-	-	-
CO3	✓	-	✓	-	-	-	-
CO4	✓	-	✓	-	-	-	-
CO5	✓	-	✓	-	-	-	✓
CO6	✓	-	✓	-	-	-	✓

CO – EA Mapping (Complex Engineering Activities)

' ✓' indicates the activity attribute addressed by the CO. EA1 = Range of resources, EA3 = Innovation. Draft mapping — please review.

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	-	-	-	-
CO2	✓	-	-	-	-
CO3	✓	-	-	-	-
CO4	✓	-	✓	-	-
CO5	✓	-	✓	-	-
CO6	✓	-	✓	-	-

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	SDG 4	Builds rigorous logical-reasoning skills that underpin quality STEM education.
CO2	SDG 4	Strengthens abstract/analytical thinking used across quality technical education.
CO3	SDG 9	Probabilistic and counting techniques support data-driven decision-making in industry and innovation.

CO4	SDG 4	Formal proof techniques cultivate rigorous, transferable analytical reasoning.
CO5	SDG 9 & SDG 11	Graph algorithms (e.g., shortest path) underpin resilient infrastructure and smart, sustainable transportation/network planning.
CO6	SDG 9	Spanning trees, Huffman coding and max-flow/min-cut techniques support efficient network and data infrastructure — industry & innovation.

IT2303: Digital Electronics and Microprocessor

Teaching Scheme	Examination Scheme
	CVV : 20 Marks
Credits : 4	LAB: 10 Marks
Lectures : 2 Hrs/week	CP: 30 Marks
Practical : 2 Hrs/week	ESE(TH): 40 Marks

Section1:	Digital Fundamentals
Number Systems – Decimal, Binary, Octal, Hexadecimal, Codes – Binary, BCD, Excess 3, Gray, Sum of products and product of sums, Minterms and Maxterms, Standard representation for logic functions, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions.	
Section2:	**Combinational Digital Circuits**
Adders, Subtractors Multiplexers & De-multiplexers, Encoder: Priority encoders, Decoders: 74138, ALU: 74181, Parity generator and checker. BCD adder and subtractor.	
Section3:	**Sequential Circuit**
Introduction of flip-flop (F.F), 1 bit memory cell, clocked S-R F.F., J-K F.F. race around condition, M/S J-K F.F, flip-flop truth table, excitation table, flip-flop conversion, flip-flop characteristics. T and D F.F, Design of 4 – bit UP-Down ripple counter using J-K flip-flop, Design of Synchronous 3 bit up/down counter, mod-n counters (IC - 7490, 7493)	
Section4:	**Introduction to 8086 Microprocessors**
Internal Architecture, Generation of physical address 8086, 8086 memory segmentation, Register Organization, addressing modes: Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing.	
Section5:	**8086 Instructions types**
Instruction types, formats, timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. 8086 pin functions: Minimum & Maximum Mode System.	
Section6:	**Interrupt Structure and Programmable Interval Timer**
Interrupt Structure, Interrupt service Routine, Interrupt Vector Table, Hardware and Software Interrupts, INTR, NMI Interrupt Response, Execution of an ISR, Priority of Interrupts.8259 control word.	
Text Books: *(As per IEEE format)*	

1	R.P. Jain, "Modern Digital Electronics", 3rd Edition, Tata McGraw-Hill, 2003, ISBN 0 - 07 -049492 – 4.
2	M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson Education, 2013, ISBN: 978-0132774203.
3	Douglas Hall, "Microprocessors and Interfacing", 2nd Edition, Tata McGraw Hill Publications, ISBN 0-07- 025742-6.
4	Kenneth J. Ayala, "The 8086 Microprocessor: Programming and Interfacing the PC", 3rd Edition, Cengage Learning, 1995, ISBN: 978-8131504777.
Reference Books: *(As per IEEE format)*	
1	Donald P. Leach, Albert Paul Malvino and Goutam Saha, Digital Principles and Applications, 8th Edition, Tata McGraw-Hill Education, 2015, ISBN: 978-0070703341.
2	Ray Duncan, "Advanced MS DOS Programming," 2nd Edition BPB Publications ISBN 0 –07 – 048677– 8.
3	Barry B. Brey, The Intel Microprocessors: Architecture, Programming, and Interfacing, 8th Edition, Pearson Education, 2009, ISBN: 978-0135026453.

Prerequisites:	
●	Basic Electronics System
Course Objectives:	
1.	To understand the fundamentals of digital electronics, number systems, Boolean algebra, and logic simplification techniques.
2.	To learn the design and operation of combinational and sequential logic circuits.
3.	To design and analyze combinational and sequential digital circuits using standard ICs and flip-flops.
4.	To understand the architecture, memory organization, addressing modes, and pin configuration of the 8086 microprocessors.
5.	To develop programming skills using the 8086-instruction set and assembly language programming concepts.
6.	To understand the interrupt structure, interrupt handling mechanisms, and programmable interrupt controller (8259) in the 8086 microprocessors.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain number systems, Boolean algebra, logic gates, and Karnaugh maps.
2.	Analyze and design combinational logic circuits.
3.	Analyze and design sequential logic circuits.
4.	Explain the architecture and organization of the 8086 microprocessor.
5.	Develop basic 8086 assembly language programs.
6.	Explain the interrupt system and 8259 Programmable Interrupt Controller (PIC).

List of Practical's:

1. Verification of Logic Gates (AND, OR, NOT, NAND, NOR, XOR, XNOR) and Boolean Algebra Theorems.
2. Design and verification of Code Converters: (a) Binary to Gray and Gray to Binary (b) BCD to Excess-3 and Excess-3 to BCD.
3. Design and implementation of a Full Adder using 4:1 Multiplexers.

4. Design and implementation of a 3-bit Asynchronous Up/Down Counter using J-K Flip-Flops.
5. 8086 Assembly Language Programming – I

a. Study of 8086 Microprocessor architecture and write an ALP to display "HELLO".
b. Write an ALP to accept and display a single-digit number.
c. Write an ALP to perform addition of two single-digit numbers.

6. 8086 Assembly Language Programming – II

a. Write an ALP to accept and display a two-digit number.
b. Write an ALP to accept and display an array of numbers.
c. Write an ALP to display the grade of students based on marks.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	1	2	-
CO2	3	3	3	-	2	-	-	-	-	-	1	3	-
CO3	3	3	3	1	2	-	-	-	-	-	1	3	-
CO4	3	2	1	-	2	-	-	-	-	-	1	3	-
CO5	3	3	2	1	3	-	-	-	1	-	2	3	2
CO6	3	2	1	1	2	-	-	-	-	-	1	3	1
Avg	3.0	2.5	1.8	0.5	1.8	0	0	0	0.2	0	1.2	2.8	0.5

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓ indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓						
CO2	✓	✓	✓	✓					
CO3	✓	✓	✓	✓	✓				
CO4	✓	✓	✓		✓				
CO5	✓	✓	✓	✓	✓	✓			
CO6	✓	✓	✓	✓	✓	✓			

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO1	✓						
CO2	✓	✓	✓				
CO3	✓	✓	✓	✓			
CO4	✓	✓					
CO5	✓	✓	✓	✓	✓		
CO6	✓	✓	✓		✓		

CO – EA Mapping (Complex Engineering Activities)

' ✓ indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓	✓	✓		
CO3	✓	✓	✓	✓	
CO4	✓	✓			
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓		✓

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	SDG 4 – Quality Education	Develops fundamental knowledge in digital electronics.
CO2	SDG 9 – Industry, Innovation and Infrastructure	Enables design of digital systems used in modern electronic applications.
CO3	SDG 9 – Industry, Innovation and Infrastructure	Develops digital circuit design skills for industrial automation and embedded systems.
CO4	SDG 4 – Quality Education	Builds understanding of microprocessor architecture and organization.
CO5	SDG 9 – Industry, Innovation and Infrastructure	Develops programming skills for microprocessor-based embedded applications.
CO6	SDG 9 – Industry, Innovation and Infrastructure	Provides knowledge of interrupt handling and controller design for reliable embedded systems.

IT2305: Operating Systems

Teaching Scheme	Examination Scheme
Credits : 3	CVV: 20 Marks
Lectures : 2 Hrs/week	LAB: 10 Marks
Practical : 2 Hrs/week	COURSE PROJECT : 30 Marks
Tutorial : - Hrs/week	ESE TH(W): 40 Marks

Prerequisites:	
●	1. Basics of Computer System 2. Computer Organization and Architecture. 3. Data Structures and any Programming Language.
Course Objectives:	
●	1. To introduce the fundamental concepts, architecture, services, and process management mechanisms of modern operating systems.
●	2. To develop an understanding of CPU scheduling techniques and their impact on system performance.
●	3. To familiarize students with memory management techniques, virtual memory, and page replacement policies.
●	4.To provide knowledge of concurrency control, synchronization mechanisms, and deadlock handling techniques in operating systems.
●	5. To understand I/O device management, buffering techniques, and disk scheduling algorithms for efficient resource utilization.
●	6. To introduce file system organization, storage management techniques, and the architecture of the Linux operating system.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand the architecture, functions and process management mechanisms of operating systems.(Understand-2)
2.	Apply CPU scheduling algorithms and analyze their performance using scheduling metrics.(Apply-3)
3.	Illustrate different memory management techniques used in operating systems.(Understand-2)
4.	Apply synchronization mechanisms to solve process synchronization problems and analyze deadlock handling techniques in operating systems..(Apply-3)
5.	Discuss I/O management techniques and apply different disk scheduling algorithms.(Understand-2)
6.	Explain file management, secondary storage management, and Linux operating system features.(Understand-2)

Section1:	Introduction to Operating Systems and Process (5 Hr)
Introduction to Operating Systems, Types of OS, Virtualizing The CPU, Virtualizing Memory, Concurrency, Persistence, Design Goals Process: Process abstraction, System calls for Process management, Process States: 2, 5, 7 state models, Process execution mechanisms, Process Control	
Section2:	**Scheduling (4Hr)**
Scheduling Metrics, First In, First Out (FIFO), Shortest Job First (SJF), Shortest Time-to-Completion First (STCF), Round Robin, Multi-Level Feedback Queue, The Priority Boost, Multiprocessor Scheduling	
Section3:	**Memory Management (6 Hr)**
Memory Management Requirements, Memory Partitioning, Paging, Segmentation, Address Translation, Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit. Virtual Memory, VM with Paging, VM with Segmentation, Page Replacement Policies: FIFO, LRU, Optimal ,Cache management	
Section4:	**Concurrency (6 Hr)**
Thread implementations – user level and kernel level threads, Concurrency: Issues with concurrency, Principles of Concurrency, Mutual Exclusion: OS/Programming Language Support: Semaphores, Mutex, Classical Process Synchronization problems, Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Deadlock Recovery	
Section5:	**I/O Devices (3 Hr)**
I/O Devices - Types, Characteristics of devices, I/O Buffering. Disk Scheduling: FCFS, SSTF, SCAN, C-SCAN ,LOOK and C-LOOK,Device Driver	
Section6:	**File Management and case study in OS (4 Hr)**
File Management: Concepts, File Organization, File Directories, File Sharing. Record Blocking, Secondary Storage Management, Free Space management Case Study of: Linux Operating Systems.	

Text Books: ***(As per IEEE format)***

1	Stallings William., "Operating Systems", Fourth Edition, Prentice Hall of India,2001
2	Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau "Operating Systems: Three Easy Pieces", Arpaci-Dusseau Books, March, 2015
3	Silberschatz, A, Galvin, P.B, and Gagne, G., "Operating System Principles", Eight Edition, John Wiley & Sons, 2008.

Reference Books: ***(As per IEEE format)***

1	Bach Maurice J. "The Design of the UNIX Operating System", Second Edition Prentice Hall of India, 2001
2	Yashavant Kanetkar; "Unix Shell Programming"; 2nd Edition, BPB Publications
3	Sumitabha Das; "Unix Concepts and Applications"; 4th Edition, TMH.

List of Practical's (Minimum Six):

1. Study the Basic and Advance Linux commands
2. Any shell scripting program.
3. Implement process management system calls (fork(), exec(), and wait()) and demonstrate process creation, execution, synchronization, zombie processes, and orphan processes.

4. Write a program to compute the finish time, turnaround time and waiting time for the following algorithms:
First come First serve b) Shortest Job First (Preemptive and Non Preemptive)
Priority (Preemptive and Non Preemptive) d) Round robin
5. Implement multithreading using the POSIX pthread library by developing a matrix multiplication application using pthread_create(), pthread_join(), and pthread_exit().
6. Implement classical process synchronization problems using threads, mutexes, and semaphores to demonstrate synchronization mechanisms.
7. Write a program to check whether given system is in safe state or not using Banker's Deadlock Avoidance algorithm.
8. Write a program to calculate the number of page faults for a given reference string using following page replacement algorithms:
FIFO b) LRU c) Optimal
9. Perform a case study: XV6 : Linux Kernel configuration, compilation and rebooting from the newly compiled kernel

List of Project areas:

1. Design and implementation of a Multiprogramming Operating System: Stage I
   i. CPU/ Machine Simulation
   ii. Supervisor Call through interrupt
2. Design and implementation of a Multiprogramming Operating System: Stage II
   i. Paging
   ii. Error Handling
   iii. Interrupt Generation and Servicing
   iv. Process Data Structure

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	0	0	1	0	1	3		
CO2	3	3	2	2	2	0	0	0	0	0	1	3	1	
CO3	3	2	0	0	2	0	0	0	1	0	1	3		
CO4	3	3	2	2	2	0	0	0	0	0	1	3	1	
CO5	3	2	2	0	2	0	0	0	0	0	1	3		
CO6	3	3	0	0	2	0	0	0	1	0	1	3	1	
Avg	3.0	2.33	2	2	2	0	0	0	1	0	1.17	3	1	

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9

CO1			✓	✓					
CO2		✓	✓	✓	✓	✓			
CO3		✓	✓	✓		✓			
CO4		✓	✓	✓	✓	✓			
CO5			✓	✓	✓	✓			
CO6			✓	✓		✓			

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO							
CO1	✓		✓	✓			
CO2	✓	✓	✓	✓			✓
CO3	✓	✓	✓	✓			✓
CO4	✓	✓	✓	✓		✓	✓
CO5	✓	✓	✓	✓			✓
CO6	✓		✓	✓			

CO – EA Mapping (Complex Engineering Activities)

'✓ indicates the activity attribute addressed by the CO

CO	**CO**	**EA1**	**EA2**	**EA3**	**EA4**	**EA5**
CO1	**CO1**	✓				✓
CO2	**CO2**	✓	✓	✓		✓
CO3	**CO3**	✓	✓			✓
CO4	**CO4**	✓	✓	✓		✓
CO5	**CO5**	✓	✓	✓		✓
CO6	**CO6**	✓	✓			✓

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	**SDG(s) Addressed**	**Justification / Linkage**
CO1	SDG 4 – Quality Education	Develops foundational knowledge of operating system concepts and process management essential for computing education.
CO2	SDG 9 – Industry, Innovation and Infrastructure	Enables efficient CPU scheduling and resource utilization techniques used in modern computing systems and industrial applications.
CO3	SDG 9, SDG 12 – Responsible Consumption and Production	Promotes efficient memory management and optimal utilization of computing resources, reducing resource wastage.
CO4	SDG 9 – Industry, Innovation and Infrastructure	Develops synchronization and deadlock handling skills required for building reliable and efficient computing systems.
CO5	SDG 9, SDG 12 – Responsible Consumption and Production	Encourages efficient I/O management and disk scheduling to improve resource utilization and system performance.

CO6	SDG 4, SDG 9 – Quality Education; Industry, Innovation and Infrastructure	Enhances practical knowledge of Linux operating systems and file management, preparing students with industry-relevant skills.

MM1316: ROBOTICS

Teaching Scheme	Examination Scheme
Credits : 3	CP : 20 Marks
Lectures : 2 Hrs/week	CVV: 20 Marks
Tutorial : 1 Hrs/week	HA:20 Marks
	MSE: 40 Marks

Prerequisites:	
1. Basic knowledge of Electrical and Electronic Engineering, including semiconductor devices and digital logic. 2. Basic understanding of Microprocessor/Microcontroller concepts and embedded systems.	

Course Objectives:	
•	1. Understand the fundamentals of robotics, robot anatomy, classifications, performance parameters, and the architecture of the Internet of Things (IoT) leading to the Internet of Robotic Things (IoRT).
•	2. Apply robot kinematics concepts, including coordinate systems, degrees of freedom, forward and inverse kinematics, and Denavit–Hartenberg (D-H) parameters for analyzing robot motion.
•	3. Explain the working principles, characteristics, selection, and interfacing of actuators, semiconductor devices, and digital electronic circuits used in robotic systems.
•	4. Develop embedded applications using ATmega/ESP32 microcontrollers by utilizing peripherals, timers, interrupts, and communication interfaces for robotic and IoT applications.
•	5. Interface various sensors and implement wired/wireless communication protocols to acquire, process, and transmit robotic sensor data in IoT environments.
•	6. Design and implement cloud-connected robotic systems by integrating IoT platforms, data analytics, cybersecurity concepts, and ROS-IoT integration for real-world applications.

Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain the fundamentals of robotics, robot configurations, performance characteristics, IoT architecture, and Internet of Robotic Things (IoRT) concepts.
2.	Analyze robot kinematics using coordinate systems, workspace analysis, forward/inverse kinematics, and Denavit–Hartenberg (D-H) methodology.
3.	Select appropriate actuators, semiconductor devices, and digital electronic components for robotic applications based on performance requirements.
4.	Develop embedded programs using ATmega/ESP32 microcontrollers for interfacing actuators, sensors, and communication peripherals in robotic systems.
5.	Implement sensor interfacing and communication protocols (RS232, I²C, SPI, Wi-Fi,

	Bluetooth/BLE, Zigbee, LoRaWAN, and MQTT) for IoT-enabled robotic applications.
6.	Design and evaluate an IoT-enabled robotic system by integrating cloud platforms, telemetry, data analytics, security considerations, and emerging ROS-IoT concepts to solve engineering problems.

Section1:	**Foundations of Robotics & IoT(5 Hours)**
Introduction to robotics; robot anatomy and specifications; classification and configurations; mechanical, electrical and electronic components; accuracy, precision, resolution, repeatability; robot analogy with the human body. IoT blend: introduction to IoT architecture (perception, network, application layers), the convergence of robotics and IoT into the Internet of Robotic Things (IoRT), and real-world examples of connected robots.	
Section2:	**Robot Kinematics & Configurations (5 Hours)**
Degrees of freedom, robot coordinate systems, roll-pitch-yaw, workspace; kinematic linkages and reference frames; forward and inverse kinematics; D-H matrix. IoT blend: remote monitoring of joint-level kinematic data, cloud logging of pose/trajectory data for digital-twin visualization of robot motion.	
Section3:	**Actuators, Semiconductor Devices & Digital Electronics (5 Hours)**
Actuators: pneumatic, hydraulic, and electrical (solenoid coil, relay); construction and working of DC, BLDC, stepper, and servo motors; merits, demerits, applications and selection of actuators. Semiconductor devices: diodes, rectifiers, Zener diode, LED, BJT (switch, amplifier, multivibrator), FET, MOSFET, IGBT, Op-amp. Digital electronics: logic gates, basic gates using transistors, flip-flops, counters, registers, ADC, DAC. IoT blend: IoT-based remote actuator control and relay switching using cloud commands.	
Section4:	**Microcontrollers & Embedded IoT Nodes(5 Hours)**
Microcontroller fundamentals; ATmega architecture, peripherals, ports, registers, memory types, timers, counters, interrupts. IoT blend: programming the ATmega/ESP32 family as an IoT edge node, low-power embedded design considerations, firmware over-the-air (OTA) update concepts, and interfacing microcontrollers with cloud-connected gateways.	
Section5:	**Sensors & IoT Communication Systems(4 Hours)**
Sensors: proximity (range), tactile (contact), light (photodiode, IR, phototransistor) with applications such as opto-isolators, opto-encoders, and cameras; tilt sensor, gyroscope (acceleration sensor), Hall effect sensor, temperature sensor, ultrasonic sensor; sensor interfacing, control, and PWM. Serial communication w.r.t. ATmega328P: RS232, I2C, SPI. IoT blend: wireless communication protocols for IoT-Robotics — Wi-Fi, Bluetooth/BLE, Zigbee, LoRaWAN, and MQTT for sensor-data publishing.	
Section6:	**Cloud Integration, Data Analytics & Applications(4 Hours)**
IoT cloud platforms for robotics (e.g., AWS IoT, Azure IoT Hub, ThingSpeak); real-time sensor dashboards and telemetry; basics of edge vs. cloud analytics for robotic decision-making; data security and privacy in connected robots; case studies — IoT-enabled industrial robots, agricultural robots, and service/assistive robots; introduction to ROS-IoT integration concepts.	

Text Books: *(As per IEEE format)*	
1	"Industrial Robotics: Technology, Programming, and Applications (Special Indian Edition)", Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, McGraw Hill Education (India), 2nd Edition, ISBN – 978-1259006210.
2	"Internet of Things: A Hands-on Approach", Arshdeep Bahga and Vijay Madisetti, Universities Press, 1st Edition, ISBN – 978-8173719547.
3	"The AVR Microcontroller and Embedded Systems: Using Assembly and C", Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Pearson Education, 2nd Edition, ISBN – 978-0138003319.
4	"Electronic Devices and Circuit Theory", Robert L. Boylestad and Louis Nashelsky, Pearson Education, 11th Edition, ISBN – 978-0132622264.
Reference Books: *(As per IEEE format)*	
1	"Introduction to Robotics: Mechanics and Control", John J. Craig, Pearson Education, 4th Edition, ISBN – 978-0133489798.
2	"Robot Modeling and Control", Mark W. Spong, Seth Hutchinson and M. Vidyasagar, John Wiley & Sons, 1st Edition, ISBN – 978-0471649908.
3	"Making Embedded Systems: Design Patterns for Great Software", Elecia White, O'Reilly Media, 2nd Edition, ISBN – 978-1098151546.
4	"Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", Maciej Kranz, John Wiley & Sons, 1st Edition, ISBN – 978-1119285687.

List of Assignments:

1.Explain robot anatomy, classifications, robot specifications (accuracy, precision, resolution, repeatability), and compare the human body with a robot. Describe the IoT architecture (perception, network, and application layers) and discuss the concept of the Internet of Robotic Things (IoRT) with at least three real-world applications.

2.Explain degrees of freedom, robot coordinate systems, roll-pitch-yaw representation, workspace, forward and inverse kinematics, and Denavit-Hartenberg (D-H) parameters. Solve the forward kinematics of a simple two-link manipulator and discuss the role of cloud-based trajectory logging in digital twins.

3.Compare pneumatic, hydraulic, and electrical actuators based on construction, working principle, advantages, disadvantages, and applications. Explain the operation of diode, Zener diode, BJT, MOSFET, IGBT, and operational amplifier with suitable circuit diagrams.

4.Describe the architecture of the ATmega328P microcontroller, including memory organization, ports, timers, counters, interrupts, and peripherals. Explain how ESP32 functions as an IoT edge node and discuss low-power embedded design and firmware over-the-air (OTA) update concepts.

5.Explain the working principle, interfacing method, and applications of proximity, ultrasonic, Hall effect, gyroscope, temperature, and light sensors. Compare RS232, I²C, and SPI communication protocols, and discuss Wi-Fi, Bluetooth/BLE, Zigbee, LoRaWAN, and MQTT for robotic IoT applications.

6.Study cloud platforms used in robotics (such as AWS IoT, Azure IoT Hub, and ThingSpeak), and explain real-time telemetry, edge vs. cloud analytics, and data security in connected robots. Prepare a case study on any one IoT-enabled robotic application (industrial, agricultural, healthcare, warehouse, or service robot) and discuss the role of ROS-IoT integration.

List of Project areas:

1. IoT-Based Smart Obstacle Avoidance Robot
2. Cloud-Connected Line Following Robot
3. IoT-Enabled Warehouse Delivery Robot
4. Smart Agricultural Monitoring and Rover System
5. Wi-Fi Controlled Surveillance Robot with Live Sensor Dashboard
6. Industrial Equipment Health Monitoring System
7. IoT-Based Robotic Arm for Pick-and-Place Operations
8. Smart Home Security Robot with Intruder Detection
9. Autonomous Environmental Monitoring Robot
10. Digital Twin for Mobile Robot Motion Monitoring

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	1	2	1	-	-	-	1	2	1
CO2	3	3	2	2	2	-	-	-	-	-	1	2	1
CO3	3	2	2	-	2	1	1	-	-	-	1	2	1
CO4	2	2	3	2	3	1	-	-	1	1	1	3	2
CO5	2	3	2	2	3	2	1	-	1	-	1	3	2
CO6	2	3	3	3	3	2	2	1	2	1	2	3	3
Avg	2.5	2.5	2.16	2.25	2.33	1.6	1.25	1	1.33	1	1.16	2.5	1.66

IT2268: DESIGN THINKING-III

Teaching Scheme: Tutorial 01 Hr./week

Credits: 01

Course Prerequisites: Problem Based Learning, Project Centric Learning

Course Objective:

To provide ecosystem for students and faculty for paper publication and patent filing

Section 1: Topics/Contents

What is research?

Importance of Paper Publication and Patents

Structure of Paper

Journal Publication

Publication in conference

Literature Review

Research Paper Writing

Journal Ratings and Evaluation

How to rate a Journal?

Intellectual property (IP)

Research Ethics

Entrepreneurship

Section 2: Topics/Contents

Structure of The paper

Journal List (Top 50 Journals)

Selection of the journal

Use of various online journal selection tools

Plagiarism checking

Improving contents of the paper

Patent drafting

Patent search

Filing of patent

Writing answers to reviewer questions

Modification in manuscript

Checking of publication draft

Course Outcome: [Publication of paper or patent]

The student will be able to

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to Research
3. Apply the methodology of doing research and mode of its publication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

IT2272: ENGINEERING DESIGN AND INNOVATION III

Course Prerequisites: Problem Based Learning

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group soas to develop team skills and learn professionalism.
6. To develop an ecosystem to promote entrepreneurship and research culture among the students.

Course Relevance: Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course-based projects, curriculum can be enriched with semester long Engineering Design and Development courses, in which students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such projects, students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the project domain, thereby achieving project centric learning. Modern world sustained and advanced through the successful completion of projects. In short, if students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquiry-based learning. Project based learning will also redefine the role of teacher as mentor in the learning process. The PCL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to analyze, design and apply categories of Bloom's Taxonomy.

SECTION-1

Preamble - The content and process mentioned below is the guideline document for thefaculties and students to start with. It is not to limit the flexibility of faculty and students; ratherthey are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Trends in Engineering Technology" are designed as a ladder to extend connectivity of software technologies to solve real world problems using an interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:
Industry Communication Standards, Single Board Computers and IoT, Computational Biology (Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence, Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and Cyber Securities).

Suggest an assessment Scheme:

MSE and ESE

Text Books: (As per IEEE format)

1. A new model of problem-based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017

2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.

Stem Project based learning and integrated science, Technology, Engineering andmathematics approach. By Robert Robart Capraro, Mary Margaret Capraro

Reference Books: (As per IEEE format)

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based andproject-based learning in engineering. Rotterdam: Sense Publishers. 2007.

2. Project management core textbook, second edition, Indian Edition , by Gopalan.

3. The Art of Agile Development. By James Shore & Shane Warden.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Identify the real life problem from societal need point of view

CO2: Choose and compare alternative approaches to select most feasible one

CO3: Analyze and synthesize the identified problem from technological perspective

CO4: Design the reliable and scalable solution to meet challenges

CO5: Evaluate the solution based on the criteria specified

CO6: Inculcate long life learning attitude towards the societal problems

TY IT Module V

Subject Head	Course	Credits	CVV	CP	LAB	GD/PPT	HA	MSE (R)	ESE (R)	ESE TH(W)	PRACT+ CVV	ESE-Direct Evaluation	Total
IT3231	**Computer Network**	4								40	60		100
IT3232	**Artificial Intelligence**	3	20	30	10					40			100
IT3233A	**Compiler Design**	4	20	40		20	20						100
IT3233B	**Network Security**	4	20	40		20	20						100
IT3233C	**Data Science and Analytics**	4	20	40		20	20						100
MD04	**PEC2:Coursera**	3										100	100
MD05	**OE1::Coursera**	4										100	100
MM1309A	**Organizational Behaviour**	3		30		20	10			40			100
IT3225	**VSEC-DT**	1										100	100
IT3235	**ERI**	2						30	70				100
	Total	**24**											**800**

IT3231: Computer Network

Teaching Scheme	Examination Scheme
Credits : 4	ESE: 40 Marks
Lectures : 3 Hrs/week	Pract + CVV : 60 Marks
Practical : 2 Hrs/week	
Tutorial : - Hrs/week	

Prerequisites:	
●	1. Fundamentals of Computer, C/C++ programming.
Course Objectives:	
●	1. Understand the importance of Computer Network and its usage.
●	2. Study error control and flow control techniques
●	3. Solve real-world problems in the context of today's internet (TCP/IP and UDP/IP). .
●	4. Distinguish and relate various physical Medias, interfacing standards and adapters
●	5.Implement mathematically and logically the working of computer protocols in abstract.
●	6. To understand the concepts and functions of major Application Layer protocols and their role in network communication and services
Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain computer network fundamentals, architectures, communication models, and topologies..
2.	Describe Physical Layer concepts, transmission media, transmission modes, and network devices
3.	Analyze Data Link Layer protocols for framing, error control, flow control, and medium access.
4.	Apply Network Layer concepts including IP addressing, subnetting, routing, and congestion control.
5.	Explain Transport Layer services, TCP/UDP protocols, connection management, and QoS.
6.	Illustrate the working of Application Layer protocols such as DNS, HTTP, SMTP, FTP, DHCP, and SNMP..

Unit 1: Introduction- Introduction to computer network, LAN, MAN, WAN, PAN, Ad-hoc Networks, Network Architectures- Client-Server, Peer To Peer, Network Topologies- Bus, ring, tree, star, mesh, hybrid. Communication Models- OSI Model, TCP/IP Model, Design issues for layers.

Unit 2 : Physical Layer- Physical Layer: Transmission media- Guided media, unguided media. Transmission Modes-Simplex, Half-Duplex and Full-Duplex. Network Devices- Hub, Repeater, Bridge, Switch, Router, Gateways and Brouter. Spread spectrum signal, FHSS, DSSS., Line Coding Techniques.

Unit 3: DLL-Data Link Layer: Logical Link Layer- Services to Network Layer, Framing, Error Control and Flow Control. Framing in LLC- framing challenges, types of framing. Error Control in LLC- error detection, error correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. Flow Control Protocols- Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity- PPP and HDLC. Medium Access Control: Channel Allocation- Static and Dynamic, Multiple Access Protocols- Pure and Slotted ALOHA, CSMA, WDMA, IEEE 802.3 Standards and Frame Formats, CSMA/CD.

Unit 4: Network layer-Network Layer: Switching techniques, IP Protocol, IPv4 and IPv6 addressing schemes, Subnetting, NAT, CIDR, ICMP, Routing Protocols- Distance Vector, Link State, Path Vector, Routing in Internet- RIP,OSPF, BGP, Congestion control and QoS,

Unit 5 : Transport Layer-Transport Layer: Services, Berkley Sockets, Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, TCP, TCP Timer management, Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless.

Unit 6: Application Layer-Application Layer: Domain Name System (DNS), Hyper Text Transfer Protocol (HTTP), Email:SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP).

List of Practical's (Minimum Eight):

1. Study and implement various networking commands on terminal.
2. Use Socket programming to create Client and Server to send Hello message.
3. Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming codes or CRC. Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer-to-peermode. (50% students will perform Hamming Code and others wil lperform CRC)
4. Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in peer-to-peer mode
5. Write a program to find class and type of a given IP address.
6. Write a program to demonstrate subnetting and find the subnet masks.
7. Write a program using TCP socket for wired network for following: a. Say Hello to Eachother (For all students) b. File transfer (For all students) c. Calculator (Arithmetic) (50%students) d. Calculator (Trigonometry) (50% students)
8. Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Videoone file each) between two machines.

9. Write a program to implement: a. Network Routing: Shortest path routing, RIP, OSPF. b. Analysis of congestion control (TCP and UDP).
10. Write a program to analyse following packet formats captured through Wireshark for wired networks. 1.Ethernet 2. IP 3.TCP 4. UDP

List of Course Seminar Topics:
1. Asynchronous Transfer Mode 2. Need Of Multiplexing for Signal Modulation 3. TDM with PAM a case study 4. Noise signal 5. Basic Network Protocols 6. Manchester Vs Differential Manchester coding technique 7. Amplitude Shift Keying: Working and Applications 8. Nyquist Sampling Theorem 9. CDMA 10. Line coding Techniques with example
List of Course Group Discussion Topics:
1. TCP/IP Model 2. Mobile IP 3. Congestion Control and QoS 4. Wireless Technology for Short range and long range 5. Application Protocols and its security 6. IP Protocols 7. Data Communication Issues in IP Networks and Solutions to it 8. Congestion control in hybrid networks 9. Issues in Real time Audio and video transmission protocol. 10. IPV6
List of Home Assignments:
Design:
1. Enumerate the challenges in Line coding. Draw the line code for the sequence 010011110using Polar NRZ-L and NRZ-1 schemes. 2. 2.Design the procedure to configure TCP/IP network layer services. 3. Simulation of Routing Protocols using NS2 4. Simulation of FTP based Protocols using CISCO packet Tracer/ NS2 5. Simulation of Congestion Control Protocols Using NS2
Case Study:

1. Amplitude and Frequency Modulation Technique 2. Digital to Analog and Analog to Digital converters 3. Study of Various VPNs 4. IoT Solutions to Current Network Requirement 5. Unix Solutions for Broadcast System
Blog:
1. Communication Protocol 2. Emerging Trends in Computer Networks 3. Use of IOT in Networks 4. Cloud based Network Solutions for real world problems 5. Recent Trends in Computer Security
Surveys:
1. Survey of wireless Technologies 2. Survey of Congestion control methodologies 3. Survey of Bluetooth Technology 4. Survey of Virtual Private Networks 5. Survey of ADHOC Networks
Text Books:
1. James F. Kurose, and Keith W. Ross," A Top-Down Approacht," 4th edition, Publisher: Addison-Wesley ISBN: 0-321-49770-8 2. Behrouz A. Forouzan ,"Data Communication and Networking", 4th edition, Tata McGraw Hill 3. Andrew S. Tanenbaum, "Computer Networks" ,5th Edition, Pearson Education
Reference Books:
1. Kurose, Ross,"Computer Networking a Top Down Approach Featuring the Internet", Pearson; 6th edition (March 5, 2012), ISBN-10: 0132856204 2. Holger Karl and Andreas Willig,"Protocols and Architectures for Wireless Sensor Network", Wiley, ISBN: 0-470-09510-5 3. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2004
Moocs Links and additional reading material:
1. www.nptelvideos.in 2. https://www.my-mooc.com/en/categorie/computer-networking

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Programme Outcomes												Program Specific Outcomes			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	3	3							1			2		3	
CO2	3	2		3	2								2			
CO3	2	2	3				2				2				3	
CO4	2	2		3			2					2		3		
CO5	2				3	3		2	2							
CO6			3		2	3			2						3	3

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓							
CO2	✓	✓	✓						
CO3	✓	✓	✓	✓					
CO4	✓	✓	✓	✓	✓				
CO5	✓	✓	✓	✓	✓	✓			
CO6	✓	✓	✓	✓	✓	✓	✓		

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO1	✓	✓					
CO2	✓	✓	✓				
CO3	✓	✓	✓	✓			
CO4	✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓	✓	✓	
CO6	✓	✓	✓	✓	✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓			
CO2	✓	✓	✓		
CO3	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
	SDG(s) Addressed	Justification / Linkage
CO1	SDG 4 – Quality Education	Develops fundamental knowledge of computer networks and communication models, strengthening technical education and lifelong learning.
CO2	SDG 9 – Industry, Innovation and Infrastructure	Introduces communication media and networking devices that form the backbone of modern digital infrastructure.
CO3	SDG 9 – Industry, Innovation and Infrastructure	Enhances reliable and efficient data communication through data link layer protocols and error control mechanisms.
CO4	SDG 9 – Industry, Innovation and Infrastructure	Applies IP addressing, routing, and congestion control concepts for designing scalable and efficient communication networks.
CO5	SDG 9 – Industry, Innovation and Infrastructure	Focuses on transport protocols and QoS to improve the performance and reliability of communication systems.
CO6	SDG 9, SDG 17	Explains Internet application protocols that enable global connectivity, communication, and collaboration across organizations.

IT3232: ARTIFICIAL INTELLIGENCE

Teaching Scheme	Examination Scheme
Credits : 3	CVV: 20Marks
Lectures : 2 Hrs/week	CP: 30Marks
Practical : 2 Hrs/week	Lab: 10Marks
Tutorial : - Hrs/week	ESE(Theory): 40Marks

Prerequisites:	
●	1. Data structures 2. Discrete Mathematics, Data Structures, basic probability theory and statistics, 3. Knowledge of any programming language- (Python, GO).
Course Objectives:	
●	To understand the fundamental concepts, principles, and foundations of Artificial Intelligence and intelligent agents
●	To develop knowledge of various AI search strategies and problem-solving techniques used in intelligent systems
●	To acquire understanding of knowledge representation methods and reasoning mechanisms used in AI systems.
●	To gain familiarity with AI programming using PROLOG and basics of Artificial Neural Networks.
●	To understand uncertainty handling techniques including fuzzy logic, probabilistic reasoning, and non-monotonic reasoning.
●	To explore modern AI applications and advanced techniques such as metasearch systems and Retrieval-Augmented Generation (RAG).
Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain the fundamental concepts of Artificial Intelligence, intelligent agents, knowledge representation, and problem formulation.
2.	Apply uninformed and informed search strategies to solve complex AI-based problem-solving tasks.
3.	Design knowledge representation systems using logic, predicate calculus, and inference mechanisms for intelligent reasoning
4.	Demonstrate AI programming concepts using PROLOG and develop understanding of Artificial Neural Networks and their applications
5.	Analyze and apply uncertainty-handling techniques such as fuzzy logic, statistical reasoning, and non-monotonic reasoning in AI systems.
6.	Evaluate modern AI applications including metasearch engines and Retrieval-Augmented Generation (RAG) for real-world problem solving.

Section1:	**Foundations and Intelligent Agents**
Introduction, A.I. Representation, Non-AI &AI Techniques, Representation of Knowledge, KnowledgeBase Systems, State Space Search, Production Systems, Problem Characteristics,	

types of production systems, Intelligent Agents and Environments, concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation Case Study- 1 : AI for everyone/ Building AI Projects Case Study- 2 : AI and Society / Ethics for AI	
Section2:	**Search Strategies**
Formulation of real world problems, Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search, and Comparison of Uninformed search Strategies Generate& test, Hill Climbing, Best First Search, A*, Game playing: Minimax Search, Alpha-Beta Cutoffs, Waiting for Quiescence Case Study - 3 : State of Art Game Programs and Analysis	
Section3:	**Knowledge Representation and Reasoning**
Knowledge representation, Approach; Issues in knowledge representation, Structured representation of knowledge, Propositional logic, Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, First order logic, unification and lifting. Weak-slot and filler structure, Strong slot and filler structures. Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Case Study 4:-Study of Zapier and Gumloop	
Section4:	**Introduction to PROLOG and ANN**
AI Programming Language (PROLOG): Introduction, How Prolog works?Some hands on PROLOG examples. Introduction to Neural networks:- basics, comparison of human brain and machine, biological neuron, general neuron model, activation functions, Perceptron learning rule, applications and advantages of neural networks. Brief introduction to single layer and multiplayer networks Case Study 5:-Study of CrewAI	
Section5:	**Handling Uncertainty**
Non-Monotonic Reasoning, Logics for Non-Monotonic Reasoning, Semantic Nets, Statistical Reasoning, Fuzzy logic: fuzzy set definition and types, membership function, designing a fuzzy set for a given application. Sources of uncertainty, types of uncertainty (aleatoric and epistemic), reasoning under uncertainty, and limitations of deterministic approaches. Case Study 6:-Study of LangGrpah and LangChain	
Section6:	**AI Applications and Advanced AI**
Metasearch: Introduction to Metasearch, Need and Significance of Metasearch, Difference between simple search and Metasearch, basics working of metasearch, Real Life Examples of metasearch engines Retrieval-Augmented Generation (RAG),Explainable AI, Generative AI, Agentic AI Case Study 6:-Study of Grad-CAM , Captum	
Text Books: ***(As per IEEE format)***	
1	Elaine Rich and Kevin Knight, Artificial Intelligence, 2nd, Ed., Tata McGraw Hill, 1991
2	Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd, Ed.,Pearson Education,2003
Reference Books: ***(As per IEEE format)***	
1	Ivan Bratko, Prolog Programming For Artificial Intelligence, 2nd Ed. Addison Wesley, 1986.

2	Eugene, Charniak, Drew Mcdermott, Introduction to Artificial Intelligence, Addison Wesley, 1985
3	Nils J. Nilsson, Principles of Artificial Intelligence, 1st Ed., Morgan Kaufmann,1982

List of Practical's (Minimum Six):

1 Study Assignment: Compare different algorithms and evaluate their performance/cost. E.g. depth- first search (DFS) to heuristic algorithms such as Monte Carlo tree search (MCTS. Since all of the studied algorithms converge to a solution from a solvable deal, effectiveness of each approach to be measured by how quickly a solution was reached, and how many nodes were traversed until a solution was reached.

2. Assignment on Heuristic Search Techniques: Implement Best- first search (Best-Solution but not always optimal)

3. Implementation of A* algorithm (Always gives optimal solution) for solving Puzzle problems.

4. Implementation of Min-Max Search Procedure with alpha beta pruning for finding the solutions of games.

5. Design a fuzzy set for shape matching of handwritten character techniques

6. Assignment on Constraint Satisfaction Problem: Implement graph coloring problem.

7. Implementation of Unification algorithm by considering Resolution concept.

List of Project areas:

1. AI Agents for Autonomous Task Execution.
2. Retrieval-Augmented Generation (RAG) for Enterprise Knowledge Systems.
3. Multimodal AI for Image, Audio, and Text Understanding
4. AI-Powered Digital Twins for Smart Industries
5. Federated Learning for Privacy-Preserving Healthcare
6. Explainable AI (XAI) for Medical Diagnosis
7. AI for Climate Change Prediction and Sustainable Development
8. Edge AI for Real-Time IoT Applications
9. Reinforcement Learning for Autonomous Robotics
10. Human-AI Collaborative Decision Support Systems
11. AI Copilots for Education and Research

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												PSO			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3	PSO3
CO1	3	2			2							1	3	2	1	1
CO2	2	3	2	1	3							1	3	3	2	1
CO3	2	3	3	2	2							1	3	3	2	2
CO4	3	2	2	2	3					1		1	3	2	3	2
CO5	3	3	2	2	3							2	2	3	3	2
CO6	2	2	2	1	2	2	2	2	1	1	1	2	3	2	3	3

Avg	2.33	2.50	2.20	1.60	2.30	2	2	2	1	1	1	1.33	2.83	2.33	2.20	1.83

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

' ✓ indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	2	2	3	2		1		1	
CO2	1	3	3	3		2		2	
CO3	1	3	3	3		2		2	
CO4	1	2	2	3		3		2	
CO5	1	3	3	3	1	3	1	2	
CO6	1	2	2	3	2	3	2	3	1

CO – WP Mapping (Complex Engineering Problems) Sample Table

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

CO – EA Mapping (Complex Engineering Activities)

'✓ indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	1		1		2
CO2	3	2	3	1	3
CO3	3	2	3	1	3
CO4	3	2	2	1	2
CO5	3	3	3	2	3
CO6	3	3	3	3	3

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	**SDG 4 – Quality Education**, **SDG 9 – Industry, Innovation and Infrastructure**	Introduces the fundamental concepts of Artificial Intelligence, enabling learners to build knowledge and skills required for innovation and advanced technologies.
CO2	**SDG 9 – Industry, Innovation and Infrastructure**, **SDG 8 – Decent Work and Economic Growth**	AI search strategies are used to develop efficient problem-solving techniques that improve industrial processes, automation, and intelligent decision-making.
CO3	**SDG 9 – Industry, Innovation and Infrastructure, SDG 11 – Sustainable Cities and Communities**	Knowledge representation and reasoning techniques support the development of intelligent systems for smart infrastructure, urban planning, and automation.
CO4	**SDG 9 – Industry, Innovation and Infrastructure**, **SDG 4 – Quality Education**	Prolog programming and Artificial Neural Networks provide practical AI skills that foster innovation and prepare students for emerging technologies.
CO5	**SDG 3 – Good Health and Well-being**, **SDG 9 –**	Uncertainty handling and neural networks enable AI-based solutions for healthcare diagnostics, environmental monitoring, predictive analytics, and

	Industry, Innovation and Infrastructure, **SDG 13 – Climate Action**	sustainable engineering applications.
CO6	**SDG 3 – Good Health and Well-being**, **SDG 8 – Decent Work and Economic Growth**, **SDG 9 – Industry, Innovation and Infrastructure**, **SDG 11 – Sustainable Cities and Communities**, **SDG 16 – Peace, Justice and Strong Institutions**	AI applications across healthcare, education, agriculture, finance, smart cities, cybersecurity, and governance contribute to sustainable development, economic growth, societal well-being, and responsible use of technology.

IT3233A: Compiler Design

Teaching Scheme	Examination Scheme
Credits : 4	CVV: 20 Marks
Lectures : 3 Hrs/week	CP: 40 Marks
Practical : 2 Hrs/week	PPT: 20 Marks
	HA: 20 Marks

Prerequisites:	
●	1. Operating Systems 2. Theory of Computation
Course Objectives:	
1	understand the fundamentals of compilers and system software in program execution.
2	understand the translation process from high-level language to machine-level language.
3	know lexical, syntax, and semantic analysis techniques for program verification.
4	learn syntax-directed translation and intermediate code generation methods.
5	learn code generation, optimization, and runtime environment techniques.
6	know modern compiler design approaches for emerging computing technologies.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Design and implement basic compiler components such as lexical analyzer, parser, and code generator.
2.	Apply syntax-directed translation and semantic analysis techniques in compiler construction.
3.	Perform local and global code optimization for efficient program execution.
4.	Generate intermediate and target machine code using runtime environment concepts.
5.	Develop solutions for problems related to compiler design and language processing.
6.	Adapt to emerging trends and technologies in compiler construction and programming language processing.

Section 1:	**Introduction to Compilers, interpreters, Assembler, Linker and**
Introduction to compiler phases, features of machine-dependent and machine-independent compilers, overview of types of compilers, and introduction to cross compilers. Interpreters: comparison between compiler and interpreter, phases and working of interpreters. Preprocessor: header files and macro expansion. Assembler: introduction to assembler and overview of types of assemblers. Linker and Loader: introduction to linker and loader, their functions, and overview of types of linkers and loaders.	
Section 2:	**Lexical and Syntax Analysis Techniques**
Introduction to compiler phases and passes, bootstrapping, lexical analyser, tokens, lexemes, patterns, regular expressions, finite automata (NFA and DFA), scanner implementation, LEX/FLEX tool. Syntax Analysis: Context-Free Grammar (CFG), parse trees, ambiguity in grammar, top-down and bottom-up parsing techniques, recursive descent parsing, LL(1) parsing, First and Follow sets, shift-reduce parsing, operator precedence parsing, basics of LR parsing, and error handling in parsing.	
Section 3:	**Advanced Syntax and Semantic Analysis**
Bottom-up parsing techniques, LR parsers and overview of types of LR parsers, construction of LALR	

parsing tables, introduction to YACC/BISON tool, type checking and type conversion, symbol table organization and structure.	
Section 4:	**Syntax-Directed Translation and Intermediate Code Generation**
Syntax-directed definitions and translation, semantic rules, type checking, symbol table and its operations, intermediate representations, and intermediate code generation. Three-address code, quadruples, triples, translation of array references in arithmetic expressions, and control flow statements such as if, while, and for loops. Runtime environment and activation records. Error detection and recovery: lexical, syntactic, and semantic phase errors.	
Section 5:	**Code Generation and Optimization Techniques**
Issues in code generation, basic blocks and flow graphs, next-use information, simple code generator, DAG representation of basic blocks, peephole optimization, and code generation from DAGs. Code optimization techniques, sources of optimization, optimization of basic blocks, machine-dependent optimization, constant propagation, and live range analysis.	
Section 6:	**Run-Time Environments and Data Flow Analysis**
Global data flow analysis, runtime environments, source language issues, storage organization, storage allocation strategies, access to non-local names, parameter passing techniques, and data flow analysis. Case Studies: LLVM compiler infrastructure, compiling object-oriented programming features, compilation in multicore environments, deep learning compilation, parallel compilers, and web compilers.	
Text Books:	
1	A. V. Aho, M. S. Lam, R. Sethi, and J. D. Ullman, *Compilers: Principles, Techniques, and Tools*, 2nd ed. Boston, MA, USA: Addison-Wesley, 2006. ISBN: 978-0321486813.
2	K. D. Cooper and L. Torczon, *Engineering a Compiler*, 2nd ed. Burlington, MA, USA: Morgan Kaufmann, 2011. ISBN: 978-0120884780.
3	A. W. Appel and J. Palsberg, *Modern Compiler Implementation in Java*, 2nd ed. Cambridge, U.K.: Cambridge University Press, 2002. ISBN: 978-0521820608.
4	V. Raghavan, *Principles of Compiler Design*. New Delhi, India: Tata McGraw-Hill Education, 2010. ISBN: 978-0070702570.
Reference Books:	
1	S. S. Muchnick, *Advanced Compiler Design and Implementation*. San Francisco, CA, USA: Morgan Kaufmann, 1997. **ISBN:** 978-1558603202.
2	J. R. Levine, T. Mason, and D. Brown, *Lex & Yacc*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 1992**. ISBN:** 978-1565920002.
E Resources:	
1	NPTEL, Compiler Design Course. [Online]. Available: https://nptel.ac.in
2	Coursera, Compiler Design and Programming Languages Courses. [Online]. Available: https://www.coursera.org
3	edX, Compiler Construction Learning Resources. [Online]. Available: https://www.edx.org
4	GeeksforGeeks, Compiler Design Tutorials. [Online]. Available: https://www.geeksforgeeks.org/compiler-design-tutorials/
5	LLVM Foundation, LLVM Compiler Infrastructure Project. [Online]. Available: https://llvm.org

List of Practical's (Minimum Six):

1. Design and implement a lexical analyser to identify keywords, identifiers, constants, and operators from a given source program.

2. Develop LEX/FLEX programs for token recognition, word/line counting, and pattern matching using regular expressions.
3. Implement a recursive descent parser for validating arithmetic expressions based on a given grammar.
4. Compute FIRST and FOLLOW sets and construct an LL(1) predictive parsing table for a given grammar.
5. Implement shift-reduce parsing and construct LR/SLR/LALR parsers for arithmetic expressions.
6. Develop YACC/BISON specifications to implement a parser for a given grammar.
7. Design and implement a symbol table for storing variable information and perform type checking.
8. Implement syntax-directed translation schemes for arithmetic expressions and assignment statements.
9. Generate intermediate code representations such as Three-Address Code (TAC), quadruples, and triples.
10. Implement intermediate code optimization techniques such as constant folding, dead code elimination, and peephole optimization.
11. Develop a simple code generator for arithmetic expressions and control flow statements.
12. Implement mini compiler components for a subset of C/C++ language including lexical analysis, parsing, intermediate code generation, and optimization.

List of Tutorials

1. Study of compiler phases, interpreters, assemblers, linkers, and loaders.
2. Comparison of compiler and interpreter with execution flow analysis.
3. Construction of regular expressions, NFA, and DFA for token recognition.
4. Design of lexical analyser using LEX/FLEX tool.
5. Construction of parse trees and derivations using Context-Free Grammar (CFG).
6. Computation of FIRST and FOLLOW sets and construction of LL(1) parsing tables.
7. Implementation and analysis of shift-reduce, operator precedence, and LR parsing techniques.
8. Construction of LALR parsing tables using YACC/BISON tool.
9. Symbol table management, type checking, and semantic error handling.
10. Generation of intermediate code representations such as Three-Address Code, quadruples, and triples.
11. Study of code optimization techniques including DAG representation, constant propagation, and peephole optimization.
12. Analysis of runtime environments, storage allocation strategies, and data flow analysis with case studies on LLVM and modern compiler technologies.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												PSO			
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO	3	2	3	–	3	–	–	–	1	1	–	1	3	2	3	–

1																
CO 2	3	3	2	2	2	–	–	–	–	1	–	1	3	3	2	1
CO 3	3	3	2	2	3	–	–	–	–	–	–	1	3	3	2	2
CO 4	3	2	3	1	3	–	–	–	–	1	–	1	3	2	3	2
CO 5	2	3	3	2	2	–	–	–	1	1	1	2	3	3	3	2
CO 6	2	2	2	2	3	1	1	1	1	1	1	3	2	2	2	3
Avg	**2.67**	**2.5**	**2.5**	**1.8**	**2.67**	**1**	**1**	**1**	**1**	**1**	**1**	**1.5**	**2.83**	**2.5**	**2.5**	**2**

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓ indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓		✓			
CO2		✓	✓	✓		✓		✓	
CO3		✓	✓	✓	✓	✓		✓	
CO4		✓	✓	✓	✓	✓			
CO5	✓	✓	✓	✓	✓	✓		✓	
CO6			✓	✓	✓	✓	✓	✓	✓

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓	✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓ indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓	✓		✓
CO2	✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	**SDG 4: Quality Education**	Designing and implementing compiler components enhances students' programming, analytical thinking, and software engineering skills, contributing to quality technical education.

CO2	**SDG 4: Quality Education**	Applying syntax-directed translation and semantic analysis develops problem-solving abilities and strengthens competency in compiler construction and programming language processing.
CO3	**SDG 9: Industry, Innovation and Infrastructure**	Code optimization techniques improve software efficiency, execution speed, and resource utilization, supporting innovative and sustainable computing infrastructure.
CO4	**SDG 9: Industry, Innovation and Infrastructure**	Intermediate and target code generation contributes to the development of reliable and efficient software systems used in modern computing industries.
CO5	**SDG 4: Quality Education**, **SDG 9: Industry, Innovation and Infrastructure**	The compiler design project promotes experiential learning, innovation, and development of practical software solutions for real-world applications.
CO6	**SDG 4: Quality Education**, **SDG 9: Industry, Innovation and Infrastructure**, **SDG 8: Decent Work and Economic Growth**	Learning emerging compiler technologies and modern language processing tools enhances lifelong learning, innovation, employability, and readiness for advanced software engineering careers.

IT3233B: Network Security

Teaching Scheme	Examination Scheme
Credits : 3	CVV: 20 Marks
Lectures : 3 Hrs/week	PPT: 20 Marks
Practical : 2 Hrs/week	Course Project: 40 Marks
Tutorial : Hrs/week	HA: 20 Marks

Prerequisites:	
●	Basic understanding of Computer Networks.
●	Basic knowledge of Computer Architecture and Organization
●	Knowledge of Operating System fundamentals.
Course Objectives:	
●	Understand fundamental concepts of network security, cybersecurity principles, threats, vulnerabilities, and risk management.
●	Learn cryptographic techniques, authentication mechanisms, and secure communication protocols used in modern networks.
●	Develop skills to configure and analyze security technologies such as firewalls, intrusion detection/prevention systems, and VPNs.
●	Understand ethical hacking methodologies, cyber-attack techniques, vulnerability assessment, and incident response processes.
●	Apply machine learning and security analytics techniques for threat detection and cybersecurity data analysis.
●	Evaluate security challenges and protection mechanisms in cloud computing, IoT, blockchain, and emerging technologies
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand core principles of network and information security.
2.	Apply cryptographic and authentication mechanisms for secure communication
3.	Configure and analyze firewall, IDS and VPN technologies
4.	Identify cyber attacks and perform basic vulnerability analysis
5.	Analyze cybersecurity data using machine learning and security analytics techniques
6.	Evaluate security challenges in cloud, IoT and emerging technologies

Section1:	**Foundations of Network Security and Cybersecurity**
Importance of Network Security, Principles of Network Security and Cybersecurity, CIA Triad, Threats, Vulnerabilities and Risk Management, Network Security Policies and Standards, TCP/IP Security Fundamentals and IPv6 Security, Network Protocol Analysis and Packet Structures, Introduction to Wireshark and Traffic Monitoring, Security Issues in LAN, WLAN and Internet	

Architecture	
Section2:	**Cryptography and Authentication Mechanisms**
Classical and Modern Cryptography, Symmetric and Asymmetric Encryption, DES, AES, RSA and Diffie-Hellman Algorithms, Hash Functions, Digital Signatures and Certificates, Public Key Infrastructure (PKI) and X.509, Multi-factor Authentication and Biometrics_Secure Email and SSL/TLS Concepts	
Section3:	**Network Defense and System Security**
Firewalls and Firewall Architectures, Packet Filtering, Proxy Servers and Bastion Hosts, Intrusion Detection and Prevention Systems, Snort IDS Configuration and Signature Analysis, Linux and Windows Security Hardening, VPN Fundamentals and IPSec, Security Monitoring and Log Analysis	
Section4:	**Ethical Hacking and Cyber Attack Techniques**
Footprinting, Reconnaissance and Scanning Techniques, Vulnerability Assessment and Penetration Testing Basics, Malware: Viruses, Worms, Trojan Horses and Ransomware, Password Attacks and Social Engineering, Web Application Security Basics, Denial of Service and Distributed DoS Attacks, Introduction to Digital Forensics and Incident Response	
Section5:	**Security Analytics and AI in Cybersecurity**
Introduction to Machine Learning for Security, Security Analytics and Threat Intelligence, Classification and Clustering Techniques for Intrusion Detection, Anomaly Detection using Machine Learning, Adversarial Machine Learning Concepts, Security of AI/ML Systems, Case Studies on Malware Detection and Security Analytics	
Section6:	**Cloud, IoT and Emerging Security Technologies**
Cloud Computing Security Fundamentals, Virtualisation and Container Security, IoT Architecture and IoT Security Challenges, Blockchain Security Basics, Zero Trust Architecture, Business Continuity Planning and Disaster Recovery, Cyber Laws, Ethics and Compliance Standards	
Text Books: ***(As per IEEE format)***	
1	William Stallings, "Cryptography and Network Security - Principles and Practices", Prentice Hall of India, Third Edition, 2003 ISBN: 8178089025
2	B. A. Forouzan and D. Mukhopadhyay, "Cryptography and Network Security", 3rd ed., McGraw-Hill Education, 2015.
3	N. Godbole and S. Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 2nd ed., Wiley India, 2011.
Reference Books: ***(As per IEEE format)***	
1	C. Chio and D. Freeman, *Machine Learning and Security: Protecting Systems with Data and Algorithms*. Sebastopol, CA, USA: O'Reilly Media, 2018.
2	Y. Vorobeychik and M. Kantarcioglu, *Adversarial Machine Learning*. San Rafael, CA, USA: Morgan & Claypool Publishers, 2018.
3	W. Easttom, *Network Defense and Countermeasures: Principles and Practices*, 3rd ed. Burlington, MA, USA: Jones & Bartlett Learning, 2014.
Online resources	

	Wireshark Foundation, "Wireshark User Guide." [Online]. Available: https://www.wireshark.org/docs/. [Accessed: Jul. 2, 2026]. Cisco Systems, "Snort Documentation." [Online]. Available: https://docs.snort.org/. [Accessed: Jul. 2, 2026]. OpenSSL Software Foundation, "OpenSSL Documentation." [Online]. Available: https://docs.openssl.org/. [Accessed: Jul. 2, 2026].

List of Practical's:

1. **Packet analysis using Wireshark**- Capture and analyze network traffic using Wireshark. Study packet structures, TCP/IP protocols, ARP, DNS, HTTP, HTTPS, and identify suspicious network activities through packet inspection.
2. **Network Traffic Monitoring and Protocol Analysis**- Monitor real-time network communications and investigate protocol behavior, communication patterns, packet headers, and network performance metrics.
3. **Firewall configuration and rule implementation**- Configure firewall rules using Windows Firewall, UFW, or iptables. Implement packet filtering, access control policies, port blocking, and traffic management rules to secure a network.
4. **Snort IDS installation and alert analysis**- Install and configure Snort Intrusion Detection System. Create custom detection rules, generate alerts for malicious traffic, and analyze intrusion logs.
5. Develop a Python application that demonstrates the basic principles of RSA public-key cryptography for a **4-bit numerical message (0–15)**. The application should generate RSA public and private keys using small prime numbers, encrypt a 4-bit message using the public key, and decrypt it using the private key. Verify that the original message is correctly recovered after decryption.
6. Develop a Python application that accepts a **4-bit binary message (0000–1111)** and generates its hash value using a standard hash function. The application should demonstrate data integrity verification by comparing hash values before and after modifying the input message and detecting any change in the data.
7. **Basic vulnerability scanning using open-source too**ls-Perform vulnerability scanning using tools such as Nmap, OpenVAS, or Nessus Essentials. Identify open ports, services, and potential security weaknesses in systems.
8. **Linux security hardening exercises**- Implement security best practices on Linux systems, including user privilege management, file permissions, SSH security, service management, auditing, and system updates.
9. **Secure Authentication and Encryption Mechanisms**- Configure password policies, multi-factor authentication, SSL/TLS certificates, and secure communication channels
10. **Log Collection and Security Event Analysis**- Collect, analyze, and interpret system and network logs to detect anomalies, suspicious activities, and potential security incidents.

11. **Machine Learning-Based Security Analytics**- Develop a basic security analytics model using cybersecurity datasets for anomaly detection, malware classification, or intrusion detection using machine learning techniques

List of Project areas:

1. Network Intrusion Detection System
2. Network Traffic Analysis and Monitoring
3. Phishing Website Detection
4. Email Phishing Detection
5. Malware Detection and Classification
6. Ransomware Detection System
7. Security Analytics Platform
8. Cyber Threat Intelligence System
9. AI-Based Cyber Attack Detection
10. Adversarial Machine Learning for Security
11. Firewall Rule Optimization
12. Zero Trust Network Security Framework
13. Cloud Security Monitoring
14. Secure Cloud Storage System
15. IoT Intrusion Detection System
16. IoT Device Authentication Framework
17. Blockchain-Based Access Control System
18. Secure Identity Management System
19. Web Application Vulnerability Detection
20. SQL Injection Detection System

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												PSO			
CO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO12	PS O1	PS O2	PSO 3	PSO 4
CO1	3	2	-	-	1	-	-	1	-	-	-	1	2	3	2	-
CO2	3	2	2	-	2	-	-	1	-	-	-	1	1	3	2	2
CO3	2	3	2	2	3	-	-	1	-	-	-	1	1	2	3	3
CO4	2	3	1	3	2	1	-	2	-	-	-	2	1	2	3	2
CO5	2	3	1	3	3	-	-	1	-	-	-	3	2	2	3	2
CO6	2	2	2	2	2	2	1	2	-	-	-	1	3	2	2	2
Avg	3	2	2	-	2	-	-	1	-	-	-	1.5	1	3	2	2

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	-	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	-	-	-

CO4	✓	✓	✓	✓	✓	-	-	✓	-
CO5	✓	✓	✓	✓	✓	✓	-	✓	-
CO6	-	-	-	-	-	-	-	-	-

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO1	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	-	✓	-	-
CO3	✓	✓	✓	✓	✓	-	-
CO4	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓ indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	-	-	-	-
CO2	✓	✓	✓	-	-
CO3	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	**SDG 4 – Quality Education** **SDG 9 – Industry, Innovation and Infrastructure**	Develops foundational cybersecurity knowledge essential for modern digital infrastructure and technical education.
CO2	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 16 – Peace, Justice and Strong Institutions**	Secure communication mechanisms protect digital services, transactions, and institutional information systems.
CO3	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 16 – Peace, Justice and Strong Institutions**	Enhances resilience and security of critical network infrastructure and information systems against cyber threats.
CO4	**SDG 16 – Peace, Justice and Strong Institutions** **SDG 11 – Sustainable Cities and Communities**	Supports cybercrime prevention, protection of digital assets, and secure operation of smart and connected communities.
CO5	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 4 – Quality Education**	Promotes innovation through AI-driven cybersecurity solutions and develops advanced analytical skills.
CO6	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 11 – Sustainable Cities and Communities** **SDG 16 – Peace, Justice and Strong Institutions**	Ensures secure deployment of cloud, IoT, and emerging technologies that support smart infrastructure, governance, and sustainable digital ecosystems.

IT3233C: Data Science & Analytics

Teaching Scheme	Examination Scheme
Credits : 3	CVV: 20 Marks
Lectures : 2 Hrs/week	PPT:-20 Marks
Practical : 2 Hrs/week	HA: 20 Marks
Tutorial : - Hrs/week	CP: 40 Marks

Prerequisites:	
•	• Linear Algebra and Calculus. • Probability Basics
Course Objectives:	
	The course aims to enable students to:
•	1. Understand the fundamental concepts, lifecycle, and applications of Data Science and Analytics, along with the Python ecosystem used for data analysis.
•	2. Develop the ability to collect, clean, preprocess, visualize, and explore data using appropriate statistical and analytical techniques.
•	3. Apply descriptive and inferential statistical methods to analyze data and draw meaningful conclusions for decision-making.
•	4. Analyze business problems using data-driven approaches, including forecasting, customer segmentation, and experimental design.
•	5. Understand emerging trends, ethical considerations, privacy, and responsible practices in Data Science, and appreciate its applications across various domains.
Course Outcomes:	
	Upon successful completion of the course, students will be able to:
1.	Explain the concepts of Data Science, analytics, Big Data, data lifecycle, CRISP-DM methodology, and the Python ecosystem for data analysis. (Understand)
2.	Perform data acquisition, exploratory data analysis, visualization, data cleaning, preprocessing, and feature engineering using appropriate Python libraries and visualization tools. (Apply)
3.	Apply descriptive and inferential statistical techniques, including probability distributions, hypothesis testing, correlation, and regression analysis to interpret data.(Apply)
4.	Analyze business data using analytical techniques such as KPI analysis, forecasting, customer segmentation, and A/B testing to support data-driven decision-making. (Analyse)
5.	Evaluate emerging trends in Data Science, including cloud-based platforms, Explainable AI, ethics, bias, fairness, privacy, and security, while understanding the end-to-end data science project workflow. (Evaluate)
6.	Demonstrate the application of Data Science and Analytics techniques to solve real-world problems through case studies and practical implementations in domains

	such as healthcare, finance, and marketing.(Apply)

Section1:	**Introduction**
Introduction to Data Science, Data Science Lifecycle, Types of Analytics, Descriptive , Diagnostic , Predictive, Prescriptive, Data Science Process (CRISP-DM), Applications of Data Science, Data Collection and Sources, Structured, Semi-structured and Unstructured Data, Introduction to Python ecosystem NumPy Pandas, Matplotlib, Seaborn, Scikit-learn Big data overview, state of the practice in Analytics- BI Vs Data Science, Current Analytical Architecture, drivers of Big Data.	
Section2:	**Data Exploration and Visualization EDA**
Summary statistics, data profiling & data visualization. Principles of effective data visualization, choosing appropriate chart types, colour schemes, and labelling. Creating visualizations using popular Python libraries. Introduction to interactive visualization tools Tableau or Power BI for dynamic visualizations, interactive dashboards, and explore data in an intuitive manner	
Section3:	**Data Cleaning and Pre-processing**
Descriptive measures like mean, median, mode, variance, and standard deviation to describe and summarize data, Probability distributions like normal, binomial, and poison distributions and their applications. Hypothesis testing concepts: Null and alternative hypotheses, Analysis of variance, p-values, and confidence intervals, hypothesis testing. Concepts of correlation and regression analysis: to measure and interpret correlation between variables, as well as simple and multiple linear regression models.	
Section4:	**Descriptive and Inferential Statistics**
Descriptive measures like mean, median, mode, variance, and standard deviation to describe and summarize data, Probability distributions like normal, binomial, and poison distributions and their applications. Hypothesis testing concepts: Null and alternative hypotheses, Analysis of variance, p-values, and confidence intervals, hypothesis testing. Concepts of correlation and regression analysis: to measure and interpret correlation between variables, as well as simple and multiple linear regression models.	
Section5:	**Business Analytics and Decision Making**
How data analytics can contribute to achieving business goals, identifying relevant KPIs for success. Business forecasting: Time series analysis and forecasting models to predict future trends. Methods to segment customers based on their characteristics and behaviours, to drive targeted marketing strategies. A/B testing and experimental design: Introduces the principles of experimental design and A/B testing to evaluate the effectiveness of different strategies or interventions, and make data-driven decisions.	
Section6:	**Emerging Trends and Applications in Data Science**
Emerging Treads: Big Data Analytics (Overview) , Cloud-based Data Science Platforms, Explainable AI (XAI), Bias and Fairness in Data Science , Ethics and Responsible AI, Data Privacy and Security, Stages (workflow) of a typical data science project, from problem formulation to data collection, analysis, and communication of results. Case Studies: Data analytics and their applications in areas like healthcare, finance, and marketing.	
Text Books: ***(As per IEEE format)***	

1	McKinney, Wes. (2017). Python for Data Analysis, O'Reilly Media, Inc.
2	Provost, Foster and Fawcett, Tom. (2013). Data Science for Business, O'Reilly Media, Inc.
3	Hastie, Trevor; Tibshirani, Robert; Friedman, Jerome. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer.
4	Han, Jiawei; Kamber, Micheline; Pei, Jian. (2011). Data Mining: Concepts and Techniques, Morgan Kaufmann.
Reference Books: *(As per IEEE format)*	
1	Maheshwari Anil, Rakshit, Acharya, "Data Analytics", McGraw Hill, ISBN: 789353160258.
2	Mark Gardner, "Beginning R: The Statistical Programming Language", Wrox Publication, ISBN: 978-1-118-16430-3.
3	Luís Torgo, "Data Mining with R, Learning with Case Studies", CRC Press, Talay and Francis Group,ISBN9781482234893
4	Carlo Vercellis, "Business Intelligence - Data Mining and Optimization for Decision Making", WileyPublications, ISBN: 9780470753866.

List of Practical's (Minimum Six):

- Python for Data Science: - Install and configure Anaconda/Jupyter Notebook or Google Colab, Perform array operations using NumPy, Create and manipulate DataFrames using Pandas, Read data from CSV and Excel files, Compute descriptive statistics.
- Data Exploration and Visualization:- Generate summary statistics, Perform data profiling, Create histograms, box plots, scatter plots, bar charts, pair plots, and heatmaps, Interpret insights from visualizations.
- Interactive Data Visualization: - Import a dataset into Tableau or Power BI, Create interactive charts and filters, Design a dashboard showing KPIs, Present business insights using visual analytics.
- Data Cleaning and Pre-processing:- Handle missing values using deletion and imputation techniques, Detect and remove outliers, Remove duplicate records, Standardize inconsistent data, and Normalize numerical features.
- Feature Engineering and Data Transformation:-Perform Label Encoding and One-Hot Encoding, Apply Feature Scaling (Normalization and Standardization), Extract date/time-based features, perform basic text preprocessing (tokenization and stop-word removal).
- Statistical Analysis Using Python:- Compute mean, median, mode, variance, and standard deviation, Visualize probability distributions, Perform hypothesis testing (t-test or chi-square test), Calculate confidence intervals, Perform correlation analysis, Fit a simple linear regression model.
- Business Analytics Case Study:-Identify business KPIs, Perform customer segmentation using demographic or transaction data, Conduct trend analysis, Perform simple forecasting using time-series data, Present recommendations based on findings.

- A/B Testing and Experimental Design: - Compare two sample datasets representing Variant A and Variant B, Perform hypothesis testing, Interpret p-values and confidence intervals, Recommend the better-performing strategy.
- Course Project: - Implement the complete data science lifecycle on a real-world dataset. Tasks to be done
- Problem formulation
- Data collection
- Data cleaning and preprocessing
- Exploratory Data Analysis
- Feature engineering
- Statistical analysis
- Visualization and dashboard creation
- Business insights and recommendations
- Discussion on ethical issues, bias, fairness, and data privacy related to the selected application

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)												PSO			
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	-		2	-	-	-	-	-	-	-	3	2	1	1
CO 2	3	3	2	2	3	-	-	-	1	-	-	-	3	3	2	2
CO 3	3	3	2	3	2	-	-	-	-	-	-	-	3	3	2	2
CO 4	2	3	3	3	3	-	-	-	2	-	-	-	3	3	3	2
CO 5	2	2	1	2	2	-	-	-	1	-	-	2	2	2	2	3
CO 6	2	3	3	3	3	-	1	-	2	-	-	2	3	3	3	3
Avg	2.5	2.6	2.2	2.6	2.5	-	1	-	1.5	-	-	2	2.8	2.6	2.1	

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	3	1	1	1					
CO2	3	2	2	2	1	1	1	1	1
CO3	3	2	3	2	1	1		1	
CO4	3	3	3	2	2	2			
CO5	2	3	2	3	2	3	2		
CO6	3	3	3	3	2	3		2	

CO – WP Mapping (Complex Engineering Problems) Sample Table

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

CO – EA Mapping (Complex Engineering Activities)

CO	EA1	EA2	EA3	EA4	EA5
CO1	2	1	1	1	-
CO2	3	2	2	1	1
CO3	3	1	2	1	1
CO4	3	3	3	2	1
CO5	2	2	2	3	-
CO6	3	3	3	3	-

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	**SDG4,SDG8 &SDG9**	The course promotes innovation through Big Data, cloud computing, machine learning, and data-driven technologies that strengthen digital infrastructure and industrial applications.
CO2	**SDG3,SDG4,SDG8 & SDG9**	The course equips students with analytical thinking, statistical methods, Python programming, and modern data analysis tools, promoting quality technical education and lifelong learning.
CO3	**SDG1**	Data Science and Analytics enable governments, NGOs, and organizations to identify poverty patterns, optimize the allocation of welfare resources, predict vulnerable populations, improve financial inclusion through data-driven policies, and support evidence-based decision-making for poverty alleviation programs.
CO4	**SDG1,SDG3**	Data Science techniques are applied to healthcare analytics, disease prediction, patient monitoring, medical diagnosis, and clinical decision support systems, improving healthcare outcomes
CO5	**SDG5**	Business analytics, forecasting, KPI analysis, and customer analytics improve organizational productivity, operational efficiency, and evidence-based business decisions.
CO6	**SDG3**	Data Science techniques are applied to healthcare analytics, disease prediction, patient monitoring, medical diagnosis, and clinical decision support systems, improving healthcare outcomes

MD1309A: Organizational Behavior

Teaching Scheme	Examination Scheme
Credits : 3	CP: 30 Marks
Lectures : 2 Hrs/week	PPT: 20 Marks
Practical : - Hrs/week	HA:10 Marks
Tutorial : 1 Hrs/week	ESE TH(W):40 Marks

Prerequisites:	**NIL**
Course Objectives:	
1.	To introduce the fundamental concepts, scope, and models of organizational behavior and the functions and roles of a manager.
2.	To familiarize students with the dynamics of organizational change and the approaches used to manage and overcome resistance to change.
3.	To acquaint students with the major theories of motivation and their application to practical problems in organizations.
4.	To develop an understanding of group and team dynamics, and to build awareness of leadership styles required for effective team functioning.
5.	To enable students to apply the Management by Objectives (MBO) technique for achieving organizational goals.
6.	To create awareness of personality, attitude, organizational culture, and spirituality, and to inculcate the ability to make ethical decisions in professional life.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Describe the concepts of organizational behavior and management practices.
2.	Summarize the problems occurring due to organizational change and Analyze how the theories and empirical evidence can help to solve contemporary organizational issues.
3.	Apply theories of motivation to practical problems in organizations in a critical manner.
4.	Justify the role of leadership qualities.
5.	Apply MBO technique to achieve the organizational objectives
6.	Develop the skills that are necessary for making ethical decisions in Professional life

Section1:	**Foundations of Organizational Behavior, Organizational Change, and Motivation**

Introduction: A review of the Manager's Job Management Functions, Management Roles, Management Skills, Effective versus Successful Managerial Activities. Definition, Importance, Scope, Fundamental Concepts of OB, Challenges and Opportunities of OB Different models of OB - autocratic, custodial, supportive, collegial and SOBC. Disciplines That Contribute to the OB Field - Psychology, Social Psychology, Sociology, Anthropology. Responding to Economic Pressures, Responding to Globalization, Managing Workforce Diversity, Improving Customer Service.

Types of changes: Dilemma of change, Pressure of change, Resistance to change Force field analysis, Change process, Overcoming the resistance to change, Approaches to Managing Organizational Change: Lewin's Three-Step Model, Creating a Culture for Change: Stimulating a Culture of Innovation, Creating a Learning Organization, Work Stress and Its Management: What Is Stress? Potential Sources of Stress, Individual Differences, Cultural Differences, temporariness, Consequences of Stress, Managing Stress, balance Work–Life Conflicts.

Definition, Importance, Motives – Characteristics, Classification of motives - Primary & Secondary motives. Theories of Motivation - Maslow's Theory of need hierarchy - Herzberg's theory, Goal-Setting, Self-Efficacy Theory , Reinforcement Theory , Equity Theory, Expectancy Theory , Motivating by Job Design: How Can Jobs BeRedesigned? Alternative Work Arrangements, Employee Involvement Programs, Using Rewards to Motivate Employees

Section2:	**Group Dynamics and Leadership, Personality, and Organizational Culture**

Concept of Group & Team, Differences Between Groups and Team, Theories of Group Formation - Formal and Informal Groups. Importance of Team building, Stages of Group Development - The Five-Stage Model, Group Decision Making, Groups versus the Individual, Problem-Solving Teams, Self-Managed Work Teams, Creating Effective Teams, Leadership, Quality Circle.

Concept of MBO technique and details, phases, Concept of personality: Development of personality – Attributes of personality, perception, values, and attitudes. Learning Behavior - Emotional Intelligence in organization. Johari window - Nature and dimensions of attitude – Developing the right attitude. Concept of Organizational Culture, Culture's Functions, Creating an Ethical. Organizational Culture, Creating a Positive Organizational Culture, What Is Spirituality? Spirituality and Organizational Culture, Why Spirituality Now? Characteristics of a Spiritual Organization, Achieving a Spiritual Organization, Criticisms of Spirituality, How a Culture Begins, Creating and Sustaining Culture, Keeping a Culture Alive.

Text Books: ***(As per IEEE format)***

1	N. Langton, S. P. Robbins, and T. A. Judge, *Fundamentals of Organizational Behaviour*, 6th ed. Toronto, ON, Canada: Pearson Education Canada, 2022.
2	S. P. Robbins and T. A. Judge, *Organizational Behavior*, 13th ed. Upper Saddle River, NJ, USA: Pearson Education, 2009.

Reference Books: ***(As per IEEE format)***

1	L. J. Mullins, *Essentials of Organisational Behaviour*, 2nd ed. Harlow, U.K.: Pearson Education, 2010.

2	I. Brooks, *Organizational Behaviour: Individuals, Groups and Organisation*, 3rd ed. Harlow, U.K.: Pearson Education, 2009.
3	R. H. Hall, *Organizations: Structures, Processes, and Outcomes*, 10th ed. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2010.
4	S. P. Robbins, *Organizational Behavior: Concepts, Controversies, and Applications*, 6th ed. Englewood Cliffs, NJ, USA: Prentice Hall, 1989.
5	H. L. Tosi and N. P. Mero, *The Fundamentals of Organizational Behavior*. Malden, MA, USA: Blackwell Publishing, 2003.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	**Program Outcome (PO)**												**PSO**			
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**	**PSO 4**
CO1	1	-	-	-	-	2	1	1	2	1	1	1	-	-	-	-
CO2	1	3	2	2	-	2	2	1	2	2	2	2	1	2	-	1
CO3	1	2	2	1	-	1	-	1	2	1	2	1	-	1	-	-
CO4	-	1	-	-	-	2	-	2	3	2	3	1	-	-	-	-
CO5	1	2	2	1	1	1	-	1	2	1	3	1	-	2	1	-
CO6	-	1	-	-	-	2	1	3	2	1	1	2	-	-	-	-
Avg	1.0	1.8	2.0	1.3	1.0	1.7	1.3	1.5	2.2	1.3	2.0	1.3	1.0	1.7	1.0	1.0

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓' indicates the knowledge profile drawn upon by the CO.

CO	**WK1**	**WK2**	**WK3**	**WK4**	**WK5**	**WK6**	**WK7**	**WK8**	**WK9**
CO1	✓	-	-	-	-	-	✓	-	-
CO2	✓	-	-	-	-	-	✓	✓	-
CO3	✓	-	-	-	-	-	-	✓	-
CO4	-	-	-	-	-	-	✓	-	✓
CO5	-	-	-	-	✓	✓	-	-	-
CO6	-	-	-	-	-	-	✓	-	✓

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO1	-	-	-	-	-	-	-
CO2	-	✓	✓	✓	-	-	-
CO3	-	-	✓	-	-	-	-
CO4	-	✓	-	-	-	-	-
CO5	-	-	-	-	-	-	✓
CO6	-	✓	-	-	-	-	-

CO – EA Mapping (Complex Engineering Activities)

'✓ indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	-	-	-	-	-
CO2	-	✓	✓	-	-
CO3	-	-	✓	-	✓
CO4	-	✓	-	✓	-
CO5	✓	-	✓	-	-
CO6	-	-	-	✓	-

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	SDG 4, SDG 8	Builds foundational understanding of organizational and managerial practices that underpin quality education in management and decent workplace environments.
CO2	SDG 8, SDG 9	Understanding organizational change equips learners to support innovation and sustain decent work conditions amid evolving industry practices.
CO3	SDG 3, SDG 8	Motivation theories connect to employee well-being and the creation of productive, decent work environments.
CO4	SDG 5, SDG 10, SDG 16	Effective, inclusive leadership promotes gender equity, reduced inequality, and strong, accountable institutional practices.
CO5	SDG 8, SDG 9, SDG 12	Applying MBO promotes efficient, goal-driven use of organizational resources, supporting responsible production and sustained economic growth.
CO6	SDG 16, SDG 5, SDG 10	Developing ethical decision-making skills underpins just, inclusive, and accountable organizational governance.

IT3225: Design and Thinking V

Teaching Scheme: Tutorial 01 Hr./week

Credits: 01

Course Prerequisites: Problem Based Learning, Project Centric Learning

Course Objective:

To provide ecosystem for students and faculty for paper publication and patent filing

Section 1: Topics/Contents

What is research?

Importance of Paper Publication and Patents

Structure of Paper

Journal Publication

Publication in conference

Literature Review

Research Paper Writing

Journal Ratings and Evaluation

How to rate a Journal?

Intellectual property (IP)

Research Ethics

Entrepreneurship

Section 2: Topics/Contents

Structure of The paper

Journal List (Top 50 Journals)

Selection of the journal

Use of various online journal selection tools

Plagiarism checking

Improving contents of the paper

Patent drafting

Patent search

Filing of patent

Writing answers to reviewer questions

Modification in manuscript

Checking of publication draft

Course Outcome: [Publication of paper or patent]

The student will be able to

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to Research
3. Apply the methodology of doing research and mode of its publication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

IT3214: ENGINEERING DESIGN AND INNOVATION V

Course Prerequisites: Problem Based Learning

Teaching Scheme Theory: 1 Hour/Week

Lab: 6 Hours/Week

Credits: 4

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposingsolutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.
6. To develop an ecosystem to promote entrepreneurship and research culture among the students.

elevance: Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course based projects, curriculum can be enriched with semester long Engineering Design and Development courses, in which students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City,Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such projects,students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the project domain, thereby achieving project centric learning. Modern world sustained and advanced through the successful completion of projects. In short, if students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquiry-based learning. Project based learning will also redefine the role of teacher as mentor in the learning process. The PCL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to analyze, design and apply

categories ofBloom's Taxonomy.

SECTION-1

Preamble - The content and process mentioned below is the guideline document for thefaculties and students to start with. It is not to limit the flexibility of faculty and students; ratherthey are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Trends in Engineering Technology" are designed as a ladder to extend connectivity of software technologies to solve real world problems using an interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:
Industry Communication Standards, Single Board Computers and IoT, Computational Biology (Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence, Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and CyberSecurities).

Suggest an assessment Scheme:

MSE and ESE

Text Books: (As per IEEE format)

1. A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017

2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, WileyPublishers. 2019.

3. Stem Project based learning and integrated science, Technology, Engineering andmathematics approach. By Robert RobartCapraro, Mary Margaret Capraro

Reference Books: (As per IEEE format)

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based and project-basedlearning in engineering. Rotterdam: Sense Publishers. 2007.

2. Project management core textbook, second edition, Indian Edition , by Gopalan.

3. The Art of Agile Development. By James Shore & Shane Warden.

Moocs Links and additional reading material:

www.nptelvideos.in

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Identify the real-life problem from societal need point of view

CO2: Choose and compare alternative approaches to select most feasible one

CO3: Analyze and synthesize the identified problem from technological perspective

CO4: Design the reliable and scalable solution to meet challenges

CO5: Evaluate the solution based on the criteria specified

CO6: Inculcate long life learning attitude towards the societal problems

Structure Module VII

Course Type	Course Code	Course Name	Assessment Scheme (100 mark scale)												
			In Semester Assessment							End Semester Assessment					Total
			Lab	CP	MSE-MCQ	MSE (R)	Sem / GD / HA			ESE			ESE Review	CVV	100
							Sem	GD	HA	W	MCQ	Pr			
S1-LLP	LLP	Linked In Learning (List of subjects attached seperately)													100
S2-OE2	IT4216	Data Management, Protection and Governance			30				10		30			30	100
S2-OE2	IT4218	Network Security			30				10		30			30	100
S3-OE3	IT4230	Cyber Securtiy and Privacy(NPTEL course)			30				10		30			30	100
S4-OE3	IT4263	Responsible & Safe AI Systems			30				10		30			30	100
S4	IT4207	Major Project				30							70		100

Course code	Course name	Total number of Contact hours				Credits
		Theory	Lab	Tut	Total Hours	
LLP	Linked In Learning (List of subjects attached separately)	2	-	-	2	2
IT4216	Data Management, Protection and Governance					
IT4218	Network Security	2	-	-	2	2
IT4230	Cyber Security and Privacy	2	-	-	2	2
IT4263	Responsible & Safe AI Systems (NPTEL course)					
IT4207	Major Project	-	20	-	20	10
	Total	**8**	**20**	**-**	**20**	**18**

Structure Module VIII

Subject	BTech Sem1/Sem2 (Internship Module)	MSE Review	Lab	ESE Review	Credits
IT4257	Industry Internship	30	-	70	16
					Total Credits-16

IT4216: DATA MANAGEMENT, PROTECTION AND GOVERNANCE

Course Prerequisites: Database Management System, Operating System

Course Objectives:

To facilitate the learner to –

1. Get acquainted with the high-level phases of data life cycle management.
2. Acquire knowledge about the various aspects of data storage, data availability,data protection.
3. Gain exposure to various solutions/reference architectures for various use-cases.
4. Understand the technical capabilities and business benefits of data protection.

Teaching Scheme

Theory: 2 Hours/Week

Credits: 2

Course Relevance: Since technology trends such as Machine Learning, Data science and AI rely on data quality, and with the push of digital transformation initiatives across the globe, data management, governance and security is very much important.

SECTION-I

Data Storage, Availability and Security

Introduction to data life cycle management (DLM): - Goals of data life cyclemanagement, Challenges involved: Volume of data source, Ubiquity of data locations, User demand for access; Stages of data life cycle - creation, storage, usage, archival, destruction; Risks involved without DLM, benefits, best practices.

Data storage and data availability :- Storage technology: Hard Disk Device (HDD), Solid State Devices (SSD), memory devices, Data access - block, files, object ; Data center End to End View – overview of complete stack including storage, network, host, cluster, applications,virtual machines, cloud storage ; Storage virtualization technologies - RAID level, storage pooling, storage provisioning ; Advance topics in storage virtualization – storage provisioning, thin provisioning; Cloud storage – S3, glacier, storage tiering;

High Availability: Introductionto high availability, clustering, failover, parallel access

Data Threats and Data center security: - Type of Threats: Denial of Service (DoS), man in the middle attacks, Unintentional data loss, Repudiation, Malicious attacks to steal data;

Introduction to Ransomware; Understanding, Identification and Threat modeling tools Security (TLS), key management, security in cloud, Design and architecture considerations for security**.**

SECTION II

Data Protection, Regulation and Governance

Introduction to data protection: - Introduction- Need for data protection, basic of back-up/restore; Snapshots for data protection, copy-data management (cloning, DevOps); De-duplication; Replication; Long Term Retention – LTR; Archival; Design considerations: System recovery, Solution architecture, Backup v/s Archival, media considerations and management (tapes, disks, cloud), challenges with new edge technology (cloud, containers)

Data regulation, compliance and governance: - Regulations requirements and Privacy Regulations: The Health Insurance Portability and Privacy Act of 1996 (HIPPA), PII (Personally Identifiable Information), General Data Protection Regulation (GDPR)

; Information Governance: Auditing, Legal Hold, Data classification and tagging (Natural Language Processing); India's Personal Data Protection bill

Applications uninterrupted: - Understand data management aspects of traditional and new edge applications; Reference architecture/best practices *(pick 2-3 case studies from belowtopics):* Transactional Databases (Oracle, MySQL, DB2), NoSQL Databases (MongoDB, Cassandra),Distributed applications (micro service architectures),Cloud applications – Platform as Service (PaaS), Software as Service (SaaS), Kubernetes, Multi-Tiered applications, ETL workloads, Data analytics (AI/ML)

List of Home Assignments:

Design:

1. Design data management aspects for cloud applications.
2. Design data management aspect for MongoDB/Cassandra.
3. Design data management aspect Distributed applications.
4. Design data life cycle management for any application.
5. Design data management for any multi-tiered application.

Case Study:

1. Consider different Transactional and NoSQL Data bases. Comparative study.
2. Compare various cloud applications based on Platform as service and Software as service.
3. Data Analytics based study for data management.
4. Study of Multi-Tiered Applications
5. Study data management in DevOps

Blog:

1. Comparative study of data protection schemes.
2. study of The Health Insurance Portability and Privacy Act of 1996 (HIPPA)
3. Need of data management, protection and governance
4. How Threat modelling tools are useful? Consider any application related to it.
5. Role of storage Technology for cloud storage.

Surveys:

1. Survey on data protection challenges with new edge technology like cloud
2. Survey on General Data Protection Regulation (GDPR)
3. Survey on Data classification and tagging in Natural Language Processing
4. Survey on Ransomware data security.
5. Survey on Kubernetes.

Suggest an assessment Scheme:

MSE, ESE, HA

Text Books: (As per IEEE format)

1. Robert Spalding, **'Storage Networks: The complete Reference'**.Vic (J.R.) Winkler, **'Securing The Cloud: Cloud Computing Security Techniques andTactics'**, Syngress/Elsevier - 978-1-59749-592-9

Reference Books: (As per IEEE format)

Martin Kleppmann, **'Designing Data-Intensive Applications'** , O'Reilly

Web References:

1. https://www.enterprisestorageforum.com/storage-hardware/storage-virtualization.html
2. https://searchstorage.techtarget.com/definition/data-life-cycle-management
3. https://www.hitechnectar.com/blogs/three-goals-data-lifecycle-management/

4. https://www.bmc.com/blogs/data-lifecycle-management/
5. https://www.dataworks.ie/5-stages-in-the-data-management-lifecycle-process/
6. https://medium.com/jagoanhosting/what-is-data-lifecycle-management-and-what- phases would- it-pass-through-94dbd207ff54
7. https://www.spirion.com/data-lifecycle-management/
8. https://www.bloomberg.com/professional/blog/7-phases-of-a-data-life-cycle/
9. https://www.datacore.com/storage-virtualization/
10. https://www.veritas.com/content/dam/Veritas/docs/solutionoverviews/
11. V0907_SB_InfoScale-Software-Defined-Infrastructure.pdf
12. https://www.veritas.com/solution/digital-compliance
13. https://www.veritas.com/solution/data-protection
14. https://www.veritas.com/gdpr

Course Outcome:

By taking this course, the learner will be able to –

1. Understand the data management world, challenges, and best practices.
2. Compare various concepts and technologies for enabling data storage and highavailability.
3. Illustrate various types of data threats and approaches to ensure data centersecurity.
4. Explain the various concepts related to data protection.
5. Outline different standards for compliance and governance of data.
6. Understand various approaches for designing data intensive enterprise applications and industry standard solutions in data management.

IT4218: NETWORK SECURITY

Teaching Scheme: 2 Hours/Week

Credits: 2

Prerequisites: Computer Networks.

Unit 1: (5 Hours)

Introduction

Introduction to Security: Vulnerabilities, Threats, Threat Modeling, Risk, attack, and attack types,Avoiding attacks, Security services.

key security properties - Confidentiality, Integrity, Availability.

Protocol Vulnerabilities: DoS and DDoS, session hijacking, ARP spoofing, Pharming attack, DictionaryAttacks.

Software vulnerabilities: Phishing, buffer overflow, Cross-site scripting attack, Virus and Worm Features, Trojan horse, Social engineering attacks, ransomware, SYN-Flooding, SQL-injection, DNSpoisoning, Sniffing

Unit 2: (4 Hours)

Private key cryptography

Mathematical background for cryptography: modulo arithmetic, GCD (Euclids algorithm), Role of random numbers in security, Importance of prime number, DES, AES.

Chinese remainder theorem

Unit 3: (5 Hours)

Public key cryptography

RSA: RSA algorithm, Key generation in RSA, attacks on RSA.

Diffie-Hellman key exchange: Algorithm, Key exchange protocol, Attack.

Elliptic Curve Cryptography (ECC), Elliptic Curve arithmetic. Diffie-Hellman key exchange

Unit 4: (5 Hours)

Authentication and access control

Message authentication and Hash Function. Authentication: One-Way Authentication, Mutual Authentication, SHA-512, The Needham-Schroeder Protocol.

Kerberos, X.509 authentication service, public key infrastructure.

Access Control in Operating Systems: Discretionary Access Control, Mandatory Access Control, RoleBased Access Control.

Unit 5: (5 Hours)

Security application and design

Part A: Network layer security: IPSec for IPV4 and IPV6.Transport layer security: SSL and TLS. Application layer security: Security services, S/MIME, PGP, Https, Honey pots.

Security design: End-to-end security, Security composability, Open design, Cost and tradeoffs

Unit (4 Hours)

Cyber Security:

Cyber Attack, Cyber Reconnaissance, Crimes in Cyber Space-Global Trends & classification, e-commerce security, Computer forensics, facebook forensic, mobile forensic, cyber forensic, digital forensic

Text Books

1. *"Cryptography and Network Security-Principles and Practices" by William Stallings, PearsonEducation, 2006, ISBN 81-7758-774-9, 4th Edition.*

2. *"Network Security and Cryptography", by Bernard Menezes, Cengage Learning, 2010, ISBN 81-315-1349-1, 1st Edition.*

Reference Books

1. "Computer Security: Art and Science", by Matt Bishop, Pearson Education, 2002, ISBN 0201440997, 1st Edition.

2. "Network security, private communication in a public world", by Charlie Kaufman, Radia Perlmanand Mike Spencer, Prentice Hall, 2002, ISBN 9780130460196, 2nd Edition.

3. "Cryptography and Information Security", by V.K. Pachghare, PHI, 2015, ISBN-978-81-203-5082-3, Second Edition.

Additional Reading

1."Security architecture, design deployment and operations", by Christopher M. King, Curtis Patton andRSA press, McGraw-Hill, 2001, ISBN 0072133856, 1st Edition.

2 'Inside Network Perimeter Security" by Stephen Northcott, Leny Zeltser, et al, Pearson Education Asia,ISBN 8178087618, 1st Edition.

Course Outcomes

Upon completion of the course, the students will be able to:

1) Analyze cryptographic techniques using a mathematical approach by examining nature of attack.

2) Establish type of attack on a given system.
3) Identify different types of attacks.
4) Justify various methods of authentication and access control for application of technologies.
5) Design a secure system for protection from the various attacks for 7-layer model by determining the need of security from various departments of an organization.
6) Estimate future needs of security for a system by researching current environment on a continuous basis for the benefit of society various sections of industry and society.

IT4230: Cyber Security and Privacy

Course Prerequisites: Computer Network, Information System, A core course on Management Information Systems desirable (not mandatory)

Course Objectives:

1. To understand foundation of information security and related concepts
2. To study security management and planing
3. To understand security policies and strategies
4. To learn cryptography for security, regulatory frameworks
5. To emphasize the importance of economics of privacy

Teaching Scheme Theory: 1 Hour/Week

Credits:2

Course Relevance: This NPTEL course introduces the concepts, technologies, practices and challenges associated with cybersecurity as applied in organizations. Protection as well as disclosure of information pose unique challenges and also allude to economic and technological implications.

SECTION-I

Unit I

Week 1: Foundations, cyber security, information security and related concepts, Principles of information security management, Confidentiality, Integrity, Availability and related concepts.

UNIT II

Week 2: Security management, Governance, Risk and Compliance (GRC) , Contingency planning, incidence response, disaster recovery and business continuity.

UNIT III

Week 3: Understanding security policy, security behavior, Risk management: Risk identification, threat modeling, strategies.

SECTION-II

UNIT IV

Week 4 : Control strategies and protection mechanisms, Cryptography for security.

UNIT V

Week 5: Information security and privacy, Regulatory landscape: Fair information practices, US regulatory frameworks.

Week 6: Regulatory landscape: EU's GDPR and its implications and other privacy and cyber security regulations, Cyber security and privacy in the Indian context, evolution and issues.

UNIT VI

Week 7: Economics of privacy, privacy calculus and trade-offs, privacy paradox, managing stakeholders, making choices on security and privacy

Suggest an assessment Scheme:

MSE, ESE, Home Assignment, CVV

NPTEL Course Link:

https://onlinecourses.nptel.ac.in/noc23_cs127/preview

The student will be able –

1) To understand principles of information security management (2)
2) To study security management and planning (2)
3) To understand security policies and strategies for risk management (3)
4) To learn cryptography for security. (3)
5) To discuss cyber security regulations (2)
6) To explain the importance economics of privacy. (3)

FFNo:654

IT4263: Responsible & Safe AI Systems

Prerequisites: Any level of machine learning / AI course would help, it is not mandatory though

COURSE LAYOUT

Week 1 & 2:

- AI Capabilities Improvement in last 5-10 years
- Imminent risks from AI Models: Toxicity, bias, goal misspecification, adversarial examples etc.
- Long-term risks from AI Models: Misuse, Mis generalization, Rogue AGI
- Principles of RAI - Transparency; Accountability; Safety, Robustness and Reliability; Privacy and Security; Fairness and non-discrimination; Human-Centered Values; Inclusive and Sustainable development, Interpretability
- Recap of Deep Learning Techniques, Language/Vision Models
- AI Risks for Gen models
- Adversarial Attacks – Vision, NLP, Superhuman Go agents

Week 3 & 4:

- ML Poisoning Attacks like Trojans
- Implications for current and future AI safety
- Explainability
- Imminent and Long-term potential for transparency techniques
- Mechanistic Interpretability
- Representation Engineering, model editing and probing
- Critiques of Transparency for AI Safety

Week 5 & 6:

- Privacy & Fairness in AI

Week 7 & 8:

- Metrics and Tools for RAI - measuring bias/fairness, adversarial testing, explanations (Lime/SHAP/GradCam), audit mechanisms
- Regulation landscape - DPDP act (India), GDPR (EU), EU AI act, US presidential declaration, Ethical approvals, informed consent, participatory design, future of work, Indian context

- What is AGI? When could it be achieved?
- Instrumental Convergence: Power Seeking, Deception etc.

Week 9 & 10:

- RAI in Legal domain
- RAI in Health care domain
- RAI in Education domain
- A few other domains
- Policy issues in RAI

Week 11 & 12:

- Couple of panel discussion with industry practitioners, academic, government (possibly), and others.
- Fireside chat with eminent personalities
- Recorded Paper reading discussion

IT4207: MAJOR PROJECT

Teaching Scheme Lab: 20 hours/week

Credits: 10

Course Relevance:

This is a culmination of four years of learning into Practical. This course is essential forGraduate Engineers to practice the successful management of a software development project. The course emphasizes on project life cycle phases requirement engineering, system analysis andsystem design and gives them the exposure to research in any area of their interest. A further aimis for students to heighten personal awareness of the importance of developing strategies for themselves and It is a way of increasing the student's maturity and preparing him/her for their future career. The students carry out cutting edge projects with a flexibility to balance between research- and application-oriented work as per their interest. The program enables the students to find opportunities for higher studies in top ranking universities abroad, and to find jobs in dream companies.

The Motivation for this Major Project is

a. Synthesis of knowledge
b. To demonstrate the aptitude of applying the own knowledge to solve a specific problem.
c. To mature the knowledge.
d. Preparation for joining the working world.

The Project Work can lead to:

a. Novice algorithm development
b. Optimization of existing system/method
c. New state of the art application
d. Some incremental work in any existing field of their choice

Overview of the Course:

1. The Student Project Group is expected to make a survey of situation for identifying the requirements of selected Technological Problem. The Student Project Group will be monitored by Internal Guides and External Guides (if any).
2. The project requires the students to conceive, design, implement and operate a mechanism (the design problem). The mechanism may be entirely of the student's own design, or it may incorporate off-the-shelf parts. If the mechanism incorporates off-the-shelf parts, the students must perform appropriate analysis to show that the parts are suitable for their intended purpose in the mechanism.
3. The project must be open-ended – meaning that there is not a known correct answer to the design problem. Students are expected to apply their creativity (simply copying orre-creating something that already exists is not acceptable).
4. The project must have an experimental component. Students must conceive, design,

implement and operate an appropriate experiment as part of the project. The experiment might be to collect data about some aspect of the design (i.e., to verify that the design will work as expected). Alternatively, the experiment could be to verify that the final mechanism performs as expected.

2. Upon receiving the approval, the Student Project Group will prepare a preliminary project report consisting Requirement Definition Document, Feasibility Study Document, System Requirement Specification, System Analysis Document, Preliminary System Design Document. All the documents indicated will have a prescribed format.
3. The Project Work will be assessed jointly by a panel of examiners having more than Five Years experience. The Project Groups will deliver the presentation of the Project Work which will be assessed by the panel.
4. The Student Project Group needs to actively participate in the presentation. The panel of examiners will evaluate the candidate's performance based on presentation skills, questions based on the Project Work, understanding of the Project, analysis and designperformed for the project.
5. The Student Project Groups are expected to work on the recommendations given bythe panel of examiners. In no case any variation in Project Theme will be

permitted.

6. The outcome of the project should be tangible in terms of paper publication/patent/SOP/prototype

7. The Project should justify the work worth 10 credits.

Assessment Scheme

Sr. No.	Content	Marks
1	Development of Prototype/ Model	20
2	Innovativeness and intellectual input	20
3	evaluation of literature review	10
4	Individual contribution	10
5	Usage of Modern Tool/ Technology and experimental competency	10
6	Presentation of the Project Work	10
7	Results and analysis	10
8	Quality Publication and Project Report	10

Note:

The student needs to identify a technological problem in the area of Computer Engineering or Information Technology of their choice like signal processing, computer vision, machine learning and artificial intelligence, control systems, game theory, and communication networks and address the problem by formulating a solution for the identified problem. The project work needs to be undertaken by a group of maximum FOUR and minimum of THREE students. The Project work will be jointly performed by the project team members.

The Project Group will prepare a synopsis of the project work which will be approved by the concerned faculty member. The project should not be a reengineering or reverse engineering project. In some cases, reverse engineering projects will be permissible based on the research component involved in it. The project work aims at solving a real-world technical problem. Hence ample literature survey is required to be done by the students. Application-oriented projects will not be acceptable. Low-level custom User Interface development and its allied mapping with a particular technology will not be accepted.

Following is the list of recommended domains for Project Work: signal processing, computer vision, machine learning and artificial intelligence, IoT, BlockChain, Image Processing, data Science etc.

Course Outcomes:

Upon completion of the course, graduates will be able to -

1. Model the Real-World Problem
2. Identify the Design within Specification and Available Resources
3. Realize the Solution within Defined references
4. Defend his Design with Technical and Ethical reasoning
5. Adapt to changing Technological and Human resource advances
6. Use the gained knowledge for other Real-World Problems
7. Project will involve development of a compact solution to current problem/s in chosenfield.

IT4257: INDUSTRY INTERNSHIP

Credit: 16

Course Relevance: Implementation of technical knowledge acquired during previous three yearsof Internship and to get acquainted with Industry culture.

SECTION-1

Get used to corporate culture

Realization of Internship as per problem statement Design, Testing / Experimentation, Analysis / ValidationDocumentation and Report Writing

Quality of Work

Performance in Question & Answers SessionRegular interaction with guide

SECTION-2

Problem Statement

Literature Review

Clarity about the objectives of Internship ActivityRequirement Analysis, Internship Planning

Knowledge of domain, Latest technology, and modern tools used /to be used

Neat project documentation

Suggest an assessment Scheme:

MSE review for 50 marks converted to 30ESE review for 100 marks converted to 70

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Explore career alternatives prior to graduation.CO2: Integrate theory and practice.

CO3: Develop work habits and attitudes necessary for job success.

CO4: Develop communication, interpersonal and other critical skills in the job interview process. CO5: Acquire employment contacts leading directly to a full-time job following graduation from college.

CO6: Practice Project Management and learn team dynamics