Course Type	Course Code	Course Name	Credits
PCC	ITPCC509	AUTOMATA THEORY	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ITPCC301- Engineering Mathematics-III

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design /Development of Solution
4. PO 4: Conduct investigation of Complex Problem
5. PO 8: Individual and Collaborative Team work
6. PO 9: Communication
7. PO 11: Life-long learning

Course Objectives:

1. To enable students to comprehend and apply the concepts of formal languages, including alphabets, strings, regular expressions, and grammars, and to analyze their properties and closure operations in computational systems.
2. To equip students with the ability to design, analyze, and differentiate between deterministic (DFA) and non-deterministic finite automata (NFA), and to convert regular expressions to finite automata for language recognition and validation.
3. To provide students with the knowledge to construct and simplify context-free grammars (CFG), convert them to Chomsky and Greibach normal forms, and design pushdown automata (PDA) for parsing and recognizing context-free languages.
4. To help students understand the theoretical foundations of Turing Machines (TM), including deterministic and non-deterministic variants, and to analyze the halting problem and its implications on the limits of computability.
5. To enable students to apply automata theory, including finite automata, context-free grammars, pushdown automata, and Turing machines, in practical applications such as lexical analysis, syntax parsing, pattern matching, and compiler design.

Module	Details	Hrs.
00.	**Course Introduction** This course delves into the theory behind computation, formal languages, and abstract models, exploring topics such as finite automata. It has practical applications in algorithmic complexity, compiler construction, and artificial intelligence. By understanding the boundaries and potentials of computational systems, it equips students to design efficient algorithms and advance artificial intelligence development.	01
01.	**Introduction and Regular Languages:** ***Learning Objective:*** *To make learner able to apply fundamental and theoretical engineering principles to analyze and construct alphabets, strings, regular expressions, and grammars. Evaluate and compare closure properties and problem statements involving language recognition and classification.* **Contents:** Languages: Alphabets and Strings. Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL grammars, Closure properties ***Self-Learning Topics:*** *Applications of Regular Expressions in Real-World Scenarios (e.g., text processing, search algorithms).* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply fundamental engineering principles to analyze alphabets, strings, and regular languages, demonstrating their role in formal language theory. (P.I. 1.3.1)* *LO 1.2: Apply theoretical principles of computer science to construct and interpret regular expressions, regular grammars, and different types of regular languages. (P.I. 1.4.1)* *LO 1.3: Evaluate problem statements involving language recognition and define objectives for analyzing regular and context-free grammars, including RL and LL grammars. (P.I. 2.1.1)* *LO 1.4: Compare and contrast various closure properties of regular languages, selecting the most efficient method for solving problems related to language classification. (P.I. 2.2.4)*	06-08
02.	**Finite Automata:** ***Learning Objective:*** *To make learner able to evaluate and analyze problem statements related to Finite Automata (FA), including DFA, NFA, and their equivalence. Compare methods for FA minimization, explore design alternatives for Moore and Mealy Machines, and validate their conversions through testing and analysis.* **Contents:** Finite Automata: FA as language acceptor or verifier, NFA (with and without ε), DFA, RE to NFA, NFA to DFA, Reduced DFA, NFA-DFA equivalence, FA to RE. Finite State Machines with output: Moore and Mealy machines. Moore and Mealy M/C conversion. Limitations of FA. ***Self-Learning Topics:*** *Applications of Finite Automata in Compiler Design (e.g., lexical analysis).* *Comparison of Moore and Mealy Machines in Real-World Systems (e.g., vending machines, traffic light controllers).* ***Learning Outcomes:***	07-09

	A learner will be able to *LO 2.1: Evaluate problem statements related to Finite Automata (FA) and define objectives for analyzing DFA, NFA, and their equivalence in language recognition. (P.I. 2.1.1)* *LO 2.2: Compare and contrast alternative methods for FA minimization and transformation, selecting the most efficient process for converting FA to RE and DFA reduction. (P.I. 2.2.5)* *LO 2.3: Explore various design alternatives for constructing Moore and Mealy Machines and analyze their functional differences in system design. (P.I. 3.2.1)* *LO 2.4: Verify and validate the correctness of Moore-Mealy machine conversion through testing and analysis, ensuring functional consistency in state-based system design. (P.I. 3.4.3)*	
03.	**Context Free Grammars:** ***Learning Objective**:* *To make learner able to apply fundamental engineering and theoretical principles to define, describe, and analyze Context-Free Grammars (CFGs) and their derivations. Evaluate CFG-based problem statements, identify ambiguity, and compare simplification techniques like CNF and GNF for computational efficiency.* **Contents:** Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification and Normalization (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3) ***Self-Learning Topics:** Applications of Context-Free Grammars in Programming Languages (e.g., syntax analysis in compilers).* *Comparison of CNF and GNF in Parsing Algorithms (e.g., efficiency and usability).* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply fundamental engineering knowledge to define and describe the characteristics of Context-Free Grammars (CFGs) and their role in formal language theory. (P.I. 1.3.1)* *LO 3.2: Apply theoretical principles of computation to analyze derivations in CFGs and demonstrate the impact of leftmost and rightmost derivations on parse trees. (P.I. 1.4.1)* *LO 3.3: Evaluate CFG-based problem statements and define clear objectives for identifying ambiguity and grammar simplification methods. (P.I. 2.1.1)* *LO 3.4: Compare and contrast different CFG simplification techniques, including CNF and GNF, to determine the most efficient form for computational applications. (P.I. 2.2.4)*	**06-08**
04.	**Push Down Automata:** ***Learning Objectives:*** *To make learner able to apply engineering and computational principles to define and analyze Context-Free Grammars (CFGs) and their derivations. They will also evaluate CFG-based problems, identify ambiguities, and compare simplification techniques to determine the most efficient forms for computational applications.* **Contents:** Push Down Automata: Deterministic (single stack) PDA, Equivalence between PDA and CFG. Power and Limitations of PDA. ***Self-Learning Topics:** Applications of PDA in Compiler Design (e.g., parsing context-free languages).* *Comparison of PDA with Finite Automata (e.g., expressive power and limitations).* ***Learning Outcomes:***	**06-08**

	A learner will be able to *LO 4.1: Apply computer engineering principles to design and analyze Pushdown Automata (PDA) for recognizing Context-Free Languages (CFL) with required applicability and performance. (P.I. 2.3.1)* *LO 4.2: Apply mathematical foundations to implement PDA transitions and validate their correctness through computational analysis. (P.I. 2.4.1)* *LO 4.3: Explore design alternatives for constructing PDAs and evaluate their efficiency in recognizing various types of languages. (P.I. 3.2.1)* *LO 4.4: Verify and validate PDA functionalities by testing equivalence with Context-Free Grammars (CFG) to ensure correctness in language recognition. (P.I. 3.4.3)*	
05.	**Turing Machine:** ***Learning Objective/s:*** *To make learner able to design and simulate Turing Machine models to solve computational problems, comparing different types of Turing Machines for efficiency. They will also validate state transitions, explore the Universal Turing Machine, and analyze undecidability using the Halting Problem.*	**07-09**
	Contents: Turing Machine: Definition and components of a Deterministic Turing Machine, Transition function, state transitions, and tape movements in a DTM. Non-deterministic Turing Machine (NDTM) and its differences from DTM, Multi-tape Turing Machines: Introduction, design, and comparison with single-tape TMs, Universal Turing Machine (UTM) and its significance in the theory of computation. Statement and formal definition of the Halting Problem, Proof of the undecidability of the Halting Problem using a diagonalization argument, Implications of the Halting Problem on the limits of computability.	
	Self-Learning Topics: *Applications of Turing Machines in Modern Computing (e.g., theoretical models of computation).* *Comparison of Turing Machines with Finite Automata and Pushdown Automata (e.g., expressive power and limitations).*	
	Learning Outcomes :	
	A learner will be able to *LO 5.1: Apply computer engineering principles to design Turing Machine (TM) models for solving computational problems with required performance and applicability. (P.I. 2.3.1)* *LO 5.2: Compare and contrast single-tape, multi-tape, deterministic, and non-deterministic Turing Machines to identify the most efficient computational model for a given problem. (P.I. 2.2.4)* *LO 5.3: Explore design alternatives for constructing and simulating Turing Machines, evaluating their efficiency in solving complex computational problems. (P.I. 3.2.1)* *LO 5.4: Verify and validate the correctness of state transitions and tape movements in a Turing Machine by testing against computational problems. (P.I. 3.4.3)* *LO 5.5: Define the Universal Turing Machine (UTM) and investigate its significance in the theoretical foundations of computation, including its scope and importance. (P.I. 4.1.1)* *LO 5.6: Design and develop methodologies for proving undecidability using the Halting Problem, analyzing its implications on the limits of computability. (P.I. 4.2.1)*	
06.	**Applications of Automata:**	**05-07**

Learning Objective/s:

To make learner able to design and analyze automata-based models for lexical analysis, syntax parsing, and language processing, understanding their applications in compiler design and text processing. They will also collaborate effectively, produce structured technical reports, and stay updated with advancements in computational linguistics and sustainable computing practices.

Contents:

Finite Automata (FA): String Recognition: FA is used for recognizing regular languages, making it applicable in lexical analysis in compilers.

Pattern Matching: FA is employed in searching for specific patterns within strings.

Context-Free Grammars (CFG): Syntax Analysis in Compilers: CFGs are fundamental in defining the syntax of programming languages and are crucial in compiler design for parsing source code.

Natural Language Processing: CFGs are utilized to model the syntax of natural languages, aiding in parsing and understanding sentences.

Pushdown Automata (PDA): Parsing in Compiler Design: PDAs are essential in the design of parsers for context-free grammars during the syntax analysis phase of compilers.

Balanced Parentheses Checking: PDAs can be employed to recognize languages involving balanced parentheses, brackets, or nested structures.

Expression Evaluation: PDAs can be used to evaluate arithmetic expressions by keeping track of the stack.

Turing Machines (TM): Algorithm Analysis: TMs help in understanding the fundamental limits of computation and analyzing the efficiency of algorithms.

Simulating Computations: TMs can simulate any algorithmic process, providing a theoretical foundation for computational studies.

Introduction to Compiler and Its Phases.

Self-Learning Topics: *Applications of Finite Automata in Network Security (e.g., intrusion detection systems).*

Use of Pushdown Automata in Designing Programming Language Interpreters (e.g., Python, Java).

Learning Outcomes:

A learner will be able to

LO 6.1: Define and investigate the role of Finite Automata (FA) in lexical analysis and pattern matching, interpreting its technical applications in compiler design and text processing while analyzing sourced information for feasibility and sustainability. (P.I. 4.1.1, 9.1.1, 11.3.2)

LO 6.2: Design and implement Context-Free Grammars (CFGs) for syntax analysis, programming language parsing, and natural language processing, while understanding the societal relevance of computational linguistics and the importance of staying updated with advancements in the field. (P.I. 4.2.1, 11.2.2)

LO 6.3: Define and investigate the working of Pushdown Automata (PDA) in parsing, balanced parentheses checking, and expression evaluation, collaborating effectively in teams and communicating technical findings through structured documentation. (P.I. 4.1.1, 8.2.1,9.1.2)

LO 6.4: Design and develop automata-based computational models for compiler design and language processing applications, evaluating their broader impact on

	modern software development and sustainable computing practices. (P.I. 4.2.1, 11.3.2) *LO 6.5: Collaborate in teams to analyze and explore the role of Turing Machines (TM) in algorithm analysis and computational theory, discussing their significance in understanding the limits of computation while recognizing the need for continuous learning. (P.I. 4.1.1, 8.3.1, 11.2.2)* *LO 6.6: Produce well-structured technical reports and presentations on case studies related to automata applications, ensuring clarity in communication while analyzing technical information for feasibility and sustainability. (P.I. 4.2.1, 9.1.2, 11.3.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
2.4.1	Applies engineering mathematics to implement the solution.
3.2.1	Ability to explore design alternatives.
3.4.3	Ability to verify the functionalities and validate the design.
4.1.1	Define a problem for purposes of investigation, its scope and importance
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and nontechnical information
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Analyze and construct regular expressions, grammars, and languages, evaluate language recognition problems, and compare closure properties to solve classification problems using theoretical principles of computer science and formal language theory. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Design, analyze, and differentiate between deterministic (DFA) and non-deterministic finite automata (NFA), and convert regular expressions to finite automata for language recognition and validation. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Construct, simplify, and classify context-free grammars (CFG), resolve ambiguity, and apply Chomsky hierarchy concepts to design pushdown automata (PDA) for parsing and

recognizing context-free languages. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*

4. Design and analyze Turing Machines (TM), prove the undecidability of the Halting Problem, and evaluate its implications on the limits of computability and theoretical computer science. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)*
5. Design and analyze Finite Automata (FA), Context-Free Grammars (CFGs), Pushdown Automata (PDA), and Turing Machines (TM) for applications in lexical analysis, syntax parsing, compiler design, and computational theory, while evaluating their societal impact and communicating findings through structured technical reports and collaborative discussions. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, LO 6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPCC509.1	3	3	-	-	-	-	-	-	-	-	-
ITPCC509.2	-	3	3	-	-	-	-	-	-	-	-
ITPCC509.3	3	3	3	-	-	-	-	-	-	-	-
ITPCC509.4	-	3	3	3	-	-	-	-	-	-	-
ITPCC509.5	-	-	-	3	-	-	-	3	3	-	3
Average	**3**	**3**	**3**	**3**	-	-	-	**3**	**3**	-	**3**

Text Books :

1. Introduction to languages and the Theory of Computation, J. C. Martin, Fourth edition, 2010, McGraw-Hill Education.
2. Theory of Computation A Problem Solving Approach, Kavi Mahesh, Kindle Edition, 2011, Wiley India.

Reference Books :

1. Theory of Computation, Vivek Kulkarni, Kindle Edition, 2013, Oxford University Press.
2. Theory of Computer Science, Automata Languages & Computations, N. Chandrashekhar, K.L.P. Mishra, Third edition, 2006, PHI publications.

Other Resources :

1. NPTEL Course: Introduction to Automata, Languages and Computation, by Prof. Sourav Mukhopadhyay, Computer Science and Engineering, IIT Kharagpur: -
   Web link - https://onlinecourses.nptel.ac.in/noc21_cs19/preview
2. NPTEL Course: Theory of Automata, Formal Languages and Computation, by Prof. Kamala Krithivasan, Computer Science and Engineering, IIT Madras: -
   Web link - https://archive.nptel.ac.in/courses/106/106/106106049/#

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

a) One MCQ Test as per GATE exam pattern / level: 05 Marks
b) Article reading with report writing: 05 Marks
c) Class Test: 05 Marks
d) Regularity and active participation:05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B.END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	ITPCC510	ARTIFICIAL INTELLIGENCE	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ITPCC301: Engineering Mathematics-III
2. ITPCC405: Engineering Mathematics-IV
3. ITPCC303: Data Structures & Analysis

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct Investigation of complex problems
5. PO5: Engineering tool usage
6. PO6: The Engineer and The World
7. PO8: Individual and Collaborative Teamwork
8. PO9: Communication
9. PO11: Life-long Learning

Course Objectives:

1. To impart the basic ideas and techniques underlying the design of intelligent systems.
2. To impart the knowledge of mechanism of mind that enables intelligent thought and action.
3. To introduce advanced representation formalism, search techniques, planning and learning techniques to solve problems and to design AI systems.
4. To introduce the methods to analyse and process uncertain and incomplete information.

Module	Detailed Contents	Hrs
00.	**Course Introduction** Artificial Intelligence course deals with techniques to tackle complex real-world problems with various AI techniques and rigorous mathematical tools. This course includes the foundational principles and practice implementing various AI systems.	01
01.	**Introduction to Artificial Intelligence** ***Learning Objective/s:*** *To formulate the problem and apply the concept of various intelligent agents to real time applications.*	04-06

	Contents: **Artificial Intelligence:** Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI **Intelligent Agents:** Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent, Agent Environments PEAS representation for an Agent. Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems	
	Self-Learning Topics: *Explore applications and current trends of AI.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Formulate the given problem and identify its components. (P.I.-2.2.1)* *LO 1.2: Identify appropriate type of an agent, PEAS parameters and task environment for the given problem. (P.I.-2.1.2)* *LO 1.3: Solve the given problem using different type of agents. (P.I.-3.2.1)* *LO 1.4: Select the optimal solution for the given problem based on the requirement of the problem. (P.I.-3.2.2)*	
02.	**Problem Solving** ***Learning Objective/s:*** *To apply searching techniques to find the optimal solution. Also expected to implement the various adversarial methods for game playing.*	**09-11**
	Contents: **Search Methods:** Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search **Local Search Algorithms and Optimization Problems:** Hill climbing search, Simulated annealing, Genetic algorithms **Constraint Satisfaction Problem Solving:** Crypto-Arithmetic Problem, Water Jug, Graph Coloring **Adversarial Search:** Game Playing, Min-Max Search, Alpha Beta Pruning **Demonstration of Search Techniques using open source tool**	
	Self-Learning Topics: *IDA*, SMA*.* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply the constraint satisfaction fundamentals to solve the problem. (P.I.-1.3.1)*	

	LO 2.2: Apply Artificial intelligence methods to solve problem (P.I.-1.4.1) *LO 2.3: Identify the heuristic functions for the given problem to get optimal solution. (P.I.- 2.2.3)* *LO 2.4: Select and apply best searching method to solve a given problem. (P.I.- 2.2.4)*	
03.	**Knowledge and Reasoning** ***Learning Objective/s:*** *To acquaint the knowledge of various types of knowledge representation and apply it to solve problem. Also expected to analyze the inferences drawn using belief network and fuzzy logic.*	**09-11**
	Contents: **Knowledge Representation:** Knowledge based Agents, WUMPUS WORLD Environment, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, forward chaining, backward Chaining. Knowledge Engineering in First-Order Logic, Unification, Resolution **Uncertain Knowledge and Reasoning:** Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network, Markov decision process, Fuzzy Set Theory: Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Fuzzy Max-Min and Max-Product Composition, Membership function, Fuzzy extension principle, Fuzzy Systems- fuzzification, defuzzification methods, and design of fuzzy controllers. **Demonstration of knowledge representation and reasoning system using open source tool**	
	Self-Learning Topics: *Explore more inference mechanisms.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply the knowledge based agent to solve the given problem (P.I.-1.3.1)* *LO 3.2: Apply the predicate and first order logic methods to prove the given fact or to find solution (P.I.-1.4.1)* *LO 3.3: Solve the given problem using the different methods to handle uncertainty. (P.I.-2.2.3)* *LO 3.4: Identify the fuzzy logic solution to solve an uncertain problem. (P.I.-2.1.3)* *LO 3.5: Design the fuzzy controllers to develop a sustainable solution for a given problem. (P.I.-3.1.1, 6.4.2)* *LO 3.6: Verify and validate the design of a fuzzy controller by identifying the risks/impacts of rule base design process. (P.I.-3.4.3, 6.3.1)*	
04.	**Planning** ***Learning Objective/s:*** *To apply the knowledge of planning to solve a problem by decomposing it in to sub problems.*	**03-05**
	Contents: The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. **Demonstration of Planning techniques using open source tool**	

	Self-Learning Topics: *Representing real world problems as planning problems.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Define a precise problem statement and analyse the impact of causal link constraints. (P.I.-3.1.1, 6.3.1)* *LO 4.2: Design and develop the sustainable planning solution to a real world problem. (P.I.-3.2.2, 6.4.2)*	
05.	**Learning** ***Learning Objective/s:*** *To apply the learning to a network also expected to analyze and interpret the result.*	**04-05**
	Contents: Types of Learning, McCulloch Pitt model, Hebb Network, Linear separability. Supervised Learning algorithms: Perceptron (Single Layer, Multilayer), Delta learning rule, Back Propagation algorithm. Un-Supervised Learning algorithms: Winner take all, Self-Organizing Maps, Learning Vector Quantization, Introduction to reinforcement learning **Demonstration of Learning techniques using open source tool**	
	Self-Learning Topics: *PAC Learning*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply the Artificial neural concept to solve problem. (P.I.-1.1.1)* *LO 5.2: Apply the different learning methods to solve a problem. (P.I.-1.4.1)*	
06.	**AI Applications & Recent trends** ***Learning Objective/s:*** *To apply the concepts of artificial intelligence to design and analyze the real life applications.*	**08-10**
	Contents: **Applications:** Expert System Introduction to NLP- Language models, Grammars, Parsing Robotics - Robots, Robot hardware, Problems Robotics can solve AI applications in Healthcare, Retail, Banking **Recent trends:** Explainable AI, Responsible AI, Generative AI	
	Self-Learning Topics: *Cognitive AI*	

	Learning Outcomes: *The learner will be able to* *LO 6.1: Define a problem statement along with the research gap and identify risk/impact of industrial practice on society and environment., Choose and apply AI technique and tool, to design a solution, and effectively present the solution. (P.I.- 3.1.1,4.1.1,5.1.1, 6.3.1,8.2.1,9.1.1,11.1.2)* *LO 6.2: Identify the recent AI technique alternative to traditional techniques for the selected problem, use it to design a sustainable solution with AI tool and effectively present the solution in a team. (P.I.- 3.2.1,4.2.1,5.2.2, 6.4.2,8.3.1,9.1.2,11.2.1)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem.
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods
3.1.1	Able to define a precise problem statement with objectives and scope.
3.2.1	Ability to explore design alternatives.
3.2.2	Ability to produce a variety of potential design solutions suited to meet functional requirements.
3.4.3	Ability to verify the functionalities and validate the design.
4.1.1	Define a problem for purposes of investigation, its scope and importance
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities.
5.2.2	Demonstrate proficiency in using discipline specific tools.
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
6.4.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.3.1	Present result as a team, with smooth integration of contributions from all individual efforts.

9.1.1 Read, understand and interpret technical and nontechnical information.

9.1.2 Produce clear, well- constructed, and well-supported written engineering documents.

11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

11.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap.

Course Outcomes:

A learner will be able to

1. Formulate and solve the problem using modern tools for development of sustainable solution by analyzing the impact of different types of agent. *(LO 1.1, LO1.2, LO1.3, LO1.4, LO 6.1, LO 6.2)*

2. Select and Apply the appropriate searching method to solve the given problem. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*

3. Analyse and Apply an appropriate knowledge-representation and planning models to solve the real world problems by evaluating societal and environmental aspects on the design of models. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6, LO 4.1, LO 4.2)*

4. Apply learning techniques to solve a given problem. *(LO 5.1, LO5.2)*

5. Design and develop AI applications in real world scenarios using AI tools and effectively present the solution. *(LO 6.1, LO 6.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPCC510.1	-	3	3	3	3	3	--	3	3	-	3
ITPCC510.2	3	3	-	-	-	-	-	-	-	-	-
ITPCC510.3	3	3	3	-	-	3	-	-	-	-	-
ITPCC510.4	3	-	-	-	-	-	-	-	-	-	-
ITPCC510.5	-	-	3	3	3	3	--	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**	**3**	-	**3**

Text Books :

1. Artificial Intelligence: A Modern Approach ,Stuart J. Russell and Peter Norvig, Fourth Edition" 2020, Pearson Education.
2. Artificial Intelligence ,Saroj Kaushik, First edition, 2011,Cengage Learning,
3. Artificial Intelligence, George F Luger, Fourth edition, 2005, Pearson Education.

Reference Books :

1. Principles of Artificial Intelligence, Nils J. Nilsson, First Edition,1990, Narosa Publication.
2. A First Course in Artificial Intelligence, Deepak Khemani, Sixth Edition.2018, McGraw Hill Publication
3. Artificial Intelligence ,Patrick H. Winston, 3rd edition, 1993,Pearson Education.
4. Artificial Intelligence, Elaine Rich and Kevin Knight, Third Edition,2017, McGraw Hill Education,

Other Resources :

1. NPTEL Course: Artificial Intelligence, Prof. S. Sarkar, Prof. P. Mitra, IIT Kharagpur
   Web Link- https://nptel.ac.in/courses/106105078
2. NPTEL Course: Artificial Intelligence, Prof. P. Dasgupta, IIT Kharagpur
   Web Link- https://nptel.ac.in/courses/106105079

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One Assignment on live problems/ case studies: 10 Marks

Students should be assigned a real life problem statement (different for each student). Students are expected to research and collect required resources to solve the problem. They can use the resources and solve the problem on assigned date and time in Institute premises in presence of faculty member. This assignment should be graded for 10 marks depending on the parameters as analysis, design, application of appropriate AI technique and outcome for selected problem statement.

b) One Think Pair Share (TPS) activity: 05 Marks

c) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC5011	ANALYSIS OF ALGORITHMS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ITPCC303: Data structure & Analysis
2. ITPCC405: Engineering Mathematics-IV

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3 : Design/development of solutions
4. PO8: Individual and Collaborative Team work
5. PO9: Communication

Course Objectives :

1. To provide mathematical background for analysis of algorithm
2. To introduce various advanced data structures.
3. To provide comprehensive knowledge about different techniques of problem solving/ algorithm design.
4. To make the students select and apply different algorithm design techniques for problem solving.
5. To familiarize learners with advanced algorithms and the concepts of pattern matching.

Module	Details	Hrs
00.	**Course Introduction** This course includes different techniques of problem solving and their applications for solving problems belonging to multidisciplinary domains. It also involves analysis of algorithms developed using these techniques, selection and application of an optimal technique/algorithm for solving a given problem. The course contents enable software engineers to make decisions on the design and implementation of more efficient algorithms, leading to faster and more scalable software systems in resource constrained diverse industry applications where high performance is a key factor.	**01**
01.	**Fundamentals of the analysis of algorithms and Advanced Data Structures**	**06-08**

	Learning Objective: *To introduce different methods to determine the time and space complexity of different algorithms and to select and apply the most suitable one for a particular problem.* *To introduce advanced data structures and operations on them.*	
	Contents: Fundamentals of the analysis of algorithms: Time and Space complexity, Asymptotic analysis and notation, average and worst-case analysis, Recurrences: The substitution method, Recursive tree method, Masters method. **Advanced Data Structures :** Definition , properties and operations on B tree, B+ tree, Red-Black Trees. Topological Sort –Definition, DFS method, adjacency matrix method.	
	Self-Learning Topics: *Analysis of Time and space complexity of iterative and recursive algorithms.* *Implementation of B tree and Red-Black Tree.*	
	Learning Outcomes : *A learner will be able to* *LO 1.1: Apply different methods to determine topological ordering of a directed acyclic graph. (P.I.-1.3.1)* *LO 1.2: Apply search and insert operations on B/B+ Tree. (P.I.-1.4.1)* *LO 1.3: Differentiate between B Tree and B+ tree and select appropriate data structure between the two for providing indexed sequential access of data. (P.I.-2.2.4)* *LO 1.4: Apply different methods to derive the time complexity of a given recursive algorithm. (P.I.-1.3.1)* *LO 1.5: Apply appropriate method to derive the time complexity of a given Iterative algorithm. (P.I.-1.4.1)* *LO 1.6: Analyze the time complexity of Iterative and recursive algorithms. (P.I.-2.4.1)* *LO 1.7: Identify and Use appropriate method to determine the time complexity of a recurrence relation. (P.I.-2.2.3)* *LO 1.8: Identify and Apply appropriate method to determine the topological ordering of a given graph.. (P.I.-2.2.3)*	
02.	**Divide and conquer technique and Greedy Algorithms** ***Learning Objective/s:*** *To make the learners master Divide and conquer and Greedy technique and make them apply these techniques to solve large scale complex and optimization problems.*	**07-09**
	Contents: **Divide and conquer technique:** Introduction to Divide and conquer technique of problem solving. Advantages, disadvantages. Types of problems that can be solved using D&C. Binary Search, Merge sort and Quick sort, Finding minimum and maximum algorithm. Analysis of all these algorithms. **Greedy Algorithms :** Introduction to Greedy Algorithms. Advantages, disadvantages. Types of problems that can be solved using Greedy Algorithms. Knapsack Problem, Job sequencing using deadlines, Optimal storage on tape, Optimal Merge Pattern. Analysis of all these algorithms.	

	Self-Learning Topics: *Implementation of minimum and maximum algorithm, Knapsack problem, Job sequencing using deadlines.*	
	Learning Outcomes : *A learner will be able to* *LO 2.1: Apply Greedy technique to solve a given problem. (P.I.-1.3.1)* *LO 2.2: Apply Divide and Conquer strategy to design an algorithm to solve a given problem (P.I.-1.4.1)* *LO 2.3: Identify and Use appropriate algorithmic design technique to solve a given problem. (P.I.-2.2.3)* *LO 2.4:Analyze the time complexity of algorithms designed using Divide and Conquer technique. (P.I.- 2.4.2)*	
03.	**Dynamic Algorithms** ***Learning Objective:*** *To acquaint the knowledge of dynamic programming technique to solve and analyze optimization problems in diverse application domains.*	**06-08**
	Contents: **Dynamic Algorithms :** Introduction to Dynamic Algorithms. Advantages, disadvantages. Types of problems that can be solved using Dynamic Algorithms. Comparison of Dynamic algorithms with D&C and Greedy algorithms. All pair shortest path, 0/1 knapsack, travelling salesman problem, Matrix Chain Multiplication, Optimal binary search tree. Analysis of All these algorithms.	
	Self-Learning Topics: *Implementation of All pair shortest path, 0/1 Knapsack and OBST..*	
	Learning Outcomes : *A learner will be able to* *LO 3.1: Determine an optimal order of Multiplication for multiplying a given chain of matrices (P.I.-1.3.1)* *LO 3.2: Use dynamic programming approach to solve a given problem. (P.I.-1.4.1)* *LO 3.3: Identify different methods used for solving knapsack problem. (P.I.-3.2.1)* *LO 3.4: Identify and apply appropriate problem solving technique to determine an optimal solution of a given problem. (P.I.-3.2.2)* *LO 3.5: Select and apply an appropriate technique to solve 0/1 knapsack problem and present the solution effectively in a team. (P.I.-2.2.4, P.I.-8.2.1, P.I.-9.2.2)* *LO 3.6: Select and apply an appropriate technique to solve travelling salesman problem and present the solution effectively in a team.. (P.I.-2.2.3, P.I.-8.3.1, P.I.-9.3.1)*	
04.	**Backtracking and Branch and bound** ***Learning Objective:*** *To acquaint the learners about Backtracking and Branch and bound algorithmic design techniques and make them apply and analyze these techniques to solve a wide range of computational problems including optimization, constraint satisfaction, puzzle solving, graph algorithms etc.*	**06-08**

	Contents: **Backtracking** : Introduction to Backtracking. Types of (decision) problems that can be solved using Backtracking Algorithms. N-queen problem, Sum of subsets or Graph coloring problem. **Branch and Bound :** Introduction to Branch and Bound. Types of (optimization) problems that can be solved using Branch and Bound, Comparison between Backtracking and Branch and Bound. Travelling Salesperson Problem or 15 Puzzle problem. Analysis of All these algorithms.	
	Self-Learning Topics: *Implementation of N-queen problem, 15 Puzzle problem.*	
	Learning Outcomes : *A learner will be able to* *LO 4.1: Use backtracking to solve a given problem (P.I.-1.3.1)* *LO 4.2: Apply Branch and Bound technique to solve a given problem. (P.I.-1.4.1)* *LO 4.3: Identify different algorithmic design techniques to solve a given problem. (P.I.-2.1.2)* *LO 4.4: Differentiate between Backtracking and Branch and Bound technique and select the best technique for solving a given optimization problem (P.I.- 2.2.4)*	
05.	**String matching algorithms** ***Learning Objective/s:*** *To acquaint the learners about the knowledge of string matching algorithms and to make the learners apply and analyze string matching algorithms for identifying patterns in textual data.*	**07-09**
	Contents: Introduction to string matching algorithms. The naïve string-matching algorithm, Rabin Karp algorithm, Knuth Morris-Pratt algorithm, Longest Common Subsequence (LCS). Analysis of All these algorithms.	
	Self-Learning Topics: *Implementation of Robin Karp algorithm, KMP algorithm and LCS.*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply Rabin Karp algorithm for pattern matching. (P.I.-1.3.1)* *LO 5.2: Compute the longest common subsequence for a given set of strings. (P.I.-1.4.1)* *LO 5.3: Apply Knuth Morris-Pratt algorithm to find the given pattern in a given string. (P.I.- 2.4.1)* *LO 5.4: Analyze the time complexity of Naïve Pattern matching algorithm. (P.I.-2.4.2)*	
06.	**Introduction to Advanced Algorithms and NP problems** ***Learning Objective/s:***	**05-07**

	To introduce/identify advance algorithms that are used for solving compute intensive and optimization problems for some of which the exact algorithms are of very low efficiency and the properties of NP hard and NP Complete problems.	
	Contents: **Optimization Algorithms:** Genetic algorithm (GA), **Approximation Algorithms:** Vertex-cover problem, **Parallel Computing Algorithms:** Fast Fourier Transform, Introduction to P, NP, NP-Hard and NP-Complete Problems.	
	Self-Learning Topics: *Implementation of Genetic algorithm and Vertex-cover problem.*	
	Learning Outcomes : *A learner will be able to* *LO 6.1: Solve Fast Fourier Transform problem using Parallel algorithm implementation. (P.I.-1.3.1)* *LO 6.2: Apply approximate algorithm to solve vertex cover problem. (P.I.-1.4.1)* *LO 6.3: Use genetic algorithm approach to solve an optimization problem. (P.I.-2.3.1)* *LO 6.4: Identify the limitations of P, NP, NP- Hard and NP- Complete problems. (P.I.- 2.4.3)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No. P.I. Statement

1.3.1 Apply engineering fundamentals.

1.4.1 Apply theory and principles of computer science engineering to solve an engineering problem.

2.1.2 Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem

2.2.2 Identifies functionalities and computing resources.

2.2.3 Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions

2.2.4 Compare and contrast alternative solution/methods to select the best methods

2.4.1 Applies engineering mathematics to implement the solution.

2.4.2 Analyze and interpret the results using contemporary tools.

2.4.3 Identify the limitations of the solution and sources/causes.

2.4.4 Arrive at conclusions with respect to the objectives.

3.2.1 Ability to explore design alternatives.

3.2.2 Ability to produce a variety of potential design solutions suited to meet functional requirements.

3.3.1 Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.

8.2.1 Demonstrate effective communication, problem solving, conflict resolution and leadership skills.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

9.2.2 Deliver effective oral presentations to technical and non-technical audiences

9.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations

Course Outcomes : Learner will be able to

1. Apply mathematical aspects and fundamentals of AOA for analysis of algorithms. *(LO1.4, LO1.5, LO1.7, LO 6.4)*
2. Apply different operations on advanced data structures. *(LO 1.1, LO1.2, LO1.3, LO1.8)*
3. Select and apply appropriate algorithm design technique for solving the given problem. *(LO 2.1, LO 2.2, LO 2.3, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4 , LO 5.1, LO 5.2, LO 5.3, LO 6.1, LO 6.2, LO 6.3)*
4. Analyse complexity of different algorithms. *(LO 1.6, LO 2.4, LO 5.4)*
5. Solve a given problem by selecting and applying an appropriate algorithmic design technique and present the solution effectively in a team. *(LO 3.5, LO 3.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC5011.1	3	3	-	-	-	-	-	-	-	-	-
ITPEC5011.2	3	3		-	-	-	-	-	-	-	-
ITPEC5011.3	3	3	3	-	-	-	-	-	-	-	-
ITPEC5011.4	-	3	-	-	-	-	-	-	-	-	-
ITPEC5011.5	-	3	-	-	-	-	-	3	3	-	-
Average	**3**	**3**	**3**	-	-	-	-	**3**	**3**	-	-

Text Books :

1. Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, 3rd Edition, 2009, MIT Press.
2. Algorithms: Design and Analysis, Harsh Bhasin, 2015, OXFORD University Press.
3. Fundamentals of Computer Algorithms, Horowitz, Sahani, Rajsekaran, Universities Press.
4. C and Data structures, Deshpande, Kakde, 1st Edition, 2003, Dreamtech Press.

Reference Books :

1. Digital Image Processing using MATLAB , Rafael C. Gonzalez and Richard E. Woods, 2003, Pearson Education.
2. Data Structures and Algorithms in C++, Goodritch, Tamassia, Mount, WILEY India Edition, 2015.
3. Data Structures using C, Reema Thareja , Second Edition, 2014, OXFORD.
4. Data Structures and Algorithm Analysis in C, Mark A. Weiss, Second Edition, 2020, Pearson.

Optimization Algorithms and Applications, By Rajesh Kumar Arora, First Editon, 2015,
5. Chapman and Hall.

Other Resources :

1. NPTEL Course: Design and Analysis of Algorithms By Prof. Madhavan Mukund, Chennai Mathematical Institute. Web link- https://nptel.ac.in/courses/106/106/106106131/

2. NPTEL Course: Image Processing using Python By Prof. Sourav Mukhopadhyay; Department of Computer Science and Engineering, IIT Kharagpur
Web link- https://archive.nptel.ac.in/courses/106/105/106105164/

3. NPTEL Course: Computer Vision and Image Processing - Fundamentals and Applications By Prof. Tim Roughgarden, Department of Computer Science, Stanford University, Stanford.
Web link- https://www.coursera.org/specializations/algorithms

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One MCQ test as per GATE exam pattern/level: 05 Marks

b) Class Test : 05 Marks

c) Think-pair-share worksheets: 05 Marks

d) Regularity and active participation in class :05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAM (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC5012	CLOUD COMPUTING SERVICES	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

ESL103: Programming Laboratory-I (C)

ITPCC304: Database Management System

Program Outcomes addressed:

1 PO1: Engineering knowledge

2 PO2: Problem analysis

3 PO3: Design/development of solutions

4 PO4: Conduct investigations of complex problems

5 PO8: Individual and Collaborative team work

6 PO9: Communication

7 PO11: Life-long learning

Course Objectives:

1. To make learner to develop a deep understanding of cloud computing and virtualization technologies by analyzing architectures, deployment models, and system performance while fostering problem-solving, teamwork, and continuous learning
2. To make learner analyze and design scalable cloud-based service models by evaluating their essential components, assessing trade-offs, and defining system requirements while ensuring security, efficiency, and resource management.
3. To make learner develop and document structured approaches for selecting, implementing, and managing virtualization technologies, cloud platforms, and security frameworks
4. To familiarize Investigation and assessment of the security, privacy, and compliance challenges in cloud computing, focusing on IAM, Governance, Risk, and Compliance (GRC) standards.
5. To demonstrate communication, teamwork, and problem-solving skills by analyzing and presenting cloud computing concepts, security concerns, and emerging technologies.

Module	Details	Hrs.
00.	**Course Introduction**	**01**

	Cloud computing is a virtualization-based technology that allows us to create, configure, and customize applications via an internet connection. The cloud technology includes a development platform, hard disk, software application, and database.	
	Introduction to cloud computing ***Learning Objective:*** *To impart the concept of cloud computing and different types of service ,deployment model.*	**5-7**
	Contents: Introduction to cloud computing, need for cloud computing and its components, cloud & other similar configurations, cloud types: NIST and Cloud Cube Model, characteristics of cloud computing, deployment models, service models, advantages and disadvantages of Cloud Computing.	
	Self-Learning Topics: *Study the recent trends in cloud computing architectures and related technologies*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental engineering concepts to analyze cloud computing architectures, including service and deployment models. (PI- 1.3.1)* *LO 1.2: Utilize knowledge of cloud computing fundamentals to compare cloud architectures with traditional computing models.(P-I 1.4.1)* *LO 1.3:Evaluate the given problem statement and identify and categorize different cloud computing models (NIST and Cloud Cube Model) based on their characteristics and functionalities. (PI- 2.1.1)* *LO 1.4:Identify the advantages and disadvantages of cloud computing by assessing different deployment and service models. (PI -2.1.2)*	
01.	**Virtualization** ***Learning Objective:*** *To familarize the concept of Virtualization. Also expected to apply the concept of virtualization to create VM.*	**5-7**
	Contents: Characteristics of virtualized environment, structures of virtualization, implementation levels of virtualization, mechanisms of virtualization, pros and cons of virtualization, virtualization vs cloud computing, Xen and KVM architecture.	
	Self-Learning Topics: *Comparison between different virtualization techniques*	
	Learning Outcomes:	
	A learner will be able to *LO 2.1: Evaluate problem statement **to id**entify and categorize different virtualization technologies based on their architectures and functionalities. (PI - 2..1.1)* *LO 2.2: Analyze the impact of virtualization on system performance and resource management and arrive at conclusion. (PI- 2.4.4)* *LO 2.3: Develop structured approaches for selecting appropriate virtualization solutions based on specific system requirements. (PI- 3.4.1)*	

	LO 2.4: Document system requirements for implementing virtualization technologies effectively. (PI 3.1.2) *LO 2.5: Apply specialized engineering knowledge to analyze virtualization concepts, demonstrate effective communication and teamwork in presenting and discussing their role in modern computing, and recognize the need to stay current with evolving technologies.. (PI-1.4.1, 8.2.1, 9.1.3, 11.2.1)* *LO 2.6: Collaborate effectively in a team to interpret technical documentation, apply engineering fundamentals to understand and implement advancements in virtualization technologies, and recognize the importance of continuous learning to stay updated with evolving technological trends. (PI -1.3.1,8.3.1, 9.1.1, 11.2.2)* *LO 2.7: Apply Specialized Engineering Knowledge for Virtualization Concepts (PI-1.4.1)* *LO 2.8: Study the features, structures, and levels of virtualization using engineering principles. Understand virtualization mechanisms, compare it with cloud computing, and examine the pros and cons of Xen and KVM architectures. (PI-1.3.1)*	
03.	**Cloud Computing Services** ***Learning Objective:*** *To impart the knowledge of cloud computing services. Also expected to use services according to the requirement.* **Contents:** SPI Model of Cloud computing, Everything as a Service (XaaS): Database as a Service, Storage as a Service, Security as a Service, Collaboration as a Service, Monitoring as a Service, Network as a Service, Disaster Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service. ***Self-Learning Topics:*** *Study of different cloud computing platforms providing XaaS services* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Understand the SPI (Software, Platform, Infrastructure) model of cloud computing and the fundamentals of Everything as a Service (XaaS). Analyze different cloud-based services, including Database as a Service, Storage as a Service, and Security as a Service. (PI- 1.3.1)* *LO 3.2: Examine the implementation and benefits of cloud service models, including Collaboration, Monitoring, Networking, Disaster Recovery, Identity Management, Analytics, and Backup as a Service. Evaluate their role in modern computing and enterprise solutions. (PI- 1.4.1)* *LO 3.3: Identify and evaluate the essential components of cloud-based service models (SPI) and their functionalities based on selected problem. (PI -2.1.1)* *LO 3.4: Critically assess the advantages, disadvantages, and trade-offs of various XaaS solutions to reach substantiated conclusions. (PI- 2.4.4)* *LO 3.5: Design scalable cloud service-based solutions by defining system requirements aligned with organizational needs. (PI- 3.2.2)* *LO 3.6: Identify **system specifications** for implementing XaaS models with considerations for security, efficiency, and resource management. (PI- 3.1.2)*	**5-7**
04.	**Amazon Web Services and Cloud Platform** ***Learning Objectives:*** *To familiarize amazon web services and also expected to use AWS* **Contents:**	**11-13**

	Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys	
	Self-Learning Topics: *Comparison of AWS services with other cloud service platforms like Azure and GCP*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Understand AWS cloud concepts, including compute, storage, networking, and database services. Explore EC2 instances, S3 storage, Virtual Private Cloud (VPC), and CloudWatch for monitoring. Analyze key differences between object and block storage, relational and non-relational databases, and data backup solutions. (PI- 1.3.1)* *LO 4.2: Examine the architecture and functionality of AWS core services, including EC2, S3, VPC, CloudWatch, and DynamoDB. Evaluate security mechanisms, networking configurations, and database management features to enhance cloud-based solutions. (PI- 1.4.1)* *LO 4.3: Design cloud-based solutions and define system requirements using AWS compute, storage, and database services. (PI- 3.1.1)* *LO 4.4: Identify system architecture for implementing AWS cloud services with security, performance, and cost considerations. (PI- 3.1.2)* *LO 4.5: Apply specialized engineering knowledge to analyze technological advancements in AWS cloud services and evaluate their role in modern IT infrastructure, while recognizing the need for continuous learning to keep pace with emerging technologies. (PI- 1.4.1,11.2.1)* *LO 4.6: Apply engineering fundamentals to understand AWS cloud computing and recognize the importance of continuous learning to stay updated with emerging trends and best practices.. (PI-1.3.1, 11.2.2)*	
05.	**Open stack Cloud platform & Severless Computing** ***Learning Objective/s:*** *To make learner understand the open stack architecture and also expected to learn sercerless computing*	**6-8**
	Contents: Open source Cloud Platform: Introduction to Openstack cloud platform, Components and modes of Operations, Architecture of Openstack cloud platform. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing. Serverless Computing: Introduction, Working with Serverless environment,Basics of severless events and functi ons, AWS Lambda	
	Self-Learning Topics:	

	To study different open source cloud computing platforms and compare them based on different XaaS services provided by them.	
	Learning Outcomes : *A learner will be able to* *LO 5.1:Understand the architecture, components, and operational modes of the OpenStack cloud platform. Analyze the fundamentals of mobile cloud computing, including its architecture, benefits, and challenges. Explore serverless computing concepts, events, and functions.* (PI- 1.3.1) *LO 5.2 Examine the working principles of OpenStack, mobile cloud computing, and serverless environments. Evaluate AWS Lambda functions and serverless event-driven architectures to develop scalable cloud-based applications.* (PI:-1.4.1)*:* *LO 5.3: Design scalable cloud-based solutions and define system requirements using OpenStack, mobile cloud architectures, and AWS Lambda. (PI- 3.1.1)* *LO 5.4: Identify system specifications for implementing OpenStack and mobile cloud computing with security, scalability, and performance considerations. (PI- 3.1.2)* *LO 5.5: Utilize appropriate tools and techniques to collect and analyze data for evaluating cloud performance and efficiency. (PI -4.3.1)* *LO 5.6: Synthesize data and information to draw meaningful conclusions regarding OpenStack performance, mobile cloud computing efficiency, and serverless computing effectiveness. (PI- 4.3.4)*	
06.	**Cloud Security & Privacy**	**5-7**
	Learning Objective/s: *To make learner understand the concept of cloud security and Also expected to provide security to the cloud*	
	Contents: What is security, why is it required in cloud computing, Different types of security in cloud, attacks, and vulnerabilities, IaaS security, PaaS security, SaaS security, trust boundary, Audit and reporting. Introduction to Identity and access Management (IAM), IAM Challenges, IAM Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services. Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud?, Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC).	
	Self-Learning Topics: *To assess and analyze how the security and privacy is maintained in different cloud computing platforms*	
	Learning Outcomes: *A learner will be able to* *LO 6.1:Understand the importance of security in cloud computing, including different types of security, attacks, and vulnerabilities. Analyze security measures for IaaS, PaaS, and SaaS, along with trust boundaries, auditing, and reporting. Explore Identity and Access Management (IAM) architecture, challenges, and best practices. (PI- 1.3.1)* *LO 6.2: Examine security frameworks, IAM protocols, and governance models for securing cloud services. Evaluate privacy concerns, legal and regulatory implications, and Governance, Risk, and Compliance (GRC) requirements in cloud computing environments. (PI- 1.4.1)* *LO 6.3: Apply specialized engineering knowledge to analyze cloud security principles, identify and define system requirements, evaluate threats and vulnerabilities in IaaS, PaaS, and SaaS environments, and draw substantiated conclusions to develop effective solutions for complex engineering problems. (PI- ,1.4.1,2.1.1, 3.1.2, 2.4.4)*	

	LO 6.4: Apply engineering fundamentals to evaluate Identity and Access Management (IAM) frameworks, identify system requirements and relevant security protocols, collaborate effectively in teams to design secure cloud solutions, communicate findings through clear documentation and presentations, and recognize the need for continuous learning to ensure compliance with Governance, Risk, and Compliance (GRC) standards. (PI -1.3.1,3.1.1, 2.1.2, 8.2.1, 8.3.1, 9.1.1, 9.1.3, 11.2.1, 11.2.2)	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.4.4	Arrive at conclusions with respect to the objectives
3.1.1	Able to define a precise problem statement with objectives and scope.
3.1.2	Able to identify and document system requirements from stake holders.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and nontechnical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to -

1. Analyze and implement cloud computing architectures, virtualization technologies, and cloud service models. *(LO 1.1, 1.2, 1.3, 1.4,2.1, 2.2, 2.7, 2.8, 3.1, 3.2, 3.3, 3.4)*
2. Assess, implement, and optimize cloud solutions using AWS services (EC2, S3, RDS, VPC, CloudWatch) and OpenStack platforms. *(LO 4.1, 4.2, 4.3, 4.4, 5.1, 5.2, 5.3, 5.4)*

3. Apply virtualization technologies ,security measures, IAM protocols, and governance models to ensure secure cloud computing environments and cloud service-based solutions. *(LO 2.3,2.4, 3.5,3.6,6.1, 6.2, 6.3, 6.4)*
4. Evaluate cloud performance, explore mobile cloud computing, and apply serverless architectures like AWS Lambda for scalable solutions. *(LO 5.1, 5.2, 5.5, 5.6)*
5. Work in teams to analyze cloud documentation, present solutions effectively, and stay updated with evolving cloud computing trends. *(LO 2.5, 2.6, 4.5, 4.6, 6.2, 6.3, 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC5012.1	3	3	-	-	-	-	-	-	-	-	-
ITPEC5012.2	3	-	3	-	-	-	-	-	-	-	-
ITPEC5012.3	3	3	3	-	-	-	-	3	3	-	3
ITPEC5012.4	3	-	-	3	-	-	-	-	-	-	-
ITPEC5012.5	3	3	3	-	-	-	-	3	3	-	3
Average	**3**	**3**	**3**	**3**	-	-	-	**3**	**3**	-	**3**

Text Books :

1. Cloud computing Bible, Barrie Sosinsky, Wiley publication
2. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, Dreamtech Press[p;plpkok
3. Mastering Cloud Computing, Rajkumar Buyya, MGH publication
4. AWS certified solution Architect, Joe Baron et.al, Cybex publication
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Publication
6. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication

Reference Books :

1. Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, Jack Dongarra, Morgan Kaufmann Publication
2. Cloud Computing for Dummies, Judith Hurwitz, Wiley Publication
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication
   Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Other Resources :

1. NPTEL Course : Cloud Computing by Prof. Soumya Kanti Ghosh, IIT Kharagpur **Web Link** https://archive.nptel.ac.in/courses/106/105/106105167/
2. NPTEL Course : Google Cloud Computing Foundations by Prof. Soumya Kanti Ghosh, IIT Kharagpur, and experts from Google Cloud **Web Link** https://onlinecourses.nptel.ac.in/noc20_cs55/preview
3. NPTEL Course : Cloud Computing and Distributed Systems by Prof. Sudip Misra, IIT Kharagpur **Web Link**- https://onlinecourses.nptel.ac.in/noc25_cs12/preview

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

a) 01 MCQ test strictly as per GATE exam pattern / level) (Please ensure that all quizzes are conducted offline, not online: 05 Marks

b) One Class Test:05 Mark

c) Article reading & summarization: 05 Marks

d) Regularity and active participation :05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC5013	DATA WARE HOUSING & MINING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ITPCC304: Database Management System

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct investigation of complex problems
5. PO8: Individual and collaborative team work
6. PO9: Communication

Course Objectives:

Learner is expected to

1. To acquaint with the principles of Data warehousing and Data Mining..
2. To inculcate comprehensive knowledge about the architecture of a Data Mining system.
3. To familiarize the concepts of the various Data preprocessing Methods
4. To gain knowledge of the supervised and unsupervised learning algorithms.

Module	Detailed Contents	Hrs
00.	**Course Introduction:** A data warehouse serves as a robust foundation for data mining activities. It provides a clean, integrated, and historical dataset that makes mining more effective. The integration of these technologies helps organizations in deriving deeper insights, supporting strategic decisions, and maintaining a competitive edge. Data warehouses and data mining (DWM) allow organisations to effectively store, manage, and analyse huge quantities of data, resulting in important insights that fuel corporate success. A data warehouse consolidates data from several sources, making it easier to run complicated queries and generate reports while maintaining data consistency and accuracy. Data mining, on the other hand, employs sophisticated techniques such as clustering, classification, and association analysis to uncover hidden patterns and trends in the data. DWM helps to improve customer relationships, detect fraud, and stay competitive in an increasingly data-driven world.	**01**
01.	**Data Warehousing and Business Analysis:** ***Learning Objective:*** *To gain knowledge of Data Warehouse, design of data warehouse and implement it.*	**07-09**

	Contents: Data Warehouse characteristics, Data Warehouse Architecture, Data Extraction, Transformation and Loading.Online Analytical Processing (OLAP) and Online Transactional Processing (OLTP), Dimensional modeling: Star, Snowflakes OLAP and Multidimensional Data Analysis, OLAP Architecture, OLAP operation	
	Self-Learning Topic: *Data Marts, Major issues in Data Mining*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply engineering fundamentals to define data warehouse and data mining. (PI-1.3.1)* *LO1.2: Identifies functionalities of OLTP and OLAP (PI-2.2.2)* *LO1.3: Apply theory and principles of dimensional modelling to real life problem. (P.I.-1.4.1)* *LO1.4: Analyze and interpret star schema and snowflake for real-life problem statement (PI- 3.2.1)* *LO1.5: Implement the data warehouse in terms of OLAP cube (PI- 3.4.2)* *LO1.6: Apply computer engineering principles to attain the inference from result from OLAP operations (PI- 2.4.4)*	
02.	**Data Exploration and Data Preprocessing** ***Learning Objective:*** *To know various steps in pre-processing datasets.*	**05-07**
	Contents: Data Mining as a step in KDD, Data Mining Functionalities, Data Mining applications. Types of Attributes, Statistical Description of Data, Measuring Data Similarity and Dissimilarity, Data visualization techniques. Why Preprocessing? Data Cleaning, Data Integration, Data Reduction: Attribute Subset Selection, Histograms, Clustering, Sampling, Data Cube aggregation, Data transformation and Data Discretization: Binning, Histogram Analysis	
	Self-Learning Topic: *Principal Component Analysis*	
	Learning Outcomes: *The learner will be able to* *LO2.1: Apply concept of datamining attributes to identify types of attributes. (P.I.-1.3.1).* *LO2.2: Apply statistical description to given data (P.I.-1.4.1)* *LO2.3: Apply dissimilarity measures to find the similarity between data objects and give solution for grouping the data samples (P.I.- 2.4.1)* *LO2.4: Apply the preprocessing techniques like cleaning, integration, reduction, transformation on the dataset to obtain the quality data for datamining (PI-2.3.1)* *LO2.5: Use appropriate visualization techniques to analyze data (PI-4.3.1)* *LO2.6: Interpret the data with visualization approach (PI-4.3.3)*	
03.	**Classification and Prediction** ***Learning Objectives:*** *To impart the knowledge of supervised learning algorithm.*	**06-08**
	Contents: Classification methods: Decision Tree Induction: Attribute Selection, Measures, Tree pruning.	

	Bayesian Classification: Naïve Bayes Classifier. k-nearest neighbors Prediction: Structure of regression models; Simple linear regression, Evaluating the Accuracy of a Classifier or Predictor, Holdout, Random Sampling, Cross Validation, Bootstrap Introduction of Ensemble methods: Bagging, Boosting,.	
	Self-Learning Topics: *Random forest, SVM, Multiple linear regression, logistic regression*	
	Learning Outcomes: *The learner will be able to* *LO3.1: Identify and Apply the classification algorithm like decision tree and Bayesian classification algorithm on dataset (P.I.- 2.1.2)* *LO3.2: Analyze and interpret prediction of dependent variable using linear regression. (PI-2.4.2)* *LO3.3: Implement Holdout, Random Sampling, Cross Validation, Ensemble methods to improve the performance of classification. (P.I.- 3.4.2)* *LO3.4: Validate the functionalities of model created using classification by finding Accuracy and Error measures, Precision, Recall. (PI-3.4.3)*	
04.	**Clustering** ***Learning Objectives:*** *To acquaint the knowledge of unsupervised learning algorithm.*	**06-08**
	Contents: Cluster Analysis: Basic Concept A Categorization of Major Clustering Methods: Partitioning Methods: K-means, K-medoid, Hierarchical methods: Agglomerative, Divisive. Density-Based Methods: DBSCAN. Outlier Analysis: What are outliers? Types of outliers. Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based.	
	Self-Learning Topics: *Hierarchical method: BIRCH, Density based method: OPTICS, Grid based methods: STING, CLIQUE*	
	Learning Outcomes: *The learner will be able to* *LO4.1: Identify different clustering algorithm for user's problem. (P.I.- 2.1.2)* *LO4.2: Identify the functionalities of algorithm selected (P.I.- 2.2.2)* *LO4.3: Apply clustering algorithm to find the group in dataset. (P.I.-3.4.2)* *LO4.4: Validate the created model using error measures. (P.I.-3.4.3)*	
05.	**Frequent Pattern Mining** ***Learning Objective:*** *To impart the knowledge of mining patterns from dataset.*	**05-06**
	Contents: Market Basket Analysis, Support and Confidence Measures, Frequent Itemset, Closed Itemset, and Association Rules; Apriori Algorithm, FP-Growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical data formats; Introduction to Advance Pattern Mining: Mining Multilevel Association Rules and Multidimensional Association Rules.	
	Self-Learning Topics: *Association Mining to Correlation Analysis, lift, Introduction to Constraint-Based Association Mining*	
	Learning Outcomes: *The learner will be able to* *LO5.1: Apply the concept of market basket analysis (P.I.- 1.3.1)* *LO5.2: Apply the pattern mining methods like Apriori Algorithm and FP growth*	

	algorithm to find association rules among item set. (P.I.- 4.3.3) *LO5.3: Use vertical data format to find patterns (PI- 4.3.1)* *LO5.4: Apply theory of advance pattern mining methods like mining multilevel association rules and multidimensional association rules to analyse the data. (P.I.-1.4.1)*	
06.	**Case study on data mining methodologies:** ***Learning Objectives:*** *To identify the various data mining techniques for mining different datasets*	**08-10**
	Contents: Web Content Mining, Web Structure Mining, Web Usage Mining, Spatial Mining, Text Mining	
	Self-Learning Topics: Multimedia Data Mining	
	Learning Outcomes: *The learner will be able to* *LO6.1: Identify various techniques to solve the real life problem (P.I.- 2.1.2, P.I.-8.2.1)* *LO6.2: Identify functionalities and computing resources to find the solution (PI- 2.2.2)* *LO6.3: Implement data mining stages to find the solution (PI - 3.4.2, P.I.- 9.1.1)* *LO6.4: Interpret and validate the results of data mining case study with different evaluation techniques (P.I.- 3.4.3, P.I.- 8.3.1, P.I.- 9.2.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P. I. Number	**P. I. Statement**
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.2.2	Identifies functionalities and computing resources.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
2.4.1	Applies engineering mathematics to implement the solution.
2.4.2	Analyze and interpret the results using contemporary tools.
2.4.4	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
3.2.1	Analyze and interpret the results using contemporary tools.
3.4.2	Ability to implement and integrate the modules.
3.4.3	Ability to verify the functionalities and validate the design.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1. 1	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.2	Deliver effective oral presentations to technical and non-technical audiences

Course Outcomes:

Learner will be able to

1. Design data warehouse and apply OLAP operations for analysis of data. (*LO1.1, LO1.2, LO1.3, LO1.4, LO1.5, LO1.6*)
2. Use pre-processing techniques and perform exploratory data analysis. (*LO2.1, LO2.2, LO2.3, LO2.4, LO2.5, LO2.6*)
3. Apply supervised learning algorithms to datasets. (*LO3.1, LO3.2, LO3.3, LO3.4*)
4. Apply unsupervised learning algorithms to datasets. (*LO4.1, LO4.2, LO4.3, LO4.4*)
5. Apply frequent Pattern mining on data sets to find association between item sets (*LO5.1, LO5.2, LO5.3, LO5.4*).
6. Collect the data, preprocess it, select a data mining task, apply it to the preprocessed data, and evaluate the model in relation to the appropriate research article. (*LO6.1, LO6.2, LO6.3, LO6.4*).

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC5013.1	3	3	3	-	-	-	-	-	-	-	-
ITPEC5013.2	3	3	-	3	-	-	-	-	-	-	-
ITPEC5013.3	-	3	3	-	-	-	-	-	-	-	-
ITPEC5013.4	-	3	3	-	-	-	-	-	-	-	-
ITPEC5013.5	3	-	-	3	-	-	-	-	-	-	-
ITPEC5013.6	-	3	3	-	-	-	-	3	3	-	-
Average	3	3	3	3	-	-	-	3	3	-	-

Text Books:

1. Data Mining Concepts and Techniques, Han, Kamber, 3rd Edition.
2. Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Paulraj Ponniah, Wiley Publications

Reference Books:

1. Data Mining, Vikram Pudi & Radha Krishna, Oxford Higher Education.
2. Data Mining Techniques, Michael Berry and Gordon Linoff, 2nd Edition Wiley Publications.,

Other Resources:

1. NPTEL Course: Data Mining by Prof. Pabitra Mitra, IIT Kharagpur **Web Link-** https://onlinecourses.nptel.ac.in/noc22_cs11/course

A. IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)

a) Numerical Assignment/s (min 20 problems) -05 Marks

b) Class test based on above (a) numerical assignment: 05 Marks

c) Article reading & summarization activity: 05 Marks

d) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	ITLBC506	CLOUD COMPUTING LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
25	25	50

Pre-requisite:

1. ESL103 : Programming Laboratory-I (C)

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO8: Individual and Collaborative team work
5. PO9: Communication
6. PO11: Life-long learning

Course Objectives:

1. To make learner develop fundamental concepts to install, configure, and optimize virtualization environments (hosted and bare-metal) using tools such as VirtualBox, KVM, Xen, Hyper-V, and VMware ESXi, ensuring efficient resource management and compatibility with cloud infrastructures.
2. To make learner to deploy and manage cloud infrastructure and services (IaaS, PaaS, and STaaS) on platforms like AWS, Azure, and Google Cloud, focusing on resource optimization, scalability, and performance
3. To make learner to implement and manage cloud-based services (DBaaS and IAM) with an emphasis on security, compliance, and adaptability to evolving industry standards.
4. To make learner Collaborate effectively in teams to define system requirements, implement cloud-based solutions, and document system specifications and deployment strategies while demonstrating effective communication, leadership, and problem-solving skills.
5. To make learner Cultivate proficiency in container orchestration through the deployment and management of Kubernetes clusters, emphasizing documentation, scalability, orchestration strategies, and awareness of emerging industry trends.

Module	Details	Hrs.
00.	**Course Introduction** This is foundation course which deals with a wide range of benefits, including improved accessibility, flexibility, and cost-effectiveness, making it a central part of modern technology infrastructure.	**00**
01.	**Overview & Virtualization.:** ***Learning Objective:***	**04**

	Learner is expected to gain knowledge types of hypervisor to create virtual machine and expected to implement it	
	Contents: Introduction and overview of cloud computing. Hosted Virtualization using KVM Hypervisor and its types **Task 1:** To implement Hosted Virtualization usingVirtual Box & KVM. **Task 2:** To implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify various types of hypervisors by applying engineering fundamentals and analyze their architectures to define precise problem statements with clear objectives for selecting the most suitable type for specific applications..* (PI-1.3.1, 3.1.1) *LO 1.2: Set up and manage bare-metal virtualization using hypervisors like Xen, Hyper-V, or VMware ESXi by applying specialized engineering knowledge, identifying system requirements, and analyzing resource usage, scalability, and efficiency..* (PI- 1.4.1, 3.1.2)	
02.	**Types of cloud services** ***Learning Objective:*** *Learner is expected to list and identify cloud computing services to implement real time application* **Task 3:** To implement Infrastructure as a Service usingAWS/Microsoft Azure/Google cloud platform. **Task 4:** To implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. **Task 5:** To Implement Security as a Service on AWS/Azure **Task 6:** To implement Identity and Access Management (IAM) practices on AWS/Azure cloud.	**08**
	Contents: Infrastructure Services, Platform Services, Cloud Services: IaaS, PaaS, STaaS, DbaaS, IAM andSecurity as a Service on AWS and Azure	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Work as a team to plan, set up, and manage virtual machines, storage, and networking in an IaaS environment using AWS, Azure, or Google Cloud. Apply engineering fundamentals to define system requirements, ensure high performance and security, use various cloud services (IaaS, PaaS, STaaS, DBaaS, IAM, and Security as a Service), adapt to new cloud technologies, and communicate and solve problems effectively during deployment*. (PI -1.3.1, 1.4.1,3.1.1, 8.2.1, 8.3.1, 11.2.1, 11.2.2)	

	LO 2.2: Work together as a team to specify system requirements and configurations for deploying applications on cloud-based PaaS platforms. Implement Identity and Access Management (IAM) using AWS or Azure to improve security and ensure proper access control. Stay updated with new technologies in PaaS and IAM to understand their impact on modern application development and follow evolving identity management standards (PI-3.1.2, 8.2.1, 8.3.1, 11.2.1, 11.2.2)	
03.	**Storage Services and Containerization** ***Learning Objective:*** *Learner is expected to define and demonstrate storage services to provide access to the required data and implement it for real time application.*	**08**
	Task 7 : To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. **Task 8 :** To implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/MongoDB Lab/ Firebase. **Task 9 :** To implement Containerization using Docker on AWS/Azure/Google cloud platform.	
	Self-Learning Topics:	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Set up Storage as a Service (STaaS) using tools like OwnCloud, AWS S3, Glacier, or Azure Storage to manage data efficiently, securely, and at scale. Document storage configurations, follow best practices, and stay updated with new storage technologies and trends. (PI 3.1.2, PI 11.2.1, PI 11.2.2)* *LO 3.2: Define system requirements to deploy and manage cloud-based Database as a Service (DBaaS) solutions using SQL/NoSQL databases like AWS RDS, Azure SQL, MongoDB, or Firebase. Use engineering knowledge to implement containerization with Docker on AWS, Azure, or Google Cloud to improve application performance and scalability while staying updated with the latest technologies. (PI 3.1.1, PI 11.2.1)*	
04.	**Introduction and overview of Kubernetes:** ***Learning Objectives:*** *Learner is expected to define and demonstrate Kubernetes Configuration and Deployment, Networking in Kubernetes to automate the deployment, scaling, and management of containerized applications. It provides a highly flexible architecture for managing workloads across clusters of machines, whether on-premise or in the cloud.* **Task 10:** **To study and implement container orchestration using Kubernetes on AWS/Azure/Google cloud platform**	**10**
	Contents: Kubernetes Core Concepts, Kubernetes Configuration and Deployment, Networking in Kubernetes	
	Self-Learning Topics:	
	Learning Outcomes:	

	A learner will be able to *LO 4.1: Read, interpret, and develop comprehensive documentation for deploying and managing containerized applications using Kubernetes on AWS, Azure, or Google Cloud, ensuring efficient orchestration, scalability, and security while maintaining a logical flow of deployment processes, adhering to best practices, and identifying existing solutions and methods for effective cloud-based container orchestration.* (Aligned with PI 1.3.1,2.2.3, 9.1.1, 9.1.2) *LO 4.2: document Kubernetes deployment steps and best practices to make cloud-based container orchestration more efficient, scalable, and secure by identifying necessary functions and computing resources.(PI 2.2.2)*	
	Total	**30**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.2	Identifies functionalities and computing resources.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.1.2	Able to identify and document system requirements from stake holders.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and nontechnical information
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents
11.1.1	Describe the rationale for requirement for continuing professional development
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to –

1. Identify and analyze different types of hypervisors and their architectures to define clear problem statements and select suitable solutions for specific applications. *(LO 1.1, LO 1.2)*
2. Deploy and manage virtual machines, storage, and networks in an IaaS environment while applying engineering fundamentals, defining system requirements, ensuring security, and adapting to evolving cloud technologies. *(LO 2.1, LO 2.2)*
3. Implement and document cloud-based storage (STaaS) and database (DBaaS) solutions to manage data efficiently and securely while staying updated with the latest tools and technologies. *(LO 3.1, LO 3.2)*
4. Deploy, manage, and document containerized applications using Docker and Kubernetes to improve application scalability, performance, and security through efficient orchestration and adherence to best practices. *(LO 4.1 , LO 4.2)*
5. Collaborate effectively in teams to solve complex cloud computing problems, communicate solutions, and adapt to new technologies while ensuring proper documentation and deployment processes. *(LO 2.1, LO 2.2, LO 4.1, LO 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITLBC506.1	3	-	3	-	-	-	-	-	-	-	-
ITLBC506.2	3	-	3	-	-	-	-	3	-	-	-
ITLBC506.3	-	-	-	-	-	-	-	-	-	-	3
ITLBC506.4	-	3		-	-	-	-	-	-	-	-
ITLBC506.5	3	3	3	-	-	-	-	-	3	-	3
Average	**3**	**3**	**3**	-	-	-	-	**3**	**3**	-	**3**

Text Books :

1 Bernard Golden, "Amazon Web Services for Dummies", John Wiley & Sons, Inc.

2 Michael Collier, Robin Shahan, "Fundamentals of Azure, Microsoft Azure Essentials", Microsoft Press

3 RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw-Hill Education

4 Barrie Sosinsky, "Cloud Computing Bible", Wiley publishing

5 John Paul Mueller, "AWS for Admins for Developers", John Wiley & Sons, Inc.

6 Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , "Docker Cookbook - Second Edition", Packt publication

7 Jonathan Baier, "Getting Started with Kubernetes-Second Edition", Packt Publication

Reference Books :

Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication

Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Other Resources :

1. NPTEL Course : Cloud Computing by Prof. Soumya Kanti Ghosh, IIT Kharagpur **Web Link** https://archive.nptel.ac.in/courses/106/105/106105167/
2. NPTEL Course : Google Cloud Computing Foundations by Prof. Soumya Kanti Ghosh, IIT Kharagpur, and experts from Google Cloud **Web Link** https://onlinecourses.nptel.ac.in/noc20_cs55/preview
3. NPTEL Course : Cloud Computing and Distributed Systems by Prof. Sudip Misra, IIT Kharagpur **Web Link**- https://onlinecourses.nptel.ac.in/noc25_cs12/preview

A. IN-SEMESTER ASSESSMENT (25 MARKS)

1. CONTINUOUS ASSESSMENT (25 MARKS)

a) Task Execution :10 Marks

Students will be given 10 tasks based on list as per mentioned in the syllabus. Each task carries10 Marks. Average will be taken of all tasks. Students will be evaluated based on logic building for the selected problem and expected output.

b) Deployment of real time application on cloud: 10 Marks

· A group of 3 students should be assigned a real life problem statement.

· Students are expected to collect required resources to create a frontend and backend for the selected problem.

· Students should prepare a presentation of 10-15 minutes.

·c) Regularity & Active participation: 05 Marks

B. END SEMESTER EXAMINATION (Practical and Oral Exam) (25 Marks)

a) Task Execution: 10 Marks

Students will be given task (different task for every student) and will be evaluated as per the parameters mentioned in continuous assessment.

b) Results and discussion, Inferences drawn from the above task: 05 Marks

c) Oral based on entire syllabus :10 Marks

Two examiners, one Internal and one External will do the evaluation

Course Type	Course Code	Course Name	Credits
LBC	ITLBC507	MOBILE APPLICATION DEVELOPMENT LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
25	25	50

Pre-requisite :

1. ESL205 :Programming Laboratory-II (Java)
2. ITSBL301 : Python Laboratory
3. ITSBL402 : Full Stack Development Laboratory

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solution
4. PO5: Engineering tool usage
5. PO8: Individual and Collaborative Team work
6. PO9: Communication
7. PO11: Life-Long learning

Course Objectives:

1. To provide hands-on experience in developing cross-platform mobile applications using Flutter and Dart programming.
2. To enable students to design and implement user-friendly and interactive UIs using Flutter widgets, layouts, and animations.
3. To equip students with the skills to integrate Firebase for backend functionality and manage data persistence using file handling and JSON.
4. To train students in testing and deploying Flutter applications on Android and iOS platforms.
5. To foster teamwork, communication, and lifelong learning skills through collaborative projects and technical documentation.

Module	Detailed Contents	Hrs.
00.	**Course Introduction** In the Mobile Application Development Laboratory, where we focus on creating dynamic and user-friendly mobile apps using Flutter. This lab provides hands-on experience in building cross-platform applications, leveraging Dart programming, and mastering UI/UX design principles.	**01**
01.	**Basics of Flutter Programming** ***Learning Objective/s:*** *To make learner able to demonstrate and apply Flutter, covering fundamental Dart basics, understanding widget lifecycle events, constructing widget and element trees, and achieving proficiency in Flutter installation to create a basic "Hello World" app, establishing a foundational understanding of Flutter development.*	**04**
	Content:	

	Introduction of Flutter framework, Understanding Widget Lifecycle Events, Dart Basics, Widget Tree and Element Tree, Basics of Flutter installation, Flutter Hello World App. **Tasks:** 1. To install and configure Flutter Environment. 2. To run basic flutter hello world app.	
	Self-Learning Topics: *State management*	
	Learning Outcomes : *A learner will be able to* *LO 1.1: Apply the Flutter framework to develop simple mobile applications, integrate widget and element trees to create visually appealing apps, utilize modern engineering tools like Flutter SDK and Dart programming language, and recognize diverse learning preferences in mobile application development. (P.I.- 1.3.1, 3.4.2, 5.1.1, 8.1.1)* *LO 1.2: Apply suitable tags according to the given problem, verify the functionality of mobile apps using Dart Basics, demonstrate proficiency in using Flutter and Dart tools to create, debug, and run simple mobile applications, and present basic Flutter application implementations as a team, ensuring smooth integration of contributions. (P.I.- 1.4.1, 3.4.3, 5.2.2, 8.3.1)*	
02.	**Developing Flutter UI: Widgets, Layouts, Gestures** ***Learning Objective/s:*** *To make learner able to apply common widgets and also build high level view of layouts and apply gestures to mobile app.*	**06**
	Content: USING COMMON WIDGETS: SafeArea, Appbar, Column, Row, Container, Buttons, Text, Richtext,Form ,Images and Icon. BUILDING LAYOUTS: high level view of layouts, Creating the layout, Types of layout widgets APPLYING GESTURES: Setting Up GestureDetector, Implementing the Draggable and Dragtarget Widgets,Using the GestureDetector for Moving and Scaling **Tasks:** 3. To design Flutter UI by including common widgets. 4. To create an interactive Form using form widget 5. To design a layout of Flutter App using layout widgets	
	Self-Learning Topics: *Designing responsive layouts, and handling user gestures*	
	Learning Outcomes : *A learner will be able to* *LO 2.1: Apply safearea, appbar, column, row, buttons, text, and icon into mobile apps, identify GestureDetector for moving and scaling, recognize the strengths and limitations of Flutter widgets and layout tools, and read, understand, and interpret technical documentation related to Flutter UI components. (P.I.- 1.3.1, 2.1.2, 5.2.1, 9.1.1)* *LO 2.2 Apply different types of layout widgets, identify Draggable and Dragtarget Widgets, demonstrate proficiency in using Flutter's widget tree and gesture detection tools to implement complex UI designs, and demonstrate effective communication by producing well-structured UI design documentation. (P.I.- 1.4.1, 2.3.2, 5.2.2, 9.1.2)*	

03.	**Developing Flutter UI: Animation and Navigation** ***Learning Objective/s:*** *To make learner able to design effective forms, add buttons, and navigation bars using Bootstrap, facilitating the development and design user-friendly web interfaces.*	**04**
	Content:	
	ADDING ANIMATION TO AN APP: Using Animated Container, Using Animated CrossFade, Using Animated Opacity, Using Animation Controller, Using Staggered Animation CREATING AN APP'S NAVIGATION: Using the Navigator, Using the Named Navigator Route, Using the Bottom NavigationBar, Using the TabBar and TabBarView **Tasks:** 6. To include icons, images, charts in Flutter app 7. To apply navigation, routing and gestures in Flutter App	
	Self-Learning Topics: *Implement seamless app navigation with navigators, bottom navigation bars, and tab bars*	
	Learning Outcomes : *A learner will be able to* *LO 3.1: Implement and integrate animation and navigation modules within a Flutter application, identify and apply Flutter's animation and navigation tools to create dynamic and interactive user interfaces, and evaluate the limitations of these tools to validate their effectiveness in real-world applications. (P.I.- 3.4.2, 5.1.1, 5.3.1)* *LO 3.2: Design and develop interactive UI components by integrating animations and navigation features, and evaluate the limitations of Flutter's animation and navigation tools, validating their effectiveness in real-world applications. (P.I.- 3.4.3, 5.3.1)*	
04.	**Working with files** ***Learning Objective/s:*** *To make learner able to apply libraries and work with files using JSON.*	**04**
	Content: Including libraries in your Flutter app, including a file with your app, Reading/Writing to files, Using JSON. **Tasks:** 8. To include libraries and working with files in Flutter app.	
	Self-Learning Topics: *Manage files, and read/write data using JSON for efficient data handling and storage*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Analyze and interpret file-handling results using contemporary tools, identify the strengths and limitations of tools used for acquiring and storing file-based data, and demonstrate proficiency in using discipline-specific tools for file handling in Flutter. (P.I.- 2.4.2, 5.2.1, 5.2.2)* *LO 4.2: Identify the limitations of various file storage methods and their sources/causes, and demonstrate proficiency in using discipline-specific tools for file handling in Flutter. (P.I.- 2.4.3, 5.2.2)*	

05.	**Using Firebase with Flutter** ***Learning Objective/s:*** *To familarize the steps involved in setting up and configuring a firebase project and adding a cloud Firestore database and implementing security.*	**06**
	Content: Adding the Firebase and Firestore Backend, Configuring the Firebase Project, adding a Cloud Firestore Database and Implementing Security **Tasks:** 9. To Connect Flutter UI with firebase database.	
	Self-Learning Topics: *Implement robust security measures* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Evaluate and implement Firebase as a backend service for Flutter applications, recognize the importance of lifelong learning in adapting to evolving backend technologies, and analyze sourced technical information for the feasibility and sustainability of Firebase integration. (P.I.- 3.4.2, 11.1.1, 11.3.2)* *LO 5.2: Verify functionalities and validate the integration of Firebase services, and recognize the importance of lifelong learning in adapting to evolving backend technologies. (P.I.- 3.4.3, 11.1.1)*	
06.	**Testing and Deploying of Flutter Application** ***Learning Objective/s:*** *To make learner able to apply widget testing and also deploy flutter apps on Android/iOS.*	**05**
	Content: Widget testing, Deploying Flutter Apps on Android / iOS **Tasks:** 10. To test and deploy production ready Flutter App on Android platform. 11. Implementation of Mini Project on selected case study.	
	Self-Learning Topics: *Learn the essentials of widget testing for ensuring app reliability and the steps for deploying Flutter apps on Android and iOS platforms.* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Identify modern engineering tools for testing and deployment of mobile applications, recognize and adapt to diverse working and learning preferences, read, understand, and interpret deployment and testing documentation for Flutter applications, and demonstrate proficiency in using discipline-specific testing and deployment tools. (P.I.- 5.1.1,5.2.2, 8.1.1, 9.1.1)* *LO 6.2: Present test results as a team with well-integrated contributions from all members, produce clear, well-constructed, and well-supported test documentation, and demonstrate proficiency in using discipline-specific testing and deployment tools. (P.I.-5.2.2, 8.3.1, 9.1.2)*	
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.4.2	Analyze and interpret the results using contemporary tools.
2.4.3	Identify the limitations of the solution and sources/causes.
3.4.2	Ability to implement and integrate the modules.
3.4.3	Ability to verify the functionalities and validate the design.
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
5.2.2	Demonstrate proficiency in using discipline specific tools
5.3.1	Discuss limitations and validate tools, techniques and resources
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and nontechnical information
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents
11.1.1	Describe the rationale for requirement for continuing professional development
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes:

Learner will be able to

1. Apply Flutter framework and Dart programming to develop cross-platform mobile applications, demonstrating proficiency in engineering fundamentals and tools. (*LO1.1, LO1.2)*
2. Design and implement user interfaces using Flutter widgets, layouts, and animations, ensuring responsiveness and interactivity. *(LO2.1, LO2.2, LO3.1, LO 3.2)*
3. Integrate Firebase services and manage data persistence using file handling and JSON, demonstrating the ability to work with backend technologies. *(LO 3.2, LO 4.1, LO 4.2, LO 5.1)*
4. Evaluate and execute testing and deployment processes for Flutter applications, ensuring functionality and performance on Android and iOS platforms. *(LO5.1,LO 5.2, LO6.1,LO 6.2)*
5. Collaborate effectively in teams to develop, test, and present mobile applications, while producing clear and well-structured technical documentation. *(LO2.1, LO2.2, LO3.1, LO3.2, LO 5.1, LO 5.2,LO6.1, LO6.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITLBC507.1	3	-	3	-	3	-	-	3	-	-	-
ITLBC507.2	3	3	3	-	3	-	-	-	3	-	-
ITLBC507.3	-	3	3	-	3	-	-	-	-	-	3
ITLBC507.4	-	-	3	-	3	-	-	3	3	-	3
ITLBC507.5	3	3	3	-	3	-	-	3	3	-	3
Average	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**3**	**3**	**-**	**3**

Text Books:

1. Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, By Rap Payne, 2019
2. Beginning Flutter a Hands-on Guide to App Development, Marco L. Napoli, 2020, Wiley.

Reference Books:

1. Flutter in Action by Eric Windmill, MANING, 2019.
2. Google Flutter Mobile Development Quick Start Guide.Packt,2019.

Other Resources:

1. Flutter

   Web link: https://archive.nptel.ac.in/courses/106/106/106106156/
2. NPTEL Course: Android Mobile Application Development , Dr. Himanshu N. Patel , Dr. Babasaheb Ambedkar Open University, Ahmedabad
   Web Link- https://onlinecourses.swayam2.ac.in/nou25_ma01/preview

A. IN-SEMESTER ASSESSMENT (25 MARKS)

1. Continuous Assessment (25 Marks)

a) Task Execution : 10 Marks
b) Mini Project (Presentation with Q&A): 10 marks
c) Regularity and active participation in class :05 Marks

B. END SEMESTER ASSESSMENT (Practical & Oral Exam) (25 MARKS)

a) Execution of Task: 10 Marks
b) Presentation on Mini Project with Q&A: 10 Marks
c) Oral Test:05 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
AEC	AEC 502	PROFESSIONAL COMMUNICATION & ETHICS-2	02

Examination Scheme					
Distribution of Marks			**Exam Duration (Hrs.)**		**Total Marks**
In-semester Assessment		**End Semester Examination (ESE)**			
Continuous Assessment	**Mid-Semester Exam (MSE)**		**MSE**	**ESE**	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Teamwork
3. PO9 : Communication
4. PO11: Life-long learning

Course Objectives:

1. To inculcate in students, professional and ethical attitude, effective communication skills, team work and a multidisciplinary approach.
2. To provide students with an academic environment where they will be aware of the need for excellence, leadership and lifelong learning to build a successful academic & professional career.
3. To create awareness about professional ethics and codes of professional practices.
4. To prepare students for a successful academic and/or professional career that meets the global academic and/or corporate requirement by providing students to work on multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork, and other interpersonal skills.

Module	**Details**	**Hrs.**
00.	**Course Introduction** The curriculum of Professional Communication and Ethics-2 is designed to provide students with an academic environment that promotes a professional and ethical attitude as they participate in individual and team activities. The practical sessions will supplement the learner's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global industrial and corporate requirements. The curriculum will create an awareness of professional ethics and the standard code of conduct. It will further inculcate within the budding engineer the social commitment as responsible technical citizens. It will enhance the learner's team building capacities,	**01**

	interpersonal skills and leadership skills so as to become a well-rounded professional in their field of expertise.	
01.	**EMPLOYABILITY SKILLS** ***Learning Objectives:*** *1. Customised writing skills and Content Development: To develop effective writing skills to craft a clear, concise, and compelling Statement of purpose, formal letters and resumes for a specific purpose.* *2. To instil productive and efficient skills to participate confidently and constructively in group discussions and interviews for employability* *3. To inculcate Ethical Communication & Empathetic Listening*	
	Contents: **1.1 Business Correspondence** o Letter Writing (Principles, Format, Structure, Content, Types) o Job Application Letter o Joining Letter o Resignation Letter o Resume Writing **1.2 Statement of Purpose/ Letter of Intent or Interest** o Purpose o Elements of SOP/LOI o Structure o Tips for writing effective and ethical SOP/LOI **1.3 Verbal Aptitude Tests** modeled on CAT,GRE,GMAT,IELTS **1.4 Group Discussions**: Purpose, parameters of evaluating, Types of GDs (Traditional, Case-based & Role Plays), GD Etiquettes, and Importance of inclusivity, respectful listening and expression of diverse ideas for a common goal. **1.5 Personal Interviews:** Preparation, Types of questions, Types of interviews and modes of interviews. Types: Structured, Stress, Behavioural, Problem Solving & Case-based, Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual **1.6 Significance of Ethical approach during Group Discussions and Interviews** o Respectful listening o Speaking Assertively o Inclusivity of diverse individuals o Mindfulness and openness to different ideas o Common Goal of Consensus	**03**
	Self-Learning Topics: ***Watch recordings of professional interviews from online resources.(ex: Civil Service interviews), IIM and UPSC GDs***	

	Activities: *1. Prepare an SOP for admission procedure in a reputed university.* *2. Participate in GDs on a given topic followed by Mock Interview.* *3. Attempt Verbal Aptitude and Comprehension Tests.* *4. Write a Job Application/Resignation/Request/Enquiry letter in the learned format* *5. Write a Resume as a fresh graduate trainee for a specific post.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Write clear, concise and professional letters of various types that effectively convey information, build relationships and achieve professional objectives.(9.1.3, 9.2.3, 9.3.2, 11.1.1)* *LO 1.2: Rationally apply gained knowledge of group discussions and aptitude tests for continuous improvement and professional growth in academia and industry. (8.1.2, 8.2.1, 11.1.1.)* *LO 1.3: Exhibit the ethical code of conduct by treating all team mates with respect and dignity, by listening attentively to each member, and encouraging diversity of ideas during a GD. (7.3.1, 8.1.1, 8.2.2,8.2.3, 8.2.4, 9.2.3)* *LO 1.4: Demonstrate through group discussions and mock interviews, the ability to effectively identify unethical conduct and arrive at ethical decisions through strong leadership skills and respectfully lead a team or oneself to the desired goal. (7.1.1,8.1.2,8.2.1,8.2.3, 8.2.4, 8.3.1,9.2.2, 9.2.3)* *LO 1.5: Exhibit a calm demeanor by effectively preparing for competitive exams through mock tests which contain comprehending logical instructions, analysis, problem solving and verbal aptitude assessment (8.2.4, 9.1.1,11.1.1)*	
02.	**INTERPERSONAL SKILLS & ETHICS** ***Learning Objectives:*** 1. *Develop Problem Solving & Critical Thinking: To help budding engineers understand the importance of interpersonal skills and demonstrate creativity, resourcefulness, along with enhanced communication in personal and professional settings.* 2. *Self-Management & Ethical Awareness: To create awareness of Ethical and Social Responsibility towards individual and society by fostering self and team management leading to increased productivity and job readiness.*	**03**
	Contents: **2.1 Interpersonal Skills (implementation in all AE activities)** o Emotional intelligence o Effective Leadership o Team Building o Conflict Management o Negotiation & Ethical Conflict Resolution o Time management, o Assertiveness **2.2 Importance of Ethics in Interpersonal Relations** o Ethical and Inclusive Decision making. o Ethics in relation to Emotional Quotient	

	Self-Learning Topics: Follow industry leaders and experts on social media or read articles on topics related to corporate ethics and social responsibility. ***Activity:*** 1. *Listen to podcasts that discuss ethics, communication and interpersonal skills, such as "The TED Radio Hour" or "How I Built This" and conduct a GD on its learnings.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the learned interpersonal skills in various A.E. activities such as Report presentations, drafting business plans and SOP in an accepting, respectful and inclusive manner. (7.3.1,8.1.1, 8.1.2, 8.2.1, 8.2.2, 9.2.1, 9.2.3)* *LO 2.2: Apply the awareness of ethics while participating in a well-organized, time bound and constructive GD on topics raising ethical and moral concerns. (7.2.2, 7.3.1,8.2.1, 8.3.1, 9.2.3)* *LO 2.3: Apply empathetic and effective speaking skills utilizing ethical values and principles to resolve any social problem while working in a diverse team for group activities. (7.2.2, 7.3.18.1.1, 8.2.1, 8.2.2, 8.2.3, 9.2.1, 9.2.2.)* .	
03.	**ADVANCED TECHNICAL WRITING:PROJECT/PROBLEM BASED LEARNING** ***Learning Objective:*** *1. Structure & Organisation: To enable the learner to craft a well-structured technical report, utilizing a logical flow with clear introduction, body and flow, ensuring clarity and coherence in their writing.* *2. Effective Communication: To enhance the ability to communicate complex information clearly and concisely, using relevant visual aids and making the information accessible to technical and non-technical audience.*	**03**
	Contents: **3.1 Technical/Academic Report** o **Classification of reports on the basis of**: Subject Matter, Time Interval, Function, Physical Factors. o **Parts of a long formal report**: Front Matter, Main Body and Back Matter. o **Language and style of Reports:** Grammar, Tone, Style, Vocabulary, Format of the report from title page to appendices. **3.2 Definition, purpose and types of Proposal** o Parts of a Proposal**:** Elements, Scope and Limitations, Conclusion o Technical Proposal/Synopsis **3.3 Technical Paper Formats (APA/IEEE)** **Parts of a Research paper**: o Title Page o Abstract, o Introduction o Problem Statement/Hypothesis o Research methods, o Data Search (Primary/Secondary) o Quantitative/ Qualitative Analysis o Discussion, o Delimitations, o future scope and	

	o References. o Appendix o Acknowledgement **3.4 Significance of Presenting and Publishing a Research Paper** o Reading Secondary Data o Looking for research gaps o Understanding Need to fill research gap o Creating a Problem Statement o Writing a Synopsis o Writing an academic paper in the APA/IEEE format	
	Self-Learning Topics: ***Read academic research papers and look for gaps in the research area.*** ***Activity*:** *1. Prepare an Academic Research Paper on any technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *The learner will be able to* *LO3.1: Write, individually or as a team, a research paper, with logical & rational progression of ideas, effectively, in a time bound manner to everyone's understanding (8.3.1, 9.1.3, 9.2.3)* *LO3.2: Read, comprehend, and interpret previous research/ secondary source data and clearly state the purpose of research using the IEEE format. (9.1.1,9.1.3,11.3.1)* *LO3.3: Demonstrate the ability to use critical thinking to find gaps in research, interpret the technical and non-technical data and present it with clarity. (9.1.1, 9.1.3, 11.1.2, 11.3.1)* *LO3.4: Apply gained knowledge of technical writing for continuous improvement in academia and professional growth. (11.1.1)*	
04.	**TECHNICAL/BUSINESS PESENTATIONS** ***Learning Objectives:*** *1. The development of effective presentation structure and content for academic and technical presentation with the help of ICT* *2.Capacity building for delivering confident and persuasive presentation to both technical and non-technical audience individually or in a team.*	**02**
	Contents: **4.1 Effective Presentation Strategies:** o Purpose of a presentation, o Understanding the audience, location and the event, o Arranging the material, structuring the presentation, o Making effective slides and platform skills. **4.2 Group Presentations:** o Working with a mixed team (Diversity) o Sharing responsibility in a team (Delegation) o Creating the content together (Uniformity) o Transition phases and Coordination. (Teamwork) o Time Management (Individual and Team)	

	4.3 Individual Presentations: o Introduction of Self and Topic o Understanding the audience, building rapport o Time Management o End with Q n A, Feedback	
	Self-Learning Topics: *Watch YouTube videos of presentations like TED TALKS on motivational topics* ***Activity*:** *1. Prepare an academic research paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Demonstrate efficacious and seamless presentation skills to all audiences as an individual and a team with impeccable leadership qualities through proper delegation, problem solving and management (8.1.2, 8.2.1,8.3.1, 9.1.3, 9.2.2, 9.3.2)* *LO4.2: Engage with a diverse team and a mixed audience, during presentations, keeping in mind their uniqueness and differences. (7.3.1.,8.1.1,8.1.2,8.3.1,9.2.2, 9.2.3)*	
05.	***CORPORATE ETHICS*** ***Learning Objective/s:*** 1. *Ethical Principles & Frameworks: To aid the learner to differentiate between various codes of conduct and ethics in the social and professional world.* 2. *Analyse & Resolve Ethical Dilemmas: To enforce the significance of ethical citizenry & generate awareness on the importance of IPR and its consequences*	**02**
	Contents: **5.1. Intellectual Property Rights : Significance, Duration, Laws** o Copyrights o Trademarks o Patents o Geographical Indication o Industrial Designs o Trade Secrets **5.2. Start- Up Skills:** o Financial Literacy o Risk Assessment o Data Analysis. **5.3. Gender Equity & Inclusivity at the Work Place** o Study on Cases related to Gender Equity in India & Global o Corporate Social Responsibility o Inclusivity at the work place o Corporate Code of Conduct	
	Self-Learning Topics: Read a biography on a Business Leader/Philanthropist, Collect information on some failed startups. Assess and analyse the reasons for their failure.	

	Activity: 1. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* 2. *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Utilise professional, moral and ethical principles to identify wrong conduct and suggest ethical solutions through IPR, Gender Equity and Corporate ethics (7.1.1, 7.2.2, 7.3.1)* *LO 5.2: Critically evaluate various socioeconomic, gender issues of discriminatory nature, while emulating equality and open mindedness in all teams, sectors and activities. (7.1.1, 7.2.2,7.3.1, 8.1.1, 8.1.2, 9.2.3)* *LO 5.3: Employ the awareness of IPR to avoid or solve unethical practices in professional life by following standard rules and practices and emerge as a productive team member and a progressive leader. (7.1.1,7.2.2, 8.2.1, 8.2.2, 11.1.1)* *LO 5.4: Assess a failed business plan, analyse reasons for failure and suggest viable solutions as a team keeping in consideration both the individual and team effort. (8.2.1, 8.3.1,9.1.3, 11.1.2)*	
	Activities for Ability Enhancement (Practical Sessions):	**30**
	Contents: 1. *Write a job application letter, a joining letter, a letter of apology, a request letter. Attach a Resume to the Job Application letter. Follow Standard formats and protocols for each document. (5M)* 2. *Prepare an Academic Research Paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper (5M) + Presentation & Group Dynamics (5M)]* 3. *Prepare an SOP for admission procedure in a reputed university. (5M)* 4. *Participate in GDs on given topic followed by Mock Interview ((10 M)* 5. *Attempt Verbal Aptitude and Comprehension Tests(5M)* 6. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* ***OR*** *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)* 7. *Active Participation & Regularity (5M)*	
	Activities will start in the inverted pyramid, viz., with group activities first so as to build confidence and ending with solo presentations in the form of research paper presentation or Gender Equity presentation. *Group Discussion, Interview Skills, Presentation skills will have at least three mock drills before the final assessment of the same.* *Rigorous development of the English language, social and professional etiquette will be the praxis*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies
7.3.1	Apply and exhibit universal human values and a diverse and inclusive mind-set, free of discrimination
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution andleadership skills
8.2.2	Treat other team members respectfully
8.2.3	Listen to other members
8.2.4	Maintain composure in difficult situations
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that themain point is clear
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.2.3	Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team.
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	State the rationale for the requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Communicate and present effectively and ethically with mixed media in both oral and written forms business reports and documents which will in turn provide a solid foundation for their future managerial roles. (*LOs 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1)*
2. Exhibit the skill set required for successful employability while expressing ethical, assertive and inclusive leadership skills. (*LOs 2.1, 2.2, 2.3, 3.2, 4.2, 4.3, 5.2)*
3. Develop a critical thinking acumen to prepare for and give various competitive exams, emerge successful in group discussions and conduct healthy debates. (*LOs 1.3, 2.1, 2.2, 2.3, 3.1, 4.2)*
4. Develop creative and mindful thinking while demonstrating the knowledge of professional and personal etiquettes & ethics, such as diversity and inclusivity, in the global environment. (*Los 1.2, 2.2, 2.4,1.3, 3.2, 4.3, 5.1, 5.2, 5.3, 5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
AEC502.1	-	-	-	-	-	-	3	3	3	-	3
AEC502.2	-	-	-	-	-	-	3	3	3	-	3
AEC502.3	-	-	-	-	-	-	2	3	3	-	3
AEC502.4	-	-	-	-	-	-	3	3	3	-	3
Average	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**3**

Reference Books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin:*
2. *Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021).
3. *Business communication today*. Upper Saddle River, NJ: Pearson.
4. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
5. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South Western Cengage Learning.
6. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
7. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and

Practice. Oxford University Press

8. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
9. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Other Resources :

1. NPTEL Course: https://archive.nptel.ac.in/courses/109/104/109104030
   Dept. of Humanities and Social Sciences, IIT Kanpur, A Course on Communication Skills

CONTINUOUS INTERNAL ASSESSMENT (50 Marks)

1. Assignments on Resume Writing and Business Correspondence (5M)
2. Prepare an Academic Research Paper (3500-4000 words) on any one socio-technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper/ IEEE (5 M) + Presentation & Group Dynamics. (5M)]
3. Prepare an SOP for admission procedure in a reputed university. (5M)
4. Participation in Final GD on concrete/abstract topic followed by Mock Interview. (10M)
5. Verbal Aptitude Tests (5M)
6. Analyse a Case Study on the topic of Gender Equity & Inclusivity and present (APA) OR

   Analyse a failed start up present your case to a mixed audience (APA) (10M)
7. Regularity and Active participation (5M)

Course Type	Course Code	Course Name	Credits
MNP	ITMNP503	MINI PROJECT- 2A	01

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Engineering Tool Usage
6. PO6 : The Engineer & the world
7. PO7 : Ethics
8. PO8 : Individual & Collaborative Team work
9. PO9 : Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
  - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
  - 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
  - 25 marks for the Final Report & Presentation
  - 05 marks for Regularity and active participation
- Continuous Assessment marks distribution in semester VI (50 marks):
  - 15 marks for the In-Semester Two Presentations
  - 05 marks for Participation in Project Competitions, TPP, etc.
  - 25 marks for the Final Report & Presentation

- 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester V:

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
  - The first review will focus on finalizing the problem statement (topic approval).
  - The second review will centre on finalizing the proposed solution.

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
HSS	HSS502	ENTREPRENEURSHIP	02

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total Marks**
50	--	50

Pre-requisite: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer & The world
5. PO7: Ethics
6. PO10: Project Management & Finance
7. PO11: Life-Long learning

Course Objectives:

1. To develop Entrepreneurial mindset amongst the learners.
2. To promote Entrepreneurship as life-skills to improve quality of life, skills of creation and management of entrepreneurial pursuits.
3. To explore paths of the innovation through the creative problem-solving skills
4. To familiarize with the steps involved in 'idea to product' development.
5. To get acquainted with the preparation of pitch at ideation, business idea presentation and funding stages

Module	Details	Hrs
00.	**Course Introduction:** This course aims to equip individuals with the knowledge, skills, and mindset needed to identify and pursue new business opportunities. It aims to foster an entrepreneurial culture and mindset to help develop the next generation of entrepreneurs who can create jobs, drive economic growth, and contribute to the society. Entrepreneurship is a life skill that will help an individual succeed in a variety of scenarios, both personal and professional. By its very nature, entrepreneurship is an interdisciplinary field that draws from a range of disciplines, including business, economics, engineering, and social sciences. Some of the key topics covered in Entrepreneurship Course include opportunity recognition, market research, business planning, financing, marketing, and management while emphasizing the development of critical thinking, creativity, risk-taking, and problem- solving skills.	**01**
01.	**Fundamentals of Entrepreneurship**	**5-6**
	Learning Objectives:	

	• To gain knowledge about the concepts and principles of entrepreneurship, including opportunity recognition and value creation. • To develop an entrepreneurial mindset and skills that will enable them to identify, evaluate, and pursue viable business opportunities with confidence.	
	Contents: Introduction to Entrepreneurship, Entrepreneurial Mindset, Opportunity Identification, Market Analysis & Customer Research, Business Models & Go-to-Market, Funding and Financial Management, Marketing Aspects, Scaling the Venture and Growth Strategies: *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: The learner would be able to: • Understand the concept of Entrepreneurship • State the myths, advantages and limitations of Entrepreneurship • Interpret and analyze market research data and customer analysis to make informed business decisions. • Discuss the steps in the process of Entrepreneurship	
02.	**Technological Innovation and Entrepreneurship**	**4-5**
	Learning Objectives: • To enhance creative problem-solving skills and to examine the importance of innovation in business success. • To identify the types of Innovation • To gain knowledge for taking an idea to product development stage while protecting the idea with IPR.	
	Content: Foundations of Creativity and Innovations, Creative thinking process, Types of Innovation: Incremental, Disruptive, and Radical, Innovation Process: from idea to execution; Protecting ideas - Patents and IPR. Exploring Technological Innovation through Case Studies.	
	Learning Outcome: The learner would be able to • Use their understanding of the role Technological innovation plays in driving business success. • To formulate steps for taking an idea to product stage with necessary patents	
03.	**Ideation, Prototyping, Testing, Validation and Commercialisation**	**5-6**
	Learning Objectives:	

	• Experiment to test Minimum Viable Products (MVPs) and validate business ideas. • To formulate a Build-Measure-Learn feedback loop for continuous improvement.	
	Contents: Identifying customer needs and problems to solve, Ideation, Concept Development, Design Thinking, Prototyping, Minimum Viable Product (MVP), Testing, and Iterations. Understanding the Market, customer feedback and refinement of business idea based on feedback. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: The learner would be able to • Select specific measures to design, test, and validate Minimum Viable Products (MVPs) to assess business ideas. • Interpret the learnings from the build-measure-learn feedback loop to facilitate continuous improvement and learning.	
04.	**Financial Resources**	**3-4**
	Learning Objectives: • Describe the key concepts, and strategies related to fundraising for entrepreneurial ventures. • Compare various funding sources, including angel investors, venture capitalists, grants, and crowdfunding platforms. • Devise and create compelling investor pitches, develop financial projections.	
	Contents: Funding new ventures – bootstrapping, crowd sourcing, Angel investors, VCs, debt financing, and due diligence; Raising fund during life-cycle of a new ventures. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: The learner would be able to • Recognize various fundraising strategies and techniques, enabling s to choose the most appropriate funding sources for their entrepreneurial ventures. • Sketch effective pitches and fundraising campaigns tailored to different types of investors and funding sources, ensuring successful capital-raising efforts.	
05.	**National Entrepreneurial Culture**	**4-5**

	Learning Objectives: • To gain knowledge of legal and regulatory requirements for startups, including compliance with relevant regulations. • To identify the various government initiatives to develop the start-up ecosystem.	
	Contents: Entrepreneurial Ecosystem in India, Key regulations and legal aspects, Forms of Business Ownership, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc. Government incentives for entrepreneurship, Incubation, & Acceleration.	
	Learning Outcome: • Describe the current scenario of Entrepreneurial activity in India. • To state legal and regulatory requirements and compliances for start-ups. • To state the various government initiatives to support the entrepreneurs.	
06.	**Start-up Case Studies**	**3-4**
	Learning Objectives: To relate the real life case studies and analyse them for acquiring the clarity on various aspects of entrepreneurship covered in the first 5 modules	
	Contents: Case Studies of various start-ups (with Indian Context): Start-ups from Tech, Edtech, Fintech, and Agriculture domain; Study of successful start-ups and failed start-ups.	
	Learning Outcome: To evaluate the real-world examples and case studies that will help them understand the practical aspects of idea to product, fundraising and financial management in the context of entrepreneurship.	
Course Conclusion		**01**

In-semester Assessment - Continuous Assessment: Suggested

1 Teams of 3-4 students shall present a One-Minute business idea pitch– ideation phase-10 marks
2 Teams of 3-4 students shall present a Three-Minute Business Pitch –Validation phase-10 marks
3 Teams of 3-4 students shall present a Five-Minute Business Pitch for Funding- 15 marks
4 Teams of 3-4 students shall present analysis of one case study of successful or failed start-up- (15 Marks)

Course Outcome:

1. State the concept of Entrepreneurship and Indian Start-up ecosystem
2. Identify the business ideas and to analyse the environment for potential business opportunity.
3. Identify the specific measures to design, test, and validate Minimum Viable Product.
4. State the key concepts, and strategies related to fundraising for entrepreneurial ventures.
5. Identify the legal and regulatory framework for entrepreneurs in Indian context.
6. Analyse and correlate the reasons for the success or the failure of entrepreneurial firms.

Text Books:

1. Poornima Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
7. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.

Reference Books:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
3. India as Global Start-up Hub: Mission with Passion by C B Rao
4. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker
5. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich, Veland Ramadani, Springer (2017)
6. Entrepreneurship- Theory, Process Practice –by Kuratko &Hodgetts, Thompson South-Western Publication

Relevant Websites:

1. www.msme.gov.in
2. www.dcmesme.gov.in
3. www.msmetraining.gov.in

Other Resources:

1. NPTEL Course: Entrepreneurship By Prof. C Bhaktavatsala Rao, IIT Madrao
   Weblink https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. NPTEL Course: Entrepreneurship Essentials By Prof. Manoj Kumar Mondal, IIT Kharagpur
   Weblink https://onlinecourses.nptel.ac.in/noc21_ge06/preview

Course Type	Course Code	Course Name	Credits
PCC	ITPCC611	CRYPTOGRAPHY & NETWORK SECURITY	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
Continuous Internal Evaluation		End Semester Exam			
Continuous Assessment	Mid-Sem Exam		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ITPCC401: Engineering Mathematics-IV
2. ITPCC406: Computer Network

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO11: Life-Long Learning

Course Objectives:

1. To impart the basic concepts of security services and cryptographic techniques.
2. To acquaint the knowledge of different symmetric key cryptographic techniques.
3. To introduce the various asymmetric key cryptographic techniques.
4. To inculcate the cryptographic hash functions , authentication protocols and malicious software.
5. To learn the basics of Web security, Transport layer security, IP security, Email security and various types of system security.

Module	Detailed Contents	Hrs
00.	**Course Introduction:** Cryptography and Network Security is a fundamental aspect of modern data security, serving as a shield to protect sensitive information from unauthorized access and potential breaches. It is important for organizations to have a good cryptography system in place in today's digital landscape.	01
01.	**Introduction to Security Concepts and Basic Cryptography** ***Learning Objective:*** *To impart the knowledge of the basic concepts of security services and classical cryptographic techniques used in real time applications.*	10-12

	Contents: The need for security, Security approaches, Principles of security, Basic Security services: confidentiality, integrity, availability, non-repudiation, privacy, Types of security attacks: Active attacks and Passive Attacks, Security Mechanisms, The OSI security architecture, Network security model, Concept of Cryptography, Classical Encryption techniques: mono-alphabetic and poly-alphabetic, substitution techniques: Caesar Cipher, Multiplicative Cipher, Affine Cipher, Autokey Cipher, Vigenère cipher, Playfair cipher, Hill Cipher ,Transposition techniques: keyed and keyless transposition ciphers, Introduction to steganography.	
	Self-Learning Topic: *Study some basics of Quantum Cryptography.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply the knowledge of fundamental concepts of security services and its mechanisms in various applications (P.I.-1.3.1)* *LO 1.2 : Apply various types of classical encryption techniques for security purpose. (P.I.-1.4.1)* *LO 1.3: Identify and assess impact of different types of substitution, transposition techniques on secure used in real-time cryptographic applications . (P.I.-2.1.3, 6.1.1)* *LO 1.4: Compare and analyse the effectiveness of various encryption techniques in addressing modern digital world cybersecurity challenges.. (P.I.- 2.2.4,6.3.1)*	
02.	**Symmetric Key Cryptography** ***Learning Objective:*** *To acquaint the knowledge of various block cipher modes, symmetric key cryptographic techniques in real time applications.*	**06-08**
	Contents: Euclidean algorithm, Modular Arithmetic, Prime numbers, Fermat's and Eulers theorem, Congruence relation, Chienese Remainder Theorem, Block cipher modes of operation: Electronic Code Book (ECB) mode, Cipher Block Chaining (CBC) mode, Cipher Feedback (CFB) mode, Output Feedback (OFB) mode, Counter mode (CTR), Data Encryption Standard (DES), Advanced Encryption Standard (AES), Stream Ciphers: Rivest Cipher 4 (RC4), Rivest Cipher 5 (RC5) algorithm.	
	Self-Learning Topics: *Study some more types of ciphers like Feistel Cipher, XOR Cipher, Keyword Cipher, Null Cipher.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the knowledge of fundamental mathematical concepts in the field of security. (P.I.-1.1.1)* *LO 2.2: Apply various block cipher modes of operation in various encryption standards. (P.I.-1.3.1)* *LO 2.3: Identify various Symmetric Key Cryptographic techniques. (P.I.- 2.1.3)* *LO 2.4: Compare and contrast different types of the stream ciphers and select the optimal strategy. (P.I.- 2.2.4)*	
03.	**Asymmetric Key Cryptography** ***Learning Objective:***	**06-08**

	To impart the knowledge of different asymmetric key cryptographic techniques in real time applications.	
	Contents: Public key cryptography, Principles of public key cryptosystems, The RSA algorithm, Elgamal Cryptography, Elliptic Curve Cryptography, Key distribution and Key exchange protocols, Diffie-Hellman Key Exchange, Man in the middle attack.	
	Self-Learning Topics: *Study some other types of attacks like denial-of-service attack, DDOS, SYN Flood attack.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply principles of public key cryptosystems. (P.I.-1.3.1)* *LO 3.2: Apply RSA asymmetric key cryptographic algorithm in real time application. (P.I.-1.1.1)* *LO 3.3: Compare and evaluate the effectiveness of Elgamal Cryptography and Elliptic Curve Cryptography technique in real-world security systems (P.I.-2.2.4)* *LO 3.4: Apply the concept of key distribution in the Diffie-Hellman Key Exchange Algorithm to develop secure communication protocols.(P.I.-2.1.3)*	
04.	**Cryptographic Hash Functions and Authentication Protocols** ***Learning Objective:*** *To identify different hash functions , hashing techniques and authentication protocols.*	**06-08**
	Contents: Concept of cryptographic hash function, properties of secure hash function, Hashing Techniques: Secure Hash Algorithm-256 (SHA-256), Secure Hash Algorithm-512 (SHA-512), Message Digest (MD5), Hash based Message Authentication Code (HMAC) and Cipher based Message Authentication Code (CMAC), Digital Signature Schemes: RSA, DSS, Attacks on Digital Signature, Remote user Authentication Protocols, Kerberos, Digital Certificate:X.509, Public Key Infrastructure (PKI).	
	Self-Learning Topics: *Study Zero-knowledge protocols, Lightweight Directory Access Protocol (LDAP), Cryptographic hash Functions in blockchain.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the concept of Cryptographic Hash Functions in cybersecurity and cryptography. (P.I.-1.3.1)* *LO 4.2: Apply the concept of hashing techniques to ensure data integrity and analyze the societal impact of cryptographic hashing techniques in securing sensitive data, ensuring privacy, and preventing malicious activities .P.I.-1.4.1, 6.2.1)* *LO 4.3: Compare and contrast remote user authentication protocols. (P.I.-2.2.4)* *LO 4.4: Identify and analyze various Digital Signature Schemes used in real-time applications, evaluating their significance in engineering & societal contexts . (P.I.-2.1.3, 6.3.1)*	
05.	**Malicious Programs** ***Learning Objective:*** *To familiarize various malicious programs and countermeasures required to protect system against malicious code.*	**01-03**
	Contents: SPAM, Trojan horse, Viruses, Worms, System Corruption, Attack Agents, Information Theft, Trapdoor, Keyloggers, Backdoors, Rootkits, Zombie, SQL injection, Phishing, Countermeasures.	

	Self-Learning Topics: *Study the recent malicious software and their effects.*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply knowledge of different types of malicious software to protect the system from virus. (P.I.-1.3.1)* *LO 5.2: Implement countermeasures to protect system from malicious programs. (P.I.-1.4.1)*	
06.	**Network Security and Applications** ***Learning Objective:*** *To introduce the basics of web security, transport layer security, IP security, Email security and various types of system security in the network.*	**08-10**
	Contents: Web security considerations, Secure Electronic Transaction Protocol, Secure Sockets Layer (SSL)Architecture, Transport Layer Security (TLS), IP level Security: Introduction to IPSec, IPSec Architecture, Protection Mechanism (Authentication Header and Encapsulating Security Payload), Email security : Pretty Good Privacy (PGP), S/MIME, Intruders, Intrusion detection System (IDS), Firewall design principles, types of firewalls, Case Studies on Cryptography and security: Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability, Virtual Elections.	
	Self-Learning Topics: *Study advanced Security Applications like Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis.*	
	Learning Outcomes: *A learner will be able to* *LO6.1: Apply and analyze web security ,Transport Layer Security (TLS),IP security to identify potential threats and designing effective solutions to enhance cybersecurity (P.I.-1.3.1,2.2.3,3.2.2)* *LO6.2: Apply and analyze email security protocols, such as SMTP, POP,S/MIME , PGP, for protecting email communication against cyber threats and evaluate its ethical and societal implications to address evolving threats. (P.I.-1.4.1,2.2.2,3.2.1,6.1.1, 7.1.1,11.2.1)* *LO 6.3: Analyze real-world security challenges by using various network security and evaluate the ethical, societal, and technological implications of cryptographic security measures in modern applications, emphasizing continuous learning and professional responsibility (P.I.-2.3.1, 6.2.1,7.2.2,11.2.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P. I. Number	**P. I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems.
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem
2.2.2	Identifies functionalities and computing resource.

2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solution/methods to select the best methods
3.2.1	Ability to explore design alternatives.
3.2.2	Ability to produce a variety of potential design solutions suited to meet functional requirements.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional, and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public.
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current developments.
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

Course Outcomes:

Learner will be able to

1. Apply fundamental security concepts and various encryption techniques to enhance secure communication and evaluate their role in data security, privacy, and societal implications. *(LO 1.1,LO1.2,LO1.3,LO1.4)*
2. Apply different symmetric key cryptographic techniques to enhance data security in real-world application. *(LO 2.1,LO 2.2,LO 2.3,LO 2.4)*
3. Apply various asymmetric key cryptographic techniques to ensure data security in real time application. *(LO 3.1, LO3.2, LO3.3, LO3.4)*
4. Identify hashing techniques, various authentication protocols to enhance security and apply the knowledge of malicious software to implement countermeasures to protect system. *(LO 4.1,LO 4.2,LO 4.3,LO 4.4,LO5.1,LO5.2)*
5. Analyse web, TLS, IP-level, and email security mechanisms to protect digital communication. Also evaluate their societal, ethical, and technological impact while emphasizing continuous learning in cybersecurity. *(LO 6.1,LO 6.2,LO 6.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPCC611.1	3	3	-	-	-	3	-	-	-	-	-
ITPCC611.2	3	3	-	-	-	-	-	-	-	-	-
ITPCC611.3	3	3	-	-	-	-	-	-	-	-	-
ITPCC611.4	3	3	-	-	-	3	-	-	-	-	-
ITPCC611.5	3	3	3	-	-	3	3	-	-	-	3
Average	**3**	**3**	**3**	-	-	**3**	**3**	-	-	-	**3**

Text Books:

1. Cryptography and Network Security, Principles and Practice, William Stallings, Sixth Edition, March 2013, Pearson Education.
2. Cryptography & Network Security, Behrouz A. Ferouzan, First Edition, 16 March 2007, Tata McGraw Hill.
3. Cryptography and Network Security, Behrouz A. Forouzan & Debdeep Mukhopadhyay, Second Edition, 2010, Tata McGraw Hill Education.
4. Cryptography & Network Security, Bernard Menezes, Sixth Edition ,2010, Cengage Learning.

Reference Books:

1. Cryptography and Network Security, Atul Kahate, Third Edition, 2013, Mc Graw Hill.
2. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Second Edition,2001, John Wiley and Sons Inc.
3. Network Security Bible, Eric Cole, Second Edition, 2011.Wiley.

Other Resources:

1. NPTEL Course: Cryptography and Network Security by Dr. Debdeep Mukhopadhyay, IIT Kharagpur
   Web Link- https://nptel.ac.in/courses/106105031
2. NPTEL Course: Foundation of Cryptography by Prof. Ashish Choudhary, IIT Bengaluru
   Web Link- http://www.digimat.in/nptel/courses/video/106106221/L46.html
3. NPTEL Course: Cryptography and Network Security by Prof. Sourav Mukhopadhyay , IIT Kharagpur.
   Web Link- https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs28/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One MCQ Test as per GATE exam pattern / level: 05 Marks

b) One Class Test:05 Marks

c) One Think Pair Share (TPS) activity: 05 Marks

d) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC6021	INFRASTRUCTURE MANAGEMENT	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ITPCC406: Computer Network
2. ITPCC407: Operating System
3. ITLBC506: Cloud Computing Laboratory
4.

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct investigations of complex problems
5. PO10: Project management and finance
6. PO11: Life-Long Learning

Course Objectives:

1. To introduce the perspective of Infrastructure Management.
2. To make learner learn concepts of Network Infrastructure Management.
3. To make learner demonstrate System and Storage Management skills
4. To impart the knowledge of fundamentals of Cloud computing and Cybersecurity in IT Infrastructure management
5. To acquaint learner with Emerging Technologies in IT Infrastructure management

Module	Details	Hrs.
00.	**Course Introduction** The Infrastructure Management course includes a combination of technical, managerial, and practical aspects related to planning, designing, implementing, and managing IT infrastructure. It is the process of keeping an organization's IT infrastructure - hardware, data storage, operating systems, networks and communications, enterprise software, and internet platforms - running smoothly.	**01**
01.	**Introduction to IT Infrastructure management** ***Learning Objective:***	**05-07**

	To make learner identify and summarize basics of infrastructure management, Role of Infrastructure Managers and challenges faced.	
	Contents: Definition, Scope and Importance of IT Infrastructure. Evolution, Goals and types for Infrastructure Management. Role of Infrastructure Managers. Challenges in IT infrastructure management.	
	Self-Learning Topics: *Identify current trends in IT infrastructure management.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply concepts of Infrastructure management to Information System (P.I.-1.3.1)* *LO 1.2: Apply the knowledge of infrastructure managements to find challenges of Infrastructure management (P.I.-1.4.1)* *LO 1.3: Identify processes for manager role in Infrastructure management (P.I.-2.1.2)* *LO 1.4: Identify the functionalities of components of IT infrastructure (P.I.-2.2.2)*	
02.	**Network Infrastructure management** ***Learning Objective:*** *To familiarize with the different components, protocols, standards, topologies and challenges of network infrastructure management*	**08-10**
	Contents: Definition, scope, and importance of network infrastructure management. Current trends and challenges in network management. Network architecture, models, protocols and standards. Network devices and their functions. Network performance optimization and QoS, Network topologies and design principles. **Demonstration of Network Infrastructure Management techniques using open source tool.**	
	Self-Learning Topics: *Identify Career paths and opportunities in network infrastructure management.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Identify objectives of network infrastructure management (P.I.-2.1.1)* *LO 2.2: Identify current trends and challenges in network management. Network architecture, models, protocols and standards (P.I.-2.1.2)* *LO 2.3: Apply fundamentals for network performance optimization (P.I.-1.3.1)* *LO 2.4: Apply different network topologies and design principals to network infrastructure management (P.I.-1.4.1)*	
03.	**System Management** ***Learning Objective:*** *To make learner analyze different server requirements for managing the resources.*	**06-08**
	Contents: Server hardware and architecture, Server operating systems (Windows Server, Linux Server), Server management and configuration, High	

	availability and disaster recovery planning. Containerization (Docker, Kubernetes) and its role in IT infrastructure. **Demonstration of System/Server Management techniques using open source tool.**	
	Self-Learning Topics: *Identify current trends in server configuration available in the market.* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply concepts to achieve high availability and disaster recovery (P.I.-1.3.1)* *LO 3.2: Apply different NLP approaches to mining information from clinical text (P.I.-1.4.1)* *LO 3.3: Identify role of containerization in IT infrastructure (P.I.-2.2.3)* *LO 3.4: Identify server operating system and configuration required for IT infrastructure management. (P.I.-2.1.2)*	
04.	**Storage Management** ***Learning Objective:*** *To familiarize with storage technologies like SAN, NAS, CAS etc. and understand storage management challenges for business continuity.*	**06-08**
	Contents: Storage technologies (SAN, NAS, CAS), RAID configurations and data redundancy, Monitoring the storage Infrastructure, Storage management activities and provisioning, Backup and recovery strategies, Replication strategies, Storage Infrastructure Management challenges. **Demonstration of Storage Management techniques using open source tool**	
	Self-Learning Topics: *Identify current trends in storage technologies available in the market* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Apply concepts to achieve data redundancy in storage technologies(P.I.-1.3.1)* *LO 4.2: Apply fundamentals to find challenges in Storage Infrastructure Management (P.I.-1.4.1)* *LO 4.3: Identify different techniques to monitor storage infrastructure (P.I.-2.2.3)* *LO 4.4: Identify Backup/recovery and Replication processes for Storage Infrastructure Management (P.I.-2.1.2)*	
05.	**Cloud computing and Cybersecurity in IT Infrastructure** ***Learning Objective:*** *To make learner aware of the different cloud computing models, security audit, monitoring and compliance.*	**06-08**
	Contents: Introduction to cloud computing models, deployment models. Cloud security and compliance. Security principles and best practices. Network security (firewalls, VPNs, IDS/IPS). Identity and access management, Security auditing and monitoring. Ethical considerations in IT infrastructure management. **Demonstration of Cloud and Cybersecurity Management techniques using open source tool**	
	Self-Learning Topics:	

	Case study of any cyber security based IT infrastructure managing industry. ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Use appropriate techniques to collect data required for cloud security and compliance (P.I.-4.3.1)* *LO 5.2: Define problems encounter during application of Security principles and best practices used in investigation of IT infrastructure (P.I.- 4.1.1)* *LO 5.3: Identify access management, Security auditing and monitoring in IT infrastructure (P.I.- 2.2.3)* *LO 5.4: Identify processes used for Ethical considerations in IT infrastructure management (P.I.-2.1.2)*	
06.	**Emerging Technologies in IT Infrastructure** ***Learning Objective:*** *To make learner aware of emerging technologies in IT infrastructure management domain and should be able to provide to mitigate the risk associated with business continuity.* **Contents:** Internet of Things (IoT) and its impact on IT infrastructure. Edge computing and its relevance. Artificial Intelligence (AI) and machine learning in infrastructure management. Project planning and scheduling, Budgeting and resource management, Risk assessment and mitigation in infrastructure projects. **Demonstration of IoT and Edge Computing techniques using open source tool** ***Self-Learning Topics:*** *Case studies and future trends IT infrastructure Management of different Industries* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Synthesize requirements for risk assessment and mitigation in infrastructure projects and select most appropriate proposal (P.I.- 3.1.5, 10.2.1)* *LO 6.2: Design Project planning and scheduling alternatives for IT infrastructure management and identify tasks required to complete the tasks (P.I.- 3.2.1, 10.3.1)* *LO 6.3: Identify technological advances in edge computing relevance on IT infrastructure (P.I.- 2.1.2, 11.2.1)* *LO 6.4: Identify and analyze impact of IoT on performance and sustainability of IT infrastructure (P.I.- 2.3.1, 11.3.2)*	**06-08**
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.2	Identifies functionalities and computing resources.

2.2.3 Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
3.1.5 Explore and synthesize system requirements from larger social and professional concerns
3.2.1 Ability to explore design alternatives
4.1.1 Define a problem for purposes of investigation, its scope and importance
4.3.1 Use appropriate procedures, tools and techniques to collect and analyze data
10.2.1 Analyse and select the most appropriate proposal based on economic and financial considerations.

10.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks
11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Identify and apply appropriate IT infrastructure techniques to Information System. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Analyse different techniques of Network Infrastructure Management and apply appropriate techniques for the same. *(LO 2.1, LO 2.2,LO 2.3, LO 2.4)*
3. Identify and apply Server and Storage management techniques for IT infrastructure Management. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Analyse Cloud computing and Cybersecurity in IT Infrastructure Management. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Design cost effective solution using recent IoT and Edge Computing techniques for IT Infrastructure Management. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC6021.1	3	3	-	-	-	-	-	-	-	-	-
ITPEC6021.2	3	3	-	-	-	-	-	-	-	-	-
ITPEC6021.3	3	3	-	-	-	-	-	-	-	-	-
ITPEC6021.4	-	3	-	3	-	-	-	-	-	-	-
ITPEC6021.5	-	3	3	-	-	-	-	-	-	3	3
Average	**3**	**3**	**3**	**3**	-	-	-	-	-	**3**	**3**

Text Books:

1. Mishra, Nikhilesh. Mastering IT Infrastructure Management: Concepts, Techniques, and Applications., Amazon Digital Services LLC - Kdp, 2023
2. Infrastructure Planning Handbook by Prof Makarand Hastak, ASCE Press
3. Strategic Management of Large Engineering Projects by Miller and Lessard
4. Keshari, Surendra., Kumar, Narendra. IT Infrastructure and Management. India: I.K. International Publishing House Pvt. Limited, 2013.

Reference Books:

1. Kramp, Luna. Beginner'S Guide to IT Infrastructure Management- Managing Technology and Technology Teams, it Budgets, Risk, Assets, Large It Projects: Infrastructure Manager Guide Book. N.p., Independently Published, 2020.
2. Schiesser, Rich. IT Systems Management. United Kingdom, Prentice Hall PTR, 2002.
3. Choubey, Manoj Kumar. IT Infrastructure and Management: For the GBTU and MMTU. India: Pearson India, 2011.
4. Infrastructure Planning and Management in India: Opportunities and Challenges. Singapore: Springer Nature Singapore, 2022.

Other Resources :

1. NPTEL Course: Infrastructure Planning and Management by Prof. Ashwin Mahalingam, IIT Madras. Web link- https://onlinecourses.nptel.ac.in/noc21_mg81/preview
2. NPTEL Course: Infrastructure Economics by Prof. Nalin Bharti, IIT Patna. Web link- https://nptel.ac.in/courses/109106089

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

a) Assignment on live problems/ case studies: 10 Marks

Students should be assigned a real life problem statement related to IT infrastructure management domain. Students are expected to research and collect required data to design a system for the selected problem. Students should apply infrastructure management knowledge to design a system for IT resources including memory, network, server and storage requirements. Students should present their work in the form of presentation and demonstration in 10-15 minutes. This assignment should be graded for 10 marks like a design assignment based on the parameters such as data acquisition, requirement analysis, designing a system for selected problem statement.

b) One Think Pair Share (TPS) activity: 05 Marks

c) Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC6022	MACHINE LEARNING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ITPCC301: Engineering Mathematics-III
2. ITPCC405: Engineering Mathematics-IV
3. ITPCC510: Artificial Intelligence

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct Investigation of complex problems
5. PO5: Engineering tool usage
6. PO8: Individual and Collaborative Teamwork
7. PO9: Communication
8. PO11: Life-Long Learning

Course Objectives:

1. To impart the knowledge about basic difference among the techniques of Machine Learning.
2. To introduce regression, classification and clustering methods to solve problem.
3. To introduce various ensemble techniques for combining ML models
4. To impart the knowledge about design an application using Machine learning and Deep learning methods

Module	Detailed Contents	Hrs
00.	**Course Introduction** Machine Learning course deals with techniques to develop algorithms that improve automatically through experience and by the use of data. This course includes the foundational principles and practice implementing various ML systems.	01
01.	**Introduction to Machine Learning** ***Learning Objective/s:*** *To acquaint learner with interpretation of various types of machine learning and implementation of it in real time applications.*	04-06

	Contents: Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application, Training Error, Generalization error, Overfitting, Under fitting, Bias-Variance trade-off	
	Self-Learning Topics: *Explore applications of ML.*	
	Learning Outcomes: *The learner will be able to* *LO 1.1: Identify the appropriate ML method applicable to a given problem (P.I.-2.2.3)* *LO 1.2: Solve a given problem using ML technique. (P.I.-2.1.3)* *LO 1.3: Apply engineering fundamentals to identify the type of machine learning applicable to a given problem (P.I-1.3.1)* *LO 1.4: Apply the appropriate ML method applicable to a given problem. (P.I- 1.4.1)*	
02.	**Supervised Learning Methods** ***Learning Objective/s:*** *To make learner apply regression and decision tree techniques for prediction. Also expected to evaluate the performance of the method.*	**12-14**
	Contents: **Learning with Regression:** Linear Regression, Multivariate Linear Regression, Logistic Regression **Learning with Trees:** Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART) Performance Metrics: Confusion Matrix, Kappa Statistics, Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve **Learning with Support Vector Machine:** Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, Quadratic Programming, SVM for linear and nonlinear classification, Basics of Kernel trick, Support Vector Regression, Multiclass Classification. **Ensemble Learning:** Understanding Ensembles, K-fold cross validation, Boosting, Stumping, XGBoost Bagging, Subagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers **Demonstration of Regression, Decision Tree and SVM Techniques using open source tool**	
	Self-Learning Topics: *ID3 Method for Decision Tree*	
	Learning Outcomes: *The learner will be able to* *LO 2.1: Apply the regression techniques for prediction of output based on the input. (P.I.-1.3.1)* *LO 2.2: Apply Logistic regression, Decision tree and support vector machine to classify the data. (P.I.-1.4.1)* *LO 2.3: Evaluate the performance of the ML Model. (P.I.-3.3.1)* *LO 2.4: Apply ensemble learning to combine different ML classifiers. (P.I. 3.4.2)*	

03.	**Unsupervised Learning Methods** ***Learning Objective/s:*** *To make leaner apply clustering and association rule mining techniques for discovering clusters/rules.*	**06-08**
	Contents: **Learning with Clustering:** Introduction to clustering with overview of distance metrics, K means Clustering, Hierarchical Clustering. K-NN Clustering, Clustering with minimal spanning tree, Expectation Maximization Algorithm, DBSCAN **Learning with Association Rule Mining:** Discovering association rules **Demonstration of Clustering techniques using open source tool**	
	Self-Learning Topics: *K medoid clustering*	
	Learning Outcomes: *The learner will be able to* *LO 3.1: Apply different distance metrics to find clusters. (P.I.-1.3.1)* *LO 3.2: Apply the clustering algorithms to group the data in to clusters. (P.I.-1.4.1)* *LO 3.3: Select the value of K based on the given data. (P.I.-2.1.3)* *LO 3.4: Select the best linkage method used in hierarchical clustering by comparing different linkage methods. (P.I.-2.2.4)*	
04.	**Reinforcement Learning Methods** ***Learning Objective/s:*** *To make learner apply the knowledge of reinforcement learning to solve a problem.*	**03-05**
	Contents: Introduction, Elements of Reinforcement Learning, Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	
	Self-Learning Topics: *Robot Navigation as reinforcement learning problem.*	
	Learning Outcomes: *The learner will be able to* *LO 4.1: Apply the concept of reinforcement to solve a problem. (P.I.-1.3.1)* *LO 4.2: Apply different reinforcement learning methods to solve a real life problem. (P.I.-1.4.1)*	
05.	**Introduction to Deep Learning** ***Learning Objective/s:*** *To make leaner apply the deep learning networks to design application also expected to analyze and interpret the result.*	
	Contents: Introduction to Deep Learning, ANN, Machine Learning Vs Deep Learning, Working of Deep Learning; **Convolutional Neural Network:** Introduction, Components of CNN Architecture, Properties of CNN, Architectures of CNN, Applications of CNN **Recurrent Neural Network:** Introduction, Simple RNN, LSTM Implementation, Deep RNN	**08-10**

	Autoencoder: Introduction, Features, Types, **Demonstration of Deep Learning applications using open source tool**	
	Self-Learning Topics: *GAN* ***Learning Outcomes:*** *The learner will be able to* *LO 5.1: Apply the convolution operation to extract the features of Image (P.I.-1.1.1)* *LO 5.2: Apply Convolutional Neural Network to solve a problem. (P.I.-1.4.1)* *LO 5.3: Identify the components and parameters of CNN to solve a problem. (P.I.-2.1.2)* *LO 5.4: Solve the given problem by identifying the appropriate deep learning network.(P.I.-2.2.3)*	
06.	**Applications and Recent trends of Machine Learning** ***Learning Objective/s:*** *To make learner apply the concepts of machine learning to design and analyze the real life applications.*	**04-06**
	Contents: **Applications:** Recommender Systems, Machine Learning for Image Recognition, Sentiment Analysis, Machine Learning for video surveillance **Recent trends:** TinyML , MLOps	
	Self-Learning Topics: *Interpretable ML*	
	Learning Outcomes: *The learner will be able to* *LO 6.1: Define a problem statement along with the research gap, Choose ML technique and tool, use it to design a solution and effectively present the solution. (P.I.-3.1.1,4.1.1,5.1.1, 8.2.1,9.1.1,11.1.2)* *LO 6.2: Identify the recent ML technique alternative to traditional techniques for the selected problem, use it to design a solution with the help of ML tools and effectively present the solution in a team (P.I.- 3.2.1,4.2.1,5.2.2,8.3.1,9.1.2,11.2.1)*	
	Course Conclusion	**01**
Total		**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem.
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods
3.1.1	Able to define a precise problem statement with objectives and scope.

3.2.1 Ability to explore design alternatives.

3.3.1 Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.

3.4.2 Ability to implement and integrate the modules.

4.1.1 Define a problem for purposes of investigation, its scope and importance

4.2.1 Design and develop appropriate procedures/methodologies based on the study objectives

5.1.1 Identify modern engineering tools, techniques and resources for engineering activities.

5.2.2 Demonstrate proficiency in using discipline specific tools.

8.2.1 Demonstrate effective communication, problem solving, conflict resolution and leadership skills.

8.3.1 Present result as a team, with smooth integration of contributions from all individual efforts.

9.1.1 Read, understand and interpret technical and nontechnical information.

9.1.2 Produce clear, well- constructed, and well-supported written engineering documents.

11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

11.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap.

Course Outcomes:

Learner will be able to

1. Select and apply appropriate machine learning model for the given application. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Select and apply various supervised, unsupervised and ensemble machine learning techniques and evaluate the performance of the model. *(LO 2.1, LO 2.2., LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Apply the Reinforcement learning to solve a given problem. *(LO 4.1, LO 4.2)*
4. Analyse and apply Deep learning methods to solve the given problem.*(LO 5.1, LO 5.2, LO 5.3, LO5.4)*
5. Design application using machine learning techniques. *(LO 6.1, LO 6.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC6022.1	3	3	-	-	-	-	-	-	-	-	-
ITPEC6022.2	3	3	3	-	-	-	-	-	-	-	-
ITPEC6022.3	3	-	-	-	-	-	-	-	-	-	-
ITPEC6022.4	3	3	-	-	-	-	-	-	-	-	-

ITPEC6022.5	-	-	3	3	3	3	-	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**-**	**3**

Text Books :

1. Machine Learning in Action, Peter Harrington, Fourth Edition" 2020, DreamTech Press.
2. Introduction to Machine Learning, Ethem Alpaydın, First edition, 2011, MIT Press.
3. Machine Learning, Tom M. Mitchell, Fourth edition, 2005, McGraw Hill.

Reference Books :

1. Data Mining Concepts and Techniques, Han Kamber, First Edition,1990, Morgan Kaufmann Publishers.
2. Data Mining Introductory and Advanced Topics, Margaret. H. Dunham, Sixth Edition.2018, Pearson Education.
3. Machine Learning — A Probabilistic Perspective, Kevin P. Murphy, 3rd edition, 1993,Pearson Education.

Other Resources :

1. NPTEL Course: Introduction to Machine Learning, Prof. S. Sarkar, IIT Kharagpur
   Web Link- https://onlinecourses.nptel.ac.in/noc21_cs85
2. NPTEL Course: Introduction to Machine Learning, Prof. Balaraman Ravindran, IIT Madras
   Web Link- https://onlinecourses.nptel.ac.in/cnoc21_cs24

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One Assignment on live problems/ case studies: 10 Marks

Students should be assigned a real life problem statement (different for each student). Students are expected to research and collect required resources to solve the problem. They can use the resources and solve the problem on assigned date and time in Institute premises in presence of faculty member. This assignment should be graded for 10 marks depending on the parameters as analysis, design, application of appropriate ML technique and outcome for selected problem statement.

b) One Think Pair Share (TPS) activity: 05 Marks

c) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	ITPEC6023	WIRELESS TECHNOLOGY	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ITPCC302: Computer Organization and Architecture
2. ITPCC406 : Computer Network

Course Objectives:

1. To familiarize with the concepts of Wireless communication system
2. To impart knowledge of various Wireless technologies and analyse their Architectures.
3. To introduce leaners with the need of Wireless Sensor& Ad hoc Networks along with Mobile IP
4. To acquaint the learner with the security challenges in wireless systems and Analyse Different Wireless Network Security Standards
5. To make them Analyse the Design Considerations for Wireless Networks and recent trends in wireless technologies.

Module	Details	Hrs.
00.	**Course Introduction** Wireless Technology deals with the need and basic concepts of Wireless communication, with emphasis on the 4G and 5G wireless technologies along with WSN and Ad hoc networks. The fundamental concepts of this subject are essential for the Internet of Things.	**01**
01.	**Introduction to Wireless Communications** ***Learning Objective:*** *To make learner understand the technical challenges of wireless communications and the concepts to address these challenges in practical applications*	**5-6**
	Contents: **History:** Types of *Communication*, Requirements for the Wireless *Communication*, Economic and social aspects, Limitations **Technical Challenges of wireless communications:** Multipath propagation, Spectrum limitations, Limited energy, User mobility, **Modulation Techniques**-ASK, FSK, PSK, **Multiple Access Techniques** - FDMA, TDMA, CDMA, OFDMA **Spread Spectrum Techniques** –DSSS, FHSS.	
	Self-Learning Topics: *Comparison with Wired System*	

	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply different concepts of communication to study the challenges in wireless communication. (P.I.-1.3.1)* *LO 1.2: Use basics of Wireless communications (Modulation, MA and Spread Spectrum Techniques) in different applications. (P.I.-1.1.1)* *LO 1.3: Differentiate between different multiple access and spread spectrum Techniques and select the best method in various applications. (P.I.-2.2.4)* *LO 1.4: Identify major performance criteria for the design of wireless communication systems. (P.I.- 2.2.3)*	
02.	**Wide Area Wireless Networks** ***Learning Objective:*** *To acquaint the learner with the importance of mobile telecommunications technology in terms of different Cellular Generations, advancements and improvements over their predecessors.*	**7-9**
	Contents: 1G to 5G based on technological differences and advancements; Principle of Cellular Communication – Frequency Reuse concept, cluster size and system capacity, Co channel Interference, GSM –System Architecture, GSM Radio Subsystem, Frame Structure; – Network Architecture of GPRS,UMTS; **LTE, 5G:** Key requirements and drivers of 5G systems, Use cases, Massive MIMO	
	Self-Learning Topics: *CDMA2000*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Identify the cellular concept for analysis of different generation architectures. (P.I.- 2.2.3)* *LO 2.2: Analyze requirements of different Generation Architectures (GSM, UMTS, GPRS LTE) based on applications (P.I.-3.2.1)* *LO 2.3: Explore and synthesize system requirements from larger social and professional concerns of different Generation Architectures (GSM, UMTS, GPRS LTE) (P.I.-3.1.5)* *LO 2.4: Differentiate between different Cellular Generations like 2G,3G,4G and 5G* and select the best method. *(PI-2.2.4)*	
03.	**WLAN,WPAN and WMAN Standards** ***Learning Objective:*** *To make learner understand the technology and concepts of 5G along with WMAN*	**6-8**
	Contents: **Wireless MAN Technology:** WiMAX Physical layer, Media Access Control, Mobility and Networking, and 802.16 broadband wireless access standards **Wireless LAN Technology:** IEEE 802.11(Wi-Fi) – Architecture, Protocol Stack, Enhancements (802.11a, 802.11g, 802.11n, 802.11ac) and Applications	

	Wireless PAN Technology: IEEE 802.15.1 (Bluetooth) – Piconet, Scatter net, Protocol Stack; IEEE 802.15.4 (ZigBee) – LRWPAN Device Architecture, Protocol Stack	
	Self-Learning Topics: *Wi-Fi 6*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Identify the limitations of Wi-Fi along with the enhancements. (P.I.-2.4.3)* *LO 3.2: Distinguish among various wireless protocols stacks such as IEEE 802.11, IEEE 802.15, IEEE 802.16 and select the best method in various applications (P.I.-2.2.4)* *LO 3.3: Choose appropriate wireless protocol stack such as IEEE 802.11, IEEE 802.15, IEEE 802.16 for different applications. (P.I.-3.1.4)* *LO 3.4: Ability to implement and integrate different layers in IEEE 802.11, IEEE 802.15, IEEE 802.16 Protocol Stack(P.I.-3.4.2).*	
04.	**Advanced Wireless Systems Standards -WSN & Ad hoc Network, Mobile IP** ***Learning Objectives:*** *To make learner understand concepts of WSN, Adhoc network and Mobile IP architecture.*	**6-8**
	Contents: **Wireless Sensor Network-** WSN Architecture, Applications, Issues and Challenges **Introduction of Ad hoc Networks –**MANET and VANET – Characteristics, Advantages and Limitations, Applications. **Mobile IP and Wireless Application Protocol:** Fundamentals of Mobile IP, data forwarding procedures in mobile IP	
	Self-Learning Topics: E-VANET	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the concepts of WSN architecture and to use in ad hoc network. (P.I.-1.3.1)* *LO 4.2: Apply concepts of MANET and VANET based on the characteristic to understand about their applications. (P.I.-1.4.1)* *LO 4.3: Identify the need along with design challenges associated with Mobile IP (P.I.-2.1.3)* *LO 4.4: Identify process of encapsulation and de-capsulation in Mobile IP. (P.I.-2.2.3)* *LO 4.5: Explore and synthesize system requirements of VANET. (P.I.-3.1.5)* *LO 4.6: Ability to explore a variety of designs to meet functional requirements for different Ad-Hoc networks for various applications. (P.I.-3.2.1)*	
05.	**Wireless Network Security & Network Design** ***Learning Objective/s:***	**6-7**

	To make learner identify need of Wireless network security for preventing unauthorized access, against cyber threats, and Designing Wireless Networks for providing connectivity, mobility, scalability, and quality of service in modern telecommunications and IT environments	
	Contents: **Wireless Security:** GSM Security; UMTS and LTE Security; Bluetooth Security; WEP; WPA2. **Wireless Network Design Considerations:** Cisco Unified Wireless Network; Designing, Wireless Networks with Lightweight Access Points and Wireless LAN Controllers.	
	Self-Learning Topics: *Study of Wireless Security Tools*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify the algorithms used in Cellular System Security. (P.I.-2.1.3)* *LO 5.2: Analyse the security mechanisms of Bluetooth, WEP, and WPA2 for different applications. (P.I.-2.2.3)* *LO 5.3: Analyze designing of wireless networks by reading and interpreting technical papers and collaborating effectively in teams to demonstrate problem-solving and leadership skills to recognize key technological advancements in wireless networking, and to stay updated with emerging trends. (P.I -2.1.3, 8.2.1,9.1.1 and 11.2.1)* *LO 5.4: Identify existing methodologies for optimizing wireless network performance, collaborate effectively in a team to present findings and solutions for wireless network design, by delivering effective oral presentation by recognizing the importance of staying updated with emerging wireless technologies to ensure continuous professional growth and adaptability (PI 2.2.3, 8.3.1 ,9.2.2 and 11.2.2).*	
06.	**Emerging trends in Wireless Technology** ***Learning Objective/s:*** *To apply the knowledge and skills required to navigate and analyze the rapidly evolving landscape of Wireless Technologies and its applications.*	**5-7**
	Contents: Wireless Beyond 5G, Security issues in 5G, 6G: Introduction,6G Vision and Requirement, Cognitive Radio, SDR, WRAN.	
	Self-Learning Topics: *Low-Power Wide-Area (LPWA) Networks*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify the security issues of 5G for any application. (P.I.-2.2.2)* *LO 6.2: Identify the requirement of 6G. (P.I.-1.3.1)* *LO 6.3: Illustrate Cognitive Radio SDR and WRAN concepts to optimize the performance of wireless communication. (P.I.-1.4.1)* *LO6.4: Compare 5G & 6G to select best cellular Technique (P.I.-2. 2..4)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem
2.2.2	Identifies functionalities and computing resources.
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.4.3	Identify the limitations of the solution and sources/causes.
3.1.4	Ability to choose appropriate quality attributes as defined by ISO/IEC/IEEE standard.
3.1.5	Explore and synthesize system requirements from larger social and professional concerns
3.2.1	Ability to explore design alternatives.
3.4.2	Ability to implement and integrate the modules
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and nontechnical information
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to -

1. Apply concepts of communication to understanding Wireless Fundamentals and analyse challenges in wireless **c**ommunication techniques. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4))*
2. Analyse and synthesize system requirements of cellular network advancements from 1G to 5G and apply IEEE wireless standards (802.11, 802.15, 802.16) along with security mechanisms in real-world scenarios. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO5.1, LO5.2)*
3. Analyse Wireless Sensor Networks (WSN), Ad hoc Networks, and Mobile IP, evaluating their architectures, applications, and associated challenges *(LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5,LO 4.6)*
4. Identify the design challenges and constraints associated with wireless networks by collaborating effectively in teams to analyse and design wireless networks while demonstrating problem-solving, leadership skills, and staying updated with advancements in wireless networking while presenting solutions *(LO 5.3, LO 5.4)*

5. Analyse and compare next-generation wireless technologies, including 6G, Cognitive Radio, SDR, and WRAN. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITPEC6023.1	3	3	-	-	-	-	-	-	-	-	-
ITPEC6023.2	-	3	3	-	-	-	-	-	-	-	-
ITPEC6023.3	-	3	3	-	-	-	-	-	-	-	-
ITPEC6023.4	-	3	-	-	-	-	-	3	3	-	3
ITPEC6023.5	3	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	-	-	-	-	**3**	**3**	-	**3**

Text Books :

1. Wireless Communications and Networks", William Stallings, Pearson / Prentice Hall., Third Edition.
2. Wireless Communications, T.L. Singal, McGraw Hill Education
3. Designing for Cisco Internetwork Solutions, 2nd Edition, CCDA, Diane Teare, Cisco Press
4. Wireless Mobile Internet Security, 2nd Edition, Man Young Rhee, A John Wiley & Sons, Ltd. Publication

Reference Books :

1. Cellular Communications: A Comprehensive and Practical Guide, Nishith Tripathi, Jeffery H Reed, Wiley.
2. Mobile Communications Engineering: Theory and Applications, 2nd Edition, William C. Y. Lee, McGraw-Hill Publications
3. Adhoc & Sensor Networks Theory and Applications, Carlos de Morais Cordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.

Other Resources :

1. NPTEL Course on Introduction to Wireless and Cellular Communications by Prof., IIT Madras.
   Web link- https://nptel.ac.in/courses/106106167
2. NPTEL Course on Wireless Ad hoc and sensor networks by Prof. Sudip Mishra, Department of Computer Science and Engineering, IIT Kharagpur
   Web link- https://archive.nptel.ac.in/courses/106/105/106105160/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a. MCQ test based on GATE exam pattern: 05 Marks
b. One Class Test:05 Marks
c. Technical Report writing: 05 Marks
d. Regularity and active participation :05 Marks

2. **Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	ITLBC608	CRYPTOGRAPHY & NETWORK SECURITY LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
25	25	50

Pre-requisite:

1. ESL103 : Programming Laboratory-I (C)
2. ITSBL301 : Python Laboratory

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO5: Engineering tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO11: Life-Long Learning

Course Objectives:

1. To impart the knowledge of various encryption/decryption techniques.
2. To introduce the different symmetric key and asymmetric key cryptographic techniques.
3. To impart the basics of cryptographic hash functions and digital signature scheme.
4. To use network security tools and vulnerability assessment tools.

Module	Detailed Contents	Hrs
00.	**Course Introduction** Cryptography & Network Security Laboratory course plays a vital role in safeguarding data confidentiality, integrity, and availability in today's digital landscape. With the increasing prevalence of cyber threats and attacks, organizations prioritize the security of their systems and data. The main objective of this course is to build the ability to implement various encryption/decryption techniques, digital signature scheme, generate hash code and demonstrate network security tools & vulnerability assessment tools**.**	--
01.	**Classical encryption/decryption techniques (mono-alphabetic and polyalphabetic substitution techniques: Caesar Cipher, Playfair cipher, Vigenere cipher, Hill Cipher, multiplicative cipher etc.)** ***Learning Objective:*** *To apply various encryption /decryption techniques.*	**10**

	Task 1: Perform encryption, decryption using the following substitution techniques: Caesar (Additive/ Shift) cipher, Vigenere Cipher, Hill Cipher **Task 2**: Implement Playfair cipher using substitution cipher. **Task 3**: Perform encryption and decryption using following transposition techniques: Rail fence cipher and Row & Column Transformation.	
	Self-Learning Topics: *Learn about Quantum Cryptographic Shor's algorithm and quantum key distribution (QKD).*	
	Learning Outcomes: *A learner will be able to* *LO 1.1:Apply various types of classical encryption/decryption techniques in real world applications. (P.I.-1.3.1)* *LO 1.2Apply monoalphabetic and polyalphabetic substitution ciphers to encrypt and decrypt the given plaintext. (P.I.-1.4.1)* *LO 1.3: Identify the different types of substitution, transposition techniques used in real-time cryptographic applications and assess their impact on secure communication and societal implications in the modern digital world. (P.I.-2.1.3, 6.1.1)* *LO 1.4: Compare and analyze the results of various encryption/decryption techniques. Also identify their impact on data security, privacy, and societal implications in the modern digital landscape. (P.I.- 2.2.4,6.3.1)*	
02.	**Symmetric Key Cryptography** ***Learning Objective:*** *To know and apply symmetric key cryptographic techniques in real time applications.*	**06**
	Task 4: Apply DES algorithm for practical applications. **Task 5:** Apply AES algorithm for practical applications.	
	Self-Learning Topics: *Study and analyse various block cipher modes.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the knowledge of fundamental mathematical concepts in the field of security. (P.I.-1.1.1)* *LO 2.2: Apply various Symmetric Key Cryptographic techniques in real world applications. (P.I.-1.3.1)* *LO 2.3: Identify and analyze various Symmetric Key Cryptographic techniques.(P.I.- 2.1.3)* *LO 2.4: Compare and contrast DES and AES(P.I.- 2.2.4)*	
03.	**Asymmetric Key Cryptography** ***Learning Objective:*** *To know and apply different asymmetric key cryptographic technique and key exchange technique in real time applications.*	**04**
	Task 6: Implement RSA Algorithm. **Task 7:** Implement the Diffie-Hellman Key Exchange algorithm for a given problem. **Task 8:** Implement Elgamal Cryptography and Elliptic Curve Cryptography.	
	Self-Learning Topics: *Study some other types of attacks like denial-of-service attack, DDOS, SYN Flood attack.*	
	Learning Outcomes: *A learner will be able to*	

	LO 3.1: Apply principles of public key cryptosystems. (P.I.-1.3.1) *LO 3.2: Apply RSA asymmetric key cryptographic algorithm. (P.I.-1.1.1)* *LO 3.3: Apply the concept of key distribution to implement Diffie-Hellman Key Exchange algorithm (P.I.-2.1.3)* *LO 3.4: Compare and evaluate effectiveness of Elgamal Cryptography and Elliptic Curve Cryptography technique in real-world security systems. (P.I.-2.2.4)*	
04.	**Cryptographic Hash Functions and Digital Signature** ***Learning Objective:*** *To identify different hash functions and digital signature scheme.*	**04**
	Task 9: Calculate the message digest of a text using the SHA algorithm **Task 10:** Implement the Signature Scheme - Digital Signature Standard	
	Self-Learning Topics: *Study Zero-knowledge protocols, Lightweight Directory Access Protocol (LDAP), Cryptographic hash Functions in blockchain.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the concept of Cryptographic Hash Functions in cybersecurity and cryptography. (P.I.-1.3.1)* *LO 4.2: Apply SHA algorithm to calculate the message digest of a text and analyze the societal impact of cryptographic hashing techniques in securing sensitive data, ensuring privacy, and preventing malicious activities .(P.I.-1.4.1, 6.2.1)* *LO 4.3: Identify the properties of cryptographic hash functions, such as collision resistance, preimage resistance, and avalanche effect. (P.I.-2.2.3)* *LO 4.4 : Identify and analyze various Digital Signature Schemes used in real-time applications, evaluating their significance in engineering & societal contexts.(P.I.-2.1.3, 6.3.1)*	
05.	**Malicious Programs** ***Learning Objective:*** *To familiarize various malicious programs and countermeasures required to protect system against malicious code.*	**02**
	Task 11: Defeating Malware - Rootkit Hunter	
	Self-Learning Topics: *Study the recent malicious software and their effects.*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply knowledge of different types of malicious software to protect the system from virus using command line tool. (P.I.-1.3.1,5.1.1)* *LO 5.2: Use various tools to implement countermeasures to protect system from malicious programs. (P.I.-1.4.1,5.2.2)*	
06.	**Network Security and Applications** ***Learning Objective:*** *To summarize and demonstrate the network security tools and vulnerability assessment tools .*	**04**
	Task 12: Demonstrate Intrusion Detection System (IDS) using any tool eg. Snort , Security Onion, Zeek, Kismet or any other software. **Task 13:** Implementation and analysis of Email Security Protocols (SMTP, SSL/TLS, and PGP) **Task 14:** Cryptographic Analysis of Secure Inter-Branch Payment Transactions, Virtual Elections etc .	

	Self-Learning Topics: *Study advanced Security Applications like Cryptology in Contact Tracing Applications, issues related to Quantum Cryptanalysis.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Identify network security tools & vulnerability assessment tools to demonstrate IDS. (P.I.-5.1.1)* *LO 6.2: Identify the strengths and limitations of modern tools used to demonstrate IDS. (P.I.-5.2.1)* *LO 6.3: Apply and analyze email security protocol, for protecting email communication against cyber threats and evaluate its ethical and societal implications to address evolving threats (P.I.-1.3.1,2.2.3, 6.1.1, 7.1.1,11.2.1)* *LO 6.4: Evaluate and analyze cryptographic mechanisms in secure inter-branch transactions in terms of effectiveness, ethics, societal impact, and lifelong learning in financial cybersecurity(P.I.-2.4.2, 6.2.1, 7.2.2,11.2.2)*	
	Total	**30**

Performance Indicators:

P. I. Number	**P. I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems.
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions.
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.4.2	Analyze and interpret the results using contemporary tools.
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.2.2	Demonstrate proficiency in using discipline specific tools
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional, and local level.
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public.
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current developments.

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

Course Outcomes:

Learner will be able to

1. Implement classical encryption/decryption techniques to solve real time the problems. *(LO 1.1, LO1.2, LO1.3, LO1.4)*

2. Build cryptosystems by applying symmetric key cryptographic algorithms. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*

3. Implement various asymmetric key cryptographic techniques. *(LO 3.1, LO3.2, LO3.3, LO3.4)*

4. Use message digest concept in hashing algorithm and analyse its societal impact. Also apply the knowledge of various malicious programs to implement countermeasures to protect system from malicious programs. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO5.1, LO5.2)*

5. Use and demonstrate network security tools and vulnerability assessment tools . *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITLBC608.1	3	3	-	-	-	3	-	-	-	-	-
ITLBC608.2	3	3	-	-	-	-	-	-	-	-	-
ITLBC608.3	3	3	-	-	-	-	-	-	-	-	-
ITLBC608.4	3	3	-	-	3	3	-	-	-	-	-
ITLBC608.5	3	3	-	-	3	3	3	-	-	-	3
Average	**3**	**3**	-	-	**3**	**3**	**3**	-	-	-	**3**

Text Books:

1. Cryptography and Network Security, Principles and Practice, William Stallings, Sixth Edition, March 2013, Pearson Education.
2. Cryptography & Network Security, Behrouz A. Ferouzan, First Edition, 16 March 2007, Tata McGraw Hill.
3. Cryptography and Network Security, Behrouz A. Forouzan & Debdeep Mukhopadhyay, Second Edition, 2010, Tata McGraw Hill Education.
4. Cryptography & Network Security, Bernard Menezes, Sixth Edition ,2010, Cengage Learning.

Reference Books:

1. Cryptography and Network Security, Atul Kahate, Third Edition, 2013, Mc Graw Hill.

2. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Second Edition,2001, John Wiley and Sons Inc.

3. Network Security Bible, Eric Cole, Second Edition, 2011.Wiley

Other Resources:

1. NPTEL Course: Cryptography and Network Security by Dr. Debdeep Mukhopadhyay, IIT Kharagpur
   Web Link- https://nptel.ac.in/courses/106105031

2. NPTEL Course: Foundation of Cryptography by Prof. Ashish Choudhary, IIT Bengaluru.
   Web Link- http://www.digimat.in/nptel/courses/video/106106221/L46.html

3. NPTEL Course: Cryptography and Network Security by Prof. Sourav Mukhopadhyay, IIT Kharagpur.
   Web Link- https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs28/

A. IN-SEMESTER ASSESSMENT (25 MARKS)

1. Continuous Assessment (25 Marks)

Suggested breakup of distribution

a) Task Execution :10 Marks

Students will be given 10 tasks based on list as per mentioned in the syllabus. Each task carries 10 Marks. Average will be taken of all tasks. Students are expected to execute the program for given task with network simulator, protocol analyser and java. Students will be evaluated based on logic building for the given task, expected output and analysis of received results.

b) Practical Test: 10 Marks

Students will be given task (different for each student) and they will be evaluated based on the parameters mentioned in continuous assessment.

c) Regularity & Active participation: 05 Marks

B. END SEMESTER EXAMINATION (Practical and Oral Exam) (25 Marks)

Suggested breakup of distribution

a) Task Execution: 10 Marks

Students will be given task (different for each student) and they will be evaluated based on the parameters mentioned in continuous assessment.

b) Results and discussion, Inferences drawn based on above task: 05 Marks
c) Oral based on entire syllabus :10 Marks

Two examiners, one Internal and one External will do the evaluation

Course Type	Course Code	Course Name	Credits
LBC	ITLBC609	DATA SCIENCE LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
25	25	50

Pre-requisite:

1. ITSBL301: Python Laboratory

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3:Design/development of solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering tool usage
6. PO8: Individual and collaborative team work
7. PO9: Communication
8. PO11: Life-long learning

Course Objectives:

1. To inculcate comprehensive knowledge of data science using Python.
2. To learn the essential concepts of data analytics and data visualization.
3. To acquire the knowledge of machine learning and deep learning techniques.

Module	Detailed Contents	Hrs
00.	**Course Introduction** Data Science is an interdisciplinary field that combines statistics, computer science, and domain knowledge to extract insights and knowledge from data. Data Science enables organizations to utilize their data to support informed decision-making, optimize operations, and explore. Data science gives businesses a competitive advantage by allowing them to make faster, data-driven choices, stimulate innovation, and ensure long-term growth. This lab course introduces students to fundamental and advanced data science concepts through hands-on, project-based learning. Students will work on real-world datasets, implement machine learning algorithms, and build data-driven applications. The course emphasizes problem-solving, teamwork, and practical implementation of data science tools.	--
01.	**Overview of Data Science :** ***Learning Objective:*** *To impart the knowledge of numpy and pandas library*	**06**

	Contents: • Overview of Data Science • Introduction to Python and Jupyter Notebooks • NumPy and Pandas for Data Manipulation • Data Cleaning and Handling Missing Values **Task 1:** Select dataset and apply data cleaning on a Real-World Dataset	
	Learning Outcomes : *A learner will be able to* *LO1.1: Apply the knowledge of data selection to define the problem and Evaluate problem statement by identifying objectives (**Problem Statement**). (P.I. - 1.1.1, P.I. - 2.1.1)* LO1.2: *Apply data science concepts like pandas and numpy libraries to identify key features, attributes, target variable and preprocessing steps (**Data Description**) (P.I. - 1.3.1, , P.I. - 2.1.2*)	
02.	**Exploratory Data Analysis (EDA) & Data Visualization:** ***Learning Objective:*** *To inculcate EDA concept and learn different visualization techniques*	**06**
	Contents • Descriptive Statistics and Data Distributions • Data Visualization using Matplotlib and Seaborn • Statistical Hypothesis Testing • Feature Engineering Technique **Task 2:** Exploratory Data Analysis of a Public Dataset (e.g., Titanic, Iris)	
	Learning Outcomes: *The learner will be able to* *LO2.1: Perform statistical analysis and adapt appropriate visualization techniques to represent data insights with appropriate engineering tool. (**Data Analysis**) (P.I. - 2.1.2, P.I. - 2.4.2, P.I.- 5.1.1, P.I. - 5.1.2)* *LO2.2: Implement feature engineering to select relevant features to enhance data quality (**Preprocessed data**) (P.I. -3.3.1, P.I. - 3.4.2)*	
03.	**Machine Learning (ML) - Deep Learning (DL) Fundamentals:** ***Learning Objective:*** *To inculcate EDA concept and learn different visualization techniques*	**18**
	Contents • Supervised Learning: Linear Regression, Decision Trees, SVM, ensemble learning techniques. • Unsupervised Learning: Partition approach, Hierarchical clustering techniques • Introduction to Neural Networks and TensorFlow/Keras • Convolution neural networks for Image Processing • Model Evaluation and Hyperparameter Tuning **Task 3:** Apply machine learning or deep learning techniques on a real dataset prepared in previous tasks	

	Learning Outcomes: *The learner will be able to* *LO3.1: Identify and use appropriate algorithms to solve a problem with ML/DL approaches (**Approach and reason**). (P.I.- 2.1.2, P.I.-4.3.1)* *LO3.2: Design and train the ML/DL model for set objectives, tune hyperparameters to optimize model performance (**Methodology**).(P.I. -2.4.1, P.I.- 4.2.1, P.I. -3.4.2, P.I. -8.1.1, P.I.-9.2.2, P.I. - 11.1.1)* *LO3.3: Assess model accuracy using appropriate metrics and present results with appropriate visualization in document and presentation (**Results**) (P.I. -3.3.1, P.I.-5.1.1, P.I.-5.1.2, P.I.-8.3.1, P.I. -9.3.2, P.I. - 11.3.1)*	
	Total	**30**

Performance Indicators:

P. I. Number	**P. I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals.
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.4.1	Applies engineering mathematics to implement the solution.
2.4.2	Analyze and interpret the results using contemporary tools.
3.3.1	Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.
3.4.2	Ability to implement and integrate the modules.
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	Describe the rationale for requirement for continuing professional development
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes:

Learner will be able to

1. Apply principles of NumPy and Pandas to analyse the data (*LO 1.1, LO 1.2*).
2. Perform exploratory data analysis (EDA) using statistical and visualization techniques to derive meaningful insights (*LO 2.1, LO 2.2*).
3. Implement machine learning models and deep learning models. (*LO3.1, LO3.2)*.
4. Evaluate the ML/DL models and optimize their performance. (*LO 3.3)*.

5. Design and develop a data science application that can have data acquisition, processing, visualization and statistical analysis methods with supported machine learning and deep learning technique to solve the real-world problem (*LO 1.1, LO 1.2, LO2.1, LO2.2, LO 3.1, LO 3.2, LO 3.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITLBC609.1	3	3	-	-	-	-	-	-	-	-	-
ITLBC609.2	-	3	3	-	3	-	-	-	-	-	-
ITLBC609.3	-	3	3	-	-	-	-	-	3	-	3
ITLBC609.4	-	-	3	3	-	-	-	3	3	-	3
ITLBC609.5	-	3	3	3	3	-	-	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**-**	**3**

Text Books:

1. Wes McKinney, "Python for Data Analysis",O'REILLY, ISBN:978-1-449-31979-3, 1st edition, October 2012.
2. Rachel Schutt & O'neil, "Doing Data Science", O'REILLY, ISBN:978-1-449-35865-5, 1st edition, October 2013.

Reference Books:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015
2. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O'Reilly, 2016.

Other Resources:

1. NPTEL Course: Data Science for Engineers by Prof. Prof. Ragunathan Rengasamy, IIT Madras
   Web Link- https://onlinecourses.nptel.ac.in/noc22_cs28/course

2. Data science Tutorial
   Web Link- https://www.w3schools.com/datascience/

3. Web Link- https://www.computernetworkingnotes.com/networking-tutorials/

A. IN-SEMESTER ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a) Task/Project Evaluation: 20 Marks

- A group of 3 students should be assigned a real life problem statement.

- Students are expected to research and collect required resources to create a frontend and backend for the selected problem.
- Students should prepare a presentation of 10-15 minutes.
- This project should be graded for 20 marks depending on the parameters as Data Collection and data preparation (**Task1 – 6 marks**) , data analysis (**Task 2 - 4 marks**), design and model creation, implementation and model evaluation (**Task 3 - 10 marks**) for selected problem statement.

b) Regularity & Active participation: 05 Marks

B. END SEMESTER EXAMINATION (Practical and Oral Exam) (25 MARKS)

Suggested breakup of distribution

a) Task Execution: 10 Marks

Students will be given task (different task for every student) and will be evaluated as per the parameters mentioned in continuous assessment.

b) Results and discussion, Inferences drawn from the above task: 05 Marks

c) Oral based on entire syllabus: 10 Marks
Two examiners, one Internal and one External will do the evaluation

Course Type	Course Code	Course Name	Credits
SBL	ITSBL603	DEVOPS LABORATORY	02

Examination Scheme		
Continuous Assessment	**End Semester Exam (ESE)**	**Total**
50	50	100

Pre-requisite :

1. ITPCC407: Operating System
2. ITPCC408: Software Engineering
3. ITLBC404: Linux Laboratory
4. ESL205: Programming Laboratory-II (Java)
5. ITLBC506: Cloud Computing Laboratory

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO4: Conduct Investigation of Complex Problems
4. PO5: Engineering Tool Usage
5. PO6: The Engineer and The World
6. PO11: Life Long Learning

Course Objectives:

1. To introduce learners to the DevOps methodology and its principles, focusing on the collaboration, automation, and continuous integration/continuous delivery (CI/CD) model.
2. To instruct learners on version control using Git, including branching, merging, and collaborative workflows in GitHub or similar platforms.
3. To train learners on automating the build, test, and deployment processes through continuous integration and deployment (CI/CD) using Jenkins and Maven
4. To guide learners in implementing automated software testing using Selenium.
5. To provide hands-on experience with continuous deployment using Docker containers.
6. To provide learners with knowledge of using DevOps in the cloud (AWS) for code development and application deployment using AWS CodeBuild and CodeDeploy.
7. To prepare students to manage and orchestrate containerized applications using Docker Swarm, focusing on deployment, scaling, and managing clusters.
8. To introduce learners to serverless computing concepts and platforms (e.g., AWS Lambda) and the importance of continuous monitoring using tools like Nagios.
9. To upskill learners in creating Infrastructure as Code (IaC) using tools like Terraform or AWS CloudFormation.
10. To train learners in performing Static Application Security Testing (SAST) using tools like SonarQube.

Module	Detailed Contents	Hrs
00.	**Course Introduction** This course is intended to teach the advanced software development industrial strategy which is the DevOps environment. The course will delve in to the Continuous Integration and Continuous Deployment/Delivery using certain software tools which enhances the software product release schedule. It will emphasize on the standalone environment as well as the cloud environment**.**	**--**
01.	**Introduction to DevOps and Version Control** ***Learning Objective/s:*** *To study the Devops practices and implement the version control on the code using git.* **Contents:** Definition of DevOps: Challenges of traditional IT systems & processes, History and emergence of DevOps, DevOps definition and principles governing DevOps, DevOps Lifecycle. Basic Operations in a VCS. Features and benefits of GIT. **Demonstration:** • Illustrate the Devops history, Lifecycle • Install git, Learn git and git commands • Create a github account **Task 1:** Install Git and create a GitHub account. Perform basic Git operations (commit, push, pull). ***Self-Learning Topics:*** *AWS Codecommit, Mercurial, Subversion, Bitbucket, CVS, Scrum, Kanban, Agile* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Demonstrate proficiency in GIT Installation, Version Control, Working with remote repository 5.2.2, P.I-11.1.1)* *LO 1.2: Create and fork repositories in GitHub and Adapt branching, merging and rebasing concepts. (P.I-5.1.2, P.I.11.2.1)*	**08**
02.	**Continuous Integration using Jenkins** ***Learning Objective:*** *To integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment* **Contents:** Introducing Continuous Integration and Jenkins, Installing and Configuring Jenkins, Creating and configuring a job in Jenkins, Pipelining in Jenkins, Master-slave Architecture, Jenkins standalone implementation. **Demonstration:** • Install and Configure Jenkins • Creating a Pipeline in Jenkins • Implement a Master-Slave architecture	**09**

	Task 2: To understand Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to setup a build Job. **Task 3:** To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat server. ***Self-Learning Topics:*** *Travis CI, Bamboo, GitLab, AWS CodePipeline* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply the theory and principles of Jenkins (With Architecture) to build a job (P.I-1.4.1, P.I.6.1.1, PI.5.1.1)* *LO 2.2: Apply the continuous integration continuous deployment process ((P.I-1.3.1, 4.1.3, P.I.11.1.2, PI.6.4.1)* *LO 2.3: Create the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to deploy an application over the tomcat server(P.I-5.1.2,PI.4.2.1,P.I.11.2.1)*	
03.	**Continuous Testing with Selenium and Continuous Deployment: Containerization with Docker** ***Learning Objective:*** *To understand the importance of Jenkins to Build and deploy Software Applications on server environment and the infer importance of Selenium to test Software Applications* **Contents:** Introducing Continuous Testing and Selenium Installing and Configuring Selenium, Docker Architecture and Container Life Cycle, Docker commands, Dockerfile instructions. **Demonstration:** • Installing and Configuring Selenium • Installing Docker and implementing the Docker Commands • Study on Docker Architecture **Task 4:** To Setup and Run Selenium Tests in Jenkins Using Maven. **Task 5*:*** To install Docker and execute docker commands to manage images and interact with containers. ***Self-Learning Topics:*** *Junit, Cucumber, Docker Compose.* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Identify the purpose of Selenium as a tool and Install Selenium (P.I-5.1.1, P.I 11.1.2)* *LO 3.2: Demonstrate proficiency in Creating Test Cases in Selenium WebDriver (P.I-5.2.2, P.I 11.1.1)* *LO 3.3: Demonstrate proficiency to Create and Implement docker images using Dockerfile(P.I-5.2.2, P.I-11.1.2)* *LO 3.4: Create, deploy and manage web or software application on Docker Engine. (P.I-5.1.2, P.I.11.2.1)*	**09**
04.	**Introduction to Devops on Cloud, Orchestration using Docker Swarm** ***Learning Objective:*** *To understand the procedure to setup the IDE on the Cloud environment and deploy the Docker Swarms for container orchestration.*	**14**

	Contents: Cloud Computing, Types of Clouds, Types of Cloud Services, Integrated Development Environment, CodePipeline: Code Build, Code Deploy, Containerization, Container Orchestration with Docker Swarm. **Demonstration:** • Case Study: Cloud Computing, Types of Clouds, Cloud Services • Create an AWS account/Cloud Service Provider Account • Create an IDE in the AWS/cloud environment to collaborate • Demonstrate the CodePipeline • Demonstrate the Docker Swarm **Task 6:** To Setup AWS Cloud9 IDE, Launch AWS Cloud9 IDE and Perform Collaboration Demonstration **Task 7:** To Build Your Application using AWS CodeBuild and Deploy on S3 / SEBS using AWS CodePipeline, deploy Sample Application on EC2 instance using AWS CodeDeploy **Task 8:** To set Up a Docker Swarm Cluster and Deploying a Multi-Container Application	
	Self-Learning Topics: *AWS Codestar, Using Services and Ingresses to Expose Deployments in KubernetesPerform logging, monitoring, services, and volumes in Kubernetes.*	
	Learning Outcomes: *A Learner will be able to* *LO 4.1: Create the DevOps infrastructure on the cloud (P.I-5.1.1, P.I:11.2.1)* *LO 4.2: Demonstrate proficiency to set up IDE on Cloud9 (P.I-5.2.2)* *LO 4.3: Create projects on AWS using Code Build, CodeDeploy, and CodePipeline (P.I-5.1.2, P.I:11.1.2)* *LO 4.4: Install and manage Docker Swarm clusters and deploying multi-container applications. (P.I-5.2.2, P.I:11.2.2)*	
05.	**Infrastructure Automation with Terraform and DevSecOps: Static Application Security Testing (SAST)** ***Learning Objectives:*** *To be upskilled in creating, building, destroying an Infrastructure by writing a Software code, as well as be well versed with application security testing by integrating Jenkins to SonarQube/Gitlab*	**10**
	Contents: Infrastructure Automation with Infrastructure as a code (IaaC), Terraform, Static application software testing, Dynamic Application Software Testing, SonarQube. **Demonstration:** • Write a code for Infrastructure • Deploy,Change and Destroy the infrastructure in AWS/Docker using code • Install Jenkins and Sonarqube and Integrate Jenkins and Sonarqube for CICD and detect bugs, code smells and security vulnerabilities. **Task 9:** To Build, change, and destroy AWS / GCP /Microsoft Azure/ DigitalOcean infrastructure Using Terraform.	

	Task 10: Create a Jenkins CICD Pipeline with SonarQube / GitLab Integration to perform a static analysis of the code to detect bugs, code smells, and security vulnerabilities on a sample Web / Java / Python application.	
	Self-Learning Topics: *Terraform: Create Resource Dependencies, Provision Infrastructure, Define Input Variables, Query Data with output and store remote state,SAST: Snyk, OWASP ZAP, Analysis Core Plugin*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Identify the Infrastructure as Code with Terraform. (P.I-5.1.1, PI 11.2.1)* *LO 5.2: Demonstrate proficiency to Install, Build, change and Destroy Infrastructure using Terraform. (P.I-5.2.2)* *LO 5.3: Identify the potential vulnerabilities before deployment. Analysis of java / web-based project. (P.I-2.4.3,2.4.2)* *LO 5.4: Demonstrate proficiency to Perform Jenkins SonarQube / Gitlab Integration. (P.I-5.2.2, P.I.11.1.2)*	
06.	**NoOps: Serverless Computing and DevSecOps: Continuous Monitoring** ***Learning Objective:*** *Learner is expected to learn serverless computing platform like AWS Lambda which helps to code and deploy without needing to configure or manage underlying server.* *Learner also needs to be able to detect ,report, respond to attack and issues in infrastructure through continuous monitoring*	**10**
	Contents: Serverless Computing, AWS Serverless ArchitectureAWS Serverless Authentication,AWS Serverless Functions,AWS Serverless Services AWS Serverless Applications, Nagios, Nagios Core,Nagios Plugin, NRPE, Port monitoring, Service Monitoring **Demonstration:** • Create a Lamda service for serverless computing • Deploy a project on the server • Analyze the usage and performance statistics • Create a server in AWS/linux/Windows • Install nagios,nrpe in the server • Analyze the Nagios log to check for alerts. **Task 11:** To create a Lambda function which will log "An Image has been added" once you add an object to a specific bucket in S3. **Task 12:** To install and configure Nagios for monitoring	
	Self-Learning Topics: *AWS Lambda:Create a REST API with the Serverless Framework, Splunk, Snort, Tenable*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Build and Configure the Lambda function (NODEJS/PYTHON/JAVA)(P.I-5.1.2,P.I:11.2.1)* *LO 6.2: Install Nagios, Nagios Plugins (NRPE) and Objects Nagios Commands and Notification (P.I-5.2.1., PI:4.3.1,PI.11.1.2)* *LO 6.3: Monitor different servers using Nagios(Pi-5.2.2, PI:4.3.2)*	
	Total	**60**

Performance Indicators:

P.I. No	P.I. Statement
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.4.2	Identify the limitations of the solution and sources/causes.
2.4.3	Analyze and interpret the results using contemporary tools.
4.1.3	Ability to choose appropriate hardware/software tools to conduct the experiment.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
4.3.2	Critically analyze data for trends and correlations, stating possible errors and limitations
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline specific tools
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level
6.4.1	Describe management techniques for sustainable development
11.1.1	Describe the rationale for requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes:

Learner will be able to

1. Design code-sharing environments for standalone and cloud systems, applying engineering knowledge and tools, while fostering lifelong learning and social responsibility. (*LO 1.1, LO 1.2, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*

2. Implement continuous integration with Jenkins and containerization using Docker and Docker Swarm, applying engineering knowledge and tools to solve complex problems by assessing the global impact of their solutions and foster lifelong learning in software engineering. *(LO 2.1, LO 2.2, LO 2.3, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*

3. Apply continuous software testing using SAST and Selenium, utilizing engineering tools to ensure code quality thereby foster lifelong learning to stay updated with evolving testing methodologies. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4*)

4. Build and Deploy Infrastructure as Code using Terraform, applying problem analysis and engineering tools to create effective solutions thereby cultivate lifelong learning to stay current with evolving infrastructure practices. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4*)

5. Build and deploy serverless environment using AWS Lambda and monitor it with Nagios, applying engineering tools to solve complex problems and fostering lifelong learning in evolving cloud technologies. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 6.1,LO 6.2,LO 6.3*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ITSBL603.1	-	-	-	-	3	3	-	-	-	-	3
ITSBL603.2	3	-	-	3	3	3	-	-	-	-	3
ITSBL603.3	-	-	-	-	3	-	-	-	-	-	3
ITSBL603.4	-	3	-	-	3	-	-	-	-	-	3
ITSBL603.5	-	-	-	3	3	-	-	-	-	-	3
Average	**3**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**

Text Books :

1. DevOps Bootcamp, Sybgen Learning
2. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
3. Len Bass,Ingo Weber,Liming Zhu,"DevOps, A Software Architects Perspective", AddisonWesleyPearson Publication
4. AWS Certified SysOps Administrator Official Study Guide: Associate Exam by Stephen Cole (Author), Gareth Digby (Author), Chris Fitch (Author), Steve Friedberg (Author), Shaun Qual
5. Terraform: Up & Running - Writing Infrastructure as Code, Second Edition by Yevgeniy Brikman , O'Reilly
6. Kubernetes: Up and Running - Dive into the Future of Infrastructure, Second Editionby Brendan Burns,O'Reilly
7. Going Serverless with AWS Lambda: Leveraging the latest services from the AWS cloud by Ajay Pherwani , Shroff/X-Team

Reference Books:

1. Sanjeev Sharma and Bernie Coyne," DevOps for Dummies", Wiley Publication.
2. Learning Aws - Second Edition: Design, build, and deploy responsive applications using AWS by Amit Shah Aurobindo Sarkar
3. Httermann, Michael, "DevOps for Developers", Apress Publication.

Other Resources:

1. Notes : https://topperworld.in/the-ultimate-guide-to-devops-free-pdf-notes-for-success/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Task Execution (30 Marks)

Students are expected to

i. Identify the purpose of the given Task
ii. Execute the task as per the methodology explained
iii. Identify and troubleshoot the errors and installation issues that arise
iv. Demonstrate the expected task as per the specification given in the Tasks.
v. Preferable to utilize the tools specified, can choose any cloud environment.

Students will be evaluated based on following:

i. Purpose-driven objective for the given task (10 marks)
ii. Rectifying errors or introducing new methods to implement the solution (06 marks)
iii. Proper documentation of the step by step process (06 marks)
iv. Verification of Task output for the given experiment task (08 marks)

Refer the sample task given below.

Example:

To Build, change, and destroy AWS / GCP /Microsoft Azure/ DigitalOcean infrastructure Using Terraform.

Students are expected to.

i. Identify the purpose of the platform Terraform and its objective
ii. Execute given task for the procedure explained (eg.AWS) in another platform GCP/Digital Ocean/Microsoft Azure
iii. Identify errors and rectify the errors.
iv. Prepare a proper detailed document regarding the steps
v. Demonstrate the proper output

Students will be evaluated based on following:

i. Identification and Explanation of the objective of Terraform (10 marks)
ii. Rectifying errors during Installation/Build/Change/Destroy (06 marks)
iii. Well-structured and organized documentation of the Task performed (06 marks)
iv. Verification of experiment output for different inputs (08 marks)

2. Regularity and active Participation (05 Marks)

3. Practical Test (15 Marks)

a) Task Execution: 10 Marks

Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned in continuous evaluation

Students will be evaluated based on following:

i. Purpose-driven objective for the given task (04 marks)
ii. Rectifying errors or introducing new methods to implement the solution (02 marks)
iii. Proper documentation of the step-by-step process (02 marks)

iv. Verification of task output for the given problem statement (02 marks)

b) Oral based on covered syllabus: 05 Marks

B. END SEMESTER EXAMINATION (Practical & Oral Exam) (50 Marks)

a) Task Execution: 30 Marks
Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned below
   i. Purpose-driven objective for the given task (10 marks)
   ii. Rectifying errors or introducing new methods to implement the solution (06 marks)
   iii. Proper documentation of the step-by-step process (06 marks)
   iv. Verification of Task output for the given problem statement (08 marks)

b) Presentation of Results and conclusion, Inferences drawn: 05 Marks

c) Oral based on entire syllabus: 15 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
MNP	ITMNP604	MINI PROJECT- 2B	01

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Engineering Tool Usage
6. PO6 : The Engineer & the world
7. PO7 : Ethics
8. PO8 : Individual & Collaborative Team work
9. PO9 : Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

Course Objectives:

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes:

At the end of the course, students will be able to:

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
  - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
  - 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
  - 25 marks for the Final Report & Presentation
  - 05 marks for Regularity and active participation
- Continuous Assessment marks distribution in semester VI (50 marks):
  - 15 marks for the In-Semester Two Presentations
  - 05 marks for Participation in Project Competitions, TPP, etc.
  - 25 marks for the Final Report & Presentation

- 05 marks for Regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester V:

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
  - The first review will focus on finalizing the problem statement (topic approval).
  - The second review will centre on finalizing the proposed solution.

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
ELC	ELC601	RESEARCH METHODOLOGY	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer & The World
4. PO7: Ethics
5. PO8: Individual & Collaborative team work
6. PO9: Communication
7. PO11: Life-Long learning

Course Objectives:

1. To gain the knowledge of use research tools and techniques to design research projects and form the hypothesis.
2. To familiarize students about the literature review practice for identifying the research gap.
3. To gain the knowledge about collection of data and qualitative/ quantitative analysis of data and results
4. To understand the key practices in preparation of a research report / paper.
5. To foster ethical practices in research and publications

Module	Details	Hrs
00.	**Course Introduction:** This course aims to introduce students to the important aspects of research. The course is intended to make students aware of formal research and to overcome common misconceptions in research that may be present in their minds. At the end of this course, students shall be able to take up research activities in a more systematic and formal manner right from the beginning. This course on Research Methodology learned through experiential learning mechanism can play a significant and holistic role in contributing to the personal and professional development of students.	**1**
01.	**Fundamentals of Research Methodology** Types of Research, Research approaches, Empirical research methods, Significance of research, Research design, Case study method, Sampling technique, Sources of data, Selection of research problem, Research Ethics and Empiricism	**4-5**

	Exercise: A group discussion on what is research and ethics in research with related case studies shall be conducted.	
02.	**Formulation of a Research Problem & Hypothesis formulation**	**4-5**
	Content: Selection and formulation of a research problem, Objectives of formulation, Criteria of a good research problem, Literature Review Process and Formulation of Research Questions Hypothesis-Characteristics and Hypothesis Testing –Logic and Importance *Exercise: Groups of students shall make Technical Presentations on Selection of a research problem and Hypothesis formulations based on topics given.*	
03.	**Research Design**	**4-5**
	The Research framework, Research design: Need, Characteristics & Components; Experimental and non-experimental designs, Experimental and non-experimental hypothesis testing. Classification schemes for research design, Principles of experimental designs, Writing rationale for a research *Exercise: Students shall prepare the framework of research methods and techniques to conduct a study on a given real life case study covering key elements of the module.*	
04.	**Sampling Method**	**3-4**
	Probability or random sampling, Cluster sampling, Area sampling, Multi-stage sub-sampling, Random sampling with probability proportional to size, Non-probability sampling. *Exercise: A real life case study shall be demonstrated to students covering key elements of the module shall be covered.*	
05.	**Data Collection & Data Analysis**	**4-5**
	Sources of data, Collection of data, Measurement and scaling technique, Collection of data from appropriate sources (primary and secondary), Correlation and causation, Classification of quantitative analysis. Selection and analysis of multi-variate methods, Performing data analysis and presentation of results, Case study method. *Exercise: Group of students shall carry out exercise of real life data collection on a given research problem and data analysis and submit the report*	
06.	**Report Writing and Journal Publication**	**3-4**

	Preparation of a research report, Formats and Contents of report: Literature review, Presentation of research work, Research Design & Analysis, Results, Findings, and Contribution, Significance of research, and Conclusion. Mechanics of writing papers in Peer-reviewed Journals / Reputed Conferences. Ethics in Publication. *Exercise: Students shall prepare & submit a paper (4-5 pages) in a standard format (suitable universally accepted journal publication format) based on the exercises / research case study carried out in this course.*	
7	***Course Conclusion***	**1**

Course Outcome:

1: Identify and demonstrate the importance of research process in science and technology domains
2: Perform literature reviews using print and online databases.
3: Analyse the data using qualitative and quantitative methods
4: Identify and prepare the key elements of a research report/ paper
5: Illustrate the rationale for research and publication ethics

Text Books:

1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publisher, 2014.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage Publication, 2018
3. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2014

Reference Books:

1. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Ed., SAGE, 2018.Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2005.
2. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
3. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

Other Resources:

NPTEL Course: Research Methodology By Prof. Edamana Prasad, Prof. Prathap Haridoss (IIT Madras) Weblink https://onlinecourses.nptel.ac.in/noc25_ge28/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6011	ART OF LIVING	02

Program Outcomes addressed:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO8 : Individual and Collaborative Team Work
4. PO9: Communication
5. PO11: Life-Long learning

Course Objectives :

1. To provide a comprehensive understanding of the principles of the Art of Living and their relevance to holistic well-being.
2. To equip participants with practical techniques like Sudarshan Kriya, yoga, and mindfulness for stress management and emotional balance
3. To enable participants to apply the Art of Living principles to enhance relationships, productivity, and life purpose.

Module	Details
01.	**Introduction to the Art of Living** Understanding the Mind and Stress, Breath and Life Energy, Basics of Yoga and Guided Meditation
02.	**Sudarshan Kriya and Breathing Techniques** Introduction to Sudarshan Kriya, Practicing Rhythmic Breathing Techniques
03.	**Emotional Well-being** Understanding and Balancing Emotions, Forgiveness and Gratitude Practices, Guided Meditation for Emotional Healing
04.	**Relationships and Social Connections** Compassion and Effective Communication, Stress-free Relationships, Group Activities for Trust and Collaboration
05.	**Living with Purpose and Awareness** Discovering Life Purpose, Mindfulness Practices, Time Management and Productivity
06.	**Sustaining the Practices** Developing a Daily Routine, Advanced Breathing Techniques, Reflections, and Closing Meditation
Total no. of hours: **30**	

Course Outcomes :

1. Gain insights into managing stress and emotions through breathwork and meditation
2. Develop skills for building harmonious relationships and enhancing emotional intelligence.
3. Cultivate mindfulness, compassion, and clarity in daily life.
4. Sustain the Art of Living practices for long-term well-being and self-discovery.

Text Books :

1. "Celebrating Silence" by Sri Sri Ravi Shankar (1999, Sri Sri Publications Trust)
2. "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar (1995, Inner Traditions International)
3. "The Miracle of Mindfulness" by Thich Nhat Hanh (1975, Beacon Press)

Reference Books :

1. "Wisdom for the New Millennium" by Sri Sri Ravi Shankar (2000, Sri Sri Publications Trust)
2. "The Healing Power of the Breath" by Richard P. Brown and Patricia L. Gerbarg (2012, Shambhala Publications)

Course Type	Course Code	Course Name	Credits
LLC	LLC6012	YOGA AND MEDITATION	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To raise awareness of the therapeutic and preventive benefits of Yoga and Meditation
2. To nurture Holistic wellness through the harmony of body, mind and self
3. To advocate for the application of Yogic science in the treatment and prevention of psychosomatic and Lifestyle disorders.
4. To inspire the practice of Yogic Science tools for fostering health and well-being in daily life.
5. To promote the art of purposeful and mindful living by cultivating a deep sense of oneness with the self, nature and the world.

MODULE	DETAILS
1.	**Introduction to Yoga and Meditation** Definition of Yoga, Importance of Yoga for Human life, Literature of Yoga: Yoga Sutra, Bhagavat Gita – Synthesis of Yoga, Hathapradipika etc. Challenges of health in students & youth - Studies, Yogic concept of Health and Meditation, Concept of Body and Disease in Yoga, Dimensions of Health- Physical, Mental, Social and Spiritual, Different types of yoga (Karma, Gyaan, Ashtanga, Bhakti), Eight limbs of ashtanga yoga.

2.	**Yoga and Wellness** Yoga and Medical perspectives – Health related fitness, Yoga for common ailments, Scientific Researches in Yoga, Yogic anatomy of Human body, Asanas – Definitions and classifications, Scientific reasoning behind the asanas, Yoga for Stress, Technostress and Lifestyle management. Mental Disturbances and Preventive, Curative Aspect of Yoga for Mental wellness.

3.	**Essentials of Yoga Practices** Difference between Yoga and Exercise, Obstacles in the path of Yogic Practices, Disciplines in Yogic practices – Prayers, Yama, Niyama, Place, Time, Diet, Schedule, Sequence for Yogic Practices. Yogasanas: Surya Namaskara, Standing asanas and Sitting asanas, Different groups of Yogasanas – Relaxation, Meditative, Digestive etc. Psycho-physiological effects and health benefits of Yogasana, Function and effect of Asanas - Digestive system, Respiratory system, Excretory system, Circulatory system, Nervous system etc.
4.	**Meditation – Role of Breath and Pranayama** Yogic anatomy, Wellness and Triguna system, Science of Pranayama – 'Prana', the vital principle, Prana and air element, Awareness - Breath Awareness, Different types of Breathing, Breath Control, Breath and Postures, Rhythmic Breathing, Pranic body in the five-fold body (Panchakosha), Power of breath, Difference between Pranayama and breathing, Prana and nervous system, Fivefold function of prana, Benefits of pranayama

5.	**Fundamental aspects of Meditation** Pranayama and deep breathing - Concept of Inhalation (Puraka), Retention (Kumbhaka), & Exhalation (Rechaka); Important Pranayamas; Pranayama and Meditation; Mind and Meditation; Inner Instrument – Mind, Constituents of Mind - Mana, Buddhi, Ahankar and Chitta(Consciousness), Magnitude of Mind, Buddhi – the determinative faculty; Body-Mind complex; Mind Cleansing; Yogic Meditation and Mindfulness meditations; Yogic Process and Outcome of Meditation – Pratyahara, Dharana and Dhyana; Scientific studies on Meditation and Healing.
6.	**Meditation Tools and Techniques** Why Meditate - States of Mind, Mind over Body – Processing Thoughts, Preparing for Meditation – Posture, Shanti prayers, Pranayama, Training the Mind: Practicing tools- Bhramari Pranayama, Sacred Pranav (Om) mantra, Mantra Japa/ajapa, Types of Mindfulness Meditations, Yoga Nidra, Body scan meditation, etc. Benefits of Meditation

Course Outcomes:

1. Gain comprehensive insights about the necessity of yoga for daily life.
2. Obtain a simplified understanding of the impact of mindful breathing on health wellbeing.
3. Acquire knowledge of 'practice and principles' of simple awareness meditation for Mental wellness
4. Gain required knowledge to improve overall health and immune system
5. Practice simple asanas and meditation techniques to improve concentration, self-confidence and inner peace

Text Books:

1. Light on the Yoga Sutras of Patanjali by B.K. Iyengar (Publisher: Orient Longman Pvt. Ltd. Mumbai)
2. Pranayama - The Art & Science by Dr. Nagendra H R (Publisher: Swami Vivekananda Yoga Prakashan, Bangalore)
3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Recommended Books

1. Pranayama-Science of Breath by Gharote, M. (Publisher: The Lonavla Yoga Institute, India)
2. Svatmarama's HathaYogaPradeepika by Gyan Shankar Sahay (Publisher: Yogic Heritage, India)
3. Yoga for Health and Peace by Padamshree Sadashiv Nimbalkar (Publisher: Yoga Vidya Niketan, Mumbai)

Other Resources:

1. NPTEL Course: Yoga and Positive Psychology for Managing career and life by Prof. Ashish Pandey, IIT Bombay.
Weblink https://archive.nptel.ac.in/courses/110/101/110101165/

2. SWAYAM Course: Yoga for Concentration by By Dr H R Nagendra, Dr Manjunath N K and Dr Apar Avinash Saoji from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore.
Weblink: https://onlinecourses.swayam2.ac.in/aic23_ge05/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6013	HEALTH AND WELLNESS	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper.
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques.

MODULE	DETAILS
1.	**Foundations of Health Well-being** Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche Yogic anatomy of Physiological and Psyche layers, Triguna system
2.	**Physical Wellbeing** Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation

3.	**Emotional Wellness** Types of Emotions, Symptoms of emotional wellness Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc. Emotions and physical wellness Understanding the trinity of senses, sense objects and emotions, Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness

4.	**Mental Wellness** What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety, behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements
5.	**Intellectual Wellness** Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness
6.	**Spiritual Wellness** Yogic understanding of term 'spiritual' Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness Studies on Spiritual wellness and Body Healing Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements

Course Outcome: Learner will be able to

1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

Text Books

1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher:

Nisargopachar Gramsudhar Trust, Pune)

2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)

3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

Reference books

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)

2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
(Publisher: Motilal Banarsidass Publishing House, Delhi)

3. Yog – Its Philosophy and Practice by Swami Ramdev
(Publisher: Divya Prakashan, Haridwar)

Other Resources:

1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur.
Weblink https://nptel.ac.in/courses/127105236

2. NPTEL Course: The Science of Happiness and Wellbeing by By Prof. Priyadarshi Patnaik, Prof. Manas K. Mandal from IIT Kharagpur.
Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6014	DIET AND NUTRITION	02

Program Outcomes addressed:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO11: Life-Long learning

Course Objectives :

1. To provide students with a comprehensive understanding of nutrition principles and their application in promoting optimal health.
2. To develop critical thinking skills to evaluate nutritional information and make informed decisions.
3. To apply knowledge of nutrition education and counselling to promote healthy nutrition practices in individuals and group.
4. To demonstrate an understanding of role of nutrition in disease prevention and management.

Module	Details
01.	**Nutrition for wellness -1** Introduction to nutrition, food pyramid, Macros: Carbohydrates, Protein and fats, Micros: Vitamins A C E K and D, Minerals-Calcium, Iron and Zinc Importance of hydration, signs and symptoms, stages of dehydration.
02.	**Nutrition wellness -2** Introduction to mindful eating, plate concept, understanding physical and emotional hunger, eating disorder-Anorexia nervosa, bulimia nervosa and binge eating.
03.	**Exercise and fitness** Introduction to exercise and its importance, types of exercise its classification, side effects of over exercising, Impact of sedentary lifestyle on body composition.
04.	**Sleep and relaxation** Flow of circadian rhythm, sleep cycle, stages of sleep, sides effects, sleeping disorder-sleep apnea, insomnia, sleep hygiene routine and foods inducing sleep
05.	**Managing stress** Introduction to stress, causes, effects of stress, management of stress, foods and adaptogenic foods for stress management.
06.	**The lifestyle flow** Morning/ wake up rituals, meal flow i.e in which order to eat, post meal flow, bedtime rituals – how should your last hour of the day look like
Total no. of hours: **30**	

Course Outcomes :

1. Understand the fundamentals of nutrition and its role in promoting wellness.
2. Apply mindful eating practices to manage physical and emotional hunger.
3. Assess the importance of exercise and its impact on health and fitness
4. Gain insights into sleep hygiene and manage sleep-related disorders.

5. Develop strategies for stress management using nutrition and adaptogenic foods.
6. Assess the importance of exercise and its impact on health and fitness

Text Books :

1. Nutrition and dietetics by C.S. shah: covers various aspects of nutrition, including nutrient metabolism, dietary planning and diet therapy.
2. Dietetics by B. Srilakshmi- covers aspects of dietetics including nutrition, food science and diet therapy.

Reference Books :

1. Nutrition science by B. Shrilakshmi: provides an overview of nutrition, nutrient metabolism and dietary patterns
2. Food science by B. Shrilakshmi covers food, including food composition, food processing and food safety.

Course Type	Course Code	Course Name	Credits
LLC	LLC6015	PERSONALITY DEVELOPMENT	02

Program Outcomes addressed:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO11: Life-Long learning

Course Objectives :

1. To enhance self-awareness and self-confidence in the students.
2. To develop effective communication, leadership, and interpersonal skills.
3. To equip students with stress management and time management techniques.
4. To foster teamwork, problem-solving, and decision-making abilities.
5. To prepare students for professional life through resume building, interview skills, and networking.
6. To instill a growth mindset and adaptability in personal and professional contexts.

Module	Details
01.	**Self-Awareness and Emotional Intelligence** Understanding personality traits and self-assessment, Importance of emotional intelligence (EI) in personal and professional success, Strategies to enhance EI and self-awareness.
02.	**Communication Skills** Fundamentals of verbal and non-verbal communication, Public speaking, presentation skills, and storytelling, Listening skills and constructive feedback.
03.	**Leadership and Teamwork** Understanding importance of self-confidence, leadership styles, and their applications, Building effective teams and managing conflicts, Developing collaboration and networking skills.
04.	**Stress and Time Management** Recognizing stressors and managing stress effectively, Prioritization and goal-setting techniques, Tools for efficient time management and productivity.
05.	**Professional Development** Importance of presentation skills, resume writing, cover letter, and LinkedIn optimization, Interview preparation: Mock interviews and common questions, Networking skills and professional etiquette
06.	**Personal Growth and Adaptability** Developing a growth mindset and embracing lifelong learning, Cultivating resilience and adaptability to change, Setting long-term personal and professional goals
Total no. of hours: **30**	

Course Outcomes : By the end of this course, students will be able to:

1. demonstrate increased self-awareness and emotional intelligence.
2. communicate effectively in professional and personal contexts.
3. exhibit leadership and teamwork skills in various scenarios.
4. manage time and stress efficiently to enhance productivity.
5. prepare a professional resume, excel in interviews, and network effectively.
6. develop resilience, adaptability, and a growth-oriented mind-set.

Text Books :

1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ / What Makes a Leader: Why Emotional Intelligence Matters
2. Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change

Reference Books :

1. Dale Carnegie, How to Win Friends and Influence People.
2. Anthony Robbins, Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical, and Financial Destiny!
3. David J. Schwartz, The Magic of Thinking Big.
4. Robin Sharma, The Monk who sold his Ferrari.
5. Dorie Clark, Reinventing You: Define Your Brand, Imagine Your Future.
6. Gangadhar Joshi, Campus to Corporate: Your Roadmap to Employability.

Other Resources :

1. Videos and TED Talks by Simon Sinek, Brené Brown, Malcolm Gladwell and other motivational speakers
2. Online courses on communication and leadership (e.g., Coursera, LinkedIn Learning, EdX).