R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2024-25

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – I

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22MTC01	BS	Linear Algebra and Calculus	3	1	-	3	40	60	4
2	22PYC01	BS	Optics and Semiconductor Physics	3	-	-	3	40	60	3
3	22CSC01N	BES	Problem Solving and Programming using C	2	1	-	3	40	60	3
4	22EGC01N	HS	English	2	-	-	3	40	60	2
PRACTICAL										
5	22PYC03	BS	Optics and Semiconductor Physics Lab	-	-	3	3	50	50	1.5
6	22EGC02N	HS	English Lab	-	-	2	3	50	50	1
7	22CSC02N	BES	Problem Solving and Programming using C Lab	-	-	3	3	50	50	1.5
8	22MEC01N	BES	Engineering Graphics	-	1	3	3	50	50	2.5
9	22MEC38N	BES	Digital Fabrication Workshop	-	-	3	3	50	50	1.5
TOTAL				**10**	**3**	**14**	**-**	**410**	**490**	**20**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2024-25

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER -II

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22MTC04	BS	Differential Equations and Numerical Methods	3	1	-	3	40	60	4
2	22CYC01	BS	Chemistry	3	-	-	3	40	60	3
3	22EEC01	BES	Basic Electrical Engineering	2	1	-	3	40	60	3
4	22ITC20N	BES	Data Structures using C++	3	-	-	3	40	60	3
PRACTICAL										
5	22ITC21N	BES	Data Structures using C++ Lab	-	-	2	3	50	50	1
6	22ADC05N	BES	Python Programming Lab	-	1	2	3	50	50	2
7	22CYC02	BS	Chemistry Lab	-	-	3	3	50	50	1.5
8	22EEC02	BES	Basic Electrical Engineering Lab	-	-	2	3	50	50	1
9	22MEC37N	BES	Robotics and Drones Lab	-	1	3	-	100	-	2.5
10	22MBC02N	HS	Community Engagement	-	-	2	-	50	-	1
TOTAL				**11**	**4**	**14**	**-**	**510**	**440**	**22**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2025-26

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – III

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC01N	PCC	Agile Software Development	3	-	-	3	40	60	3
2	22CSC06	PCC	Discrete Structures	4	-	-	3	40	60	4
3	22CSC14N	PCC	Design and Analysis of Algorithms	3	-	-	3	40	60	3
4	22ITC02N	PCC	Java Programming	3	-	-	3	40	60	3
5	22ECC38	BES	Analog and Digital Electronics	3	-	-	3	40	60	3
PRACTICAL										
6	22CAC02N	PCC	Agile Software Development Lab	-	-	3	3	50	50	1.5
7	22CSC58	PCC	Design and Analysis of Algorithms Lab	-	-	3	3	50	50	1.5
8	22ITC03N	PCC	Java Programming Lab	-	-	3	3	50	50	1.5
9	22CAI01		MOOCs/ Training/ Internship	3-4 weeks / 90 Hours			-	-	-	2
TOTAL				**16**	**0**	**09**	**-**	**350**	**450**	**22.5**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

22CAC01N

AGILE SOFTWARE DEVELOPMENT

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Problem Solving and Programming using C, Python Programming

COURSE OBJECTIVES: This course aims to:

1. Demonstrate the ability to participate effectively in Agile Process for Software Development.
2. Explain the Purpose behind common Agile practices.
3. Apply Agile Principles and Values to a given real time problem.

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Interpret the concept of agile software engineering and its advantages in software development.
2. Analyse the core practices behind several specific agile methodologies.
3. Identify the roles and responsibilities in agile projects and their difference from projects following traditional methodologies.
4. Access implications of functional testing, unit testing, and continuous integration.
5. Determine the role of design principles in agile software design.

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	1	-	-	1	-	1	-	-	3	2	2
CO 2	3	3	2	2	2	1	2	-	2	1	-	3	2	3
CO 3	3	3	3	3	3	2	3	2	2	1	-	2	2	2
CO 4	3	3	3	3	3	2	3	2	3	2	1	3	3	3
CO 5	3	3	2	2	2	3	3	2	3	3	2	3	2	3

UNIT I

Traditional Software Engineering Practices: A Generic Process Model, Process assessment and Improvement, Prescriptive Process Models: Waterfall Model, Incremental Process Models, RAD Model, Evolutionary Process Models - Prototyping, The Spiral Model, Specialized Process Models.

UNIT II

Introduction to Agile Development: Need of Agile software development, agile context– Manifesto, Principles, Methods, Values, Roles, Artifacts, Stakeholders, and challenges. Business benefits of software agility.

UNIT III

Agile Methodologies: Need of scrum, Scrum practices –Working of scrum, Project velocity, Burn down chart, Sprint backlog, Sprint planning and retrospective, Daily scrum, Scrum roles– Product Owner, Scrum Master, Scrum Team. Extreme Programming- Core principles, values and practices. Kanban, Feature-driven development, Lean software development.

UNIT IV

Project Planning: Recognizing the structure of an agile team– Programmers, Managers, Customers. User stories– Definition, Characteristics and content. Estimation– Planning poker, Prioritizing, and selecting user stories with the customer, projecting team velocity for releases and iterations.

Project Design: Fundamentals, Design principles–Single responsibility, Open-closed, Liskov substitution, Dependency-inversion, Interface-segregation.

UNIT V

Testing: The Agile lifecycle and its impact on testing, Test driven development– Acceptance tests and verifying stories, writing a user acceptance test, Developing effective test suites, Continuous integration, Code refactoring. Risk based testing, Regression tests, Test automation.

TEXT BOOKS:

1. Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, International Edition, Pearson.
2. Robert C. Martin, “Agile Software Development, Principles, Patterns and Practices”, First International Edition, Prentice Hall.
3. Roger S. Pressman “Software Engineering: A practitioner's approach”, McGraw Hill, 9th Edition, 2010.

SUGGESTED READING:

1. Lisa Crispin, Janet Gregory, “Agile Testing: A Practical Guide for Testers and Agile Teams”, International edition, Addison Wesley.
2. Pedro M. Santos, Marco Consolaro, and Alessandro Di Gioia, “Agile Technical Practices Distilled: A learning journey in technical practices and principles of software design”, First edition, Packt Publisher.
3. Alistair Cockburn, “Agile Software Development: The Cooperative Game”, 2nd Edition, Addison-Wesley
4. “The Complete Guide to Agile Software Development” https://clearbridgemobile.com/complete-guideagile-software-development/
5. “Agile Fundamentals Ebook: A Complete Guide for Beginners”, https://agileken.com/agile- fundamentals ebook/

Online Resources:

1. “Agile Software Development”, https://www.edx.org/course/agile-software-development Accessed on August 27, 2021.
2. “Agile Software Development”, https://www.coursera.org/learn/agile-software-development Accessed on August 27, 2021.

22CSC06

DISCRETE STRUCTURES

Instruction	4L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

This course aims to:

1. Introduce Propositional and Predicate Logic.
2. Introduce various proof techniques for validation of arguments.
3. Develop an understanding of counting, functions and relations.
4. Familiarize with fundamental notions and applicability of graph theory and algebraic systems.

Course Outcomes:

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

1. Describe rules of inference for Propositional and Predicate logic.
2. Demonstrate use of Set Theory, Venn Diagrams, relations, and functions in Real-world scenarios.
3. Model solutions using Generating Functions and Recurrence Relations.
4. Determine the properties of graphs and trees to solve problems arising in computer science applications.
5. Distinguish between groups, semi groups and monoids in algebraic systems

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	1	1	-	-	-	-	1	-	-	3	-	2
CO 2	2	1	-	1	-	-	-	-	-	-	1	3	2	2
CO 3	2	2	-	1	-	-	-	-	-	-	-	3	2	2
CO 4	2	1	-	1	-	-	-	-	1	-	-	3	2	2
CO 5	2	1	-	1	-	-	-	-	-	-	-	3	-	2

UNIT – I

Introduction to Propositional Calculus: Basic Connectives and Truth tables, Logical Equivalence: Laws of Logic, Logical Implication; Rules of Inference. Predicates: The Use of Quantifiers, Quantifiers, Definitions and the Proofs of Theorems

UNIT – II

Sets: Sets and Subsets, Operations on sets and the Laws of Set Theory, Counting and Venn Diagrams. Relations and Functions: Cartesian Products and Relations. Partial ordering relations, POSET, Hasse diagrams, Lattices as Partially Ordered Sets, Equivalence relations. Pigeon hole principle. Functions: Types of Functions, Composition of functions and Inverse of functions

UNIT – III

Fundamental Principles of counting: The Rules of Sum and Product, Permutations, Combinations, Binomial Theorem; Generating Functions: Generating Functions, Calculating Coefficient of generating functions; Recurrence Relations: The First Order Linear Recurrence Relation, Second Order Linear. Homogeneous Recurrence relations with constant coefficients, Non Homogeneous Recurrence relations.

UNIT – IV

Introduction to Graphs: Graphs and their basic properties- degree, path, cycle, Sub graphs, Complements and Graph Isomorphism, Euler trails and circuits, Hamiltonian paths and cycles, Planar graphs, Euler formula, Graph Coloring and Chromatic polynomial, Matching, Applications. Trees: Definitions, Properties, Rooted Trees, Spanning Trees, Minimum Spanning trees: Algorithms of Kruskal and Prim.

UNIT - V

Algebraic Structures: Algebraic Systems, Examples and General Properties, Semi groups and Monoids. Groups: Definitions and Examples, Subgroups, Homomorphisms and cyclic groups.

Text Books:

1.Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics", An Applied Introduction, 5th edition, Pearson Education, 2016.

2.Rosen, K. H., "Discrete Mathematics and Its Applications", 8th Edition, ISBN10: 125967651X ISBN13: 9781259676512, 2019

Suggested Reading:

1. Singh, S.B., "Discrete Mathematics", Khanna Book Publishing Company, New Delhi., 3rd Edition, 2019

2. R. K. Bisht, H. S. Dhami, "Discrete Mathematics", Oxford University Press, 2015.

3. David D. Railey, Kenny A. Hunt, "Computational Thinking for the Modern Problem Solving", CRC Press, 2014

4. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", TATA Mc Graw-Hill Edition, 2017.

5. Joe L. Mott, Abraham Kandel, Theodore P. Baker, "Discrete Mathematics for Computer Scientists & Mathematicians", 2nd Edition, PHI, 2015.

Online Resources:

1. .https://nptel.ac.in/courses/111107058/
2. https://nptel-discrete-mathematics-5217

22CSC14N

DESIGN AND ANALYSIS OF ALGORITHMS

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basics of Data structures and algorithms.

Course Objectives:

This course aims to:

1. Provide an introduction to formalisms to understand, analyze and denote time complexities of algorithms.
2. Introduce the different algorithmic approaches for problem solving through numerous example problems.
3. Provide some theoretical grounding in terms of finding the lower bounds of algorithms and the NP-completeness.

Course Outcomes:

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

1. Identify and apply asymptotic notations and recurrence-solving techniques to analyze the performance of recursive algorithms
2. Apply greedy and dynamic programming strategies to solve optimization problems and identify the most suitable design approach based on problem characteristics.
3. Implement backtracking and branch-and-bound techniques to solve combinatorial and decision problems and evaluate their efficiency.
4. Solve and evaluate the performance of graph traversal and shortest path algorithms.
5. Demonstrate NP-completeness through problem reductions and complexity classes.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	-	-	2	-	-	-	-	-	-	3	-	2
CO 2	3	3	2	-	2	-	-	-	-	-	-	3	3	2
CO 3	3	3	2	-	2	-	-	-	-	-	-	3	-	2
CO 4	3	3	-	-	2	-	-	-	-	-	-	3	3	2
CO 5	2	3	-	-	2	-	-	-	-	-	-	3	-	2

UNIT - I

Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior. Performance measurements of Algorithm, Time and space trade-offs. Divide and Conquer: The general method, Minimum and Maximum Problem Analysis of recursive algorithms through recurrence relations: Iterative/Expansion method, Recursion tree method and Masters' theorem.

UNIT - II

Greedy Algorithms: The general method, Knapsack Problem, Huffman Codes, Job scheduling with deadlines. Dynamic Programming: The general method, 0/1 Knapsack, Travelling Salesman Problem, Matrix chain multiplication, Longest Common subsequence.

UNIT - III

Backtracking: The general Method, 8-Queens Problem, Graph Coloring, Hamiltonian Cycle. Branch-and-Bound: The general method, FIFO branch and bound, LC branch and bound, 0/1 Knapsack Problem using FIFO branch and bound, Travelling Salesperson problem using LC branch and bound.

UNIT - IV

Graph Algorithms: Applications of DFS: Bi-Connected components, strongly connected components, topological sorting. Shortest Path Algorithms: Dijkstra's, Bellman-Ford, Floyd-Warshall

UNIT - V

Theory of NP-Completeness: Polynomial time, Polynomial time verification, P, NP, NP-hard and NP-Complete classes, NP-Completeness and Reducibility. Standard NP-Complete Problems and Reduction Techniques: The

Clique Problem, Vertex-Cover Problem.

Text Books:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, “Introduction to Algorithms”, MIT Press/McGraw-Hill, 4th Edition, 2022.
2. E. Horowitz, sartaj sahni and sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Universities Press, 2008.

Suggested Reading:

1. Michael T Goodrich and Roberto Tamassia, “Algorithm Design: Foundations, Analysis”, and Internet Examples, Wiley Second Edition.

Online Resources:

1. https://nptel.ac.in/courses/106101060/

22ITC02N

JAVA PROGRAMMING

(Common to CSE, IT, AI&DS , CET and allied branches)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives

The course aims to:

1. Introduce the fundamental concepts of Object-Oriented Programming (OOP).
2. Guide students through the process of creating and managing classes and objects.
3. Explain and demonstrate the use of inheritance and polymorphism.
4. Teach effective handling of runtime exceptions and the basics of multithreading.
5. Provide hands-on experience with Java's IO package for application development.

Course Outcomes

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

1. Apply OOP concepts to develop structured Java applications.
2. Utilize inheritance and interfaces to enhance code reusability and flexibility.
3. Implement exception handling and multithreading to manage complex program flows.
4. Build applications using the Java Collection Framework.
5. Develop programs that handle input and output operations using the IO package.

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	3	3	2	2	-	1	2	1	2	2	2	2
CO 2	2	2	3	2	2	1	-	1	2	1	2	2	2	2
CO 3	2	2	3	2	2	1	-	1	2	1	2	2	2	2
CO 4	2	2	3	2	2	1	-	1	2	1	2	2	2	2
CO 5	2	2	3	2	3	1	-	1	2	1	2	2	3	3

UNIT-I

Introduction to Java: Procedural and object-oriented programming paradigms, Principles, Features, Basic structure a java program, Java Primitive Data Types, Basic Operators, Flow-control statements. Defining Classes, Adding Instance Fields and Methods, Object Creation, Constructors, Access Modifiers, Method Overloading and Constructor Overloading, Use of static and final keyword, Arrays, Strings and String Tokenizer, Scanner.

UNIT-II

Inheritances and Packages: Types of Inheritance, super keyword, preventing inheritance, the Object class, method overriding and dynamic method dispatch, abstract classes and methods. Interfaces, Interfaces vs. Abstract classes, Inner classes and types, Packages, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

UNIT-III

Exception Handling and Threading: What are exceptions, Error vs. Exception, usage of try, catch, throw, throws and finally clauses, Multithreading in Java, Life cycle of Thread, how to create threads, Thread class in java, Thread priorities, Thread Synchronization. Introduction to Generics, Advantages of Generics, Generic class, Type Parameters, Generic Methods.

UNIT-IV

Collections: Overview of Java Collection Framework, Collection Interfaces – Collection, Set, List, Map, Collection classes – Array List, Linked List, Hash Set, Tree Set, Hash Map, Tree Map, Iteration over Collections – Iterator and List Iterator, Comparable and Comparator interface, Introduction to Java 8 Features, Lambda Expressions, Functional Interfaces.

UNIT-V

Java I/O and NIO: Input Stream, Output Stream, Reader, Writer, File Reader, File Writer, Bufferedreader, Bufferedwriter, Object Serialization and Deserialization, Java NIO: Non-blocking I/O, Path, Files, Selectors, Channels, Buffers, Asynchronous I/O, NIO vs. IO

Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 12th Edition, Tata McGraw Hill Publications, 2020.
2. K Somasundaram "Advanced Programming in Java2" Jaico Publishing House, 2008.

Suggested Reading:

1. E Balaguruswamy "Programming with Java", TataMcGraw-Hill, 6th Edition, 2019.
2. Paul Deitel and Harvey Deitel "Java How to Program, Early Objects ", 11th Edition., 2018.

Web Resources:

1. https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html
2. https://nptel.ac.in/courses/106106147/2

22ECC38

ANALOG AND DIGITAL ELECTRONICS

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Electronic device concepts.

Course Objectives:
This course aims to:

1. Learn basic concepts and working principles of analog devices.
2. Learn various techniques for logic minimization.
3. Comprehend the concepts of various combinational circuits and sequential circuits.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Understand the basic concepts related to analog devices and digital circuits.
2. Design the combinational and sequential circuits.
3. Examine the behavior of logic gates.
4. Analyze the behavior of the digital system design.
5. Evaluate the performance of real time combinational circuits and sequential circuits.

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	1	1	3	1	1	2	1	2	2	1	1	1
CO 2	2	3	3	3	3	-	1	3	1	1	2	1	1	1
CO 3	1	2	1	1	1	-	1	-	-	2	2	1	1	1
CO 4	1	3	1	2	1	-	1	1	1	2	2	1	2	1
CO 5	2	1	2	1	2	-	1	1	-	2	2	1	1	2

UNIT -I
Devices: Concepts of semiconductors, V-I Characteristics of P-N Junction diode, current equation. Characteristics of Zener Diodes, Special diodes: LED, Photo Diode.
Applications: Zener Diode as a voltage regulator, Half Wave Rectifier and Full Wave Rectifier.

UNIT-II
Bipolar Junction Transistors: Classification, Operation of Bipolar Junction Transistor, Configurations: CB, CE Characteristics, Applications.
Field Effect Transistor: Junction Field Effect Transistor: Principle of Operation, Characteristics of JFET, parameters and Operation of MOSFET

UNIT-III
Boolean Algebra and Logic Simplification: Number system representation and conversion, Binary Arithmetic, Complements, Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Introduction to all Logic Gates, Minimization of Switching Functions: Karnaugh map method, Logic function realization: AND-OR, OR-AND and NAND/NOR realizations.

UNIT-IV
Introduction to Combinational Design: Binary Adders, Subtractors, Code converters Binary to Gray, Gray to Binary, BCD to excess3, BCD to Seven Segment display, Decoders, Encoders, Priority Encoders, Multiplexers, De-multiplexers.

UNIT-V
Sequential Logic Design: Latches, Flipflops, Difference between latch and flipflop, types of flipflops like S-R, D, T JK and Master-Slave JK FF, flipflop conversions, Ripple and Synchronous counters, Shift registers.

Text Books:

1. Robert L.Boylestad, Louis Nashelsky, “Electronic Devices and Circuits Theory”, Pearson Education, 9th Edition, LPE, Reprinted, 2006.
2. Morris Mano M. and Michael D.Ciletti, “Digital Design, With an Introduction to Verilog HDL”, 5th Edition, Pearson 2013.

Suggested Reading:

1. R.P. Jain, “Modern digital Electronics”, Tata McGraw Hill, 4th Edition, 2009.
2. Thomas L. Floyd, “Digital Fundamentals”, Pearson, 11th Edition, 2015.

22CAC02N

AGILE SOFTWARE DEVELOPMENT LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Data Structures, Programming Languages

Course Objectives:

This course aims to:

1. To understand project requirements by writing user stories, creating diagrams, and estimating effort.
2. To apply software design techniques and derive test cases from project blueprints.
3. To implement agile practices like functional testing, TDD, and CI for better code quality and delivery.

Course Outcomes:

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

1. Write clear and concise user stories and design essential UML artifacts such as use case and class diagrams.
2. Estimate project effort and plan development tasks effectively.
3. Derive and execute test cases for both web and mobile applications.
4. Apply agile practices like TDD and CI for improved software quality and delivery.
5. Refactor legacy code to enhance maintainability without altering existing functionality.

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	3	1	2	-	-	-	2	3	1	3	1	2
CO 2	2	2	2	1	1	-	-	-	2	2	3	2	2	1
CO 3	3	3	3	3	3	-	-	-	1	2	2	2	1	3
CO 4	2	3	3	2	3	-	-	-	2	3	2	3	2	2
CO 5	3	2	2	2	3	-	-	2	1	2	2	3	1	2

Lab Experiments:

1. Write user stories for a given project.
2. Design a use case diagram for a given project.
3. Design a class diagram for a given project.
4. Design CRC cards for given classes of project.
5. Estimate the effort required for completing a given project.
6. Derive test cases for a given project through its blueprint.
7. Perform functional testing on a web application.
8. Derive test cases and test a simple mobile application.
9. Practice test-driven development (TDD) to write tests before implementing features.
10. Set up continuous integration (CI) and automate testing in an agile environment.
11. Refactor legacy code to improve readability and maintainability without altering its functionality.

Text Books:

1. Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices “,First Edition, Pearson Education Limited 2014 .
2. Roger S. Pressman,”Software Engineering: A Practitioner’s Approach”, Seventh Edition, Roger S. Pressman,

Suggested Reading:

1. Martin Fowler,” UML Distilled: A Brief Guide to the Standard Object Modeling Language", Third Edition , Addison-Wesley

22CSC58

DESIGN AND ANALYSIS OF ALGORITHMS LAB

Instruction	3 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Programming and Problem Solving, Basics of Data structures and algorithms lab and Object Oriented Programming.

Course Objectives:

This course aims to:

1. Design and construct simple programs by using the different design strategies for solving different problems.
2. To enhance programming skills while improving their practical knowledge in implementing the algorithms.
3. To strengthen the practical ability and to apply suitable algorithmic approaches for solving real time problems.

Course Outcomes:

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

1. Apply Divide and Conquer to solve problems like Minimum-Maximum.
2. Develop solutions for optimization problems like Fractional Knapsack, Job Scheduling using Greedy algorithms.
3. Develop and Analyse solutions of 0/1 Knapsack and LCS using Dynamic Programming.
4. Design and Implement solutions using Backtracking for N-Queens, Graph Colouring problems.
5. Implement Topological Sorting and Dijkstra's Algorithm for graph problems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	3	2	-	-	-	-	-	-	-	-	3	-	2
CO 2	2	3	2	-	-	-	-	-	-	-	-	3	1	2
CO 3	2	3	2	-	-	-	-	-	-	-	-	3	1	2
CO 4	2	3	2	-	-	-	-	-	-	-	-	3	-	2
CO 5	2	3	2	-	-	-	-	-	-	-	-	3	1	2

List of Experiments:

1. Implement the Minimum-Maximum Problem using the Divide and Conquer approach.
2. Implement the Fractional Knapsack Problem using the Greedy approach.
3. Implement Job Scheduling with Deadlines using the Greedy approach.
4. Implement the 0/1 Knapsack Problem using Dynamic Programming.
5. Implement the Longest Common Subsequence (LCS) using Dynamic Programming.
6. Implement the N-Queens Problem using Backtracking.
7. Implement the Graph Coloring Problem using Backtracking.
8. Implement Topological Sorting on directed acyclic graphs (DAGs).
9. Implement Dijkstra's Algorithm for finding the shortest path in a graph.
10. Implement bi-connected components
11. Case Studies on dynamic programming, backtracking, branch and bound, breadth first search

Text Books:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press/McGraw-Hill, 4th Edition, 2022.
2. Michael T Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis", and Internet Examples, Wiley Second Edition.

22ITC03N

JAVA PROGRAMMING LAB

(Common to CSE, IT, AI&DS , CET and allied branches)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives:

This course aims to:

1. Introduce the core principles of Object-Oriented Programming (OOP).
2. Explain the object-oriented approach to designing and implementing classes and objects.
3. Demonstrate the use of inheritance and polymorphism in Java.
4. Illustrate exception handling and multithreading techniques for managing runtime behaviour.
5. Explore Java's IO package for developing basic input/output functionalities in applications.

Course Outcomes:

Upon successful completion of this course, student will be able to:

1. Apply OOP principles to design and develop Java applications.
2. Implement inheritance and interfaces to build modular and reusable code.
3. Use exception handling and multithreading to manage multiple execution paths efficiently.
4. Develop robust applications utilizing the Java Collection Framework.
5. Integrate Java IO concepts for effective data input and output operations in applications.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	3	3	2	2	-	1	2	1	2	2	2	2
CO 2	3	3	3	2	2	1	-	1	2	2	2	2	2	2
CO 3	2	2	3	2	2	1	-	1	2	1	2	2	2	2
CO 4	2	2	3	2	2	1	-	1	2	1	2	2	2	2
CO 5	3	3	3	2	3	1	-	1	2	2	2	2	3	3

LIST OF EXPERIMENTS

1. Implement the program(s) to handle the various data types, operators, expressions, control-flow, and strings.
2. Develop a java program(s) for constructors.
3. Develop a java program to demonstrate the method overloading and riding.
4. Develop a java program(s) to deal with different types of inheritances and interfaces.
5. Implement the program(s) to demonstrate the packages.
6. Develop a java program(s) to handle user defined exceptions with multiple catch blocks.
7. Implement program(s) to demonstrate Multithreading and thread synchronization.
8. Implement program(s) to demonstrate generics.
9. Implement the collection framework classes with Iterator/List Iterator.
10. Develop a java program(s) to implement the features of JDK8.

Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 12th Edition, Tata McGraw Hill Publications, 2020.
2. K Somasundaram "Advanced Programming in Java2" Jaico Publishing House, 2008.

Suggested Reading:

1. E Balaguruswamy "Programming with Java", TataMcGraw-Hill, 6th Edition, 2019.
2. Paul Deitel and Harvey Deitel "Java How to Program, Early Objects ", 11th Edition., 2018.

Web Resources:

1. https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html
2. https://nptel.ac.in/courses/106106147/2

22CAI01

MOOCs / Training / Internship-1

Instruction / Demonstration / Training	3-4 Weeks / 90 Hours
Duration of Semester End Presentation	-
Semester End Evaluation	-
Continuous Internal Evaluation	50 Marks
Credits	2

Prerequisite : Knowledge of Basics Sciences and Engineering Science

COURSE OBJECTIVES :

This course aims to:

1. Expose students to industrial environments, contemporary technologies, and real-world work conditions.
2. Enhance students' technical and managerial skills through practical learning opportunities and interaction with industry professionals and society.
3. Develop awareness of current technological trends, engineering responsibilities, and professional ethics relevant to their domain.

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Learn new technologies and solve real time projects.
2. Expose to the industrial environment problems and technologies
3. Gain knowledge on contemporary technologies industrial requirements.
4. Identify , Design and Develop solutions for real world problems
5. Communicate their ideas and learning experiences through reports and presentation.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	2	3	1	2	1	2	2	2	2	2	2	2
CO 2	2	2	2	1	1	2	1	2	1	2	2	2	2	2
CO 3	3	2	1	2	2	2	1	2	1	2	2	2	2	2
CO 4	1	3	3	3	1	2	1	2	3	2	2	2	2	2
CO 5	1	1	1	1	1	1	-	2	3	2	1	2	2	2

PROCESS TO BE FOLLOWED FOR CARRYING OUT INSTRUCTIONS TO STUDENTS:

1. Students may apply for internships through the AICTE Portal or through CDC of the institute by filling the application form IAP-101.
2. Industry shall scrutinize the students based on their criteria and communicate a provisional offer or confirmation letter to the student.
3. If students apply through CDC, then CDC shall nominate the students for various opportunities accordingly by issuing NOC (IAP-104).
4. The respective head of the department shall assign a faculty mentor.
5. Student shall undergo internship/industrial training at the concerned Industry/Organization by submitting the form, IAP-103.
6. During the internship, Faculty Mentor will evaluate the performance of students twice either by visiting the Industry/Organization or through obtaining periodic reports from students.
7. Student shall submit internship report to the industry/organization at the end of internship program.
8. On successful completion of the Internship, Industry/Organization shall issue Internship Certificate to the students
9. All the students should maintain discipline, professional ethics and follow the health and safety precautions during internship

Student shall maintain diary during the internship and submit the internship report at the end of the internship. The report will be evaluated by the supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Evaluation of Internship: The internship of the students will be evaluated in three stages:

1. Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
2. Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks)
3. Evaluation through seminar presentation/Viva-Voce at the Institute(This can be reflected through marks assigned by Faculty Mentor (25 marks)

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2025-26

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – IV

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC03N	PCC	Principles of Artificial Intelligence	3	-	-	3	40	60	3
2	22CAC04N	PCC	Introduction to Machine Learning	3	1	-	3	40	60	4
3	22CAC05N	PCC	Computer Architecture and Microprocessor	3	1	-	3	40	60	4
4	22CSC11N	PCC	Database Management Systems	3	-	-	3	40	60	3
5	22MTC13	BS	Mathematical Foundation for Data Science and Security	3	-	-	3	40	60	3
PRACTICAL										
6	22CAC06N	PCC	Principles of Artificial Intelligence Lab	-	-	3	3	50	50	1.5
7	22CAC07N	PCC	Introduction to Machine Learning Lab	-	-	2	3	50	50	1
8	22CSC13N	PCC	Database Management Systems Lab	-	-	3	3	50	50	1.5
9	22CAU01		Upskill Certification Course - I	-			-	25	-	0.5
TOTAL				**15**	**2**	**8**	**-**	**375**	**450**	**21.5**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

22CAC03N

PRINCIPLES OF ARTIFICIAL INTELLIGENCE

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Data structures, Discrete Mathematics, Probability Theory.

COURSE OBJECTIVES: This course aims to

1. To list the significance of AI.
2. To discuss the various components that are involved in solving an AI problem.
3. To analyze the various knowledge representation schemes, reasoning and learning techniques of AI.

COURSE OUTCOMES: On Successful completion of the course, students will be able to

1. Explain the role of agents and interaction with the environment to establish goals.
2. Identify and formulate search strategies to solve problems by applying suitable search strategies.
3. Compare and contrast the various knowledge representation schemes of AI.
4. Appraise probabilistic reasoning and model building
5. Apply Markov decision Process to solve real world problems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	-	-	-	1	-	-	-	-	2	2	1	2
CO 2	3	3	2	2	2	-	-	-	-	-	2	3	2	3
CO 3	3	2	2	2	2	-	-	-	-	-	3	2	2	3
CO 4	3	2	2	3	2	-	-	-	-	-	3	2	3	3
CO 5	3	3	3	2	2	1	-	-	-	-	3	3	3	2

UNIT - I

Introduction: **Foundations of AI, History, State of the Art, Risks and Benefits.**
Intelligent agents: Agents and Environment, The Concept of Rationality, Structure of an Agent.
Solving problems by Search- Problem-Solving Agents, State space representation, Search graph and Search tree Searching for Solutions.

UNIT - II

Uninformed Search Strategies: Uniform cost search, Iterative deepening Depth-first search, Bidirectional search**.**
Informed (Heuristic) Search Strategies: Heuristic Functions, Hill- climbing, Greedy best-first search, A* search, Simulated Annealing search.

UNIT – III

Adversarial Search: Game Theory, Alpha–Beta Pruning, Constraint Satisfaction Problems.
Logic Concepts and Logic Programming: Introduction, Propositional Calculus Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Tableau, Predicate Logic, Resolution Refutation in Propositional Logic and Predicate Logic

UNIT - IV

Knowledge Representation: Introduction, approaches to knowledge Representation, Knowledge Representation using Semantic Network, Knowledge Representation using Frames.
Probabilistic Reasoning: Probability, inference using full joint distributions, Bayes rule, Bayesian networks-representation, construction, exact and approximate inference, temporal model, hidden Markov model.

UNIT – V

Markov Decision process: MDP formulation, utility theory, multi attribute utility functions, decision networks, sequential decision problems value iteration, policy iteration partially observable MDP.

Text Books:

1. Russell, Norvig, “Artificial Intelligence: A Modern Approach”, Pearson Education, 4th Edition, 2020.
2. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, First Edition, 2011.

Suggested Reading:

1. Rich, Knight, Nair, “Artificial Intelligence”, Tata McGraw Hill, 3rd Edition 2009.
2. Trivedi. M.C., “A classical approach to Artificial Intelligence”, Khanna Publishing House, Delhi.

Online Resources:

1. http://nptel.ac.in/courses/106106126/
2. http://nptel.ac.in/courses/106105077/

22CAC04N

INTRODUCTION TO MACHINE LEARNING

Instruction	3L+1P Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Linear Algebra and Probability theory basics, Artificial Intelligence.

Course Objectives: The objectives of this course are to

1. Understand the need for Machine Learning
2. Study various machine learning techniques and its applications
3. Design solutions for real world problems using machine learning techniques.

Course Outcomes: On Successful completion of the course, students will be able to

1. Define the basic concepts related to Machine Learning.
2. Recognize the underlying mathematical relationships across ML algorithms and their paradigms.
3. Determine the various applications of Machine Learning.
4. Model, design and develop solutions to real world problems using Machine Learning Algorithms.
5. Evaluate and interpret the results of the various machine learning tools.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	-	-	-	-	2	-	2	-	2
CO 2	3	3	2	2	2	-	-	-	-	1	-	3	3	2
CO 3	2	2	2	1	2	2	2	-	-	1	-	3	3	2
CO 4	3	3	3	3	3	-	-	-	2	2	2	2	3	2
CO 5	2	3	2	3	3	-	-	-	1	2	2	3	3	2

UNIT-I

Introduction to Machine Learning: Introduction to ML, Types of Machine Learning, Data formats, Applications of Machine Learning.

Concept Learning: Concept Learning Task and General to Specific Ordering of Hypothesis.

Data Pre-processing Techniques:

Loading the data, Missing values, Outlier, Managing categorical data, k- Fold Cross-validation and Data splitting with training and test sets.

UNIT-II

Feature Engineering:

Data scaling and normalization, whitening, Feature selection and filtering, Visualization of high-dimensional Datasets and PCA.

Regression Algorithms: Linear Regression, Logistic regression, Lasso and Ridge regression, Error measures with Regression.

UNIT-III

Classification Algorithms: Decision Trees**,** k-Nearest Neighbors (k-NN), Bayes theorem, Naïve Bayes classifiers, Discriminant analysis, Support Vector Machines, Grid search, Confusion Matrix with metrics.

UNIT–IV

Ensemble Learning: Introduction to Ensemble Learning with Random Forests, AdaBoost, XGBoost, Light GBM and Voting classifier.

Clustering Algorithms: Basics of Clustering, K-means, Hierarchical Clustering, DBSCAN, Evaluation methods of Clustering.

UNIT–V

Machine Learning Architectures: Scikit-learn tools for machine learning architectures with Pipeline.

Neural Networks:

Introduction to Neural Networks, Activation functions, multi-layer perceptron, Deep learning architectures with convolutional neural networks, recurrent neural networks.

Text Books:

1. Giuseppe Bonaccorso, “Machine Learning Algorithms”, 2nd Edition, Packt, 2018.
2. Tom Mitchel “Machine Learning”, Tata McGraW Hill, 2017.

Suggested Reading:

1. Laurence Moroney,” AI and Machine Learning for Coders”, O'Reilly Media,October 2020.
2. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing Company, 2020.
3. M N Murty and Ananthanarayana V S, “Machine Learning: Theory and Practice”, Universities Press; First Edition,2024.
4. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

Online Resources:

1. Introduction to Machine Learning: https://www.youtube.com/watch?v=r4sgKrRL2Ys&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77 and https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2. Introduction to Machine Learning: https://www.youtube.com/watch?v=T3PsRW6wZSY&list=PLIg1dOXc_acbdJo-AE5RXpIM_rvwrerwR and https://onlinecourses.nptel.ac.in/noc22_cs97/preview

22CAC05N

COMPUTER ARCHITECTURE AND MICROPROCESSOR

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Analog and digital circuits.

Course Objectives: The objectives of this course are

1. To understand the basic principles of Instruction-Level Architecture and Instruction Execution, Memory System Design.
2. To learn various I/O devices and their operations, with emphasis on Instruction Level Parallelism.
3. To gain knowledge on Micro Programming and Pipelining techniques.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand the functional block diagram of single bus architecture of a computer, and perform basic arithmetic operations.
2. Comprehend the architecture and functioning of the 8086 microprocessor.
3. Design assembly language programs using 8086 instruction set.
4. Analyze memory transfer operations and improve performance using pipelining techniques.
5. Interpret the working of memory systems and architectures of large computer systems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	-	1	-	-	-	-	-	-	1	-	-	1
CO2	2	1	1	1	2	-	-	-	-	-	1	-	-	2
CO3	1	2	3	-	2	-	-	-	1	1	-	-	-	2
CO4	1	2	2	1	2	-	-	2	1	-	-	1	-	2
CO5	2	2	1	-	1	1	-	-	-	-	1	-	-	2

UNIT - I

Basic Structure of Computers: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance, Multiprocessors and Multi-computers.

Arithmetic: Addition and Subtraction of Signed numbers, Design of Carry Look-ahead Adder, Multiplication of positive numbers, Signed-Operand Multiplication, Integer Division.

UNIT - II

Basic Processing Unit: Fundamental concepts, Execution of a complete instruction, Multiple-Bus organization, Hardwired control, Micro programmed control.

8086 Architecture: CPU Architecture, Internal operation, Machine language instructions, 8086 Addressing modes.

UNIT- III

Assembly Language Programming: Instruction format, Instruction execution timing. Data transfer instructions, Arithmetic instructions.

Branch instructions, Loop instructions, NOP and HLT, Flag manipulation instructions, Logical instructions, Shift and Rotate instructions, Directives and Operators. Procedures, Interrupts and Interrupt routines, Macros .

UNIT - IV

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers– Program Controlled, Interrupt Driven and DMA, privileged and non-privileged instructions, Software Interrupts and Exceptions. Programs and processes – role of interrupts in process state transitions.

Pipelining: Basic concepts, Data hazards, Instruction hazards, Structural hazard. Influence on instruction sets, Data path and control considerations.

UNIT – V

The Memory System: Memory hierarchy, Semiconductor RAM Memories, Cache Memories, Performance considerations, Virtual Memories, Memory Management requirements, Secondary Storage.

Large Computer Systems: Forms of Parallel Processing, Array Processors, Structure of general-purpose

multiprocessors, Program Parallelism and Shared Variables.

Text Books:

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky, “Computer Organization”,5thEdition, McGraw Hill Education Edition2011.
2. Yu-chengLiu, Glenn A.Gibson, “Microcomputer Systems: The 8086/ 8088 Family”, 2nd Edition, PHI Learning 2011.

Suggested Reading:

1. M. M. Mano, “Computer System Architecture”, 3rdedition, Prentice Hall,1994.
2. William Stallings, “Computer Organisation and Architecture, Design for Performance”, Pearson, 9th Edition, 2013.
3. Douglas Hall. “Microprocessor and Interfacing programming and Hardware”, Tata McGraw Hill, Revised 2nd Edition, 2007.
4. Brey B. Brey, “The Intel Microprocessor, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro-Processors-Architecture, Programming and Interfacing”, 4thEdition, Prentice Hall.

22CSC11N

DATABASE MANAGEMENT SYSTEMS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Programming and Data Structures.

Course Objectives:

This course aims to:

1. Familiarize students with fundamental concepts of database management. These concepts include aspects of database design, database languages and database-system implementation
2. Understand about data storage techniques and indexing.
3. Impart knowledge in transaction management, concurrency control techniques and recovery procedures.

Course Outcomes:

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

1. Understand fundamental concepts of database and design database schema for an application.
2. Write relational algebra expressions and SQL queries for various tasks.
3. Apply the principles of functional dependency and normalization to ensure data integrity
4. Understand indexing and transaction processing
5. Analyze transaction processing, concurrency control and recovery mechanisms.

CO-PO & PSO ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	3	-	-	-	-	-	1	2	3	2
CO 2	2	3	2	2	3	-	-	-	-	-	1	2	3	2
CO 3	2	1	2	1	3	-	-	-	-	-	-	2	3	2
CO 4	2	1	1	-	-	-	-	-	-	-	-	3	2	2
CO 5	2	1	-	1	-	-	-	-	-	-	-	3	2	3

UNIT-I

Introduction: Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Users and Administrators, Database System Architecture, Data Models, **E-R Model**: Introduction, Constraints, E-R Diagrams, E-R Design Issues, Mapping from ER to relational model, Extended E-R Features.

UNIT-II

Relational Algebra: Introduction to relational algebra operations, Basic relational algebra operators, Natural join, Assignment operator. **SQL:** Data Types, Basic Structure of SQL Queries, Modification of the Database, Set Operations, Aggregate Functions, Data-Definition Language, Integrity Constraints, Null Values, Views, Join Expression. Simple Queries (select/project/join/ aggregate queries), Complex queries (With Clause, Nested Sub queries, Views)

UNIT-III

Functional Dependency: Trivial and Nontrivial Dependencies, Closure of Set of Functional Dependencies, Attribute closure, Irreducible Set of Functional Dependencies, lossless decomposition, **Normalization**–1NF, 2NF, 3NF and BCNF, Dependency preserved decomposition, Comparison of BCNF and 3NF.

UNIT–IV

Indexing: Basic Concepts, Primary Index, Dense and Sparse Indices, Secondary Indices, Tree-Structured Indexing,

Indexed Sequential Access Method (ISAM), B+Tree Index Files, Hash indices, Bitmap indices. **Transaction Processing:** Concept of transactions and schedules, ACID properties, Conflict-serializability

UNIT-V

Concurrency control: Lock-Based Protocols, Dead lock handling, Timestamp-Based Protocols, Validation-Based Protocols. **Recovery system:** Failure classification, Log based recovery, recovery algorithm, ARIES.

Text Books:

1. Silberschatz, Korth and Sudarshan, "Database System Concepts", 7th Edition, McGraw-Hill, 2021.
2. C.J. Date, "An Introduction to Database Systems", 8th edition, Pearson, 2020,

Suggested Reading:

1. Raghu Ramakrishnan, JohnnesGehrke, "Database Management Systems", 3rd Edition, McGraw Hill, 2014.
2. Elmasri and Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Pubs, 2017.
3. Lemahieu, Broucke and Baesens, "Principles of Database Management", Cambridge University Press, 2018.
4. Krishnan, "Database Management Systems", McGraw Hill.

Online Resources:

1. http://www.nptelvideos.in/2012/11/database-managementsystem.html.

22MTC13

MATHEMATICAL FOUNDATION FOR DATA SCIENCE & SECURITY

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. Able to learn and Analyzing data in Linear and Non-Linear form.
2. Able to fit the hypothetical data using probability distribution.
3. To know the characteristic of various continuous probability distributions.
4. To discuss the testing of hypothesis of sample data.
5. To know the security issues of Cryptography.

Course outcomes: On successful completion of this course the students shall be able to

1. Analyze the coefficient of skewness and fitting of the data by various methods.
2. Apply properties of Mathematical Expectations and analyze the various distributions.
3. Evaluate areas of curves by using various distributions.
4. Apply various tests for testing the significance of sample data.
5. Apply RSA –PKC for solving security issues.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	2	1	1	-
CO2	3	3	2	3	-	-	-	-	-	-	2	1	1	-
CO3	3	3	2	3	-	-	-	-	-	-	2	1	1	-
CO4	3	3	3	3	-	-	-	-	-	-	2	1	1	-
CO5	3	3	2	3	-	-	-	-	-	-	2	1	1	-

UNIT-I: Basic Statistics

Measures of Central Tendency, Measures of Dispersion, Moments (Moments about the mean and moments about a point). Skewness, Karl Pearson's coefficient of skewness and Bowley's coefficient of skewness for frequency distribution, Kurtosis. Correlation, coefficient of correlation, limits of correlation coefficient. Linear Regression, Regression coefficients, Properties of Regression Coefficients. Curve fitting by the Method of Least Squares, Fitting of Straight lines and Exponential curve.

UNIT-II: Mathematical Expectation and Discrete Probability Distribution

Conditional Probability, Baye's theorem. Random variable, discrete random variable, Probability Mass Function, continuous random variable, probability density function. Mathematical expectation, properties of Expectation, properties of variance. Poisson distribution, MGF and Cumulates of the Poisson distribution, Recurrence formula for the probabilities of Poisson distribution (Fitting of Poisson distribution)

UNIT-III: Continuous Probability Distributions

Normal distribution, Characteristics of normal distribution and Normal probability Curve, MGF and CGF of Normal distribution, Areas under normal curve. Uniform distribution, Moment generating function, Mean and Variance of uniform distribution. Exponential distribution, MGF, CGF, Mean and Variance of Exponential distribution.

UNIT-IV: Testing of Hypotheses

Test of significance, null and alternative hypotheses, Errors in sampling, level of significance. Large sample test: Test of significance for single proportion, difference of proportions, single mean and difference of means. Small Sample Tests: T-Test for single mean, differences of Means. F- test for equality of two population variances. Chi-Square test of Goodness of fit.

UNIT-V: Number Theory & CRYPTOGRAPHY (RSA – PKC)

Division Algorithm, Greatest Common Divisor, Euclidean Algorithm, Wilson's Theorem, Euler's Phi-Function, Euler's Theorem, Some Properties of the Phi-Function. The RSA public key cryptosystem, Implementation and

security issues, Pollard's p−1 factorization algorithm, Quadratic Residues and quadratic reciprocity.

Text books:

1. S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.
2. Burton, David M. (2007) Elementary Number Theory (7thedu.). Tata McGraw Hill Edition, Indian Reprint
3. Mathematical Cryptography by Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman Springer Science+ Business Media LLC.

Suggested Reading:

1 .W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, 3rd Ed., Wiley, 1968.
2. Sheldon Ross, "A First Course in Probability", 9th Edition, Pearson publications, 2014.
3. Koshy, T.Elementary Number Theory with Applications, Elsevier Publications, New Delhi, 2002.
4. G.A.Jones & J.M.Jones "Elementary Number Theory", Springer UTM, 2007.

Online Resources:

Course Code	Course Name	Resource Links
22MTC13	Mathematical Foundation for Data Science and Security	1. https://archive.nptel.ac.in/courses/110/107/110107114/ 2. https://archive.nptel.ac.in/courses/111/101/111101137/ (Week 1,2,4,5 &7)

22CAC06N

PRINCIPLES OF ARTIFICIAL INTELLIGENCE LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Programming Basics, Probability and Statistics.

COURSE OBJECTIVES: This course aims to

1. To design and analyze various computing algorithms and techniques using Python.
2. To apply different learning algorithms to solve real time problems.
3. To recognize the underlying mathematical models and logics behind various AI techniques.

COURSE OUTCOMES: On successful completion of the course, students will be able to,

1. Understand the basic components of library environment and installations.
2. Analyze the design heuristics and apply various techniques to solve real world problems.
3. Apply variety of algorithms to solve problems.
4. Identify how to use GitHub and submit back genuine contributions.
5. Implement problems using game search algorithms.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	2	2	1	2
CO2	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	-	3	3	3	3
CO4	2	2	2	-	3	-	2	3	3	3	3	2	2	2
CO5	3	2	3	2	3	-	-	2	-	-	3	3	2	3

Load all the experiments in GitHub Repository

Lab Experiments:

1. Design/construct the workflow of a general AI project using draw.io
2. Implement Water Jug Problem using A* search
3. Implement an 8-puzzle solver using Heuristic search technique.
4. Implement the Constraint Satisfaction problem using backtracking.
5. Implement a program for game search.
6. Implement a Bayesian network from a given data and infer the data from that Bayesian network.
7. Implement a Hidden Markov Model for a given data.
8. Implement a MDP to run value iteration in any environment.
9. Implement a MDP to run policy iteration in any environment.
10. Build a bot to build any game using easy AI libraries

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice **Hall, 2010.**
2. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011.

22CAC07N

INTRODUCTION TO MACHINE LEARNING LAB

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. To make use of Data sets in implementing the machine learning algorithms.
2. To implement the machine learning concepts and algorithms.
3. To use real world data and implement machine learning models.

COURSE OUTCOMES: After completion of this course, students will be able to,

1. Identify the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Identify and utilize modern tools that are useful for data analysis.
3. Recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
4. Implement and evaluate various Machine Learning approaches on real world problems.
5. Apply Keras ,Tensorflow and PyTorch to implement ML techniques and Case studies.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	1	1	3	2	2
CO2	2	2	2	2	3	-	-	-	1	1	2	3	2	2
CO3	2	3	3	3	3	-	-	-	1	2	2	3	2	2
CO4	3	3	3	3	3	-	-	-	2	2	2	3	2	2
CO5	2	2	3	2	3	-	-	-	2	2	2	3	2	2

LIST OF EXPERIMENTS:

1. Identification and Installation of python environment towards the machine learning, installing python modules/Packages Import scikitlearn, keras and tensorflows etc.
2. Implement the Pre-processing with Handling missing values, Detecting and treating outliers.
3. Implement the Data splitting into training, validation, and test sets, k-Fold Cross-validation.
4. Implement the Feature Engineering with Feature selection (filter, wrapper, embedded methods) and also Feature Scaling.
5. Implement Dimensionality Reduction Using Principal Component Analysis (PCA) and Supervised algorithms.
6. To build the Regression Algorithms with Linear Regression, Logistic Regression and Lasso Regression including Error measures: MAE, MSE, RMSE, R^2 Score.
7. Implement the Classification algorithms with Decision Tree, k-Nearest Neighbors (k-NN) and Support Vector Machines (SVM) with Confusion Matrix and performance metrics.
8. Implement the Ensemble Learning with Random Forest, XGBoost and Voting Classifier (Hard and Soft Voting) with performance metrics.
9. Implement the Clustering with K-Means Clustering and Hierarchical Clustering (Agglomerative & Divisive) with evaluation metrics.
10. Implement the Multi-layer Perceptron (MLP) with supervised learning classification algorithms.

TEXT BOOKS:

1. Aurélien Géron ,"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", Third Edition,2019.

ONLINE RESOURCES:

1. http://www.cs.cmu.edu/~tom/
2. http://www.holehouse.org/mlclass/

22CSC13N

DATABASE MANAGEMENT SYSTEMS LAB

Instruction	3 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: This course aims to:

1. Become familiar with the concepts of structured query language.
2. Understand about Programming Language / Structured Query Language (PL/SQL).
3. Learn database constraints, DCL, TCL and advanced SQL commands.
4. Familiarize with cursors, triggers, exceptions, procedures and functions in PL/SQL.

Course Outcomes: Upon completion of this course, students will be able to:

1. Outline the built-in functions of SQL and Create, Alter and Drop table.
2. Demonstrate Queries to retrieve and Change Data using Select, Insert, Delete and Update. Construct Queries using Group By, Order By and Having Clauses.
3. Demonstrate Commit, Rollback, save point commands and formulate the Queries for Creating Views and constraints.
4. Develop queries using Joins, Sub-Queries.
5. Develop PL/SQL code to create stored procedures, functions, cursors and exceptions.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	-	-	-	-	-	-	-	1	2	3	2
CO 2	3	2	2	2	3	-	-	-	-	-	1	3	3	2
CO 3	3	1	2	1	3	-	-	-	-	-	-	3	3	2
CO 4	3	-		2	-	-	-	-	-	-	-	3	3	2
CO 5	3	1	2	1	-	-	-	-	-	-	-	3	3	3

List of Experiments:

1. Queries using Built-In functions, like aggregate functions, String Functions, Numeric Functions, Data Functions, Conversion Functions and other miscellaneous.
2. Queries using DDL and DML statements.
3. Queries using Group By, Order By, Having Clauses and set operations.
4. Queries on Controlling Data: Commit, Rollback and Save point.
5. Queries for Creating, Dropping and Altering Tables, Views and Constraints.
6. Queries using Joins, views and Sub-Queries.
7. Write PL/SQL code using Basic Variables, bind and substitution variables.
8. Write PL/SQL code using Control Structures.
9. Write PL/SQL code using Procedures, Functions.
10. Write PL/SQL code using Cursors, Triggers and Exceptions.

Text Books:

1. "Oracle: The complete Reference", Oracle Press.
2. Nilesh Shah, "Database Systems Using Oracle", PHI, 2007.

Suggested Reading:

1. Rick FVander Lans, "Introduction to SQL", 4th Edition, Pearson Education, 2007.
2. "The Language of SQL (Learning)" by Larry Rockoff.
3. Steven Feuerstein, "Oracle PL/SQL Programming", 6th Edition, O'reilly publications, 2014.

Online Resources:

- https://onlinecourses.nptel.ac.in/noc22_cs91/preview

22CAU01

UPSKILL CERTIFICATION COURSE - I (Need to get from Central Committee)

22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2026-27

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – V

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Durationof SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC08N	PCC	Deep Learning	3	-	-	3	40	60	3
2	22CAC09N	PCC	Full Stack Web Development	2	1	-	3	40	60	3
3	22CSC15N	PCC	Operating Systems	3	-	-	3	40	60	3
4	22*****	PEC	Professional Elective – I	3	-	-	3	40	60	3
5	22*****	OE	Open Elective-I	3	-	-	3	40	60	3
6	22MBC01	HS	Engineering Economics and Accountancy	3	-	-	3	40	60	3
PRACTICAL										
7	22CAC10N	PCC	Deep Learning Lab	-	-	3	3	50	50	1.5
8	22CAC11N	PCC	Full Stack Web Development Lab	-	-	3	3	50	50	1.5
9	22CSC18N	PCC	Operating Systems Lab	-	-	3	3	50	50	1.5
10	22CAI02N		Industrial / Rural Internship-2	3-4 weeks / 90 Hours			-	50	-	2
TOTAL				**17**	**1**	**9**	**-**	**440**	**510**	**24.5**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

PE1 (T) Semester-V		Open Elective-I Semester-V	
22CAE01N	Soft Computing	22CEO01	Infrastructure for Smart Cities
22CAE02N	Knowledge Representation and Reasoning	22ECO02	Remote Sensing & GIS
22CAE03N	Image Processing	22MEO01	Principles of Design Thinking
22CSE08	User Interface and User Experience Design	22MB**	Engineering Leadership
22CSE19	Big Data Analytics		

22CAC08N

DEEP LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Calculus, Probability and Statistics, Python Programming, Machine Learning.

Course Objectives: The objectives of this course are

1. Provide students with a strong foundation in the history, concepts, and mathematical principles of deep learning.
2. Develop students' skills in gradient descent methods and regularization techniques for effective model training.
3. Equip students to design and implement convolutional and recurrent neural network architectures.
4. Enhance students' understanding and application of autoencoders and regularization methods for robust models.
5. Expose students to the latest deep learning models and trends, preparing them for future advancements.

Course Outcomes: On Successful completion of the course, students will be able to,

1. Demonstrate comprehensive understanding of foundational deep learning concepts and neural network architectures.
2. Design and apply sophisticated neural network models to solve complex real-world problems.
3. Utilize diverse training algorithms and optimization methods to enhance deep learning model performance.
4. Implement innovative techniques for model development and regularization to improve generalization and robustness.
5. Investigate and apply recent advancements in deep learning, including transformers and GANs, to stay current in the field.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	1	1	3	-	1
CO2	3	3	2	2	3	1	1	1	1	1	1	2	3	1
CO3	3	3	3	3	3	1	1	1	2	2	2	2	3	1
CO4	3	3	3	3	3	1	1	1	2	2	2	2	3	1
CO5	3	3	3	3	3	1	1	1	2	2	2	1	2	3

UNIT-I

Biological to Artificial Neurons: Biological Neurons, Logical Computations with Neurons, The Perceptron, Multilayer Perceptron (MLP).

Activation functions: Sigmoid, Linear, Tanh, ReLu, Leaky ReLu, Softmax. **Loss functions:** Loss Function Notation, Loss Functions for Regression, Loss Functions for Classification, Loss Functions for Reconstruction. **Weight initialization functions**: Glorot, He, LeCun. Fine-Tuning Neural Network Hyper parameters.

UNIT-II

Optimizers: Gradient Descent (GD), Momentum based Gradient Descent, Nesterov Accelerated Gradient, AdaGrad, RMSProp, Adam.

The Vanishing/Exploding Gradients Problems: Batch Normalization, Gradient Clipping.

Avoiding Overfitting through Regularization: $\ell 1$ and $\ell 2$ Regularization, Dropout, Dataset augmentation, early stopping.

UNIT-III

Convolutional Neural Networks: Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling,

Pre-trained models: Introduction, LeNet. AlexNet, VGG16, GoogLeNet, ResNet50.

UNIT-IV

Recurrent Neural Networks (RNN): Introduction, Neural Networks without Hidden States, Recurrent Neural Networks with Hidden States, Converting Raw Text into Sequence Data, Backpropagation Through time, Long Short-Term Memory (LSTM), Gated Recurrent UNITs (GRU), Bidirectional RNN, Encoder-Decoder Architecture, Attention Mechanism.

Unit-V

Transformers: The Transformer Architecture, Transformers for Vision (ViT), Bidirectional Encoder Representations from Transformers (BERT) models.

Generative Adversarial Networks (GANs): Introduction, Generator, Discriminator, Training, Applications.

Text Books:

1. Goodfellow. I., Bengio. Y. and Courville. A., "Deep Learning ", MIT Press, 2016.
2. Rothman, Denis, "Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more", Packt Publishing Ltd, 2021.
3. Ganguly Kuntal, "Learning generative adversarial networks: next-generation deep learning simplified", Packt Publishing, 2017

Suggested Reading:

1. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006. ISBN 978-0-387-31073-2
3. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
4. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
5. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004. David Marr, Vision, 1982.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85/

22CAC09N

FULL STACK WEB DEVELOPMENT

Instruction	2L+1T Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basics of Programming.

Course Objectives: This course aims to

1. Create responsive web pages using HTML, CSS, Bootstrap, and JavaScript.
2. Develop dynamic front-end applications using React and understand agile development basics.
3. Build full-stack applications using Node.js, Express, and MongoDB for data handling.

Course Outcomes: Upon successful completion of this course, students will be able to

1. Design responsive web pages using HTML, CSS, and Bootstrap.
2. Develop interactive client-side features using JavaScript and AJAX.
3. Build single-page applications with React and its core features.
4. Create backend services using Node.js and Express.js.
5. Perform CRUD operations and schema design using MongoDB.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	1	-	2	2	-	2	-	1	-
CO2	3	2	3	1	3	-	-	2	2	-	3	-	2	1
CO3	3	3	3	2	3	-	-	2	2	1	3	-	2	2
CO4	3	2	3	2	3	-	-	2	1	2	3	1	2	3
CO5	3	3	3	2	3	-	-	1	1	1	3	2	3	2

UNIT-I

Introduction to Full Stack Development: HTML 5.0: Introduction to basic HTML tags, HTML DOM, Working with Images, Tables, Lists, Forms, Layout elements, Usage of span and div tags for layout structuring.

Introduction to Cascading Style Sheets (CSS): Types of CSS (Inline, Internal, External), CSS Selectors, CSS BOX Model.

Bootstrap 5: Introduction to Bootstrap framework, usage of container and container-fluid classes, grid system, UI components such as carousel, buttons, tables, forms, alerts, images, tabs/pills, navbar, and modals.

UNIT-II

JavaScript: Data types and type conversion, handling events. Object-Oriented Programming in JavaScript, use of regular expressions.

AJAX: Introduction to AJAX, working with XMLHttpRequest and the Fetch API, JSON data,sending and receiving JSON data asynchronously, and handling server responses in the browser.

UNIT-III

ReactJS: Introduction to React JS, using JSX syntax, comparison of actual DOM vs React's Virtual DOM (VDOM). Creating and managing functional components, understanding state and props, handling events, useState and useEffect hooks,React Router, Handling user inputs with controlled forms and form validation.

Angular: Introduction to Angular and Angular CLI, creating and managing Angular components and templates. Data binding: property binding and event binding.

UNIT-IV

Node.js: Introduction to Node.js and the Node Package Manager (npm). Working with Node.js modules, creating a basic web server, and understanding the request-response cycle. Working with the file system to read and write files asynchronously.

Introduction to event-driven architecture: EventEmitter class, creating custom events, and extending the EventEmitter class. Handling common I/O operations and implementing basic middleware.

UNIT-V

Express.js: Introduction to the Express.js framework for server-side application development. Routing and handling GET and POST requests, middleware functions, creating and using custom middleware, and serving static files. Using templating engines like EJS or Pug for dynamic content rendering.

MongoDB: Introduction to NoSQL databases, comparison of JSON and BSON data formats, working with MongoDB data types. CRUD operations (Create, Read, Update, Delete), schema design.

Textbooks:

1. Jon Duckett, “HTML and CSS: Design and Build Websites”, Wiley India, 1st Edition, 2011.
2. Eric Freeman, “Head First HTML and CSS”, O'Reilly Media, 2nd Edition, 2012.
3. Ethan Brown, “Web Development with Node and Express”, O'Reilly Media, 1st Edition, 2014.
4. Brad Traversy, “Modern JavaScript From The Beginning”, Traversy Media, Online Course/Edition, 2020.

Online Resources:

1. MDN Web Docs: https://developer.mozilla.org/
2. W3Schools: https://www.w3schools.com/
3. React Official Docs: https://reactjs.org/
4. Angular Official Docs: https://angular.io/
5. Node.js Official Site: https://nodejs.org/
6. Express.js Docs: https://expressjs.com/
7. MongoDB Manual: https://docs.mongodb.com/

22CSC15N

OPERATING SYSTEMS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture and Programming Fundamentals.

Course Objectives:

This course aims to:

1. Understand the basic concepts and design of an operating system.
2. Interpret the structure and organization of the file system.
3. Learn Inter Process Communication mechanisms and memory management approaches.
4. Explore cloud infrastructures and technologies.

Course Outcomes:

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

1. Understand the basics of Operating systems and its major components.
2. Illustrate the concepts related to process management.
3. Distinguish various memory management techniques.
4. Apply concepts of process synchronization and deadlocks to a given situation.
5. Evaluate various file allocation methods and security as well as recovery features in the designing Operating system.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	-	3	1	-	-	-	-	-	-	2	2	1
CO3	3	3	2	1	1	-	-	-	-	-	-	1	2	-
CO4	3	3	1	3	-	-	-	-	-	-	-	1	2	1
CO5	3	3	2	3	1	-	-	-	-	-	-	1	2	3

UNIT-I

Introduction to Operating Systems: Computer System overview, Components of a computer system, functions of OS, Examples and different types of OS (RTOS vs. desktop vs. mobile etc.), OS distributions and versions.

OS architectures: Micro-kernel, Layered, Kernel Approaches and examples, Linux/Unix OS Design and architecture overview.

UNIT-II

Process management: Program vs. process, process states, Process Control Block (PCB), OS services and system calls (fork, wait, exec, getpid, getppid etc.), system calls vs. System programs, Process scheduling- Process context switching, scheduling algorithms, scheduling criteria.

Process management in Unix/Linux. Inter Process Communication: Linux IPC Mechanisms, RPC, RPC exception handling and Security issues.

UNIT-III

Memory Management: Memory view of a process, Process memory usage requirements, virtual and physical memory related system calls (mmap, munmap, sbrk, mprotect). Address translation mechanisms static mapping, segmentation, paging, page faults, page replacement algorithms, page sharing, read/write permissions, swapping.

Memory management in Linux/Unix. Secondary Memory Management: Disk structure, disk scheduling, disk management, buffering, swap space management.

UNIT-IV

Concurrency and Synchronization: Introduction to threads, benefits, types and thread APIs, Synchronization, issues, hardware and software solutions for synchronization, Classical problems of synchronization.

Deadlocks: Introduction, necessary conditions for deadlock occurrence, RAG, deadlock handling mechanisms - prevention, avoidance and recovery.

UNIT-V

File Systems: File concepts, file types, allocation and organization methods, file handling system calls, File system metadata, directory structure, caching optimizations, File Systems case study.

OS Security and Defence: Types of threats in OS, basic security mechanisms, malware taxonomy, viruses, worms, and rootkits, logging, auditing, and recovery.

Text Books:

1. Galvin, Silberschatz, "Operating system Concepts", 10th Edition, John Wiley & Sons, 2018.
2. William Stallings, "Operating Systems Internals and Design Principles" Pearson Edition, 2012.

Suggested Reading:

1. Ekta Walia Khanna, "Operating System Concepts", 2nd Edition, Publishing House, 2019.
2. W. Richard Stevens, Stephen A. Rago, "Advanced Programming in the UNIX® Environment", 3rd Edition, Pearson Education India; 2013.
3. Maurice J. Bach, "Design of the UNIX Operating System", 1st Edition, Pearson Education India, 2015.

Online Resources:

1. Remzi H. Arpaci-Dusseau and Andrea C. , "Three Easy Pieces", Arpaci-Dusseau Arpaci-Dusseau Books, LLC https://pages.cs.wisc.edu/~remzi/OSTEP/ (online version).
2. Frans Kaashoek, Robert Morris, and Russ Cox, Xv6, a simple Unix-like teaching operating system [T4-R] https://github.com/mit-pdos/xv6-riscv (RISC-V version) [T4-X] https://github.com/mit- pdos/xv6-public (x86 version).

22CAE01N

SOFT COMPUTING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Artificial Intelligence & Machine Learning

Course Objectives:

1. Acquire the fundamental knowledge in soft computing.
2. Understand the basics of fuzzy sets and fuzzy logic rules.
3. Discuss the basics of genetic algorithms
4. Analyze the fundamentals of artificial neural network models.

Course Outcomes:

After completion of the course, students will be able to

1. Identify artificial intelligence and soft computing techniques in building intelligent machines.
2. Apply fuzzy logic and reasoning to handle uncertainty.
3. Understand different operators and basic terminologies of genetic algorithms
4. Understand the concept of artificial neural networks.
5. Evaluate different soft computing techniques for suitable applications.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	2	-	-	-	1	-	1	2	1	2	1
CO2	2	3	2	2	-	-	-	1	-	2	-	1	3	1
CO3	2	1	1	2	-	-	-	1	-	1	-	2	2	1
CO4	2	1	1	2	-	-	-	1	-	2	-	1	1	-
CO5	2	1	2	2	-	1	-	1	1	2	2	-	2	3

UNIT-I:

Introduction to Soft Computing: Introduction, Hard Computing vs Soft Computing, Soft Computing Constituents, Machine Learning Basics: Supervised, Unsupervised and Reinforcement Learning.

Introduction to Fuzzy Logic: Classical Sets (Crisp Sets) Theory: Basic Definitions and Terminology, Operations, Properties, Crisp Relations and Operations, Fuzzy Sets Theory: Operations, Fuzzy Relations and compositions, Types of Membership Functions, Features.

UNIT-II:

Fuzzy Logic and Inference rules: Introduction, Classical Logic, Multi-valued Logic, Fuzzy Logic, Fuzzy Propositions, Inference Rules for Fuzzy Propositions.

Fuzzy Inference Systems: Introduction, Fuzzy Inference System (Fuzzification, Defuzzification), Types of Fuzzy Inference Engines and its Implementation, Neuro Fuzzy System.

UNIT-II:

Introduction to Evolutionary Computing: Biological Evolutionary Process, Paradigms, Strategies, Evolutionary Programming, Advantages and applications**.**

Genetic Algorithm Process: GA Introduction, Selection, Encoding of Genetic Operators, Classification of GA, Applications, Advantages and Disadvantages of GA.

UNIT-IV:

Single Layer Feed Forward Neural Networks: Introduction, Biological Neurons, Artificial Neural Networks, ANN Model, Single Layer Feed forward Neural Network, Applications of NN.

Multi-Layer Feed Forward Neural Networks: Architecture, Learning Methods, Backpropagation Method, Design Issues of ANN, and Applications.

UNIT-V:

Radial Basis Function Neural Networks (RBNF): RBNF Introduction, Architecture, Learning, Comparison of RBNF and FFNN(Feed Forward Neural Networks), and Applications.

Recurrent Neural Networks: RNN Architecture and Training, Hopfield Networks, Self-Organizing Neural Networks.

Text Books:

1. Saroj Kaushik, Sunita Tiwari, Soft Computing Fundamentals, Techniques and Applications, McGraw Hill, 2018.

Reference Books:

1. Elaine Rich, Kevin Knight and Shivashankar B.Nair, Artificial Intelligence, 3rd Edition TMH, 2009, rp2017.
2. Jyh:Shing Roger Jang, Chuen:Tsai Sun and Eiji Mizutani, Neuro Fuzzy and Soft Computing, Prentice Hall of India/PHI, 2003.
3. Amit Konar, Artificial Intelligence and Soft Computing- Behavioural and Cognitive Modelling of the Human Brain, CRC press, 1st Edition, Taylor and Francis Group, 1999.
4. Hung T Nguyen and Elbert A Walker, A first course in Fuzzy Logic, CRC Press, 3rd Edition, Taylor and Francis Group, 2006.
5. Fakhreddine Karray and Clarence D Silva, Soft Computing and Intelligent System Design, Pearson Edition, 2004.

Online Resources:

1. http://www.myreaders.info/html/soft_computing.html.
2. https://onlinecourses.nptel.ac.in/noc22_cs54/preview

22CAE02N

KNOWLEDGE REPRESENTATIONS AND REASONING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MFDS

Objectives:

1. To understand the key concepts of knowledge representation and reasoning.
2. To explore the role of logic in knowledge representation.
3. To study ontology and its categories, including philosophical background and top-level categories.
4. To learn about knowledge representations, including knowledge engineering and representing structure in frames.
5. To examine processes, including times, events, situations, and computation, in knowledge representation.

Course Outcomes:

1. Ability to explain the key concepts of knowledge representation and reasoning.
2. Proficiency in representing knowledge in logic and understanding different varieties of logic.
3. Understanding of ontology, including ontological categories and how to describe physical entities and define abstractions.
4. Competence in representing knowledge structures in frames, rules, and data.
5. Ability to apply knowledge representation techniques to address real-world problems involving vagueness, uncertainty, and randomness

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	1	1	1	1	2	1
CO2	3	3	2	2	3	1	1	1	1	1	1	1	3	2
CO3	3	2	2	3	2	1	2	1	1	1	2	1	3	1
CO4	3	3	3	3	3	2	2	1	1	1	2	2	3	3
CO5	3	3	3	3	3	2	2	1	1	1	2	2	3	3

UNIT I:

The Key Concepts: Knowledge, Representation, Reasoning, why knowledge representation and reasoning, Role of logic

Logic: Historical background, representing knowledge in logic, Varieties of logic, Name, Type, Measures, Unity Amidst diversity

UNIT II:

Ontology: Ontological categories, Philosophical background, Top-level categories, Describing physical entities, Defining abstractions, Sets, Collections, Types and Categories, Space and Time

UNIT III:

Knowledge Representations: Knowledge Engineering, Representing structure in frames, Rules and data, Object-oriented systems, Natural language Semantics, Levels of representation

UNIT IV:

Processes: Times, Events and Situations, Classification of processes, Procedures, Processes and Histories, Concurrent processes, Computation, Constraint satisfaction

Change Contexts: Syntax of contexts, Semantics of contexts, First-order reasoning in contexts, Modal reasoning in contexts, Encapsulating objects in contexts.

UNIT V:

Knowledge Soup: Vagueness, Uncertainty, Randomness and Ignorance, Limitations of logic, Fuzzy logic, Nonmonotonic Logic, Theories, Models and the world

Semiotics Knowledge Acquisition and Sharing: Sharing Ontologies, Conceptual schema, Accommodating multiple paradigms, Relating different knowledge representations, Language patterns, Tools for knowledge acquisition

Text Books:

1. Knowledge Representation logical, Philosophical, and Computational Foundations by John F. Sowa, Thomson Learning.
2. Knowledge Representation and Reasoning by Ronald J. Brachman, Hector J. Levesque, Elsevier.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106140/

22CAE03N

IMAGE PROCESSING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Signal Processing.

Course Objectives: The objectives of this course are
1. To introduce basics of visual perception, sampling, quantization and representation of Digital images.
2. To introduce spatial domain and frequency domain filtering techniques necessary for Image processing operations.
3. To learn advanced image analysis techniques such as image restoration, image Compression, image segmentation.
4. To learn techniques of multi resolution methods, wavelets and morphological Processing.
5. To understand the applications of image processing

Course Outcomes: After completion of course, students would be able to:
1. Understand the basic image enhancement techniques in spatial & frequency domains.
2. Understand the basics of multi-resolution techniques.
3. Understand the basics of segmentation methods.
4. Apply this concept for image handling in various fields.
5. Knowledge about Morphological operations.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	1	1	1	1	1	2	-
CO2	3	2	2	2	3	1	1	1	1	1	1	1	2	1
CO3	3	2	2	2	3	1	1	1	1	1	1	2	1	-
CO4	3	2	3	3	3	2	1	1	2	2	2	2	3	1
CO5	3	2	2	2	3	1	1	1	1	1	1	2	2	-

UNIT-I
Fundamentals of Image Processing: Introduction, , fundamental steps, components, , , image sensing and acquisition, image sampling and quantization, basic relationships between pixels. Intensity Transformations and Spatial Filtering: Background, some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods.

UNIT-II
Filtering in the Frequency Domain: Background, preliminary concepts, sampling and Fourier transform of sampled functions, discrete Fourier transform (DFT) of one variable, extension to functions of two variables, some properties of the 2-D discrete Fourier transform, basics of filtering in the frequency domain, image smoothing, image sharpening, homo- morphic filtering.

UNIT-III
Image Restoration: Noise models, restoration in the presence of noise only-spatial filtering, periodic noise reduction by frequency domain filtering, linear degradation, position-invariant degradation, estimating the degradation function, inverse filtering, minimum mean square error filtering, constrained least squares filtering, geometric mean filter.

UNIT-IV
Wavelets and Multi Resolution Processing: Background, multi-resolution expansions, wavelet transforms in one dimension, the fast wavelet transform, wavelet transforms in two dimensions, wavelet packets. Image Compression: Fundamentals, image compression models, , lossy compression,.

UNIT-V
Image Segmentation: Fundamentals, point, line and edge detection, thresholding, region-based segmentation,

segmentation using morphological watersheds, the use of motion in segmentation. Morphological Image Processing: Preliminaries, erosion and dilation, opening and closing, the Hit-or-Miss transformation, some basic morphological algorithms, some basic gray-scale morphological algorithms.

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, PHI Learning Pvt. Limited, 3rd Edition, 2008.
2. Rafael C.Gonzalez, Richard E.Woods and Steven L.Eddins, Digital Image Processing Using MATLAB,2nd Edition, McGraw Hill, 2010.

Suggested Reading:

1. AL. Bovik, The Essential Guide to Image processing, 2 nd Edition, Elsevier, 2009.
2. Anil K.Jain, "Fundamentals of Digital Image Processing", PHI, 2006.
3. William K. Pratt, Digital Image Processing, John Wiley & Sons, Inc., 3rd Edition, 2001

Online Resources:

1. https://www.youtube.com/watch?v=DSGHkvQBMbs&list=PLuv3GM6-gsE08DuaC6pFUvFaDZ7EnWGX8
2. https://archive.nptel.ac.in/courses/117/105/117105135/

22CSE08

USER INTERFACE AND USER EXPERIENCE DESIGN
(Professional Elective – I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Fundamental Computer Skills, Knowledge of Web Technologies.

Course Objectives:
This course aims to:
1. Familiarize students with the fundamental principles and concepts of user interface (UI) and user experience (UX) design.
2. Equip students with the practical skills and knowledge necessary to design effective UI/UX interfaces.
3. Understand the importance of applying user-centered design methods throughout the design process.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Apply user-centered design principles to create interfaces that meet the needs and preferences of target users.
2. Demonstrate proficiency in designing intuitive user interfaces that are easy to navigate and understand.
3. Develop the skills to create wireframes, prototypes, and mockups using industry-standard design tools.
4. Gain an understanding of accessibility guidelines and principles, designing interfaces that are accessible to users with disabilities.
5. Identify emerging trends and technologies in UI/UX design.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	-	2
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	-	1
CO 3	2	3	3	3	3	2	-	3	3	3	3	3	-	1
CO 4	3	3	3	3	3	3	-	3	3	3	3	3	-	2
CO 5	3	3	1	2	2	1	-	3	3	1	-	3	2	2

UNIT - I
Introduction to UI/UX Design: Understanding UI/UX Design: Definition and importance of UI/UX design, Difference between UI and UX, Roles and responsibilities of UI/UX designers, Overview of the design process. **User-Centered Design Principles:** Principles of user-centered design, User research methods (interviews, surveys and observations), Creating user personas and scenarios, Conducting user journey mapping exercises.

UNIT – II
Design Fundamentals: Basic principles of visual design (layout, typography, color),Gestalt principles and their application in UI design, Applying visual hierarchy to improve user experience.
Introduction to design tools (Sketch, Figma, Adobe XD) Interaction Design: Principles of interaction design, Designing effective navigation systems, Feedback mechanisms and user affordances Prototyping techniques for interaction design

UNIT - III
Usability and User Testing: Understanding usability principles, Nielsen's heuristics for user interface design, conducting heuristic evaluations of UI designs, Usability testing methods (moderated vs. unmoderated, remote testing)
User Testing and Feedback: Planning and conducting usability tests, Analyzing usability test results incorporating user feedback into UI design iterations, Best practices for iterative design and testing cycles

UNIT - IV
Accessibility in UI/UX Design: Understanding accessibility guidelines (WCAG), Designing accessible interfaces

for users with disabilities, Assistive technologies and their impact on UI/UX design.
Emotional Design and Engagement: Principles of emotional design, creating emotionally engaging user experiences, Strategies for enhancing user engagement and retention, Case studies of emotionally successful UI/UX designs.

UNIT - V
Responsive and Mobile Design: Principles of responsive web design, Mobile-first design approach, Adapting layouts and content for different screen sizes, Testing and debugging responsive designs.
Designing for Mobile Platforms: Mobile UI design patterns and conventions, Navigation and interaction patterns for mobile apps, Challenges and best practices for designing mobile interfaces, Introduction to mobile prototyping tools (InVision, Marvel)

Text Books:

1. Krug, S. Don't Make Me Think, Rider publication,2006
2. Don Norman , "The Design of Everyday Things", Published by Basic Books,2013

Suggested Reading:

1. Jim K. Design Basics Index, How books,2010.
2. Lidwell, W., Holden, K. and Butler, J. Universal Principles of Design, Rockport Publishers,2010.

Online Resources:
1. User Interface Design - Course (nptel.ac.in)
2. Introduction to User Experience Design Course (Georgia Tech) | Coursera

22CSE19

BIG DATA ANALYTICS
(Professional Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Proficiency in python programming, Database fundamentals

Course Objectives:

This course aims to:

1. Introduce the importance of Big Data and the role of the Hadoop framework in analyzing large datasets.
2. Gain practical knowledge in working with Hadoop ecosystem tools such as MapReduce,pig,hive,Spark.
3. Provide hands-on experience in using Spark for real-time stream processing.

Course Outcomes:

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

1. Define and describe the types, characteristics, and challenges of Big Data and the need for its analysis.
2. Analyze the differences between traditional systems and Hadoop, and explain the functions of core components like HDFS and YARN.
3. Develop MapReduce programs and analyze different join strategies and pipeline models for big data processing.
4. Design and execute queries using Hive and Pig to extract, transform, and analyze large datasets.
5. Implement scalable data processing applications using Apache Spark and evaluate its performance over traditional frameworks

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	3	1	3	3	3	-	3	3	2	3	3	3	2
CO 2	3	3	3	3	3	2	-	3	3	2	3	3	3	2
CO 3	3	3	3	3	3	2	-	3	3	2	3	3	1	2
CO 4	3	3	3	3	3	2	-	3	3	2	3	3	2	2
CO 5	3	3	3	3	3	3	-	3	3	2	3	3	2	2

UNIT-I

Introduction to Big Data: Data and its types: Unstructured, Semi-structured, Structured – Sources of data – Evolution and Definition of Big Data – Characteristics(3Vs/5Vs) and Challenges – Need for Big Data, , Big data integration process, Applications.Overview of Business Intelligence, Data Science, Analytics – Typical analytical architecture – Types of Analytics (Descriptive, Predictive, Prescriptive)

UNIT-II

Hadoop Ecosystem: Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system (SQL, RDBMS) - Core ccomponents of Hadoop – Architecture -Hadoop 1 vs Hadoop 2 – HDFS operations, Data ingestion layer, ETL and ELT, Ingestion tools in Hadoop ecosystem, Data ingestion types.

UNIT-III

Big Data Frame Works: Hadoop Frame Work: Introduction to MapReduce, Processing data with Hadoop using MapReduce, Map Reduce Programming: I/O formats, Map side join-Reduce Side Join, Secondary Sorting-Pipelining MapReduce jobs.Introduction to YARN, Architecture, Managing Resources and Applications with Hadoop YARN.

UNIT-IV

Hive and Pig: Introduction to Hive: What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF).

Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Data types in Pig, Running Pig, Execution

Modes of Pig, HDFS Commands, Relational Operators, Eval Function, Complex Data Types, Piggy Bank, User Defined Function, Pig Vs Hive.

UNIT-V

Apache Spark Frame Work: Introduction to Apache spark-Design principles, Advantages and Disadvantages, Layered architecture, Programming with RDDs: Create RDD- Spark operations - transformations, actions-DAG in Apache spark. Case Study: Analyze student academic data to find trends, subject difficulty levels, and top performers using big data tools.

Text Books:

1. S. Chandramouli, 'Big Data Analytics', University press,2024 edition.
2. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley India Pvt. Ltd., 2016.

Suggested reading:

1. Tom White, 'Hadoop: The Definitive Guide', 4th Edition, O'Reilly Media Inc, 2015.
2. Thilinagunarathne, 'Hadoop MapReduce v2 Cookbook', 2nd Edition, Packet Publishing, 2015.
3. Chuck Lam, Mark Davis, Ajit Gaddam, 'Hadoop in Action', Manning Publications, 2016.
4. Alan Gates, 'Programming Pig', O'Reilly Media Inc, 2011.

Online resources:

1. http://www.planetcassandra.org/what-is-nosql
2. http://www.iitr.ac.in/media/facspace/patelfec/16Bit/index.html
3. https://class.coursera.org/datasci-001/lecture
4. http://bigdatauniversity.com

22CEO01

INFRASTRUCTURE FOR SMART CITIES
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: To enable the students to

1. Comprehend the Necessity of Infrastructural Development for Smart Cities.
2. Illustrate the Components and Planning Aspects of a Smart City.
3. Outline Smart Transportation Systems for Smart Cities.
4. Summarize the Significance of Disaster Resilient Infrastructure in Smart Cities.
5. Review Policies and Implementation of Smart Cities at National and Global Perspectives.

Course Outcomes: At the end of the course, Student will be able to

1. Understand the necessity of infrastructural development for smart cities.
2. Illustrate the components and planning aspects of a smart city.
3. Outline smart transportation systems for smart cities.
4. Summarize the significance of disaster resilient infrastructure in smart cities.
5. Review policies and implementation of smart cities at national and global perspective.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	-	-	-	-	1	-	-	-	-	-	-	2	-
CO 2	2	-	-	-	-	1	-	-	-	-	-	2	2	-
CO 3	2	-	-	-	3	1	-	-	-	-	-	2	3	1
CO 4	2	3	-	-	3	1	-	-	-	-	-	1	2	1
CO 5	2	-	-	-	-	1	-	-	-	-	3	-	1	2

UNIT I

Fundamental of smart city & Infrastructure: Introduction of Smart City, Concept of smart city, Objective for smart cities. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems, Infrastructures need assessment

UNIT II

Planning and development of Smart city Infrastructure: Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security.

UNIT III

Intelligent transport systems: Connected vehicles, autonomous vehicles, GPS, Navigation system, traffic safety management, mobility services, E-ticketing.

UNIT IV

Disaster resilient Infrastructure: Electricity, sanitation and water supply systems, fire hazard management, earthquake resilient structures, ICT tools.

UNIT V

Infrastructure Management: System and Policy for Smart city, integrated infrastructure management systems, worldwide policies for smart city, Government of India - policy for smart city, Smart cities in India, Case studies of smart cities.

Text Books:

1. John S. Pipkin, Mark E. La Gory, Judith R. Balu (Editors); “Remaking the city: Social science perspective on urban design”; State University of New York Press, Albany (ISBN: 0-87395-678-8)
2. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science

References:

1. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science.
2. Mission statement &guidelines on Smart City Scheme". Government of India - Ministry of Urban Development http://smartcities.gov.in/upload/uploadfiles/files/Smart City Guidelines (1).pdf
3. Grig N.S., Infrastructure engineering and management, Wiley-Interseience, 1988 5. Hudson W.R., Haas R., Uddin W., Infrastructure Management, McGraw-Hill, 1997.

E Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ar12/preview
2. http://acl.digimat.in/nptel/courses/video/105105160/L01.html

22ECO02

REMOTE SENSING AND GIS
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Prerequisite: Basic knowledge of Geography is required

Course Objectives: This course is aims to:

1. Explain the fundamental concepts of remote sensing and digital imaging techniques.
2. Make the students to understand the principles of thermal and microwave remote sensing.
3. Make the students understand the significance of GIS and the process of GIS.

Course Outcomes: Upon completion of this course, students will be able to:

1. Demonstrate the understanding of basic concepts of remote sensing and interpreting energy interactions.
2. Choose an appropriate technique for a given scenario by appreciating the types of remote sensing.
3. Distinguish the principle behind the working of microwave and LiDAR sensing.
4. Apply Microwave remote sensing techniques
5. Explain the procedure for encoding data and geospatial data analysis.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 2	3	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 3	2	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 4	2	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 5	3	1	1	1	-	1	1	-	1	-	2	1	1	1

UNIT-I
Concept of Remote Sensing: Remote sensing definition, data, process, EM bands used in remote sensing, Interactions and recording of energy: interaction with atmosphere, interaction with earth surface features (soil, water, vegetation), recording of energy by sensors, Transmission, reception and processing, Image interpretation and analysis, Applications, Advantages, and limitations of Remote sensing.

UNIT-II
Digital Imaging: Types of Remote sensing, Sensor resolutions, Digital Image, Sensor components, Principle of a long-track and across-track scanning, Hyperspectral Imaging, Thermal Remote Sensing.

UNIT-III
Microwave Remote Sensing: Active and Passive Microwave Remote Sensing, Radar Imaging: Key components of imaging radar, viewing geometry, spatial resolution, principle of RAR, SAR and their range resolution, Satellite Radar Imaging, LIDAR.

UNIT-IV
Concept of Geographic Information Systems: Key components of GIS, joining spatial and attribute data, functions, advantages and applications of GIS, Spatial data model, Raster data model, Vector data model.

UNIT-V
Process of GIS and Geospatial analysis: Data sources, encoding raster data, encoding vector data, encoding attribute data, linking spatial and attribute data, Geospatial data analysis methods database query, geospatial measurement, overlay operations, network analysis and surface analysis. Integration of GIS and remote sensing.

Text Books:

1. Basudeb Bhatta, “Remote Sensing and GIS”, 2/e, Oxford University Press, 2012.
2. Lillesand T.M., and Kiefer R.W. “Remote Sensing and Image Interpretation”, 6/e, John Wiley &Sons, 2000.

Suggested Reading:

1. James B. Campbell and Randolph H. Wynne, “Introduction to Remote Sensing”, the Guilford Press, 2011.
2. Michael N DeMers, “Fundamentals of GIS”, 2/e, John Wiley, 2008.

22MEO01

PRINCIPLES OF DESIGN THINKING
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Prerequisite: Nil

Course Objectives:
This course aims to:
1. Create awareness of design thinking approaches.
2. Identify a systematic approach for defining/identifying a problem.
3. Create design thinking teams and conduct design thinking sessions collaborativel
4. Apply both critical thinking and design thinking in parallel to solve problems.
5. Motivate to apply design thinking concepts to their real life scenarios.

Course Outcomes:
Upon completion of this course, the students are able to:
1. Understand design thinking and its phases as a tool of innovation.
2. Empathize on the needs of the users.
3. Define the problems for stimulating ideation.
4. Ideate on problems to propose solutions by working as a design thinking team.
5. Prototype and test the proposed solutions focusing on local or global societal problems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
CO 2	1	1	2	1	2	2	2	2	1	2	2	2	2	2
CO 3	1	1	2	2	1	2	2	2	1	2	2	2	2	3
CO 4	2	1	2	2	1	2	2	2	1	2	2	2	2	3
CO 5	2	1	2	2	1	2	2	2	1	2	2	2	2	3

UNIT – I
Introduction to Engineering & Thinking: Engineering for social and economic development; impact of science/engineering. Thinking and behaviour; Types of thinking – Linear thinking, lateral thinking, systems thinking, design thinking.
Introduction to Design Thinking: Importance of Design Thinking & Human centric approach – Phases in design thinking process, five-stage model as iterative method, applications of design thinking in various domains.

UNIT – II
Empathize phase: Understanding the unique needs of the user, empathize with the users, steps in empathize phase, developing empathy towards people, assuming a beginner's mind-set (what? why?), steps in immersion activity, body storming; Case studies.

UNIT – III
Define phase: Define the problem and interpret the result, analysis and synthesis, Personas – Four different perspectives on Personas, steps to creating personas, problem statement, affinity diagrams, empathy mapping; Point of View – "How might we" questions, Why-how laddering; Case studies.

UNIT – IV
Ideation phase: What is ideation, need, uses, ideation methods; Brainstorming, rules for brainstorming; Mind maps, guidelines to create mind maps; Ideation games; Six Thinking Hats; Doodling, use of doodling in expressing creative ideas; Case studies.

UNIT – V

Prototyping phase: Types of prototyping, guidelines for prototyping, storytelling, characteristics of good stories, reaching users through stories, importance of prototyping in design thinking; Value proposition, guidelines to write value proposition; Case studies.

Testing phase: Necessity to test, user feedback, conducting a user test, guidelines for planning a test, how to test, desirable, feasible and viable solutions, iterate phase.

Text Books:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires, 1st Edition, HarperCollins, 2009.
2. Michael Luchs, Scott Swan, Abbie Griffin, Design thinking: New product development essentials from the PDMA. John Wiley & Sons, 2015.
3. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solv ing, Penguin Random House India Private Limited, 2020.

Suggested Reading:

1. Jeanne Liedtka, Andrew King, Kevin Bennett, Solving problems with design thinking: Ten stories of what works. Columbia University Press, 2013.
2. Bala Ramadurai, Karmic Design Thinking - A Buddhism-Inspired Method to Help Create Human-Centered Products & Services, Edition 1, 2020.

22MB***

ENGINEERING LEADERSHIP
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives:

This course aims to:

1. To develop an understanding of the basics of Leadership and Leadership Behaviour.
2. To introduce them the concepts of Adaptive Leadership and Decision making as a Leader.
3. To discuss the importance and components of Change and Cross-Cultures in the Global era.

Course Outcomes:

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

1. Apply the knowledge of behaviour and effectiveness of Leadership in real time situations.
2. Understand the dynamics of Situations and Adaptive Leadership and its importance in leading.
3. Appraise the process of Decision Making and Empowerment and Leading in the Global Era.
4. Develop understanding towards dealing with Change, Power and Influence Tactics.
5. Interpret and Improve in cross-Cultural Management and Leadership Skills.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	-	1	1	1	-	1	2	1	1	-	-	1	-
CO 2	1	2	2	2	-	1	-	2	2	2	1	-	1	-
CO 3	1	1	2	2	1	-	1	1	1	2	-	1	2	1
CO 4	-	2	1	2	2	1	1	2	2	2	1	2	1	-
CO 5	-	1	1	1	1	2	1	2	2	2	1	1	2	1

Unit - I

Nature and Behaviour of leadership: Definitions of Leadership-Indicators of Leadership Effectiveness-Research Methods for Studying Leadership effectiveness-important Types of Leadership Behaviour-Specific Task Oriented Leader Behaviours- Specific Relations Oriented Leader Behaviours.

Unit - II

The leadership Situation and Adaptive Leadership: Different ways Situations affect Leaders-Stewart Model of Situational Determinants-Other Situational Determinants of Leader Behaviour-Guidelines for Coping with Demands and Constraints-Early Contingency theories of Effective Leader Behaviour-Guidelines for flexible, Adaptive Leadership.

Unit - III

Decision Making and Empowerment by Leaders: Decision making- Participative Leadership-Normative Decision Model-Guidelines for Participative Leadership-Delegation-Guidelines for Delegating-Psychological Empowerment-Empowerment Programs-Benefits of Empowering Leadership and Programs.

Unit - IV

Dealing with Change, Power and Influence Tactics: Types of Change in Teams and Organizations-Change Processes-Reasons for Accepting or Rejecting Change-implementing Change-guidelines for Implementing Change-How Visions influence change-Sources of Power-How Power is gained or lost-consequences of Power-Guidelines for using Power-Influence Tactics and Outcomes-Types of Proactive Influence Tactics-Power and influence Behaviour-Effectiveness of Proactive Tactics-guidelines for using Proactive Influence Tactics.

Unit - V

Developing Cross-Cultural Leadership and Skills of Leadership: Cross-Cultural and Global Leadership-Cultural Values and Leadership-Guidelines for Global Leadership-Gender and Leadership-Leadership Training Programs-Learning from Experience-Developmental Activities-Facilitating Leadership Development-Systems Perspective on Leadership Development.

Text Books:

1. Gary Yukl, William L. Gardner and Nishant Uppal, "Leadership in Organizations", Pearson Education, 9th Edition, 2019.
2. Keow Ngang Tang, "Leadership and Change Management", Springer – First Edition, 2019.
3. Patrick Dawson, Constantin Andriopoulos "Managing Change, Creativity and Innovation", Sage Publications ltd., 2nd Edition, 2014.
4. Lee R Beach, "Leadership and the Art of Change", Sage Publications ltd.,1st Edition, 2005.

Suggested Readings:

1. Ranjana Mittal, Leadership Personal Effectiveness and Team building, Vikas Publictaions, 2015
2. Peter G. Northhouse, Leadership Theory and Practice, Sage Publications, 2011.
3. Barbara Senior, Jocelyne Fleming, Organizational Change, 3e, Pearson publications, 2010
4. Mark Hughes, Managing Change, Universities Press, 2011.

Alfranch Nahavandi, The Art and science of Leadership, 7e, Pearson, 2018

22MBC01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

COURSE OUTCOMES: After Completion of the Course, Student will be able to:

1. Apply fundamental knowledge of Managerial Economics Concepts and Tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make the best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decisions based on any technique.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	3	1	1	1	-	1	1	1	-	2	1	-
CO 2	2	2	2	2	-	1	-	1	-	1	-	-	3	
CO 3	1	2	1	2	2	1	-	1	-	1	-	-	2	-
CO 4	2	2	1	2	2	1	-	3	-	1	-	-	2	1
CO 5	1	3	1	2	1	1	-	-	-	1	2	-	1	3

UNIT-I

Introduction to Managerial Economics

Introduction to Economics and Its Evolution - Managerial Economics - Its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic Concepts of Managerial Economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equi-Marginal Principle, Contribution, Negotiation Principle.

UNIT-II

Demand and Supply Analysis

Demand Analysis - Concept of Demand, Determinants, Law of Demand – Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple Numerical Problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

UNIT-III

Production and Cost Analysis

Theory of Production - Production function - Isoquants and Iso-costs, MRTS, Input - Output Relations; Laws of Returns. Cost Analysis: Cost Concepts – Types of Costs, Cost - Output Relationship – Short Run and Long Run; Market Structures – Types of Competition, Features of Perfect Competition, Price Output Determination under Perfect Competition, Features of Monopoly Competition, Price Output Determination under Monopoly Competition. Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

UNIT-IV

Accountancy

Book-keeping, Principles and Significance of Double Entry Bookkeeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Ledger Accounts, Trial Balance Concept and preparation of Final Accounts with Simple Adjustments.

UNIT-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and Sources of raising Finance. Capital Budgeting, Methods: Traditional and

Discounted Cash Flow Methods - Numerical Problems.

TEXT BOOKS:

1. Mehta P.L., ”Managerial Economics: Analysis, Problems and Cases”, Sultan Chand & Son’s Educationalpublishers, 2016.
2. Maheswari S.N. “Introduction to Accountancy”, Vikas Publishing House, 12th Edition, 2018.

SUGGESTED READINGS:

1. Panday I.M. “Financial Management”, 11th edition, Vikas Publishing House, 2016.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of IndiaPvt Ltd, 2007.
4. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2018

22CAC10N

DEEP LEARNING LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Artificial Intelligence, Machine Learning.

Course Objectives: The objectives of this course are

1. Understand basic concepts of Deep learning and their applications.
2. Evaluating Deep learning methods, models and algorithms.
3. Analyzing CNN, RNN, Transformers and GAN along with their applications.

Course Outcomes: On Successful completion of the course, students will be able to

1. Evaluate the performance of various optimization techniques used in deep learning.
2. Analyze various Autoencoders and Regularization Techniques.
3. Design and Develop various Convolution Neural Networks architectures.
4. Analyze various RNNs and Encoder Decoder Models.
5. Understand the importance of Transformers and GANs to develop real-time applications.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	2	2	3	1	1	2	1	1	1	1	2	3
CO 2	3	3	2	2	3	1	1	2	1	1	1	1	3	1
CO 3	3	3	3	3	3	1	1	2	1	1	1	3	1	1
CO 4	3	3	3	3	3	1	1	2	1	1	1	2	3	1
CO 5	3	3	3	3	3	1	1	2	1	1	1	1	2	1

List of Experiments:

1. Implementation of Perceptron for Boolean operations.
2. Implementation of Classification and regression problems with Multilayer Perceptron.
3. Compare the Performance of various Optimization techniques of Momentum Based GD, Stochastic GD, Adam.
4. Implementation of Denoising autoencoders.
5. Implementation of Regularization through L2, Dropout, and Early stopping Techniques and compare their Performance.
6. Implementation of VGG16, ResNet50 and compare their performance.
7. Implementation of LSTM for next word prediction.
8. Implementation of Encoder Decoder Models for Language translation.
9. Implementation of pretrained BERT Models.
10. Implementation of GANs for generating fake images.

Text Books:

1. Goodfellow. I., Bengio. Y. and Courville. A., "Deep Learning ", MIT Press, 2016.
2. Learning Generative Adversarial Networks: Next-generation deep learning simplified by Kuntal Ganguly, Packt, 2017
3. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
4. Hands-On Computer Vision with TensorFlow 2: Leverage deep learning to create powerful image processing apps with TensorFlow by Benjamin Planche, Eliot Andres, Packt Publishers, 2019
5. Huang, Shih-Chia, and Trung-Hieu Le. Principles and labs for deep learning. Academic Press, 2021.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85/

22CAC11N

FULL STACK WEB DEVELOPMENT LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives : This course aims to

1. Gain hands-on experience in designing modern web pages using HTML5, CSS3, and JavaScript.
2. Develop dynamic front-end applications using React and Angular fundamentals.
3. Integrate and test backend services using Node.js, Express, and MongoDB.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Explain the structure and behavior of web interfaces
2. Apply ReactJS and Angular to develop front-end applications
3. Analyze external APIs and logic for interactive UI
4. Evaluate REST APIs using Node.js and Express
5. Design and implement MongoDB for full stack applications

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	1	2	1	-	2	2	1	2	2	2	2
CO 2	3	3	3	2	3	1	1	2	2	2	3	3	3	2
CO 3	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO 4	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO 5	3	3	3	3	3	2	1	2	2	2	3	3	3	3

LIST OF EXPERIMENTS

1. Create a personal portfolio site with HTML5, CSS Grid, and Flexbox layout principles.
2. Develop a JavaScript quiz app with a timer and scoring system using DOM manipulation.
3. Design a responsive blog template using Bootstrap 5 components and utilities.
4. Build a weather forecast dashboard using JavaScript fetch API to consume a public weather API.
5. Create a multi-page site using React Router including home, about, and contact pages.
6. Develop a basic ToDo app using React Hooks (useState, useEffect) and local storage.
7. Build a contact form with validation using Angular 16 reactive forms (intro-level Angular usage).
8. Create a RESTful API for book management using Express.js and test with Postman.
9. Implement MongoDB aggregation to summarize student grades, with schema design.
10. Develop a full stack MERN app: Student registration form (React) connected to Express + MongoDB backend, deployed on local server.

Text Books:

1. Jon Duckett, *HTML and CSS: Design and Build Websites*, Wiley India, 1st Edition, 2011.
2. Valeri Karpov, *Professional JavaScript for Web Developers*, Wiley, 4th Edition, 2020.
3. Ethan Brown, *Web Development with Node and Express*, O'Reilly Media, 1st Edition, 2014.

Suggested Reading:

1. Brad Traversy, Modern Full Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker, Packt Publishing, 1st Edition, 2021.
2. Kristina Chodorow, *MongoDB: The Definitive Guide*, O'Reilly Media, 3rd Edition, 2019.

Web Resources:

1. https://developer.mozilla.org
2. https://reactjs.org/docs
3. https://angular.io/docs
4. https://nodejs.org/en/docs
5. https://www.mongodb.com/docs/
6. https://getbootstrap.com/docs/5.0/getting-started/introduction/

22CSC18N

OPERATING SYSTEMS LAB

Instruction	3 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Operating systems, Programming for problem solving.

Course Objectives: This course aims to:

1. Explore Unix/Linux operating system.theory
2. Analyze various system calls available in Linux/Unix.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand Linux/Unix environment.
2. Identify and interpret various system programs.
3. Understand and implement shell programming.
4. Simulate memory management, file allocation techniques and process schedules.
5. Analyze process and file management system calls by creating and/or modifying concurrent programs.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	2	-	1	2	1	2	2	2	-	2	1	1	-
CO 2	-	1	1	-	2	2	2	2	2	1	2	1	2	-
CO 3	1	1	1	-	1	2	2	1	2	2	1	1	3	1
CO 4	1	2	2	2	2	1	1	1	1	2	2	1	2	1
CO 5	1	1	-	2	2	1	1	2	2	1	2	1	1	1

List of Experiments: (Implement the following experiments in C Programming Langugage)

1. Demonstration of Linux/Unix file related system calls: mkdir, link, unlink, mount, unmount, users+, chown, chmod, open, close, read, write, lseek, stat, sync.
2. Demonstration of Linux/Unix process related system calls: fork, wait, exec, exit, getpid, getuid, setuid brk, nice, sleep.
3. Shell programming.
4. Implement CPU scheduling algorithms (a) Round Robin (b) SJF (c) FCFS.
5. Implement page replacement algorithms (a) FIFO (b) LRU.
6. Programs to illustrate threads.
7. Demonstration of GNU/Linux IPC mechanisms- Pipes, Semaphores, Shared memory, Message Queues.
8. Implementation of Classical Problems for synchronization (Dining philosopher problem and Producer-Consumer problem).
9. Implementation of Bankers algorithm for Deadlock detection and avoidance.
10. Implementation of Linked, Indexed and Contiguous file allocation methods.

Text Books:

1. Galvin, Silberschatz, "Operating System Concepts", 10th Edition, John Wiley & Sons, 2018.
2. Dhananjay Dhamdhare, "Operating Systems-A Concept Based Approach", 3rd Edition, McGraw Hill Education, 2017.

Suggested Reading:

1. Ekta Walia, "Operating System Concepts", Khanna Book Publishing, 2020.
2. William Stallings, "Operating Systems Internals and Design Principles", Pearson Ed., 2012.
3. Charles Crowley, "Operating Systems –A Design Oriented Approach", McGraw Hill Education, 2017.
4. Andrew S. Tanenbaum, Albert S Woodhull, "Operating systems Design and Implementation", Pearson Ed., 2009.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs88/preview
2. https://onlinecourses.swayam2.ac.in/aic20_sp05/preview

22CAI02N

INDUSTRIAL / RURAL INTERNSHIP-2

Instruction / Demonstration / Training	3-4 Weeks / 90 Hours
Duration of Semester End Presentation	-
Semester End Evaluation	-
Continuous Internal Evaluation	50 Marks
Credits	2

Prerequisite : Knowledge of Basics Sciences and Engineering Science

COURSE OBJECTIVES :

This course aims to:

1. Expose students to industrial environments, contemporary technologies, and real-world work conditions.
2. Enhance students' technical and managerial skills through practical learning opportunities and interaction with industry professionals and society.
3. Develop awareness of current technological trends, engineering responsibilities, and professional ethics relevant to their domain.

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Learn new technologies and solve real time projects.
2. Expose to the industrial environment problems and technologies
3. Gain knowledge on contemporary technologies industrial requirements.
4. Identify , Design and Develop solutions for real world problems
5. Communicate their ideas and learning experiences through reports and presentation.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	2	3	1	2	1	2	2	2	2	2	2	2
CO 2	2	2	2	1	1	2	1	2	1	2	2	2	2	2
CO 3	3	2	1	2	2	2	1	2	1	2	2	2	2	2
CO 4	1	3	3	3	1	2	1	2	3	2	2	2	2	2
CO 5	1	1	1	1	1	1	-	2	3	2	1	2	2	2

PROCESS TO BE FOLLOWED FOR CARRYING OUT INSTRUCTIONS TO STUDENTS:

1. Students may apply for internships through the AICTE Portal or through CDC of the institute by filling the application form IAP-101.
2. Industry shall scrutinize the students based on their criteria and communicate a provisional offer or confirmation letter to the student.
3. If students apply through CDC, then CDC shall nominate the students for various opportunities accordingly by issuing NOC (IAP-104).
4. The respective head of the department shall assign a faculty mentor.
5. Student shall undergo internship/industrial training at the concerned Industry/Organization by submitting the form, IAP-103.
6. During the internship, Faculty Mentor will evaluate the performance of students twice either by visiting the Industry/Organization or through obtaining periodic reports from students.
7. Student shall submit internship report to the industry/organization at the end of internship program.
8. On successful completion of the Internship, Industry/Organization shall issue Internship Certificate to the students
9. All the students should maintain discipline, professional ethics and follow the health and safety precautions during internship

Student shall maintain diary during the internship and submit the internship report at the end of the internship. The report will be evaluated by the supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Evaluation of Internship: The internship of the students will be evaluated in three stages:

1. Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
2. Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks)
3. Evaluation through seminar presentation/Viva-Voce at the Institute(This can be reflected through marks assigned by Faculty Mentor (25 marks)

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2026-27

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – VI

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Durationof SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC12N	PCC	Data Communication and Computer Networks	3	1	-	3	40	60	4
2	22CAC13N	PCC	Automata and Compiler Design	3	1	-	3	40	60	4
3	22CAC14N	PCC	Natural Language Processing	3	-	-	3	40	60	3
4	22*****	PEC	Professional Elective – II	3	-	-	3	40	60	3
5	22MTC18	PCC	Quantum Computing for Machine Learning	3	-	-	3	40	60	3
6	22EEM01		Universal Human Values-II: Understanding Harmony	-	1	-	-	50	-	1
PRACTICAL										
7	22CAC15N	PCC	Natural Language Processing Lab	-	-	3	3	50	50	1.5
8	22EGC03	BS	Employability Skills	-	-	2	3	50	50	1
9	22CAC16N		Mini Project	-	1	2	-	50	-	2
10	22CAU02		Upskill Certification Course-II	-			-	25	-	0.5
TOTAL				**15**	**4**	**7**	**-**	**425**	**400**	**23**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

PE2(T) Semester-VI	
22CAE04N	Data and Visual Analytics using AI
22CAE05N	Advanced Machine Learning
22CSE21	Extended Reality
22CSE09N	High Performance Computing
22CIE51N	Industrial Internet of Things

22CAC12N

DATA COMMUNICATION AND COMPUTER NETWORKS

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Programming for problem solving, basic knowledge of logic circuits and application in digital system.

Course Objectives: The objectives of this course are,

1. To understand the principles of data communication and organization of computer networks,
2. To analyze various routing protocols and congestion control algorithms.
3. To study the functions of the transport layer and to understand application layer protocols.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Describe the communication protocol suites like ISO-OSI and TCP/IP.
2. Illustrate and explain Data link layer protocols.
3. Distinguish the internet protocols like IP, ARP, ICMP, IGMP, routing protocols and DHCP.
4. Understand the transport protocols like TCP, UDP, RTCP and Congestion control Algorithms.
5. Summarize Application layer protocols like HTTP, DNS, FTP and Firewalls.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	-	-	-	-	1	1	2	2	2
CO 2	3	3	2	1	3	-	-	-	1	1	1	2	1	2
CO 3	3	3	2	1	3	-	-	-	1	1	1	3	2	3
CO 4	3	3	2	2	3	-	-	-	-	1	2	3	2	3
CO 5	2	2	2	1	3	1	1	-	2	2	2	2	3	2

UNIT - I

Introduction: Data communication, network types and models, TCP/IP and OSI Protocol Suite, transmission impairment, transmission modes, Transmission media (wired and wireless) and switching.

UNIT - II

Data Link Layer: Design issues, error detection and correction, elementary data link protocols, sliding window protocols, HDLC, multiple access protocols.

LAN: Wired LAN, wireless LAN, connecting devices and Virtual LAN.

UNIT - III

Network Layer: Network layer design issues, routing algorithms, congestion control algorithms, Quality of service, IPV4, IPV6, network layer protocols: ARP, RARP, ICMP, IGMP and DHCP.

UNIT - IV

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), quality of service.

UNIT - V

Application Layer: DNS, DDNS, SMTP, POP, IMAP, SSH, SFTP, WWW, HTTP, SNMP, Firewalls.

Text Books:

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw Hill, Fifth Edition,
2. 2017.
3. S. Tanenbaum, "Computer Networks", Pearson Education, Fifth Edition, 2013.
4. William Stallings, “Data and Computer Communication”, Eighth Edition, Pearson Education, 2007.

Suggested Reading:

1. Larry L.Peterson, Peter S. Davie, “Computer Networks”, Elsevier, Fifth Edition, 2012.
2. James F. Kurose, Keith W. Ross, “Computer Networking: A Top–Down Approach Featuring the Internet”, Pearson Education, 2005.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105081/
2. https://nptel.ac.in/courses/106/106/106106091/

22CAC13N

AUTOMATA & COMPILER DESIGN

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

1. Understand the central concepts of automata theory, including finite automata and their variants such as deterministic and nondeterministic finite automata.
2. Explore context-free grammars, parse trees, and pushdown automata, discerning their role in formal language theory and their equivalence with context-free grammars.
3. Analyze Turing machines and their relation to computability, recognizing the significance of undecidable problems in theoretical computer science.
4. Familiarize with the structure of a compiler and its phases, with a specific emphasis on lexical analysis and syntax analysis techniques.
5. Understand syntax-directed translation and its applications, including the generation of intermediate code and syntax-directed translation schemes.
6. Gain proficiency in designing run-time environments and mastering code generation principles. They'll also acquire knowledge of machine-independent optimizations, equipping them to design efficient compilers and runtime systems.

Course Outcomes:

Upon completing this course, students will be able to:

1. Solve computational problems using finite automata and regular expressions, including pattern matching, lexical analysis, and language recognition.
2. Develop a strong understanding of context-free grammars, pushdown automata, Turing machines, and undecidability, recognizing their importance in theoretical computer science and computational modeling.
3. Gain skills in designing and constructing compilers, focusing on lexical analysis, syntax analysis, and top-down parsing, to translate source code into executable machine instructions.
4. Master bottom-up parsing, syntax-directed translation, and intermediate-code generation to design and implement sophisticated compilers for translating high-level programming languages.
5. Learn run-time environment management, code generation, and machine-independent optimizations to design and implement high-performance compilers that generate efficient machine code across various architectures.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	-	-	-	-	2	-	1	-	-	2	1
CO 2	3	-	-	3	3	-	-	-	-	-	-	2	-	1
CO 3	-	3	3	-	-	2	3	-	-	-	-	2	-	-
CO 4	-	-	3	3	-	2	-	-	1	-	-	2	-	-
CO 5	-	-	3	3	-	-	-	-	1	1	-	2	-	-

UNIT-I

Automata: Introduction, The Central Concepts of Automata Theory, Chomsky Hierarchy of languages.

Finite Automata: Definition, Applications, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA) – Equivalence of Deterministic and Nondeterministic Finite Automata, Finite Automata with Epsilon-Transitions- Eliminating Epsilon-Transitions.

Regular Expressions and Languages: Definition, applications; Finite Automata and Regular Expressions – Converting Regular Expressions to Automata, Converting DFA's to Regular Expressions. Properties of Regular Languages - Pumping Lemma.**(Proofs Omitted)**

UNIT-II

Context-Free Grammars and Languages: Context free grammar, derivation trees, right most and left most derivation of strings, Ambiguity in context free grammars, minimization of context free grammars, Chomsky normal form, Greibach normal form, pumping lemma for context free languages.

Pushdown Automata(PDA): Definition ,Languages of a PDA, Eauivalent of PDA's and CFG's, DPDA.

Turing Machines: Definition, Types of Turing Machines, Turing Machines problems, Post's Correspondence

Problem, Chomsky hierarchy of languages.**(Proofs Omitted)**

UNIT-III

Introduction to Compilers: Definition of compiler, interpreter and its differences, The structure of a compiler – Phases of compiler, pass and phases of translation.

Lexical Analysis: The Role of the Lexical Analyzer, Specification and Recognition of Tokens, bootstrapping, The Lexical-Analyzer Generator Lex.

Syntax Analysis / Parsing: Introduction,Top-Down Parsing method, Recursive-Descent Parsing, FIRST and FOLLOW, LL (1) Grammars, Nonrecursive Predictive Parsing.

UNIT-IV

Bottom-Up Parsing: Reductions, Handle Pruning, Shift-Reduce Parsing, Introduction to LR Parsing - Simple LR, More Powerful LR Parsers - CLR Parser and LALR Parser. Parser Generators - Yacc

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax Directed Translation, Syntax-Directed Translation Schemes.

Intermediate-Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Type Checking.

UNIT-V

Run – Time Environments: Storage Organization, Stack Allocation, Heap Management.

Code - Optimization: The Principal Sources of Optimization, Basic Blocks and Flow Graphs, Optimization of Basic Blocks,Loop Optimizations.

Code Generation: Object code forms, Issues in the Design of a Code Generator, A Simple Code Generator, Peephole Optimization.

TEXT BOOKS:

1. Introduction to Automata Theory, Languages, and Computation, 3nd Edition, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
2. Compilers: Principles, Techniques & Tools, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffry D. Ullman, 2nd Edition, Pearson.

SUGGESTED READING:

1. Introduction to Formal languages Automata Theory and Computation, Kamala Krithivasan, Rama R, Pearson.
2. Kenneth C Louden, Thomson, "Compiler Construction Principles and Practice", PWS Publishing 1st edition.

NPTEL Resources:

1. Theory of Automata and Formal Languages, IIT Guwahati
   https://nptel.ac.in/courses/106103070
2. Theory of Automata, Formal Languages and Computation, IIT Madras
   https://nptel.ac.in/courses/106106049
3. Formal Languages and Automata Theory, IIT Guwahati
   https://nptel.ac.in/courses/111103016
4. NOC: Introduction to Automata, Languages and Computation, IIT Kharagpur
   https://nptel.ac.in/courses/106105196
5. Principles of Compiler Design, IISc Bangalore
   https://nptel.ac.in/courses/106108113
6. Compiler Design, IISc Bangalore
   https://nptel.ac.in/courses/106108052
7. Compiler Design, IIT Madras
   https://nptel.ac.in/courses/106106237
8. NOC: Compiler Design, IIT Kharagpur
   https://nptel.ac.in/courses/106105190

22CAC14N

NATURAL LANGUAGE PROCESSING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. Understand various Natural Language Processing Fundamentals.
2. Understand probabilistic NLP and classification of text using Python's NLTK Library
3. Understand various text representations and labelling techniques.
4. Understand various NLP models and named entities.
5. Learn RNN for NLP.
6. Understand usage of GRU and LSTM models for translation.
7. Understand various applications of NLP.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand the fundamentals of Natural Language Processing, manipulate and analyse language data.
2. Demonstrate key concepts from NLP, text representation and linguistics to describe and analyse language.
3. Demonstrate the word embedded techniques and classification of the text.
4. Make use of the Deep learning and Transformers for NLP.
5. Develop NLP applications using appropriate NLP tools and techniques.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO 2	2	2	3	2	2	2	2	2	2	3	2	2	3	2
CO 3	2	2	3	2	2	2	2	2	2	3	2	3	3	3
CO 4	2	3	2	2	2	2	2	2	2	2	2	3	3	3
CO 5	2	2	3	2	2	2	2	2	2	3	2	3	3	3

Unit-I: Introduction to NLP: Definition, History, NLP in the real world, Approaches to NLP, NLP Pipeline. Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency, Computing with Language: Simple Statistics.

Unit-II: Basic Vectorization approaches of Text Representation: One-Hot Encoding, Bag of Words, Bag of N-Gram, TF-IDF; Neural language models, N-gram language model.
Processing Raw Text: Accessing Text from the Web and from Disk, Text Processing with Unicode.
Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging.

Unit-III: Word Embedding's: Distributed universal text and handcrafted feature Representations, Count Vector, Frequency based Embedding, Prediction based Embedding, Word2Vec and Glove.
Learning to Classify Text: Supervised Classification and Text classification with Machine learning algorithms.

UNIT-IV: Deep learning for NLP: RNN for language model, Sequence Labelling and Sequence Classification, Encoder-Decoder with RNNs, GRUs and LSTMs for machine translation, Convolutional neural networks for sentence classification and Evolution metrics for NLP.
Transformers for NLP: Attention, Transformers and BERT.

UNIT-V: Case Study on NLP: Sentiment analysis, Machine translation, Question-answering based systems, Topic modelling, Text Generation and Summarization.

Text Books / Suggested Reading:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. O‟Reily,2009.
2. Deep Learning for Natural Language Processing Develop Deep Learning Models for Natural Language in Python (Jason Brownlee), Machine Learning Mastery,2017.
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf - Natural Language Processing with Transformers_ Building Language Applications with Hugging Face-O'Reilly Media (2022).
4. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019.
5. Sudharsan Ravichandiran ,Getting Started with Google BERT Build and train state-of-the-art natural language processing models using BERT.

Online Resources:

1. https://models.quantumstat.com/
2. https://www.coursera.org/learn/attention-models-in-nlp
3. https://github.com/keon/awesome-nlp

22CAE04N

DATA AND VISUAL ANALYTICS USING AI
(Professional Elective-II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Fundamentals of Data Science, Mathematical Foundation for Data Science & Security.

Course Objectives: The objectives of this course are

1. To develop design literacy for crafting effective, aesthetic, and ethical data visualizations.
2. To foster logical reasoning and problem-solving through exploration of high-dimensional and noisy datasets.
3. To master state-of-the-art data visualization tools and AI-driven analytics techniques.
4. To stimulate creative thinking through interactive dashboards and storytelling-based projects.
5. To apply computational thinking to real-world domains using dynamic, scalable, and interpretable visual solutions.

Course Outcomes: On Successful completion of the course, students will be able to

1. Identify suitable visual encoding techniques and perceptual guidelines based on data types and user goals
2. Analyze, preprocess, and transform raw data for meaningful visualization using Python and AI methods.
3. Apply dimensionality reduction, clustering, and other ML algorithms for exploratory visual analytics.
4. Design interactive dashboards with visual storytelling for real-world datasets using modern tools.
5. Build real-time, scalable analytics systems using APIs, streaming data, and visualization frameworks.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	2	1	1	1	1	2	1	2	1	1
CO 2	3	3	3	3	3	1	1	1	1	2	2	3	2	2
CO 3	3	3	3	3	3	2	1	2	2	2	2	3	2	2
CO 4	3	2	3	3	3	2	2	1	3	3	2	3	3	2
CO 5	3	3	3	3	3	2	2	2	3	3	3	3	3	3

UNIT - I: Foundations of Visualization & Creative Design Thinking : Purpose and principles of visualization,Human visual perception: Gestalt laws, preattentive attributes,Data types: categorical, time-series, multivariate, hierarchical, geographical,Design principles: alignment, contrast, color theory, hierarchy,Visualization tools overview: Tableau, Power BI, Python (Matplotlib, Seaborn), Looker Studio,Re-design of misleading graphs using ethical guidelines

UNIT - II: Data Wrangling and Visual Encoding Logics : Data cleaning, joining, reshaping with Pandas,Visual encodings: position, shape, color, motion,Graphical integrity, lie factors, ethics in design,Visual grammar: ggplot, Altair, Vega-Lite basics,Case study on transforming a raw dataset into visual insights

UNIT – III: Exploratory AI Techniques for Visual Analysis: Dimensionality reduction: PCA, t-SNE, UMAP,Clustering: K-Means, DBSCAN,Correlation and heatmaps, scatter matrix,Visualization of classification/regression models,Feature importance and SHAP explanations

UNIT – IV: Interactive Dashboards, Real-Time Streams & Storytelling : Designing dashboards: filters, KPIs, layout,Real-time data visualization using APIs/streaming,Storytelling with data: narrative + visuals,Tools: Streamlit, Dash, Power BI, Google Looker Studio,Case study: live data dashboard for public data (e.g., air quality, COVID)

UNIT – V: Network, Geospatial, and Text Visual Analytics : Graph/network visualization: centrality, clustering,Social data analysis: influencer detection, hashtag mapping,Geospatial visualization: choropleth maps, heat maps using Folium,Text visualization: word clouds, sentiment, topic modeling using NLTK/spaCy Applications in public policy, marketing, and healthcare

Textbooks:

1. **Tamara Munzner**, *Visualization Analysis and Design*, CRC Press, 2014. ISBN: 9781466508910.
2. **Claus O. Wilke**, *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, O'Reilly Media, 2019. ISBN: 9781492031086.

References:

1. **Nathan Yau**, *Data Points: Visualization That Means Something*, Wiley, 2013. ISBN: 9781118462195.
2. **Jeffrey Heer, Mike Bostock, and Vadim Ogievetsky**, *Interactive Data Visualization for the Web*, 2nd Edition, O'Reilly Media, 2014. ISBN: 9781491921289
3. **Alberto Cairo**, *The Truthful Art: Data, Charts, and Maps for Communication*, New Riders, 2016. ISBN: 9780321934079

Online Resources:

1. **Data Visualization**
   https://nptel.ac.in/courses/106106224
2. **Visual Analytics for Decision Making**
   https://nptel.ac.in/courses/106106215
3. **Introduction to Data Analytics**
   https://nptel.ac.in/courses/110106064
4. **Data Science for Engineers**
   https://nptel.ac.in/courses/106106179
5. **Applied Machine Learning**
   https://nptel.ac.in/courses/106106202

22CAE05N

ADVANCED MACHINE LEARNING

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Probability theory, Machine Learning

Course Objectives: The objectives of this course are to

1. Understand the need for Machine Learning
2. Study various machine learning techniques and its applications
3. Design solutions for real world problems using machine learning techniques.

Course Outcomes: On Successful completion of the course, students will be able to

1. Define the concepts related to Advanced Machine Learning.
2. Recognize the underlying mathematical relationships across ML algorithms and their paradigms.
3. Determine the various applications of Machine Learning.
4. Model, design and develop solutions to real world problems using Advanced Machine Learning Algorithms.
5. Evaluate and interpret the results of the various Advanced machine learning tools.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	-	3	2	2	2	2	3	1	1	2
CO 2	2	3	2	2	-	3	2	2	2	2	3	2	2	2
CO 3	2	3	3	2	-	3	3	3	2	3	3	2	3	2
CO 4	2	2	3	3	-	2	2	3	2	3	3	2	3	2
CO 5	2	2	3	3	-	2	2	2	3	2	3	3	2	2

UNIT-I

Introduction to Advanced Machine Learning:

Introduction, Categories of Machine Learning, Ensemble Learning, Meta Learning, Representation Learning, and Multi-Modal Machine learning.

Mathematical Representation: Matrix Analysis: Eigen analysis and Probability: Exponential family of distribution.

UNIT-II

High-Dimensional Machine Learning: Curse of Dimensionality, Parametric and Non-Parametric High-Dimensional Regression and Classification.

Kernel Methods: Common Kernel Functions and Kernel SVM for classification and regression.

Bayesian Representation: Core Concepts of Bayesian Representation, Bayesian Inference Techniques

UNIT-III

Graph Machine Learning:

Graph as a Universal Data Structure, Laplacian Matrix, Smoothness, Graph Construction, Learning from Data, Graph-based ML Algorithms(Semi-supervised, Supervised and Unsupervised), and Graph Regularization.

UNIT -IV

Multi-Modal Machine Learning (MMML)

Fundamentals of Multi-Modal Learning, Core Challenges in MMML, Fusion Techniques(Early, Late, Intermediate and Hybrid Fusions) , Model Architectures for MMML.

UNIT–V

AutoML and MLOps : Frameworks, Architectures, Pipelines, and Concepts. Case Studies and Industrial Applications.

Text Books:

1. Giuseppe Bonaccorso, “Advanced Machine Learning Algorithms”, 3nd Edition, Packt.

2. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. MIT Press, 2021.
3. "Multimodal Machine Learning: Techniques and Applications" by Paul Pu Liang, Louis-Philippe Morency, Ruslan Salakhutdinov, and Barnabás Póczos – CMU lecture-based textbook, released in 2022.

Suggested Reading:

1. Tom Mitchel "Machine Learning", Tata McGraW Hill, 2017.
2. John Hopcroft and Ravi Kannan, Foundations of Data Science, Hind Book Agency, TRIM Series, (2014).
3. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The Elements of Statistical Learning, Springer series in statistics, 2001.
4. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. MIT Press, 2021.
5. Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. Mathematics For Machine Learning. Cambridge University Press, 2020.
6. Koller, Daphne, and Nir Friedman. Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
7. Boumal, Nicolas. "An Introduction to Optimization on Smooth Manifolds." Available online, Aug (2020).
8. Laurence Moroney," AI and Machine Learning for Coders", O'Reilly Media,October 2020.
9. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing Company, 2020.
10. M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press; First Edition,2024.
11. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

OnlineResources:

1. Introduction to Advanced Machine Learning: https://www.youtube.com/watch?v=r4sgKrRL2Ys&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77 and https://onlinecourses.nptel.ac.in/noc23_cs18/preview

22CSE09N

HIGH PERFORMANCE COMPUTING

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture, Computer Networks Operating Systems

Course Objectives: This course aims to:

1. Understand the relevance of High performance computing, architectures and various computational models.
2. Learn basic of Open MP.
3. Learn basics of GPU.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the significance of High Performance Computing and HPC Architecture, Systems and Technologies.
2. Apply models and methodologies for parallel programming and application development.
3. Describe the message passing interface concepts.
4. Explain the architecture of GPU and Edge Computing on SoC.
5. Describe about high performance storage technologies.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	1	2	1	-	-	-	1	-	-	-	1	-
CO 2	2	2	3	1	1	-	-	-	1	-	-	1	3	1
CO 3	2	1	1	1	1	-	-	-	1	-	-	-	2	-
CO 4	2	1	2	1	1	-	-	1	1	2	-	-	2	-
CO 5	2	2	-	2	1	-	-	-	1	2	1	-	2	-

UNIT – I

Introduction – High Performance Computing Disciplines, impact of supercomputing on science, society and security; anatomy of a super computer, compute performance, a brief history of Supercomputing.

UNIT - II

HPC Architecture, Systems and Technologies: Key properties of HPC, Architecture, Parallel architecture families, Flynn's taxonomy, enabling technology, Van Neumann sequential processors, vector and pipelining, Single instruction Multiple Data Array, Multiprocessors, Heterogeneous computer structures. Commodity Clusters: Hardware architecture, Programming interfaces, Software environments.

UNIT – III

Symmetric Multiprocessor Architecture: Architecture overview, Amdahl's Law Plus, Processor Core architecture, memory hierarchy, PCI Bus, external interfaces. OpenMP: Overview of OpenMP programming model, parallel threads and loops, synchronization, reduction.

UNIT-IV

Distributed memory parallel Programming with MPI: Message passing interface standards, MPI basics, communicators, point-to-point messages, synchronization collectives, communication collectives, non-blocking point-to-point communication, user-defined data types.

UNIT – V

Accelerator Architecture: Historic perspective, introduction to Graphics Processing Units, evolution of GPU functionality, modern GPU architecture, heterogeneous system architecture, introduction to System on Chip SoC), HPC on SoC, types of SoC, Edge Computing, High Performance on Edge devices. Mass Storage: Brief history of storage, storage device technology, aggregated storage, high performance storage, all flash/SSD.

Text Books:

1. Thomas Sterling, Mathew Anderson, "High Performance Computing: Modern Systems and Practices", 1st Edition, Morgan Kaufman Publishers, 2017

Suggested Reading:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science Series, 2011.
2. Charles Severance, Kevin Dowd, "High Performance Computing", OpenStx CNX, 2021.

Online References:

1. https://nptel.ac.in/courses/106108055.

https://prace-ri.eu/wp-content/uploads/Edge-Computing-An-Overview-of-Framework-and-Applications.pdf.

22CSE21

EXTENDED REALITY
(Professional Elective-II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basic knowledge on computer hardware and software components.

Course Objectives: This course aims to:

1. To understand immersive technology current state of development for designing and developing immersive experiences.
2. To understand the sensory, emotional and narrative immersion for best practice user interface and experience design.
3. To understand the intersection of AI and VR/XR, looking at how AI is being used to improve everything from graphics rendering to user interaction.
4. To understand the applications of VR/XR in healthcare, discussing the latest research, challenges and opportunities for healthcare professionals.
5. To understand the design principles that guide the creation of immersive experiences, from 3D modelling to user interface design.

Course Outcomes: Upon completion of this course, students will be able to:

1. Define and explain principles in immersive technology for designing and developing immersive experiences.
2. Explain the sensory, emotional and narrative immersion for best practice user interface and experience design.
3. Model and create intersection of AI and VR/XR to user interaction.
4. Design the applications of VR/XR in healthcare, discussing the latest research, challenges and opportunities for healthcare professionals.
5. Choose the creation of immersive experiences, from 3D modelling to user interface design.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	3	1	-	-	-	-	-	3	3	1	1
CO 2	3	3	3	3	2	-	-	-	-	-	3	-	2	1
CO 3	3	3	3	3	3	-	-	-	-	-	3	2	3	1
CO 4	3	3	3	3	3	-	-	-	-	-	3	3	2	1
CO 5	3	3	3	3	3	-	-	-	-	-	3	2	1	1

UNIT -I

Immersive Technology: Introduction Promise and Potential, Knowing immersive technologies - AR/VR/ExR, Overview of immersive technologies, AR/VR Milestones and breakthroughs, Current state, Statistical data, Potential and Limitations of immersive technologies. 3D UI and Hardware requirements. Software Technologies used. AR and VR Environment..

UNIT-II

Designing Immersive Experience - Introduction, designing for sensory immersion, Designing for emotional immersion, Designing for narrative immersion, Best practices for user interface and experience design. Evolution of VR Hardware - Introduction to virtual reality hardware, The rise of consumer virtual reality, Virtual reality hardware design challenges, The future of virtual reality hardware, Role of haptic feedback on virtual reality hardware, Tools of VR kits and Case studies.

UNIT-III

AI in AR/VR/XR: -Introduction, AI and its usage in VR/AR, Graphic rendering, Natural language processing, User interaction, Predictive analytics. Business Landscape of AR/VR/XR- Introduction, Funding and investment, Funding and its challenges for VR/XR industry, Monetization strategies, User adoption and marketing, Technology

challenges, Case studies.

UNIT-IV

Applications of AR/VR/XR in Healthcare: -Introduction, Diagnosis and treatment, Rehabilitation and physical therapy Medical education and training, Use of immersive technology in patient education and engagement, Case studies, Design principles, Medical realities. Applications of AR/VR/XR in Education: Introduction, Immersive learning environment, Simulations and training, Personalized learning, Collaborative learning, Case studies.

UNIT -V

Ethics in Immersive Technologies: Introduction to ethics in immersive technologies, Safety and physical health Psychological and emotional impact, Case studies. 3D Modeling and User Interface Design: Introduction to 3D modelling, Modelling technique, User interface design principles, User interface design software and workflow, Implementing UIs in 3D environment, Case Study: Building VR Applications with Unity.

Text Books:

1. Immersive Realm of Extended Reality, Author Suman Dutta, First Edition 2024, Copyright © BPB Publications, India, ISBN: 978-93-55517-227

Suggested Reading:

1. Virtual Reality, Steven M. LaValle, University of Oulu, Cambridge University Press.
2. Virtual and Augmented Reality- An Educational Handbook, By Zeynep Tacgin, Cambridge Scholars Publishing Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK
3. Virtual Reality Technology, Grigore C. Burdea, Philippe Coiffet, John Wiley & Sons, 30 Jun 2003 - Computers - 464 pages
4. Handbook of Augmented Reality, Borko Furht, Springer New York, NY, Hardcover ISBN 978-1- 4614-0063-9, eBook ISBN 978-1-4614-0064-6

Online Resources:

1. https://axisxr.gg/the-future-of-xr-trends-to-look-for-in-2024/
2. https://www.interaction-design.org/literature/topics/extended-reality-xr
3. https://www.accenture.com/us-en/services/technology/extended-reality
4. https://www.sngular.com/insights/235/extended-reality-will-it-be-more-widespread-in-2024

22CIE51N

INDUSTRIAL INTERNET OF THINGS
(Professional Elective-II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-Requisites : Computer Architecture and Micro Processor, Programming for Problem Solving.

Course Objectives:
1. Understand the basics of IoT and IIOT.
2. Impart necessary and practical knowledge in Industrial Internet of Things.
3. Develop skills required to build real-time IIoT based projects.

Course Outcomes:
By the end of this course, students should be able to:
1. Understand Internet of Things and IIOT basics components.
2. Analyzing IoT Systems: Sensor Interfaces, Protocols, and Communication Modules.
3. Applying Raspberry Pi in IoT: Interface Sensors and Actuators
4.Understanding Arduino Basics
5. Develop real-time IoT-based projects.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	-	1	-	-	1	1	1	1
CO 2	1	-	-	-	-	-	-	1	-	-	1	1	2	-
CO 3	1	1	1	-	1	-	-	1	1	-	1	1	1	-
CO 4	1	1	1	-	1	-	-	1	1	-	1	1	1	-
CO 5	2	2	1	1	2	1	1	1	1	1	1	1	1	1

Unit – I

Internet of Things: The Third Wave? Definition of IoT, and M2M, Advantages and Disadvantages of IoT.More than Smart "Things": IoT key attributes, Three Major Challenges Facing IoT, Architecture of IoT.

Industrial Internet of Things (IIoT): Definition of IIoT, IoT, and M2M, IIoT Challenges, IIoT Requirements.

Unit – II
Physical design of IoT: Sensors, Networks, Standards.Things in IoT, IoT protocols,Intelligent analysis, Intelligent actions
Logical Design of IoT: IoT Functional Blocks,IoTCommunication Models, IoT Communication APIs.

Unit – III

Raspberry Pi: IoT Physical Devices and Endpoints:Introduction to Raspberry Pi-Interfaces (serial, SPI, I2C), Programming Raspberry PI with Python- Controlling LED with Raspberry PI, interfacing an LED and Switch with Raspberry PI, and Interfacing a light sensor (LDR) with Raspberry Pi

Unit – IV
Programming Arduino: Introduction, Arduino Boards, Programming Variables, if, loops, functions, digital inputs and outputs, the serial monitor, analog inputs and outputs, using libraries, Arduino data types and commands. Programming Arduino Uno with Arduino- Controlling LED with Arduino, interfacing an LED and a Switch with Arduino.

Unit – V

Domain-specific applications of IoT:Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health, and lifestyle.

Textbooks:

1. Ahmed Banafa by Introduction to Internet of Things (IoT) Published 2023 by River Publishers
2. Jivan S. Parab · MadhusudanGanujiLanjewar · Marlon Darius Sequeira · GourishNaik · Arman Yusuf Shaikh by Python Programming Recipes for IoTApplications , Springer Nature Singapore Pte Ltd. 2023.
3. ArshdeepBahga, Vijay Madisetti, Internet of Things: A hands on approach, 2014, VPT publishers
4. Simon Monk, Programming Arduino Next Steps: Going Further with Sketches, Second Edition,2019.

Reference Books:

1. Dr. SRN Reddy, RachitTirnkral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs, 2018.
2. Adrian McEwen, "Designing the Internet of Things", Wiley, 2013.
3. he Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
4. R2. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly (SPD), 2014.
5. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
6. CunoPfister, "Getting Started with the Internet of Things", O Reilly Media, 2011.

Web References:

1. Li Da Xu, Wu He, and Shancang Li, "Internet of Things in Industries: A Survey", IEEE Transactions on Industrial Informatics, Vol. 10, No. 4, Nov. 2014.
2. T. Winter, P. Thubert, A. Brandt, J. Hui, R. Kelsey, P. Levis, K. Pister, R. Struik , JP. Vasseur, R. Alexander, "RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks", IETF, Standards Track, Mar. 2012.
3. Z. Shelby, K. Hartke, C. Bormann, "The Constrained Application Protocol (CoAP)", Internet Engineering Task Force (IETF), Standards Track, 2014.
4. L.Fenzel, "What‟s The Difference Between IEEE 802.15.4 And ZigBee Wireless?", Electronic Design (Online), Mar. 2013.

22MTC18

QUANTUM COMPUTING FOR MACHINE LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To learn basic mathematical Concept for Quantum Computing.
2. To understand the evaluation of the quantum bits. & building blocks.
3. To know the basics of Quantum logic gates and circuits.
4. To learn Quantum Algorithms by various Techniques.
5. To Introduce Quantum Machine Learning Concepts and Application

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

1. Compute basic mathematical operations on Quantum bits.
2. Solve Quantum operations.
3. Apply quantum Logical gates and circuits.
4. Implement quantum algorithm.
5. Solve machine learning problems using Quantum computations.

CO-PO & PSO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	-	-	-	-	-	-	-	-	-	-	2	1
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	2	2	1	-	-	-	-	-	-	-	-	-	1	-
CO 4	2	2	2	2	-	-	-	-	2	2	-	-	2	2
CO 5	2	2	2	2	-	-	-	-	2	2	-	1	3	2

UNIT-I: Math Foundation for Quantum Computing:
Introduction to Vector Space, Subspaces, Linear Independent and dependent Vectors, Basis and Finite Dimensions. Orthogonality of Vectors, Inner product and Outer product of Hilbert Spaces. Unitary operators and projections, Eigenvalues and Eigenvectors. Introduction to GCD and Congruence.

UNIT-II: Introduction to Quantum Computing:
Quantum Mechanics (Huygens wave theory, Photo electric effect, De-Broglie hypothesis and Heisenberg's Uncertainty Principle), Origin of Quantum Computing, Qubits and multi-qubits states, Bra-ket notation, Quantum Superposition Motivation for Studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave). Block sphere representations, Multi-qubits, Inner and outer product of Multiple of qubits, Tensor product.

UNIT-III: Quantum Logical gates and Circuits:
Single Qubit gates: Pauli, Hadamard, Phase shift, Controlled gates: C-NOT, CCNOT. Quantum Entanglement, Quantum Teleportation (EPR Model) and Bell State, Introduction to Discrete Fourier transform.

UNIT-IV: Quantum Algorithms:
Quantum Fourier Transform and Quantum Phase estimation. Major Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm and Deutsch-Jozsa Algorithm.

UNIT-V: Quantum Machine Learning:
Quantum Un-Supervised Learning Algorithm: K-means algorithm, Quantum K- means, Quantum Supervised Learning Algorithm: Quantum HLL algorithm, Quantum Linear Regression, Quantum Support Vector Machine.

Text Books:

1. Michael A. Nielsen, “Quantum Computation and Quantum Information”, Cambridge University Press.
2. David McMahon, “Quantum Computing Explained”, Wiley.
3. Quantum Machine Learning: An Applied Approach: The Theory and Application of Quantum Machine Learning in Science and Industry by Santanu Ganguly, Apress.

Reference Books:-

1. Quantum Machine Learning: What Quantum Computing Means to Data Mining by Peter Wittek, Academic Press.

Online Resources:

Course Code	Course Name	Resource Links
22MTC18	Quantum Computing for Machine Learning	1. https://archive.nptel.ac.in/courses/115/101/115101092/ 2. https://coursera.org/share/b8b4d63cfbb5ff0eb6a070e16a758e40

22EEM01

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY
(Need to get from EEE)
(**B.E/B. Tech** - Common to all Branches)

Instruction	1 Hour per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

INTRODUCTION:
This course discusses the role of human values in one's family, in society and in nature. During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

COURSE OBJECTIVES: This course aims to
1. Understand the concept of universal human values
2. Cultivate empathy and respect for diversity
3. Inspire the social responsibility and global citizenship

COURSE OUTCOMES After the completion of this course, the student will be able to
1. Become familiar about themselves, and their surroundings (family, society, nature).
2. Develop empathy and respect for diversity by gaining an appreciation for different cultures, perspectives, and identities
3. Exhibit responsible and ethical behavior by adhering to principles of integrity, honesty, compassion, and justice.
4. Recognize their role as global citizens.
5. Exhibit a sense of social responsibility.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	-	1	-	-	1	-	-	1	-	-	-	1	-
CO 2	-	-	1	-	-	1	1	-	1	-	1	1	2	1
CO 3	-	-	-	-	-	1	-	-	-	1	-	-	-	1
CO 4	-	-	-	-	-	1	1	1	-	-	-	-	-	1
CO 5	-	-	-	-	-	1	1	1	-	-	-	-	1	1

MODULE -1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education
- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and
- Experiential Validation- as the process for self-exploration.
- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE- 2: Understanding Harmony in the Human Being - Harmony in Myself
- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'

- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE-3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
- Understanding the meaning of Trust; Difference between intention and competence.
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- Strategy for transition from the present state to Universal Human Order:
  a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers.
  b. At the level of society: as mutually enriching institutions and organizations.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss scenarios. Elicit examples from students' lives.

MODULE -4: Understanding Harmony in Nature and Existence - Whole existence as Coexistence.

- Understanding the harmony in Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Holistic perception of harmony at all levels of existence.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability Identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability Identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

MODE OF CONDUCT (L-T-P-C 0-1-0-0)

- While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection, and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors, in a group sitting.
- **Tutorials (experiments or practical) are important for this course**. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on basic human values.
- **It is advised to share the experience of the Faculty to the class in a capsule form.**
- **Involve more in evaluating the student by different activities with proper RUBRCCS**

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

EXAMPLE:

Module-1:	10 M
Module -2:	10 M
Module- 3:	10 M
Module-4:	10 M
Attendance & Attitude:	10 M

The overall pass percentage is 50%. In case the student fails, he/she must repeat the course.

TEXT BOOKS:

1. "A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.
2. "Teacher's Manual for A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.

REFERENCE BOOKS:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi

22CAC15N

NATURAL LANGUAGE PROCESSING LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: The objectives of this course are,

1. To learn the fundamentals of natural language processing.
2. To understand the various text processing techniques in NLP.
3. To understand the role Text Classification, Deep Learning for Text Classification techniques of NLP.
4. Using Topic Modeling, Case Studies and apply the NLP techniques to IR applications.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Understand the basic concepts of Natural language processing pipeline.
2. Implement various feature engineering and text representation techniques in NLP.
3. Illustrate text classification techniques to build NLP models.
4. Explore text summarization methods and example systems.
5. Develop strong problem solving skills by working on real world datasets and projects.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	2	2	2	2	-	1	-
CO 2	2	3	3	3	2	2	2	2	3	3	2	1	3	1
CO 3	2	3	2	3	2	2	2	2	2	2	2	1	3	1
CO 4	2	3	2	3	2	2	2	2	3	2	2	1	3	1
CO 5	2	3	3	3	2	2	2	2	3	3	2	3	3	1

List of Experiments:

1. Demonstrate the NLP Pipeline, Workflow of the NLP Project and NLP all libraries.
2. Implement preprocessing steps: Tokenization, Stop Word Removal, Stemming and lemmatization.
3. Develop an application to explore Text Representation techniques: One-hot encoding, Bag of Words, TF-IDF and N Gram.
4. Develop the word embedded techniques: Word2Vec and Glove.
5. Build a text classification with sentiment analysis: Apply the text preprocessing techniques and classification algorithms.
6. Implement the text classification with RNN: LSTM and GRU, CNN.
7. Implement the text classification with Attention: Self – Attention and Multi Head Attention.
8. Implement the Text classification with Transformers.
9. To Build a Text Summarization using NLP techniques.
10. To build a Text generation using NLP Techniques.

Text Books / Suggested Reading:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. O‟Reily, 2009.
2. Deep Learning for Natural Language Processing Develop Deep Learning Models for Natural Language in Python (Jason Brownlee), Machine Learning Mastery, 2017.
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf - Natural Language Processing with Transformers_ Building Language Applications with Hugging Face-O'Reilly Media (2022).
4. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019.
5. Sudharsan Ravichandiran , Getting Started with Google BERT Build and train state-of-the-art natural language processing models using BERT.

Online Resources:

https://models.quantumstat.com/
https://www.coursera.org/learn/attention-models-in-nlp

https://github.com/keon/awesome-nlp

22EGC03

EMPLOYABILITY SKILLS

(BE/BTech - Common to all Branches)

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Basic Knowledge of Soft skills in the professional setting.

Course Objectives: To help the students

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

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

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

CO-PO & PSO Articulation Matrix:

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	-	1	-	-	-	1	2	3	3	1	3	-	-	-
CO 2	-	-	-	-	-	-	1	-	2	-	1	-	-	-
CO 3	-	-	-	-	-	1	1	2	1	1	3	-	1	-
CO 4	-	1	1	-	-	1	2	3	3	1	3	-	1	-
CO 5	-	-	-	-	-	-	2	3	2	1	3	-	-	-

UNIT I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT.

UNIT III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Text Books:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.

Suggested Reading:

1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

22CAC16N

MINI PROJECT

Instruction	2P+1T Hours per Week
Duration of SEE	- Hours
SEE	- Marks
CIE	25 Marks
Credits	2

22CAU02

UPSKILL CERTIFICATION COURSE-II

Instruction	-	Hours per Week
Duration of SEE		- Hours
SEE		- Marks
CIE		25 Marks
Credits		0.5

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2027-28

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – VII

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC17N	PCC	Optimization Techniques for Machine Learning	3	-	-	3	40	60	3
2	22****	PEC	Professional Elective – III	3	-	-	3	40	60	3
3	22****	PEC	Professional Elective-IV	3	-	-	3	40	60	3
4	22****	OE	Open Elective-II	3	-	-	3	40	60	3
5	22EGM01	AU	Indian Constitution and Fundamental Principles	2	-	-	2	-	50	Non Credit
PRACTICAL										
6	22CAE***	PEC	Professional Elective-IV Lab	-	-	3	3	50	50	1.5
7	22CAC18N		Technical Seminar	-	-	2	-	50	-	1
8	22CAC19N		Project Part - I	-	-	4	-	50	-	2
TOTAL				**14**	**-**	**9**	**-**	**310**	**340**	**16.5**

L: Lecture **T: Tutorial** **P: Practical**

CIE – Continuous Internal Evaluation **SEE - Semester End Examination**

PE3(T) Semester-VII		PE4(T&L) Semester-VII		Open Elective – II	
22CAE06N	Cognitive Computing	22CAE08N(T) & 22CAE09N(L)	Reinforcement Learning	22EEO01	Energy Management System
22CAE07N	Nature Inspired Computing	22CIE56(T)& 22CIE58(L)	Cyber Security Attacks & Defenses	22EGO02	Gender sensitization
22CSE10N	Software Project Management	22ITE11(T)& 22ITE12(L)	Devops Tools	22MEO03	Corporate Organizational Behaviour
22CSE25	Cloud Computing Essentials	22ITE13(T)& 22ITE14(L)	Unmanned Aerial Vehicles	22CHO04	Environmental and sustainable Development
22ITE024	Computer Vision	22ADE14(T)& 22ADE15(L)	Generative AI	22MEO06	Principles of Entrepreneurship and Startups

22CAC17N

OPTIMIZATION TECHNIQUES FOR MACHINE LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. Understand various Optimization Techniques Fundamentals.
2. Understand various Local and Global Optimization Techniques.
3. Understand various Gradient descent optimization in machine learning.
4. Understand usage of stochastic methods and Optimization for Neural Networks.
5. Understand various applications of Optimization for Machine learning.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand the fundamentals of optimization, manipulate and analyse of the optimization.
2. Demonstrate key concepts from Machine learning for Optimization to describe Optimization functions.
3. Demonstrate the Optimization with Local and Global.
4. Make use of the Gradient Descent and Stochastic Optimization Algorithms.
5. Understand different applications of Machine learning for Optimization.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	2	2	2	2	2	-	2
CO 2	2	3	3	3	2	2	2	2	2	2	2	3	3	2
CO 3	2	3	3	3	2	2	2	2	2	2	2	3	3	2
CO 4	2	2	2	3	2	2	2	2	2	2	2	2	3	2
CO 5	2	2	2	2	2	2	2	2	2	3	2	3	2	2

Unit- I

Introduction to optimization: Introduction, History, Optimization Process, Constraints, Critical Points, Conditions for Local Minima, Derivatives and Gradients, Local Descent.

Basics of Linear Algebra and Calculus

Subspaces, Eigenvalue Decomposition and Singular Value Decomposition

Unit- II

Machine learning for Optimization

What is Function Optimization, Optimization and Machine Learning, How to Choose an Optimization Algorithm, No Free Lunch Theorem for Machine Learning, Local Optimization vs. Global Optimization, Premature Convergence, Creating Visualization for Function Optimization.

Unit- III

Local Optimization

What is a Gradient in Machine Learning? Univariate Function Optimization, Pattern Search: Nelder-Mead Optimization Algorithm, Second Order: The BFGS and L-BFGS-B Optimization Algorithms.

Global Optimization

Simple Genetic Algorithm, Evolution Strategies, Differential Evolution and Simulated Annealing.

UNIT-IV

Gradient Descent

Gradient Descent Optimization, Gradient Descent with Momentum, Gradient Descent with AdaGrad, Gradient Descent with RMSProp, Gradient Descent with Adadelta, Adam Optimization Algorithm.

Stochastic Optimization Algorithms: Introduction, Stochastic Hill Climbing, Iterated Local Search, Random Search and Grid Search.

UNIT-V

Case Study on Machine learning for optimization:

Use Optimization Algorithms to Manually Fit Regression Models, Optimize Neural Network Models, Feature Selection using Stochastic Optimization and Optimize Machine Learning Model Hyperparameters.

Text Books / Suggested Reading:

1. Mykel J. Kochenderfer and Tim A. Wheeler, Algorithms for Optimization, MITPress,2019
2. Optimization for Machine Learning (Jason Brownlee), Machine Learning Mastery.
3. Linear Algebra and Learning from Data, Gilbert Strang.
4. Optimisation for Machine Learning by Suvrit Sra, MIT Press.

Online Resources:

Optimisation for Machine Learning: Theory and Implementation
https://onlinecourses.nptel.ac.in/noc23_cs64/preview

22CAE06N

COGNITIVE COMPUTING
(Professional Elective - III)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: NIL

Course Objectives:

1. To explore the important aspects of Cognitive science methods and paradigms.
2. To utilize the advanced algorithms with human interaction feedback mechanisms that support human reasoning.
3. To Assess the real-world systems by analyzing the impact of cognitive systems

Course Outcomes: On Successful completion of the course, students will be able to

1. Understand the basic cognitive concepts of AI and ML that differentiates with traditional approaches
2. Devise the development stages of cognitive architectures
3. Analyze the primary techniques and tools related to cognitive computing
4. Design Models using cognitive computing frameworks for real world requirements.
5. Solve the complex problems using cognitive computing.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	-	3	2	2	2	2	3	1	2	-
CO 2	2	3	2	2	-	3	2	2	2	2	3	2	2	1
CO 3	2	3	3	2	-	3	3	3	2	3	3	-	2	-
CO 4	2	2	3	3	-	2	2	3	2	3	3	3	2	1
CO 5	2	2	3	3	-	2	2	2	3	2	3	1	3	1

UNIT-I

Introduction to Cognitive Computing:

Cognitive Science and Cognitive Computing, Nature of Cognition, Aspects of modeling, Cognitive Systems, Levels of abstraction, Emergent and Cognitivist Perspective, Connectionist models, Applications of Cognitive Computing.

UNIT-II

Cognitive Architectures

Logic based computational model, Social interaction, Architectures: ACT-R, SOAR, Opencog, Copycat, Memory networks, Classical and formal model , Causality, Categorization, Similarity and role of analogy.

UNIT-III

Design Principles: Components of a cognitive system – Building the corpus – Bridging data into cognitive NLP and Knowledge representation in Cognitive System:The Role of NLP in a Cognitive System, Semantic Web, Technologies to Business Problems, Models for knowledge representation.

UNIT–IV

Advanced Analytics

Introduction to Big Data Analytics – Predictive Analytics, Image Analytics, Speech Analytics, Using Advanced Analytics to Create Value, Building Value with In-memory Capabilities, Impact of Open-Source Tools.

UNIT–V

Building Cognitive Applications

Emerging Platforms, Defining the domain, understanding the intended users, Defining their Attributes, defining questions and exploring insights, Corpora.

Case studies: Cognitive assistant for visually Impaired, Cognitive systems in Smart cities, Cognitive systems in

Healthcare.

Text Books:

1. Hurwitz, Kaufman and Bowles, Cognitive computing and Big Data Analytics", 1st Edition, Wiley, Indianapolis, IN 2015.
2. Vernon, David, " Artificial cognitive systems: A primer, 1st Edition, MIT Press, 2024

Suggested Reading:

1. Peter Fingar, " Cognitive Computing : A Brief Guide for Game changers", PHI Publication 2015.
2. Gerardus Blokdyk, Cognitive Computing Complete self-Assessment Guide", 2018.

22CAE07N

NATURE INSPIRED COMPUTING
(Professional Elective-III)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are,

1. To explore Knowledge on significance of intelligence.
2. To understand Genetic algorithms and applications.
3. To understand various Optimization technique models.

Course Outcomes: On successful completion of the course, students will be able to,

1. Understand various bio inspired models
2. Familiar with Genetic algorithm and its applications.
3. Explore different Ant Colony Optimization algorithmic models.
4. Compare different Artificial Bee Colony Optimization algorithmic models.
5. Apply Nature inspired techniques to real time applications.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	1	1	1	-	1	-	1	1	-	-	-	2	-
CO 2	2	1	3	2	-	2	-	1	1	-	2	-	2	-
CO 3	2	2	3	2	-	2	2	1	1	-	2	-	2	-
CO 4	2	2	2	3	-	2	-	1	1	-	2	-	2	1
CO 5	2	2	3	3	-	2	2	1	2	1	2	1	2	1

UNIT - I:
Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms. Optimisation problems – single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.

UNIT - II:
Genetic algorithms - Mathematical foundation, Genetic problem solving, crossover and mutation. genetic algorithms and Markov process, applications of genetic algorithms

UNIT - III:
Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies.

UNIT - IV:
Particle Swarm algorithms - particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

UNIT - V:
Selected nature inspired techniques-Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques- Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

TEXT BOOKS:

1. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer,2006

2. Floreano, D. and C. Mattiussi-"Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press,2008

REFERENCES:

1. Leandro Nunesde Castro-"Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group,2007.
2. Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005.
3. Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi,2020

22CSE10N

SOFTWARE PROJECT MANAGEMENT
(Professional Elective-III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Software engineering

Course Objectives: This course aims to:

1. Develop a comprehensive understanding of software project management frameworks
2. Build practical skills in planning, risk management, and quality assurance
3. Understand and apply organizational and human resource management principles

Course Outcomes: Upon completion of this course, students will be able to:

1. Analyze and apply software process maturity models and frameworks
2. Develop and manage effective project activity plans and risk management strategies
3. Analyze and apply organizational structures and project control mechanisms
4. Effectively manage human resources in software projects
5. Plan, execute, and control software projects by applying principles of software configuration management, quality assurance, and risk analysis.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	-	-	-	-	-	-	-	-	-	1	3	-
CO 2	1	3	1	2	1	1	-	2	3	1	-	3	2	-
CO 3	1	2	2	-	-	-	-	2	1	-	-	1	2	1
CO 4	1	-	-	-	-	-	-	3	2	-	-	2	2	1
CO 5	1	2	2	-	-	-	-	3	3	1	-	2	2	1

UNIT - I

Software Process Maturity Software maturity Framework, Principles of Software Process Change, Software Process Assessment, The Initial Process, The Repeatable Process, The Defined Process, The Managed Process, The Optimizing Process. Process Reference Models Capability Maturity Model (CMM), CMMI, PCMM, PSP, TSP)

UNIT - II

Activity Planning and Risk Management: Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling -Network Planning models – Formulating Network Model – Forward Pass and Backward Pass techniques – Critical path (CRM) method – Risk identification – Assessment – Risk Planning -Risk Management – – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical paths – Cost schedules.

UNIT - III

Project Organizations Line-of- business organizations, project organizations, evolution of organizations, process automation. Project Control and process instrumentation, The seven-core metrics, management indicators, quality indicators, life-cycle expectations, Pragmatic software metrics, metrics automation.

UNIT - IV

Staffing in Software Projects: Managing people – Organizational behavior – Best methods of staff selection – Motivation – The Oldham – Hackman job characteristic model – Stress – Health and Safety – Ethical and Professional concerns – Working in teams – Decision making – Organizational structures – Dispersed and Virtual teams – Communications genres – Communication plans – Leadership.

UNIT - V

Software configuration management, Software Quality assurance, Risk Analysis, Instream activities-Project Initiation, Project planning and tracking, Project closure.

Text Books:

1. Software Project Management, Walker Royce, Pearson Education ,2014
2. Managing Global Software Projects , Gopalaswamy Ramesh, Tata McGraw-Hill ,2002

Suggested Reading:

1. An Introduction to the Team Software Process, Watts S. Humphrey, Pearson Education, 2000
2. Process Improvement essentials, James R. Persse, O'Reilly, 2006
3. Software Project Management, Bob Hughes & Mike Cotterell, fourth edition, TMH, 2006
4. Applied Software Project Management, Andrew Stellman & Jennifer Greene, O'Reilly, 2006.
5. Head First PMP, Jennifer Greene & Andrew Stellman, O'Reilly, 2007
6. Software Engineering Project Management, Richard H. Thayer & Edward Yourdon, 2nd edition, Wiley India, 2004.
7. Agile Project Management, Jim Highsmith, Pearson education, 2004.

Online Resources:

1. Software Project Management - Course (nptel.ac.in)
2. Software Engineering: Software Design and Project Management Course by The Hong Kong University of Science and Technology | Coursera

22CSE25

CLOUD COMPUTING ESSENTIALS
(Professional Elective - III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Data communication and computer networks.

Course Objectives: This course aims to

1. Understand the significance of cloud computing services.
2. Understand the cloud infrastructure and Technologies.
3. Learn the security implementation features in cloud computing.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the need of cloud technology and terminology.
2. Identify and understand the cloud infrastructure.
3. To understand and apply various virtualization concepts.
4. Design solutions for the automation and migration of manual data centers.
5. Analyze the Cloud Security and privacy issues.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	1	1	1	1	-	-	-	1	-	-	-	1	-
CO 2	2	1	-	1	1	-	-	-	-	1	1	-	2	1
CO 3	2	1	-	1	1	1	-	-	-	-	-	1	3	1
CO 4	2	2	2	1	1	1	-	-	1	1	-	3	2	1
CO 5	2	2	-	1	1	1	-	-	-	2	1	-	2	1

UNIT - I

Era of Cloud Computing – Motivation, Elastic Computing and advantages- Multi-Tenant clouds, Elastic computing, Virtualized servers uses, Business model for Cloud Providers. Types of Clouds and Cloud Providers, Multi-Cloud, Hyperscalers, advantages of clouds;

UNIT - II

Virtualization and Containers -Virtual machines, hypervisor, approaches to virtualization, advantages and disadvantages of VMs, Virtual I/O devices, VM migration; Traditional apps and elasticity on demand, isolation facilities in an OS, Docker containers, Docker Terminology and Development tools.

UNIT - III

Virtual Networks – Goals of a data center network, Network hierarchies, capacity, Fat Tree Designs. Link aggregation, VLANS, VXLAN, NAT, Managing virtualization and mobility, SDNs, openflow protocol, Programming networks; Virtual Storage: NAS, SAS, mapping virtual disks to physical disks.

UNIT - IV

Automation and Cloud Programming - Need of automation, levels, AIops, automation tools, automation of manual data center practices, evolution of automation; Orchestration: legacy of automating procedures, larger scope of automation, Kubernetes MapReduce, Microservices, Serverless computing, event processing, DevOps, Edge Computing and IIoT.

UNIT - V

Cloud security and Privacy – cloud specific problems, zero trust security model, identity management, privileged access management(PAM), AI technologies and their effects on their security, Protection of remote access and privacy in a cloud environment, back doors, side channels and other concerns, firewalls

Text Books:

1. Douglas Comer, "The Cloud Computing Book: The Future of Computing Explained", A Chapman and Hall/CRC, 1st Edition Kindle Edition, 2021.
2. Anthony T Velte, Toby J, Robert Elenpeter, "Cloud Computing – A Practical Approach", McGra Hill, 2010.

Suggested Reading:

1. https://www.amazon.in/Cloud-Computing-Book-Future-
2. Explained/dp/0367706806?asin=B097N7NKJD&revisionId=&format=4&depth=1

22ITE024

COMPUTER VISION
(Professional Elective-III)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To Understand the fundamental concepts related to computer vision and Image formation.
2. To Learn feature detection, matching and detection.
3. To Become familiar with feature based alignment.
4. To Develop skills on 3D reconstruction.
5. To Understand Object Detection Techniques.

Course Outcomes:

Upon completing this Course, Students will be able to:

1. Understand Fundamentals of computer vision and physics of color.
2. Employ Image processing techniques.
3. Illustrate 2D Feature Based Image Alignment, Feature Detection and Segmentation.
4. Apply 3D Image Reconstruction Techniques.
5. Develop Innovative Computer Vision Applications.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	1	1	1	-	-	-	2	1	3	1	3	2
CO 2	3	3	3	2	3	-	1	-	2	1	2	1	3	2
CO 3	3	3	2	2	3	-	-	-	1	1	2	3	3	2
CO 4	2	3	3	2	3	-	-	-	2	1	2	3	3	3
CO 5	2	3	3	2	2	2	-	-	3	1	2	3	3	3

UNIT-I

Introduction to Computer Vision: Computer vision , Applications of computer vision, Computer vision pipeline , Image input, Image preprocessing , Feature extraction , Classifier learning algorithm. Color: The Physics of Colour, Human Colour Perception , Representing Colour. Application: Finding Specularities, Surface Colour from Image Colour.

UNIT-II

Image Formation and Processing:

Geometric primitives and transformations, Photometric image formation, digital camera, Point operators, Linear filtering, neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization.

UNIT-III

Feature Detection, Matching and Segmentation: Points and patches, Edges - Lines, Segmentation, Active contours , Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods. Feature-based Alignment: 2D and 3D Feature Based Alignment, Pose estimation, Geometric intrinsic calibration.

UNIT-IV

3D Reconstruction: Shape from X, Active range finding, Surface representations, Point-based representations, volumetric representations, Model-based reconstruction, Recovering texture maps and albedosos.

UNIT- V

Object detection: General object detection framework, Region-based convolutional neural networks (R-CNNs), Single-shot detector (SSD) , You only look once (YOLO). Generative adversarial networks (GANs): GAN architecture , Evaluating GAN models , Popular GAN applications.

Text Books:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015
3. Deep Learning for Vision Systems, Mohamed Elgendy, Manning Publications,2020.

Suggested Reading:

1. R. Hartley and A. Zisserman, “Multiple View geometry”, Cambridge university Press, 2002.
2. Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, Second Edition, Cambridge University Press, March 2004.
3. 3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

Web Resources:

1. CV online: http://homepages.inf.ed.ac.uk/rbf/CVonline
2. https://nptel.ac.in/courses/108103174
3. https://opencv.org/opencv-free-course/
4. https://docs.opencv.org/4.x/d9/df8/tutorial_root.html

22CAE08N

REINFORCEMENT LEARNING
(Professional Elective-IV)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Probability and Statistics, Machine Learning, Data Structures

Course Objectives:

1. To Understand the fundamental principles of Reinforcement Learning and MDP Process
2. To Analyze Monte Carlo Methods and Temporal-Difference learning techniques.
3. Evaluate the use of Eligibility Traces in reinforcement learning through case studies

Course Outcomes: After completion of the course, students will be able to

1. Acquire the fundamental concepts of Reinforcement Learning.
2. Apply the concepts of Finite Markov Decision Process to solve the complex problems.
3. Analyze and evaluate the effectiveness of Monte Carlo methods and On/Off Policy methods
4. Analyze and apply Temporal Difference Learning for real world problems.
5. Evaluate eligibility traces and novel reinforcement learning solutions.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	-	-	-	-	-	-	-	-	1	3	-	2
CO 2	3	3	2	2	-	-	-	-	-	-	1	3	2	2
CO 3	3	3	2	3	2	-	-	2	-	-	1	3	2	2
CO 4	3	3	3	3	2	-	2	3	-	-	2	3	2	2
CO 5	3	2	3	3	2	-	2	3	-	-	2	3	2	2

UNIT-I:

Introduction to Reinforcement Learning:-Examples, History of RL, Limitations, Scope, Elements of Reinforcement Learning, An n-armed bandit problem, Action-value methods, Incremental Implementation, Tracking a nonstationary problem, Optimistic initial values, Upper- Confidence-Bound Action Selection, Gradient bandits.

UNIT-II:

Finite Markov Decision Processes: The Agent-Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.

UNIT-III:

Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off- Policy prediction via importance sampling, Incremental implementation, Off-policy monte carlo control

UNIT-IV:

Temporal-Difference learning: TD prediction, Advantages of TD prediction methods, Optimality of TD(0), Sarsa: On-policy TD control, Q-Learning: Off-policy TD control

UNIT-V:

Eligibility Traces: n-step TD prediction, The forward view of TD(λ),the backward view of TD(λ), Equivalences of forward and backward views, Sarsa(λ), Watkin's Q(λ), Off-policy eligibility traces using importance sampling.

Case studies: TD-Gammon, Samuel's Checkers Player.

Text Books:

1. “Reinforcement learning: An introduction,” First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020.
2. “Statistical reinforcement learning: modern machine learning approaches,” First Edition, Sugiyama, Masashi. CRC Press 2015.

Reference Books:

1. “Bandit algorithms,” First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020.
2. “Reinforcement Learning Algorithms: Analysis and Applications,” Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021.
3. Alexander Zai and Brandon Brown “Deep Reinforcement Learning in Action,” First Edition, Manning Publications 2020.

Online Resources:

1. https://nptel.ac.in/courses/106106143
2. https://www.coursera.org/specializations/reinforcement-learning

22CIE56

CYBER SECURITY: ATTACKS & DEFENSES
(Professional Elective-IV)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-Requisites
Programming and problem solving, Operating systems, Computer networks, Fundamentals of Cyber Security and Tools, Cryptography and Network Security.

Course Objectives

By the end of this course, students should be able to:

1. Understand the foundational concepts of cybersecurity, including common threats like viruses, trojans, and vulnerabilities.
2. Analyse attacker techniques, motivations, and ant forensics strategies used to bypass detection systems.
3. Apply knowledge of exploitation methods such as buffer overflows, SQL injections, and shellcode to simulate common attack vectors.
4. Evaluate cyber intelligence, warfare strategies, and the implications of international cybersecurity laws like the Tallinn Manual.
5. Create strategic defenses against current and emerging threats by integrating knowledge of threat landscapes, next-gen attack techniques, and cybersecurity transformations (IoT, Cloud, Big Data).

Course Outcomes

1. Demonstrate an in-depth understanding of the dark side of computing and key security principles of modern operating systems like Microsoft Windows.
2. Identify and assess various hacking techniques and tunneling methods used by cybercriminals to cover their tracks.
3. Develop countermeasures by simulating and mitigating exploitation techniques, including format string vulnerabilities, race conditions, and malicious file attacks.
4. Critically evaluate the nature of cyber conflicts and warfare, and propose ethical and legal solutions based on global cybersecurity frameworks.
5. Apply futuristic cybersecurity strategies by incorporating virtualization, IoT, cloud computing, and social engineering trends into secure systems.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	2	-	-	1	1	1	1	3	2	3
CO 2	2	3	2	2	2	-	-	1	1	1	1	3	2	3
CO 3	2	3	3	2	3	-	-	1	1	1	1	3	2	3
CO 4	2	2	2	2	3	-	-	1	1	1	1	3	2	3
CO 5	3	3	3	2	3	-	-	1	1	1	1	3	2	3

Unit – I
Introduction: The Dark Side of the Computer, Viruses, Trojans, and Attacks, Vulnerabilities, Risk Assessment, Risk Management, Emerging Field of Cybersecurity, Microsoft Windows Security Principles.

Unit – II
Attackers' Techniques and Motivations: How Hackers Cover Their Tracks (Antiforensics), Tunneling Techniques, Fraud Techniques, Threat Infrastructure.

Unit – III
Exploitations: Techniques to Gain a Foothold: Shellcode, Integer Overflow Vulnerabilities, Stack-Based Buffer Overflows, Format String Vulnerabilities, SQL Injection, Malicious PDF Files, Race Conditions, Web Exploit Tools, Misdirection, Reconnaissance, and Disruption Methods.

Unit – IV

Cyber Intelligence, Cyber Conflicts, and Cyber Warfare: Introduction, Information Warfare Theory and Application, Cyber Intelligence and Counter-Intelligence, DoD-The U.S. Cyber Command, Nation-State Cyber Conflicts, Cyber Warfare and the Tallinn Manual on International Law.

Unit – V

Cybersecurity Threat Landscape and Future Trends: Introduction, Breaches—Global Data, Threat Landscape: Traditional Threats, Social Engineering Threats, Buffer Overflow and Structured Query Language Injection, Next-Generation Threats, Attacker's Need for Information, Transformational Changes for Cybersecurity: Virtualization, social media, Internet of Things, Cloud Computing, Big Data, Preparing Future Generations for Cybersecurity Transformational Challenges.

Textbook:

1. Johnson, T. A. (2015). Cybersecurity: Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare. CRC Press, Taylor & Francis Group.
2. Graham, J., Howard, R., & Otson, R. (2010). Cyber Security Essentials. CRC Press.

Reference Books

1. Holt, T. J., Bossler, A. M., & Seigfried-Spellar, K. C. (2020). Cybercrime and digital forensics: An introduction (2nd ed.). Routledge.
2. Godbole, N., & Belapure, S. (2011). Understanding cyber-crimes, computer forensics, and legal perspectives. Wiley India.

Web Reference

1.https://nptel.ac.in/courses/106106248

22ITE11

DEVOPS TOOLS
(Professional Elective-IV)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course is designed to:

1. Provide a comprehensive understanding of DevOps principles and their role in modern software development.
2. Explain the importance of version control systems, with a focus on Git.
3. Explore continuous integration and continuous deployment (CI/CD) using tools like Jenkins and Maven.
4. Introduce containerization concepts through Docker.
5. Explain the automation of software deployment processes using configuration management tools.

Course Outcomes:
Upon successful completion of this course, students will be able to:

1. Explain the core concepts and benefits of DevOps in software engineering.
2. Analyze the role of version control systems in collaborative development.
3. Describe the CI/CD pipeline and evaluate tools like Jenkins and Maven.
4. Illustrate the use of Docker in containerizing applications.
5. Discuss automated deployment strategies using tools such as Puppet.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	2	1	1	2	1		1	2	1	2	1	2	2
CO 2	1	2	1	1	2	1		1	2	1	2	1	2	2
CO 3	1	1	1	1	2	1		1	2	1	3	1	2	2
CO 4	1	2	1	1	2	1		1	2	1	3	1	2	2
CO 5	1	2	1	2	3	1		1	2	1	3	1	2	2

UNIT-1
Introduction to DevOps , DevOps Perspective , DevOps and Agile , Team Structure , Coordination , Barriers , The Cloud as a Platform: Features of the Cloud , DevOps Consequences of the Unique Cloud Features , Operations: Operations Services, Scrum, Kanban, and Agile.

UNIT-2
Overview GIT and its principal command lines: Installation, Configuration, Vocabulary, Git Command Lines, Understanding the GIT process and Gitflow pattern: Starting with the Git Process, Isolating your code with branches, Branching Strategy with Gitflow.

UNIT-3
Continuous Integration and Continuous Delivery: Technical Requirements CI/CD principles, Using a package manager in the CI/CD process, Using Jenkins for CI/CD implementation , Using GitLab CI .

UNIT-4
Containerizing your application with Docker: Installing Docker, Creating Docker file, Building and running a container on a local machine, Pushing an Image to Docker Hub, Deploying a container to ACI with CI/CD pipeline. Using Docker for running command Line tools, Introduction to Kubernetes Tools: Docker Compose, Docker Swarm

UNIT-5
Getting Started with Docker Composer, Deploying a Docker compose containers in ACI, Installing Kubernetes, First example of Kubernetes application of deployment, Deploying the code: The Puppet master and Puppet agents, Ansible, PalletOps, Deploying with SaltStack, DevOps Best Practices, Tools: Ansible, Saltstack

TEXT BOOKS:

1. Len Bass, Ingo Weber and Liming Zhu, DevOps: A Software Architect's Perspective, Addison-Wesley, Pearson Publication, Second Edition, 2015.
2. Mikael Krief, Learning DevOps: A comprehensive guide to accelerating DevOps culture adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins, Packt Publishing , 2022.

REFERENCE BOOKS:

1. Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet, Ryan Russell and Jason Southgate, Packt Publishing ,2018.
2. Joakim Verona, Practical DevOps, Packt Publishing , 2018.

22ITE13

UNMANNED AERIAL VEHICLES
(Professional Elective-IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim to :

1. Familiarize basics of Autonomous vehicles and its various applications.
2. Learn the Basics of navigation and explain the components used to build the drone devices.
3. Acquaint with the concepts of UAV aircraft and basics of Robot Programming.
4. Provide the payload and Navigation of Autonomous Vehicles.
5. Introduce the benefits of combining AI and Drones.

Course Outcomes:
Upon completing this course, students will be able to:

1. Understand the types, characteristics, Applications of Autonomous systems.
2. Analyze the concepts of Aerodynamics, Propulsion & Structures of Model aircraft.
3. Know the UAV / UGV Elements and Robot Arm Kinematics & Dynamics.
4. Infer about Navigation and guidance of Autonomous vehicles.
5. Explore applications of Drones in Artificial Intelligence .

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	1	1	2	1	0	1	1	1	1	1	3	2
CO 2	2	2	1	2	0	1	0	0	1	1	1	1	3	2
CO 3	2	2	1	1	0	1	0	1	1	1	1	1	3	2
CO 4	2	2	1	1	1	2	0	1	1	1	1	1	3	2
CO 5	2	2	1	1	1	1	0	0	1	1	1	1	3	2

UNIT-I
Introduction to Autonomous systems: Definition, Characteristics, differences between non autonomous Vs autonomous, Types of vehicles, Introduction to navigation and communication.

UNIT-II
Basics of navigation (Aerial and Ground): Different types of flight vehicles; Components and functions of an airplane; Forces acting on Airplane; Physical properties and structure of the atmosphere; Aerodynamics – aerofoil nomenclature, aerofoil characteristics, Angle of attack, Mach number, Lift and Drag, Propulsion and airplane structures.

UNIT-III
UAV / UGV Elements: Introduction to UAV and UGV, DGCA Classification of UAVs; Types and Characteristics of Drones: Fixed, Multi-rotor, Flight controller Software, MAVLINK protocol, Robot Arm Kinematics and Dynamics, Manipulator Trajectory planning and Motion Control, Robot Sensing, Robotic Operating System, Robotic Programming Languages.

UNIT-IV
Navigation and Guidance: Data Link; Sensors and Payloads: GPS, IMU, Light Detection and Ranging (LiDAR), Imaging cameras, Classification of payload based on applications; Hyper-spectral sensors; Laser Detection and Range (LiDAR); cameras; ultra-sonic detectors; Introduction to navigation systems and types of guidance; Mission Planning and Control, Case studies: Autonomous Obstacle avoidance - Vision, Sonar and LiDAR.

UNIT-V

AI Drones: Benefits of Combining AI and Drones, Applications of AI-Powered Drones, Challenges and ethical considerations, Drone Swarm Technologies and Algorithms, Case Studies Drone Swarms, IoT Drones.

Text books :

1. K Valavanis; George J Vachtsevanos,"Handbook of Unmanned Aerial Vehicles", Springer, Boston, Massachusetts : Credo Reference, 2014. 2016.
2. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics : Control, Sensing, Vision and Intelligence
3. John J. Craig, Introduction to Robotics: Mechanics and Control, Addison Wesley publication, 3rd Edition.
4. **Reg Austin"Unmanned Aircraft Systems: UAVS Design, Development and Deployment" John Wiley & Sons, Ltd.2011.**
5. Fahlstrom P, Gleason T (2012) "Introduction to UAV systems", 4th edn. Wiley, UK
6. Yang, L. J., & Esakki, B. (2021). Flapping Wing Vehicles: Numerical and Experimental Approach. CRC Press.
7. Sebbane, Y. B. (2022). A first course in aerial robots and drones. CRC Press.

Suggested Reading:

1. Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, John Baichtal DGCA RPAS Guidance Manual, Revision 3 – 2020
2. Aaron Martinez, Enrique Fernandez, Learning ROS for Robotics Programming: A practical, instructive, and comprehensive guide to introduce yourself to ROS, the top-notch, leading robotics framework, PACKT publishing, Open Source.
3. Andy Lennon, "Basics of R/C Model Aircraft Design" Model Airplane News Publication
4. John Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs.
5. DGCA RPAS Guidance Manual, Revision 3 - 2020

Web Resources :

1. https://onlinecourses.swayam2.ac.in/ntr24_ed12/preview
2. https://archive.nptel.ac.in/courses/101/104/101104073/
3. https://onlinecourses.nptel.ac.in/noc21_ae14/preview

22ADE14

GENERATIVE AI
(Professional Elective-IV)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Python Programming, Deep Learning

Course Objectives: This course aims to:

1. Introduce the fundamentals of generative modeling and deep learning.
2. Explore key architectures including VAEs, GANs, and Diffusion Models.
3. Apply TensorFlow/Keras to build generative models
4. Understand applications of generative AI in text, image, music, and multimodal domains.
5. Examine current and future trends in generative AI and its real-world impact.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand foundational concepts of generative modelling, probability theory, and Variational Autoencoders.
2. Analyze and implement various GAN architectures for generating synthetic data and images.
3. Explore and evaluate diffusion models including training, sampling, and analysis processes.
4. Apply transformer-based architectures for language modelling and fine-tune encoder/decoder models.
5. Develop effective prompting strategies to control and enhance outputs from generative language models.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	1	1			-	-	-	-	-	-	2	1	3
CO 2	2	3	2	3	3	-	-	-	-	-	-	3	1	3
CO 3	2	3	2	3	3	-	-	-	-	-	-	2	1	3
CO 4	2	3	2	3	3	-	-	-	-	-	-	2	1	3
CO 5	1	2	2	3	3	-	-	-	-	-	-	2	1	3

UNIT - I

Generative Modelling: What is Generative Modelling, Generative vs. Discriminative Models, The Rise of Generative Modelling, Generative Modelling Framework, **Core Probability Theory**: Sample Space, Probability Density Function, Parametric Modeling, Likelihood, Maximum Likelihood Estimation, **Variational Autoencoder**: Architecture, Exploring the Latent Space,

UNIT- II

Generative Adversarial network : Introduction, Deep Convolution GAN, Wasserstein GAN with Gradient Penalty (WGAN-GP), Conditional GAN (CGAN), **Advanced GAN**: Progressive GAN, StyleGAN, StyleGAN2

UNIT- III

Diffusion Models: Introduction, Denoising Diffusion Models (DDM) and its process, Diffusion Schedules, The Reverse Diffusion Process,The U-Net Denoising Model- Training, Sampling and Analysis, Stable Diffusion, DALL.E 2- Architecture, training Process, GLIDE, ImageGen

UNIT - IV

Transformers: Introduction, Architecture- Attention, Multi head Attention, Masking, Transformer Block, Encoder Based only Transformers Architectures and Fine Tuning : BERT, **Generative LLMs**: Introduction to LLMs, Decoder-only Transformers, Training LLMs, Fine-tuning LLMs, Introduction to various LLM: GPT, Falcon, LLaMA2

UNIT- V

Prompt Engineering: Introduction, Prompt Engineering Strategies, **Advanced Prompting Methods**: Chain of Thought, Problem Decomposition, Self-refinement, Ensembling, RAG and Tool Use, **Learning to Prompt:** Prompt Optimization,Soft Prompts

TEXT BOOK:

1. David Foster, Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, Second Edition, O'Reilly Media, 2023.
2. Tong Xiao, Jingbo Zhu. *Foundations of Large Language Models*. arXiv:2501.09223 [cs.CL], January 16, 2025.

SUGGESTED BOOKS:

1. Joseph Babcock Raghav Bali, Generative AI with Python and Tensor flow 2, Packt Publishing Ltd. UK, 2021

WEB RESOURCES:

1. https://paperswithcode.com
2. https://huggingface.co/
3. https://arxiv.org/pdf/2501.09223

22EEO01

ENERGY MANAGEMENT SYSTEM

(Open Elective-II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None.

COURSE OBJECTIVES: This course aims to

1. Know the concept of Energy Management.
2. Understand the formulation of efficiency for various Engineering Systems
3. Enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Energy Management

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Know the current Energy Scenario and importance of Energy Conservation.
2. Understand the concepts of Energy Management, Energy Auditing.
3. Interpret the Energy Management methodology, Energy security and Energy Strategy.
4. Identify the importance of Energy Efficiency for Engineers and explore the methods of improving Energy Efficiency in mechanical systems, Electrical Engineering systems
5. Illustrate the Energy Efficient Technologies in Civil and Chemical engineering systems

CO-PO & PSO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	1	-	2	1	-	-	-	1	-	1	-
CO 2	2	1	1	1	-	2	1	-	-	-	1	-	1	1
CO 3	2	2	2	1	-	2	1	-	-	-	1	-	2	1
CO 4	2	2	1	2	2	2	1	-	-	-	1	-	1	1
CO 5	1	1	2	1	1	2	2	-	-	-	1	-	-	-

UNIT-I

Various forms of Energy and its features: Electricity generation methods using different energy sources such as Solar energy, wind energy, Bio-mass energy, and Chemical energy such as fuel cells. Energy Scenario in India, Impact of Energy on economy, development, and environment sectors of national and international perspective.

UNIT-II

Energy Management-I: Defining Energy Management, need for Energy Management, Energy management techniques, importance of Energy Management, managing the Energy consumption, Energy Audit and Types, Energy Audit Instruments.

UNIT-III

Energy Management-II: understanding Energy costs, bench marking, Energy performance, matching energy use to requirement, optimizing the input, fuel & Energy substitution, material and Energy balance diagrams, Energy pricing, Energy and Environment, Energy Security

UNIT-IV

Energy Efficient Technologies-I: Importance of Energy Efficiency for Engineers, Energy Efficient Technology in Mechanical engineering: Compressed Air System, Heating, ventilation and air- conditioning, Fans and blowers, Pumps and Pumping Systems,

Energy Efficient Technology in Electrical engineering: Automatic Power Factor Controllers, Energy Efficient Motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, space cooling, energy efficiency of lifts and escalator, energy saving potential of each technology.

UNIT-V

Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering: Intelligent Buildings, And

Various Energy Efficiency Rating Systems for Buildings, Green Buildings Energy Efficiency: management of green buildings, importance of embodied energy in selection of sustainable materials, green building design, waste reduction/recycling, rainwater harvesting, maintenance of the green buildings, green building certification, Renewable energy applications.
Energy Efficient Technology in Chemical Engineering: Green chemistry, Low carbon cements, recycling paper.

TEXT BOOKS:

1. Umesh Rathore, 'Energy Management', Kataria publications, 2nd ediiton, 2014.
2. G Hariharaiyer, “Green Building Fundamentals”, Notion press.com
3. K V Shama, P Venkataseshaiah, "Energy management and conservation", I. K. International Publishing agency pvt. ltd., 2011, ISBN: 978-93-81141-29-8

SUGGESTED READING:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
2. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland Universityof Technology.
3. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

22EGO02

GENDER SENSITIZATION

(Open Elective – II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: No specific prerequisite is required.

Course Objectives: This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

Course Outcomes: After successful completion of the course the students will be able to:

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways in which gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	-	1	-	-	2	1	1	-	-	1	1	1	-
CO 2	-	-	1	-	-	2	1	1	-	-	1	1	1	-
CO 3	-	-	1	-	-	2	2	2	1	1	1	-	-	-
CO 4	-	-	1	-	-	3	2	2	1	1	1	-	1	-
CO 5	-	-	1	-	-	2	2	3	1	1	1	1	1	-

UNIT I

Understanding Gender:

Gender: Why Should We Study It? (Towards a World of Equals: Unit -1)

Socialization: Making Women, Making Men (Towards a World of Equals: Unit -2)

Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT II

Gender and Biology:

Missing Women: Sex Selection and Its Consequences (Towards a World of Equals: Unit -4) Declining Sex Ratio. Demographic Consequences.

Gender Spectrum: Beyond the Binary (Towards a World of Equals: Unit -10) Two or Many? Struggles with Discrimination.

UNIT III

Gender and Labour:

Housework: the Invisible Labour (Towards a World of Equals: Unit -3) "My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (Towards a World of Equals: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT IV

Issues of Violence

Sexual Harassment: Say No! (Towards a World of Equals: Unit -6)
Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "Chupulu".
Domestic Violence: Speaking Out (Towards a World of Equals: Unit -8)
Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice.
Thinking about Sexual Violence (Towards a World of Equals: Unit -11)
Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT V

Gender: Co - Existence

Just Relationships: Being Together as Equals (Towards a World of Equals: Unit -12) Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Additional Reading: Rosa Parks-The Brave Heart.

Textbook:

1. A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu"Towards a World of Equals: A Bilingual Textbook on Gender", Telugu Akademi, Hyderabad, 2015.

Suggested Reading:

1. Menon, Nivedita. "Seeing like a Feminist", Zubaan-Penguin Books, New Delhi, 2012.
2. Abdulali Sohaila, "I Fought For My Life…and Won", Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

Web Resources:

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

Note: Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

22MEO03

CORPORATE ORGANIZATIONAL BEHAVIOUR
(Open Elective -II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Nil.

Course Objectives: This course aims to
1. Define basic organizational behaviour principles and analyze how these influence behaviour in the work place.
2. Analyze the influence of perceptions and personality on individual human behaviour in the work place.
3. Discuss the theories of Motivation and Leadership.
4. Provide knowledge on different organizational structures; and concepts of culture, climate and organizational development and make the students familiarize with individual behavior.
5. Describe the interpersonal and their intrapersonal reactions within the context of the group and also demonstrate effective communication and decision making skills in small group settings

Course Outcomes: Upon completion of this course, students will be able to
1. Understand Organizational Behavioural principles and practices.
2. Compare various organizational designs and cultures enabling organizational development.
3. Apply motivational theories and leadership styles in resolving employee‘s problems and decision making processes.
4. Understand the group dynamics, communication network, skills needed to resolve organizational conflicts.
5. Analyze the behaviour, perception and personality of individuals and groups in organizations in terms of the key factors that influence organizational behavior.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	2	1	1	1	1	1	1	1	1	1	2	1
CO 2	3	2	3	2	2	1	1	1	-	1	2	2	2	1
CO 3	3	2	2	3	2	-	-	2	-	-	2	2	3	2
CO 4	3	2	3	2	2	-	-	1	-	2	3	2	2	2
CO 5	3	2	2	1	2	-	-	1	-	-	1	1	2	2

UNIT –I

Introduction: Organizational behaviour, nature and levels of organizational behavior, individuals in organization, individual differences , personality and ability, the big 5 model of personality , organizationally relevant personality traits, the nature of perception , characteristics of the perceiver, target and situation , perceptual problems.

UNIT – II

Organization structure: Organizational designs and structures, traditional and contemporary organizational designs, organizational culture and ethical behaviour, factors shaping organizational culture, creating an ethical culture, concepts, organizational climate, organization conflict, and organization development.

UNIT – III

Motivation and leadership: Motivation, early and contemporary theories of motivation, leadership, early and contemporary approaches to leadership.

UNIT – IV

Group dynamics: Groups and group development, turning groups into effective teams, managing change , process, types and challenges, communicating effectively in organizations, communication process, barriers to communication, overcoming barriers to communication, persuasive communication, communication in crisis situations.

UNIT – V

Power, Politics, Conflict and Negotiations: Power, politics, conflict and negotiations, sources of individual, functional and divisional power, organizational politics conflict, causes and consequences, Pondy's model of organizational conflict, conflict resolution strategies.

Text Books:

1. Jennifer George and Gareth Jones, Understanding and Managing Organizational Behaviour, Pearson Education Inc., 2012.
2. Jon L Pierce and Donald G. Gardner, Management and Organizational behaviour, Cengage Learning India (P) Limited, 2001.
3. Richard Pettinger, Organizational Behaviour, Routledge, 2010

Suggested Reading:

1. Stephen P. Robbins, Jennifer George and Gareth Jones, Management and Organizational Behaviour, Pearson Education Inc., 2009.
2. John Schermerhorn, Jr., James G. Hunt and Richard N. Osborn, Organizational Behaviour, 10th edition, Wiley India Edition, 2009.

22CHO04

ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT
(Open Elective-II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course will help the students:

1. To have an increased awareness on issues in areas of sustainability
2. To understand the role of engineering & technology within sustainable development
3. To know the methods, tools and incentives for sustainable product service system development
4. To establish a clear understanding of the role and impact of various aspects of engineering decisions on environmental, societal and economic problems.
5. To communicate results related to their research on sustainable engineering

Course Outcomes: At the completion of this course, students will be able to:

1. Understand the concept of sustainable engineering and its significance in addressing contemporary environmental challenges.
2. Explore the 4R concept of solid waste management and examine various tools and methodologies to assess and mitigate the environmental impacts of engineering activities.
3. To be aware of the principles and requirements of environmental management standards and their application in promoting environmental sustainability.
4. Analyze the challenges and opportunities associated with promoting sustainable habitats such as sustainable cities, sustainable transport, sustainable sources of energy conventional and sustainable materials for green buildings
5. Understand and evaluate the industrial processes through the principles of industrial ecology and industrial symbiosis.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	1	3	1	1	3	2	1	1	1	3	-	1	-
CO 2	2	2	3	2	1	3	2	1	1	1	3	1	1	1
CO 3	2	1	3	1	2	3	2	1	2	1	3	-	1	-
CO 4	3	1	3	3	1	3	2	2	1	1	3	-	1	-
CO 5	3	3	3	1	2	3	2	1	1	2	3	-	1	1

UNIT I

Introduction of sustainability- Need and concept of Sustainable Engineering, Social-environmental and economic sustainability concepts, Sustainable development and challenges, Sustainable Development Goals, Environmental acts and protocols – Clean Development Mechanism (CDM).

UNIT II

Economic and social factors affecting sustainability, Effects of pollution from natural sources, Solid waste-sources, impacts, 4R (Reduce, Reuse, Recycling, Recover) concept, Ozone layer depletion, Global warming, Tools used to ensure sustainability in engineering activities such as environmental management systems and environmental impact assessment studies.

UNIT III

Global, Regional and Local environmental issues, Carbon credits and Carbon trading, Carbon foot print, Environmental management standards, ISO 14000 series, Life cycle Analysis (LCA)-scope and goal, Procedures of EIA (Environment Impact Assessment) in India.

UNIT IV

Basic concept of sustainable habitat-Sustainable cities, Sustainable transport, Sustainable sources of energy conventional and renewable sources, Green Engineering: Green buildings, Green materials for sustainable design, Methods for increasing energy efficiencies of buildings**.**

UNIT V

Technology and sustainable development, Sustainable urbanization, Industrialization and poverty reduction, Social and Technological change, Industrial processes-material selection, Pollution prevention, Industrial ecology, Industrial symbiosis.

Text book:

1. Rag R. L., Introduction to Sustainable Engineering, 2nd Ed, PHI Learning Pvt Ltd, 2016.
2. Allen D. T and Shonnard D. R., Sustainability Engineering Concepts, Design and Case Studies, 1 st Ed, Prentice Hall, 2011.

Suggested Reading

1. Bradley A. S, Adebayo A. O and Maria. P., Engineering Applications in Sustainable Design and Development, 1st Ed, Cengage Learning, 2016.
2. Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams., Sustainable Engineering,1st Ed, Wiley, 2019.

Online resources:

1. Sustainable Engineering concepts and Life cycle analysis
   https://archive.nptel.ac.in/courses/105/105/105105157/
2. Sustainable Energy Technology
   https://onlinecourses.nptel.ac.in/noc23_me138/preview

22MEO06

PRINCIPLES OF ENTREPRENEURSHIP AND STARTUPS
(Open Elective-II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Nil

Course Objectives: This course aims to
1. Impart basic concepts and procedure of idea generation.
2. Familiarize the nature of industry and related opportunities and challenges.
3. Familiarize with elements of business plan and its procedure.
4. Learn the project management and its techniques.
5. Know the behavioral issues and time management.

Course Outcomes: Upon completion of this course, the students will be able to
1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	-	1	1	1	2	2	1	1	1	1	-	1	-
CO 2	1	1	1	1	1	2	2	2	2	3	1	-	1	1
CO 3	1	1	1	2	2	2	2	2	2	3	1	1	2	1
CO 4	2	1	1	2	2	2	2	1	2	3	1	1	2	1
CO 5	1	-	1	1	1	-	2	1	1	1	1	-	1	-

UNIT - I

Entrepreneurship: Definition, Characteristics of an Entrepreneur, Functions of Entrepreneurs, Entrepreneur vs. Intrapreneur, First Generation Entrepreneur, Women Entrepreneurship, Ideas and their Sources, Conception and Evaluation of Ideas.

Behavioral Aspects of Entrepreneurs: Personality: Determinants, Attributes and Models, Leadership: Concepts and Models, Values and Attitudes, Motivation Aspects.

UNIT - II

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic Growth, Small Scale Industry in India, objectives, Linkage among Small, Medium and Heavy Industries, Types of Enterprises, Corporate Social Responsibility.

UNIT - III

Business Plan: Introduction, Elements of Business Plan and its salient features, Business Model Canvas, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility Studies, Executive Summary.

UNIT - IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, human aspects of project management.

Time Management: Approaches of Time Management, their strengths and weaknesses. Time Management Matrix, Urgency Addiction.

UNIT - V

Startup: Definition, Startup Ecosystem, Startup Incubator, Need and Importance of Startups and Incubation Centers. Sources of Finance and Incentives for Startups. Innovation, Creativity, Intellectual Property in Entrepreneurial Journey. Business firm Registration Process in INDIA.

Text Books:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw-Hill Publishing Company Ltd, 1995.
3. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi, 2015.

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", 5th edition, Tata Mc Graw Hill Publishing Company. Ltd., 2005.
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.

22EGM01

INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES

(BE/BTech III/IV/VI/VII Semester - Common to all branches)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0
Credits	Non Credit

Prerequisite: Basic awareness of Indian Constitution and Government.

Course Objectives:

The course will introduce the students to:

1. Understand the history of framing of the Indian Constitution.
2. Awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Explore the organization of Union Government, and functions of President and Prime Minister.
4. Gain an insight into the inter-functionality of Union Legislature and Judiciary
5. Educate on the local governance and problems in development of rural and urban areas.

Course Outcomes:

After successful completion of the course the students will be able to:

1. Understand the history of framing of the Indian Constitution and its features.
2. Assess the realization of Fundamental Rights and Directive Principles of State Policy.
3. Analyze the challenges to federal system and position of the President and the Prime Minister in the Union Government.
4. Underline the role of the Legislature and the Judiciary in Union Government and their mutual relations.
5. Evolve the development of the local governments in India and assess the role of Collector in district administration.

CO-PO & PSO Articulation Matrix

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	-	1	-	-	1	1	1	-	-	-	-	1	-
CO 2	-	-	2	-	-	3	2	1	-	-	-	-	-	-
CO 3	-	-	1	-	-	1	-	-	-	-	-	-	-	-
CO 4	-	-	1	-	-	1	-	-	-	-	-	-	-	-
CO 5	-	-	2	-	-	3	1	1	-	-	-	-	-	-

Unit-I

Constitutional History and Framing of Indian Constitution

East India Company rule (1757-1857): Social, Economic, Political and Administrative impact of Company rule in India. British Rule (1858-1947): Indian National Movement, Government of India Acts 1909, 1919 and 1935, and Indian Independence Act 1947. Framing of the Indian Constitution: Constituent Assembly, Preamble and Salient Features.

Unit-II

Fundamental Rights, Duties and Directive Principles of State Policy

The Fundamental Rights: Features and significance of Rights. Fundamental Duties: Importance and the legal status of Duties. Directive Principles of State Policy: Socialist, Gandhian and Liberal-intellectual principles, importance and relevance.

Unit-III

Union Government and its Administration

Federalism: Division of legislative and financial powers between the Union and the State. Union Executive: Role and position of President, Prime Minister and Council of Ministers. Emergency Provisions: National Emergency, Constitutional Emergency and Financial Emergency.

Unit-IV

Union Legislature and Judiciary

Union Legislature: Parliament of India-Composition and functions of Parliament, and Parliamentary Committees. Union Judiciary: Supreme Court of India-Composition and Functions.

Unit-V

Local Self Governments

Rural Local Governments: Zilla Parishad- CEO and functions of Zilla Parishad, Mandal Parishad- Role of Elected and Officials, Gram Panchayat- Sarpanch, Secretary and Gram Sabha. Urban Local Governments: Structure and functions of Municipalities and Municipal Corporations. District Collector: Powers and functions of Collector.

Text Books:

1. Sastry Ravindra, (Ed), "Indian Government & Politics", Telugu Akademy, 2nd edition, 2018.
2. "Indian Constitution at Work", NCERT, First edition 2006, Reprinted in 2022.

Suggested Reading:

1. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. Granville Austin, "The Indian Constitution: The Cornerstone of a Nation", OUP, 2nd Edition, 1999.
4. M.V. Pylee, "India's Constitution", S. Chand Publishing, 16th Edition, 2017.
5. Rajeev Bhargava (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.

22CAE09N

REINFORCEMENT LEARNING LAB
(Professional Elective- IV Lab)

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites :- Probability & Statistics, Data Structures and Algorithms, Machine Learning

Course Objectives:-

1. Understand and implement fundamental concepts of Reinforcement Learning algorithms
2. Apply the concepts of Finite MDP and Monte Carlo Methods
3. Analyze TD learning and evaluate Eligibility traces using case studies.

Course Outcomes:-

Upon successful completion of the lab, the students will be able to :-

1. Understand and implement basic concepts of reinforcement learning
2. Design and implement MDP using value and policy iterations
3. Analyze and implement Monte Carlo Methods and TD learning algorithms
4. Apply and evaluate eligibility traces using case studies
5. Develop and implement RL algorithms to solve complex real world problems

CO-PO & PSO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	1	1	2	1	1	-	-	1	-	3	-	2
CO 2	3	3	3	2	3	2	1	-	-	1	-	3	2	2
CO 3	3	3	2	2	3	1	-	-	-	1	-	3	2	2
CO 4	3	2	2	2	2	1	-	-	-	1	-	3	2	3
CO 5	3	3	3	3	3	2	1	1	2	2	1	3	2	3

List of Experiments: -

1. Write a program to implement n-armed bandit problem, where different actions have unknown reward probabilities.
2. Write a program to implement value iteration and policy iteration algorithms for solving MDPs by using a simple grid world environment.
3. Write a program to implement the Monte Carlo Prediction Algorithms to estimate the value function for a given policy by applying on any simple environment.
4. Write a program to implement the Q-Learning Algorithm to find an optimal policy for navigating the grid with different learning rates and exploration strategies.
5. Write a program to implement the SARSA Algorithm for on-policy control in a grid or maze environment and compare its performance with Q-learning.
6. Write a program to implement the reinforcement-learning agent to play backgammon, similar to famous TD-Gammon Program.
7. Write a program that uses reinforcement learning to solve job-shop scheduling problems.
8. Write a program that visualizes the eligibility Traces for different values of λ . Observe how the eligibility traces affect the learning in TD (λ) algorithms.
9. Design and develop reinforcement learning program that implement Samuel's Checkers Player.

10. Implement TD (0), SARSA and Q-Learning Algorithms on a simple grid World environment and allow users to compare their performance, Convergence rates and explore the trade-offs between On-policy and Off-Policy Learning.

Text Books:

1. "Reinforcement Learning: An Introduction, " First Edition, Sutton, Richard S., and Andrew G, Barto, MIT Press 2020".
2. "Statistical reinforcement learning: modern machine learning approaches," First Edition, Sugiyama, Masashi. CRC Press 2015.

Suggestive Books:

1. Practical Deep Reinforcement Learning with Python , Ivan Gridin, BPB Publications.
2. "Bandit algorithms," First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020.
3. "Reinforcement Learning Algorithms: Analysis and Applications," Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021.

Online Resources:

1. https://nptel.ac.in/courses/106106143
   https://www.coursera.org/specializations/reinforcement-learning

22CIE58

CYBERSECURITY: ATTACKS & DEFENSES MECHANISM LAB
(Professional Elective- IV Lab)

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-Requisites

Programming and problem solving, Operating systems, Computer networks, Fundamentals of Cyber Security and Tools, Cryptography and Network Security.

Course Objectives

1. Master techniques for network reconnaissance using tools like Nmap and Wireshark to identify devices and assess security risks posed by open ports.
2. Configure and manage firewall rules using UFW or iptables, and validate their effectiveness using tools such as Nmap, netcat, or Metasploit.
3. Develop secure web applications, employing OWASP ZAP or Burp Suite to identify and mitigate vulnerabilities, and implement best practices in secure coding.
4. Evaluate and enhance wireless network security using Aircrack-ng or Wireshark, with a focus on understanding and implementing WPA2/WPA3 encryption standards.
5. Perform comprehensive vulnerability assessments using OpenVAS or Nessus, prioritize identified vulnerabilities, and apply effective mitigation strategies.

Course Outcomes

By the end of this course, students should be able to:

1. Ability to proficiently conduct network scans and identify devices and open ports, critically analyzing associated security risks.
2. Competence in configuring and managing firewall rules, and effectively testing their robustness against various penetration testing tools.
3. Skill in developing and testing secure web applications, implementing secure coding practices, and addressing vulnerabilities using leading security assessment tools.
4. Understanding and practical application of wireless network security principles, including encryption standards and configurations.
5. Capability to perform vulnerability scans, prioritize identified vulnerabilities based on their severity, and implement appropriate remediation actions.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	3	-	-	1	1	1	-	3	2	3
CO 2	3	2	2	2	3	-	-	1	1	1	-	3	2	3
CO 3	3	2	2	2	3	-	-	1	1	1	-	3	2	3
CO 4	3	3	3	2	3	-	-	1	1	1	-	3	2	3
CO 5	3	2	3	2	3	-	-	1	1	1	-	3	2	3

List of Experiments

1. Identify network devices and open ports using nmap and Wireshark; discuss security risks of exposed ports.
2. Test the wireless network security using Aircrack-ng or Wireshark; understand WPA2/WPA3 encryption.
3. Run vulnerability scans with OpenVAS or Nessus; identify, prioritize, and mitigate vulnerabilities.
4. Establish a secure VPN with OpenVPN and analyze potential vulnerabilities using Wireshark.
5. Use OpenSSL for encryption/decryption and configure SSL/TLS on a web server.
6. Steps to ensure the Security of any one web browser (Mozilla Firefox/Google Chrome).
7. Secure a database (MySQL/PostgreSQL) and test for SQL injection with SQLMap.
8. Create a web scraper in Python to gather data from websites.
9. "How to make strong passwords" and "password cracking techniques".

Textbooks:

1. "Nmap Network Scanning: The Official Nmap Project Guide to Network Discovery and Security Scanning" by Gordon Fyodor Lyon, Nmap Project, 2009.
2. "Wireshark Network Analysis (Second Edition): The Official Wireshark Certified Network Analyst Study Guide" by Laura Chappell, Gerald Combs, 2012.
3. "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" by Dafydd Stuttard and Marcus Pinto, Second Edition, Wiley, 2011.
4. "Metasploit: The Penetration Tester's Guide" by David Kennedy, Jim O'Gorman, Devon Kearns, Mati Aharoni, 2011.

Reference Books

1. "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software" by Michael Sikorski, Andrew Honig, 2012.
2. "Network Security with OpenSSL: Cryptography for Secure Communications" by John Viega, Matt Messier, Pravir Chandra, 2002.
3. "Bulletproof SSL and TLS: Understanding and Deploying SSL/TLS and PKI to Secure Servers and Web Applications" by Ivan Ristic, 2014.
4. "Mastering OpenVPN" by Eric F Crist, Jan Just Keijser, 2015.

Web References:

1. OWASP - Open Web Application Security Project: https://owasp.org
2. NIST Cybersecurity Framework: https://www.nist.gov/cyberframework
3. SANS Institute: https://www.sans.org/
4. CIS - Center for Internet Security: https://www.cisecurity.org
5. ISACA: https://www.isaca.org

22ITE12

DEVOPS TOOLS LAB
(Professional Elective-IV Lab)

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives

The objective of this lab is to:

1. Understand the fundamentals of DevOps in the context of software development.
2. Learn version control using Git for efficient code management.
3. Build, test, and deploy applications using Jenkins and Maven.
4. Utilize Docker for containerization of applications.
5. Develop and manage an end-to-end software deployment process.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Apply DevOps principles to streamline software development and delivery.
2. Use version control tools such as Git for collaborative coding and tracking changes.
3. Implement continuous integration and delivery using Jenkins and Maven.
4. Demonstrate containerization techniques using Docker.
5. Describe and execute deployment processes using automation tools like Puppet.

CO-PO& PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	3	3	3	1		1	2	1	2	1	2	2
CO 2	1	1	3	3	3	1		1	2	1	2	1	2	2
CO 3	1	1	3	3	3	1		1	2	1	3	1	2	2
CO 4	1	1	3	3	3	1		1	2	1	3	1	2	2
CO 5	1	1	3	3	3	1		1	2	1	3	1	2	2

List of Experiments:

S.No	Experiment Title
1.	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.
2.	Explore the Version Control System tools for Source Code Management.,
3.	Install git and create a GitHub account and To execute various GIT operations.
4.	Installing and configuring Jenkins to set up a build job will help you comprehend continuous integration.
5.	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.
6.	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers.
7.	To learn Docker file instructions, build an image for a sample web application using Docker file.
8.	Deploy a containerized application on Kubernetes cluster.
9.	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet.
10.	To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function)

TEXT BOOKS:

1. Len Bass, Ingo Weber and Liming Zhu, DevOps: A Software Architect's Perspective, Addison- Wesley, Pearson Publication, Second Edition, 2015.
2. Mikael Krief, Learning DevOps: A comprehensive guide to accelerating DevOps culture adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins, Packt Publishing , 2022.

REFERENCE BOOKS:

1. Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet, Ryan Russell and Jason Southgate, Packt Publishing ,2018.
2. Joakim Verona, Practical DevOps, Packt Publishing , 2018.

22ITE14

UNMANNED AERIAL VEHICLES LAB
(Professional Elective-IV Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives:

This course aims to

1. Understand the basic components of Unmanned aerial vehicles (Drones) and its various applications.
2. Provide hands-on experience on design, fabrication and flying of UAV-category aircraft.
3. Integration of drones with other hardware and software applications.

Course Outcomes:

Upon completing this course, students will be able to:

1. Know the parts and functions of Quad copter.
2. Demonstrate Calibration of UAV(Quadcopter) using Ardupilot Mission planner.
3. Write and test Various commands to communicate for successfully fly the drone.
4. Explore Object Avoidance using sensors and test them on UGV(Robot).
5. Design/Simulate to communicate UAV/UGV using BLE/WiFi/UHF/Cellular devices and IOT-UAV/UGV using text & voice commands.

CO-PO& PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	0	0	0	0	0	0	1	1	1	1	3	2
CO2	1	2	0	0	1	0	0	0	0	2	1	0	3	2
CO3	1	1	1	1	1	0	0	0	1	1	0	1	3	2
CO4	1	1	0	0	1	0	0	0	0	2	0	0	3	2
CO5	1	1	1	1	1	2	0	0	0	0	1	2	3	2

List of Experiments:

1. Assemble, integrate and demonstrate the Quad copter with all necessary parts.
2. Calibration of UAV(Quadcopter) using Ardupilot Mission planner and demonstrate the calibrated IMU parameters
3. Write a program to read Telemetry parameters using Serial Port using TTC device.
4. Write a program to read GPS coordinates on Raspberry Pi and Arduino micro controller
5. Write a program to send MAVLINK commands to Pixhawk version of Flight Controller
6. Write a program to connect Dronekit for communication and testing various commands
7. Use Mission planner for flight path panning and demonstrate the transfer of planning transects to flight controller
8. Write object avoidance program using the following sensors and test them on UGV(Robot)
   a. Sonar b) LiDAR c) Camera
9. Write a Program to communicate UAV/UGV using BLE/WiFi/UHF/Cellular devices
10. Write a program to communicate IOT-UAV/UGV using text & voice commanding for Swarm

Programming Languages

- Python
- C

Software Tools

- Ardupilot Mission Planner
- SITL / MAVproxy
- ROS : Robotic Operating System
- ChibiOS or latest Embedded RTOS

Text Books:

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics : Control, Sensing, Vision and Intelligence
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Addison Wesley publication, 3rd Edition.
3. Reg Austin"Unmanned Aircraft Systems: UAVS Design, Development and Deployment" John Wiley & Sons, Ltd.2011.
4. Fahlstrom P, Gleason T (2012) "Introduction to UAV systems", 4th edn. Wiley, UK
5. Yang, L. J., & Esakki, B. (2021). Flapping Wing Vehicles: Numerical and Experimental Approach. CRC Press.
6. Sebbane, Y. B. (2022). A first course in aerial robots and drones. CRC Press.

Suggested Reading:

1. J.A.M. Mendoza, V.J.G. Villela, G.S. Cervantes, M.M. Martinez, H.S. Azuela, Advanced Robotic Vehicles Programming: An Ardupilot and Pixhawk Approach, First Edition, A Press, 2020
2. Ty Audronis, Designing Purpose-Built Drones for Ardupilot Pixhawk 2.1: Build drones with Ardupilot, First Edition, CBS Publishers and Distributers, 2017
3. J. Ranga, J. Saiteja, M. Seshu, Speed Control of BLDC Motor with RPM Display, First Edition, LAP Lambert Academic Publishing, 2020
4. D. Hanselman, Brushless Motors: Magnetic Design, Performance, and Control of Brushless DC and Permanent Magnet Synchronous Motors, First Edition, E-Man Press LLC, 2012
5. A. Frazier, K. Singh, Fundamentals of Capturing and Processing Drone Imagery and Data, First Edition, CRC Press, 2021
6. J. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, First Edition, QUE Publishers, 2015

Web Resources:

1. https://robu.in/understanding-various-components-used-for-quadcopter-2/
2. https://ardupilot.org/copter/docs/common-imutempcal.html
3. https://ardupilot.org/copter/docs/common-telemetry-port-setup.html
4. https://www.youtube.com/watch?v=OeTxaClOEWs
5. https://www.youtube.com/watch?v=zxjO9q34RLs
6. https://www.youtube.com/watch?v=t4rwKoLmgVI

22ADE15

GENERATIVE AI LAB
(Professional Elective-IV Lab)

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: This course aims to:

1. Understand the fundamental concepts of generative AI models including, GANs, and transformers.
2. Gain proficiency in implementing generative AI models using TensorFlow or PyTorch.
3. Learn to evaluate and interpret the performance of generative AI models effectively.
4. Explore real-world applications of generative AI across various domains such as image generation and natural language processing.
5. Enhance problem-solving skills by experimenting with different model architectures and datasets in generative AI tasks.

Course Outcomes: Upon completion of this course, students will be able to:

1. Design and implement generative models like GANs, VAEs, and U-Net for image synthesis.
2. Apply and evaluate style transfer and diffusion models for high-quality image generation.
3. Fine-tune transformer models like BERT and GPT-2 for diverse natural language processing tasks.
4. Develop intelligent applications using OpenAI APIs and LangChain for retrieval-augmented generation.
5. Explore zero-shot and few-shot learning using advanced prompt engineering techniques for LLMs.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	3	2	3	3	-	-	-	-	-	-	3	2	2
CO 2	2	3	2	3	3	-	-	-	-	-	-	3	2	2
CO 3	2	3	2	3	3	-	-	-	-	-	-	3	3	2
CO 4	2	3	2	3	3	-	-	-	-	-	-	3	3	2
CO 5	2	3	2	3	3	-	-	-	-	-	-	3	3	2

LIST OF PROGRAMS:

1. Implement DCGAN and train it on any dataset for image generation.
2. Analyze the performance of WPGAN- GP with vanilla GAN and VAE on any dataset for image generation.
3. Implement a style transfer algorithm using GANs and apply it to images from the CIFAR-10 dataset
4. Implement a basic Unet-based denoising model for image restoration.
5. Use Hugging Face Diffusers library to generate images using Stable Diffusion
6. Analyze the performance output quality of Stable Diffusion vs DALL·E 2
7. Fine tune BERT Transformer for various NLP tasks.
8. Use decoder-only models like GPT-2 for text generation.
9. Utilize the OpenAI API to build a question-answering application powered by GPT-3, allowing users to input questions and receive relevant answers.
10. Explore zero-shot and few-shot learning with OpenAI GPT via API.
11. Perform prompt optimization using OpenPrompt or PromptSource.
12. Use RAG (Retrieval-Augmented Generation) with LLMs using LangChain.

SUGGESTED BOOKS:

1. Steve Tingiris Exploring GPT-3, Packt Publishing Ltd. Uk, 2021
2. Joseph Babcock Raghav Bali, Generative AI with Python and Tensor flow 2, Packt Publishing Ltd. UK, 2021
3. Sabit Ekin, Prompt Engineering for Chat GPT: A Quick Guide To Techniques, Tips, and Best Practices, DOI: 10.36227/tech arxiv.22683919.v2, 2023
4. Foster, D. "Generative Deep Learning. Teaching Machines to Paint, Write, Compose and Play (2019)." Beijing-Boston-Farnham-Sebastopol-Tokyo, OREILLY (2019): 330.
5. Hany, John, and Greg Walters. Hands-On Generative Adversarial Networks with PyTorch

22CAC18N

TECHNICAL SEMINAR - AIML

Instruction	2P Hours per Week
Duration of SEE	- Hours
SEE	-Marks
CIE	50 Marks
Credits	1

The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on state of the art topics in a broad area of his/her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the topic
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

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

1. Study and review research papers of new field/areas and summarize them.
2. Identify promising new directions of various cutting edge technologies in Computer Science and Engineering
3. Impart skills to prepare detailed report describing the selected topic/area.
4. Acquire skills to write technical papers/articles for publication.
5. Effectively communicate by making an oral presentation before the evaluating committee.

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-		2	-	2	2	2
CO2	3	3	3	2	-	-	-	-		2	-	3	3	3
CO3	2	2	2	-	-	-	-	-		3	-	2	2	2
CO4	2	2	2	-	-	-	-	-		3	-	2	2	2
CO5	-	-	-	-	-	-	-	-	3	3	2	1	1	1

Seminars are to be scheduled **from 3rd week to the last week of the semester** and any change in schedule shall be discouraged. For the award of sessional marks students are **judged by three (3) faculty members** and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

For the seminar, the student shall collect the information on a specialized topic, prepare a technical report, and submit it to the department. It shall be evaluated by the departmental committee consisting of Head of the Department, seminar supervisor and a senior faculty member. The seminar shall be evaluated for 50 internal marks. There shall be no semester end examination for the seminar.

Note: Topic of the seminar shall preferably be from any peer reviewed recent journal publications.

Guidelines for awarding Marks

S. No.	Description	Max.Marks
1	Contents and Relevance	10
2	Presentation Skills	10
3	Preparation of Presentation slides	05
4	Question and Answers	05
5	Report in prescribed format	20

22CAC19N

PROJECT PART - I

Instruction	4P Hours per week
Duration of End Examination	-
Semester End Examination	-
Continuous Internal Evaluation	50 Marks
Credits	2

The objective of „Project Phase – I" is to enable the student take up an investigative study in the broad field of Computer Science and Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D. The work shall include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/ Modelling / Simulation / Experiment / Design /Feasibility;
4. Preparing a Written Report on the Study conducted for Presentation to the Department;
5. Final Seminar, as oral Presentation before the Department Review Committee.

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

1. Review the literature related to the problem area / selected topic.
2. Undertake problem identification, formulation and solution.
3. Prepare synopsis of the selected topic.
4. Gather the required data and Set up the environment for the implementation.
5. Conduct preliminary analysis/modelling/simulation experiment.
6. Communicate the work effectively in both oral and written forms.

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	-	-	-	-	2	-	2	2	2
CO2	3	3	3	2	-	-	-	-		2	-	3	3	3
CO3	2	2	1		-	-	-	-		3	-	2	2	2
CO4	2	3	2	2	2	-	-	-		2	-	3	3	3
CO5	2	3	3	3	3	-	-	-		2	-	3	3	3
CO6	-	-	-	-	-	-	-	-	3	3	2	1	1	1

Guidelines for awarding CIE (Max. Marks: 50)		
Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	15	Project Status / Review
Publication	10	In conference/ Journal
Department Review Committee (DRC)	5	Relevance of the Topic
	5	Presentation Slide Preparation
	5	Presentation
	5	Question and Answers
	5	Quality of Report & Report Submission

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2027-28

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – VIII

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22****	PEC	Professional Elective-V	3	-	-	3	40	60	3
2	22****	OE	Open Elective-III	3	-	-	3	40	60	3
3	22CEM01		Environmental Science	2	-	-	2	-	50	Non Credit
PRACTICAL										
4	22CAC20N		Project Part- II	-	-	8	-	100	100	4
TOTAL				**8**	**-**	**8**	**-**	**180**	**270**	**10**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

PE5(T) Semester-VIII		**Open Elective – III (Semester - VIII)**	
22CAE10N	Conversational AI	22EGO03	Indian Traditional Knowledge
22CAE11N	Ethics and AI	22EGO01	Technical Writing Skills
22CAE12N	Machine Translation	22ECO01	System Automation & Control
22CIE53	Blockchain Technology	22MEO05	Research Methodologies and Intellectual Property Rights
22CSE23	Robotic Process Automation		

22CAE10N

CONVERSATIONAL AI
(Professional Elective - V)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. Understand the basic knowledge of conversational systems and Natural Language for Dialog Systems.
2. Analyse the toolkits that can be used to develop dialogue systems.
3. Addresses open-domain non-task-oriented dialogue systems.
4. Analyse the latest research in neural dialogue systems.
5. Explore the challenges and areas for further development of more intelligent dialogue systems.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand various concepts, issues, and technologies of Conversational AI and Natural Language for Dialog Systems.
2. Understand the Speech Recognition.
3. Understand the Dialog Management and Modelling.
4. Analyse the achievements and issues of ongoing research of neural dialogue system.
5. Make use Neural Dialogue Systems to construct intelligent dialogue systems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	1	2	1	2	-	1	-
CO 2	2	2	2	2	2	2	2	1	2	1	2	1	2	1
CO 3	2	2	2	2	2	2	2	1	2	1	2	1	2	1
CO 4	2	3	2	3	2	2	2	1	2	1	2	-	2	-
CO 5	2	2	3	3	2	2	2	1	3	1	2	1	3	1

Unit I

Introduction to Conversational AI

Introduction to Conversational AI: Introduction to AI assistants and their platforms, Primary use cases for AI assistant technology. Building your first conversational AI: Building a conversational AI for Fictitious Inc, What's the user's intent, and responding to the user.

Natural Language Understanding for Dialog Systems: Spoken Language Understanding (SLU), Frame-based SLU.

Unit II

NLU for Dialog Systems: Classification and Named Entity Recognition.

Speech Recognition: Dialogue System Components, General issues in speech processing, Core recognition and synthesis technology, working with commercial speech technology and Privacy issues in working with speech technology.

Unit III

Introducing Dialogue Systems: Dialogue System, History, Present-day Dialogue System, Modeling conversation in dialogue systems.

Rule-Based Dialogue Systems: A typical dialogue systems architecture and Tools for developing dialogue systems and Evaluating Dialogue Systems.

Unit IV

End-to-End Neural Dialogue Systems: Neural Network Approaches to Dialogue Modeling, A Neural Conversational Model, Introduction to the Technology of Neural Dialogue and Open-Domain Neural Dialogue Systems.

Evaluating Dialogue Systems: How to Conduct the Evaluation, Evaluating Task-Oriented Dialogue Systems, Evaluating Open-Domain Dialogue Systems

Unit V

Case Study: Chatbots in healthcare and mental health support, Voice-enabled devices and smart home applications.

Text Books:

1. Andrew R. Freed. Conversational AI: Chatbots that work.
2. Michael McTear . Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies).
3. Dan Jurafsky and James H. Martin. Speech and Language Processing (3rd ed. draft).
4. Yoav Goldberg. Neural Network Methods for Natural Language Processing.

Reference (s):

1. Xiaoquan Kong , Guan Wang . Conversational AI with Rasa by Packt.
2. Stephan Bisser . Microsoft Conversational AI Platform for Developers End-to-End Chatbot Development from Planning to Deployment.
3. Lee Boonstra . The Definitive Guide to Conversational AI with Dialogflow and Google Cloud build advanced enterprise chatbots, voice.

Online resources:

1. https://hao-cheng.github.io/ee596_spr2019/
2. https://github.com/search?q=conversational+AI+dialogue+systems&type=repositories
3. https://deeppavlov.ai/
4. https://github.com/jyguyomarch/awesome-conversational-ai

22CAE11N

ETHICS AND AI
(Professional Elective - V)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To understand the fundamentals of ethics and morality related to Artificial Intelligence and its societal impact.
2. To explore ethical issues, standards, regulations, and professional responsibilities in AI applications and intelligent systems.
3. To examine the challenges, global strategies, and opportunities concerning AI ethics and responsible AI deployment.

COURSE OUTCOMES: On Successful completion of this course, student will be able to

1. Explain the concepts of morality and ethics in AI and their societal impact.
2. Analyze ethical issues, harms, and initiatives in real-time AI applications.
3. Evaluate AI standards and regulations, including agent design and safe autonomous systems.
4. Interpret and apply Roboethics and moral theories in professional contexts.
5. Assess the societal implications of AI and compare national and international AI strategies.

CO-PO & PSO Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	2	3	-	2	-	1	-	-	1
CO2	2	3	2	2	1	3	3	2	2	1	2	2	2	2
CO3	2	3	2	2	2	2	3	-	2	-	2	2	2	2
CO4	2	2	1	1	-	2	3	2	3	1	2	1	1	2
CO5	2	2	2	1	-	3	3	-	2	1	2	2	2	2

UNIT I
INTRODUCTION
Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust

UNIT II
ETHICAL INITIATIVES IN AI
International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles , Warfare and weaponization.

UNIT III
AI STANDARDS AND REGULATION
Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems- Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems

UNIT IV
ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS
Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy.

UNIT V
AI AND ETHICS- CHALLENGES AND OPPORTUNITIES
Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI.

TEXT BOOKS:

1. Y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,"The ethics of artificial intelligence: Issues and initiatives", EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020
2. Patrick Lin, Keith Abney, George A Bekey," Robot Ethics: The Ethical and Social Implications of Robotics", The MIT Press- January 2014.
3. Larry A. DiMatteo, Cristina Poncibò, Michel Cannarsa "The Cambridge Handbook of Artificial Intelligence" Cambridge University Press, July 2022

REFERENCES:

1. Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017
2. Mark Coeckelbergh," AI Ethics", The MIT Press Essential Knowledge series, April 2020
3. Michael J. Quinn. "Ethics for the Information Age" 6th edition Pearson.

Web links:

1. https://sci-hub.mksa.top/10.1007/978-3-540-30301-5_65
2. https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteen-challenges-and-opportunities/
3. https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/
4. https://sci-hub.mksa.top/10.1159/000492428

NPTEL COURSES:

1. Ethics in engineering practice: https://onlinecourses.nptel.ac.in/noc24_mg131/preview

22CAE12N

MACHINE TRANSLATION
(Professional Elective - V)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Probability and Statistics, Linguistics and NLP Concepts

Course Objectives: The objectives of this course are

1. Understand the theoretical and linguistic foundations of machine translation.
2. Explore statistical and neural approaches for building MT systems.
3. Develop practical skills in implementing and evaluating MT pipelines.
4. Gain exposure to transformer models and real-world deployment.
5. Analyse multilingual translation challenges, ethical concerns, and current research trends..

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand historical developments and foundational principles of MT.
2. Analyse and implement Statistical and Neural MT models.
3. Apply transformer-based architectures and modern evaluation metrics.
4. Build and deploy machine translation systems using open-source toolkits.
5. Critically examine recent advancements, multilingual models, and research challenges in MT.

CO-PO & PSO Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	1	-	-	-	2	-	3	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	2	3	2	3	-	-	-	1	1	-	3	3	3
CO4	3	2	3	3	3	1	-	1	2	2	2	3	3	3
CO5	3	3	2	3	3	2	1	1	1	2	2	3	3	3

UNIT- I:

Foundations of Machine Translation: History and evolution of machine translation, key linguistic challenges in translation, language typology and translation difficulties, word alignment basics, phrase-based models and decoding strategies, evaluation metrics (BLEU, METEOR, TER, etc.), introduction to MT corpora, and overview of industrial applications.

UNIT-II

Statistical Machine Translation (SMT):Language models (n-gram, smoothing, perplexity), translation models (noisy channel formulation), IBM alignment models I–V, expectation maximization in MT, phrase extraction and scoring, decoding algorithms and pruning, tuning methods (Minimum Error Rate Training), and limitations of SMT.

UNIT-III:

Neural Machine Translation (NMT): Sequence-to-sequence architecture with RNNs, word embeddings and vocabulary strategies, encoder-decoder framework, attention mechanisms (Bahdanau), loss functions and training objectives, beam search decoding, data preprocessing and batching, and transfer learning with multilingual pretraining.

UNIT-IV :

Transformer Models and Industrial Systems: Transformer architecture, positional encoding, and multi-head attention, comparison of RNN vs Transformer vs CNN-based NMT, large-scale training strategies, popular toolkits (Fairseq, HuggingFace, OpenNMT), deployment and serving techniques, evaluation beyond BLEU (COMET, BLEURT), and industrial MT pipelines.

UNIT-V

Advanced Topics and Case Studies: Multilingual Neural Machine Translation (MNMT), Prompting and Fine-Tuning Large Language Models for Translation.

Case Studies: Healthcare Translation Systems and Legal and Government Translation Pipelines.

Text Books / Suggested Reading:

1. Philipp Koehn – Statistical Machine Translation, Cambridge University Press, 2009.
2. Koehn, P. – Neural Machine Translation, Cambridge University Press, 2020. https://doi.org/10.1017/9781108608480
3. Yao Fu & Graham Neubig – Machine Translation: Foundations, Advances, and Challenges, 2024.

Related Text Books

1. Thomas Wolf et al. – Natural Language Processing with Transformers, O'Reilly Media, 2022.
2. Delip Rao & Brian McMahan – Natural Language Processing with PyTorch, O'Reilly Media, 2019.
3. Denis Rothman – Transformers for Natural Language Processing (2nd Edition), Packt Publishing, 2022.
4. Jacob Eisenstein – Natural Language Processing, MIT Press, 2019.
5. Ian Goodfellow, Yoshua Bengio, and Aaron Courville – Deep Learning, MIT Press, 2016.
6. Sasha Rush – The Annotated Transformer (Online Resource), Harvard NLP. https://nlp.seas.harvard.edu/annotated-transformer

22CIE53

BLOCKCHAIN TECHNOLOGY
(Professional Elective - V)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Distributed systems, Computer networks and Basic understanding of programming concepts.

Course Objectives:

1. To get acquainted with the foundations of blockchain.
2. To provide the significance of the bitcoin ecosystem.
3. To explore the consensus mechanisms and technologies that support Ethereum.
4. To introduce Hyperledger Fabric and its architecture.
5. To familiarize blockchain use cases in various domains.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand the significance of distributed systems and blockchain.
2. Explain the concepts of bitcoin and consensus mechanisms in bitcoin mining.
3. Explore the consensus mechanisms and technologies that support Ethereum.
4. Describe Hyperledger Fabric architecture and Hyperledger projects.
5. Analyse blockchain use cases in various domains.

CO-PO & PSO Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1	-	-	1	-	1	3	3	3
CO2	3	3	2	1	3	2	-	-	2	-	1	3	3	3
CO3	3	3	2	1	3	2	-	-	1	-	2	3	3	3
CO4	3	3	2	2	2	1	-	-	2	-	2	3	3	2
CO5	3	3	2	2	3	2	-	-	2	-	1	3	3	3

Unit –I

Blockchain Foundations: Overview of distributed systems, Introduction to blockchain, Generic elements of a blockchain, Features of blockchain, Applications of blockchain, Hash Functions and Merkle Trees, Components of blockchain Ecosystem, Cryptography and Consensus Algorithms, Types of blockchain, Blockchain Platforms.

Unit –II

Bitcoin Platform: Bitcoin definition, Keys and addresses, Public keys and Private keys in bitcoin, The transaction life cycle, The transaction structure, Bitcoin payments, Consensus mechanism in bitcoin, Wallet types, Non-deterministic wallets, Deterministic wallets, Alternative Coins: Namecoin, Litecoin, Zcash.

Unit –III

Ethereum Blockchain: Introducing Smart Contracts, Ethereum blockchain, The Ethereum stack, Ethereum virtual machine (EVM), Consensus mechanism in Ethereum, The Ethereum network, Ethereum Development, Setting up a development environment, Development tools: Remix IDE, Truffle, Ganache.

Unit –IV

Hyperledger Fabric: Introduction to Hyperledger Fabric, Hyperledger Fabric architecture, Membership services, Hyperledger Projects: Fabric, Sawtooth, Iroha, Components of the Fabric, Alternate blockchains-Ripple, Corda, Hyperledger Smart Contracts (Chaincode).

Unit –V

Case studies using blockchain: Cross border payments, Know Your Customer (KYC), Food supply chain, Mortgage over blockchain, Identity on blockchain, Blockchain in Insurance Industry, Education, Healthcare, Real estate management and Metaverse.

Text Books:

1. Imran Bashir, “Mastering Blockchain - A technical reference guide to the inner workings of blockchain, from cryptography to DeFi and NFTs”, Packt Publishing Ltd, Fourth Edition, 2023.
2. Melanie Swan, "Blockchain: Blueprint for a New Economy", First Edition, O'Reilly, 2018.

Suggested Reading:

1. Andreas M. Antonopoulos, “Mastering Bitcoin Unlocking Digital Cryptocurrencies”, First Edition Apress, 2017.
2. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and BlockChain”, Packt Publishing, 2019.
3. Ramchandra Sharad Mangrulkar, Pallavi Vijay Chavan, “Blockchain Essentials - Core Concepts and Implementations”, APress Publishing, 2024.

Online Resources:

1. https://andersbrownworth.com/blockchain/public-private-keys/
2. https://www.hyperledger.org/projects/fabric
3. NPTEL courses:
4. Blockchain and its Applications,
5. Blockchain Architecture Design and Use Cases

22CSE23

ROBOTIC PROCESS AUTOMATION
(Professional Elective - V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: -

Course Objectives:
This course aims to:

1. Provide insights on robotic process automation (RPA) technology and its value proposition
2. Introduce different platforms for RPA
3. Learn different types of variables, control flow and data manipulation techniques
4. Familiarize with Image, Text and data Tables Automation
5. Describe various types of Exceptions and strategies to handle them.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Gain insights into Robotic Process Automation Technology
2. Acquire knowledge of RPA Platforms and components
3. Identify and understand Image, Text and Data Tables Automation
4. Understand various control techniques and OCR in RPA
5. Describe Exception Handling and Debugging techniques

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	-	-	-	-	-	-	-	-	-	-	3	2	2
CO 2	2	1	1	-	2	-	-	-	1	2	-	3	3	2
CO 3	2	1	1	2	2	-	-	-	1	1	-	3	3	3
CO 4	2	1	1	1	2	-	-	-	1	-	-	3	3	3
CO 5	2	1	-	1	1	-	-	-	-	-	-	3	3	3

UNIT– I
RPA Foundations- What is RPA - flavors of RPA- history of RPA- The Benefits of RPA- The downsides of RPA- RPA Compared to BPO, BPM and BPA - Consumer Willingness for Automation- The Workforce of the Future- RPA Skills- On-Premise Vs. the Cloud- Web Technology- Programming Languages and Low Code OCR- Databases-APls- Al- Cognitive Automation-Agile, Scrum, Kanban and Waterfall Devops Flowcharts.

UNIT–II
RPA Platforms- Components of RPA- RPA Platforms-About Ui Path- About UiPath - The future of automation - Record and PIay - Downloading and installing UiPath Studio -Learning Ui Path Studio- - Task recorder - Step by step examples using the recorder.

UNIT–III
Sequence, Flowchart, and Control Flow-sequencing the workflow- Activities-Control flow, various types of loops, and decision making-Step-by step example using Sequence and Flowchart-Step-by-step example using Sequence and Control Flow-Data Manipulation-Variables and Scope Collections-Arguments – Purpose and useData table usage with examples Clipboard Management-File operation with step-by-step exampleCSV/Excel to data table and vice versa [with a step-by-step example).

UNIT–IV
Handling Events -Taking Control of the Controls- Finding and attaching windows- Finding the 08 controlTechniques for waiting for a control- Act on controls - mouse and keyboard activities- Working with Ui Explorer- Handling eventsRevisit recorder- Screen Scraping- When to use OCR- Types of OCR availableHow to use OCR- Avoiding typical failure points.

UNIT–V

Exception Handling, Debugging, and Logging- Exception handling- Common exceptions and ways to handle them- Logging and taking screenshots Debugging techniques- Collecting crash dumps- Error reporting, Industry Use case, Future of RPA.

Text Books:

1. Tom Taulli, ―The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems‖, Apress Publishing, 2020
2. Alok Mani Tripathi, ―Learning Robotic Process Automation‖, Packt Publishing, 2018.

Suggested Reading:

1. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant, Independently Published, 1st Edition 2018.
2. Frank Casale , Rebecca Dilla, Heidi Jaynes , Lauren Livingston, ―Introduction to Robotic Process Automation: a Primer‖, Institute of Robotic Process Automation,1st Edition 2015.
3. Srikanth Merianda,‖Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation‖, Consulting Opportunity Holdings LLC, 1st Edition, 2018

Online Resources:

1. https://www.uipath.com/rpa/robotic-process-automation
2. https://www.academy.uipath.com

22EGO03

INDIAN TRADITIONAL KNOWLEDGE
(Open Elective – III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Indian Culture.

Course Objectives:
This course aims to:
1. To get a knowledge in Indian Culture.
2. To know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature.
3. Learn the philosophy of ancient, medieval, and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.

CO-PO & PSO Articulation Matrix

PO/ PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	2	1	1	2	3	2	2	1	2	1	1	1
CO 2	1	1	2	1	1	2	3	2	2	1	2	2	1	2
CO 3	1	1	2	1	1	2	3	2	2	1	2	1	1	1
CO 4	1	1	2	1	1	2	3	2	2	1	2	1	1	1
CO 5	1	3	2	1	1	2	3	2	2	2	3	2	2	1

UNIT I
Culture and Civilization: Culture, Civilization and heritage, general characteristics of culture, importance of culture in human life, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian Cuisine, Martial arts.

UNIT II
Education System: Education in ancient, medieval and modern India, aims of education, subjects, Languages, Science and Scientists of ancient. Medieval and modern India. Concepts of Sciences in Indian Knowledge Systems.

UNIT III
Linguistic Wealth: Indian languages and Literature: The role of Sanskrit, Morphology and brevity of Sanskrit, Concepts of NLP in IKS. Paleography, Fundamentals of Vedic Mathematics, Significance of scriptures to current society, Indian semantics and lexicography, Darshanas.

UNIT IV
Art, Technology & Engineering: Sculpture, Painting and Handicrafts, Indian Music, Dance Drama and Theatre, introduction to Mayamatam, Iron and Steel technology, Use of metals in medicinal preparations.

UNIT-V
Science and Logic: Heliocentric system, Sulbasutras, Katapayadi, Engineering in Vedas, Adaptability of Sanskrit in Computer languages, Related commands Hindu calendar, 6 Pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka- Induction and deduction, Ayurvedic biology, Definition of health.

Text Books:

1. B. Madhavan, Nagendra Pavana, Vinayak Rajat Bhat, "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning, June 2022.
2. Kapil Kapoor, "Text and Interpretation: The Indian Tradition", D K Print World Ltd., 2005.
3. Samskrita Bharati, "Science in Sanskrit",2017.
4. Satya Prakash, "Founders of sciences in Ancient India", Govindram Hasanand, 1986.

Suggested Reading:

1. Brajendranath Seal, "The Positive Sciences of the Ancient Hindus", Motilal Banarasidass, 2016.
2. Kancha Ilaiah, "Turning the Pot, Tilling the Land: Dignity of Labour in Our Times", Navayana, 2019.
3. Balram Singh and others, "Science & Technology in Ancient Indian Texts", D.K. Print World Ltd, 1st edition, 2012.
4. Smt. Kalpama Paranjepe, "Ancient Indian insight and Modern Science", Bhandarkar Oriental Research Institute, 1996.
5. Pradeep Parihar, "Vedic World and Ancient Science", World House Book Publishing, 2021.

22EGO01

TECHNICAL WRITING SKILLS
(Open Elective – III)

(Open Elective -BE/B.Tech - Common to all Branches)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Language proficiency and the ability to simplify complex technical concepts for a diverse audience.

Course Objectives:

The course will introduce the students to:

1. Process of communication and channels of communication in general writing and technical writing in particular.
2. Learn Technical Writing including sentence structure and be able to understand and use technology specific words.
3. Write business letters and technical articles.
4. Write technical reports and technical proposals.
5. Learn to write agenda, record minutes of a meeting, draft memos. Understand how to make technical presentations.

Course Outcomes:

After successful completion of the course students will be able to:

1. Communicate effectively, without barriers and understand aspects of technical communication.
2. Differentiate between general writing and technical writing and write error free sentences using technology specific words.
3. Apply techniques of writing in business correspondence and in writing articles.
4. Draft technical reports and technical proposals.
5. Prepare agenda and minutes of a meeting and demonstrate effective technical presentation skills.

CO-PO & PSO Articulation Matrix

PO/PSO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	2	1	1	-	1	2	3	3	2	3	-	1	2
CO 2	-	1	-	1	-	-	1	2	2	1	2	-	-	3
CO 3	-	2	-	2	-	1	1	2	3	2	2	-	1	3
CO 4	2	2	1	3	-	2	1	3	3	2	2	1	2	3
CO 5	1	1	1	1	-	1	1	3	3	2	2	1	2	3

Unit - I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal communication. Barriers to communication. Technical Communication – Definition, oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

Unit II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

Unit III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature and significance, types. Journal articles and Conference papers, elements of technical articles.

Unit IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.

Technical Proposals: Definition, types, characteristics, structure and significance.

Unit V

Mechanics of Meetings: Preparation of agenda, participation, chairing and writing minutes of a meeting. Memorandum. Seminars, workshops and conferences.

Technical Presentations: Defining purpose, audience and locale, organizing content, preparing an outline, use of Audio Visual Aids, nuances of delivery, importance of body language and voice dynamics.

Textbooks:

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

Suggested Reading:

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

22ECO01

SYSTEM AUTOMATION AND CONTROL
(Open Elective – III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge about physical parameters in industry is required

Course Objectives:
This course aims to:
1. Learn the concepts industrial control systems
2. Learn how to measure the physical parameters in industry
3. Learn the applications of Robots in industry.

Course Outcomes:
After completion of this course, students will be able to:
1. Understand the features of various automatic and process control systems.
2. Define and analyze various measuring parameters in the industry.
3. Compare performance of various controllers (P, PD, PI, and PID).
4. Illustrate the role of digital computers in automation.
5. Develop various robot structures for different applications.

CO-PO & PSO Articulation Matrix

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	3	2	2	1	-	1	-	-	2	1	1	1
CO 2	3	3	3	2	1	1	-	1	-	-	1	1	1	1
CO 3	3	3	3	3	2	1	-	1	-	-	2	1	1	1
CO 4	2	2	2	2	2	2	-	1	-	-	2	1	1	1
CO 5	3	3	3	3	2	2	-	2	-	-	1	2	2	1

UNIT-I
Introduction to Automatic Control Systems: Purpose of Automatic Control, How an Industrial Control System is implemented, Introduction to Automatic Control theory.
Sensors: Sensor definition, Different types of Sensors:Motion, Position, Force, Level sensors, and Thermo couples.

UNIT-II
Theory of Measurements: Measurement goals and concepts, Scale factor, Linearity, accuracy, Range, Resolution, Precision and repeatability.
Measurement Techniques and Hardware: Typical Sensor outputs, Bridge measurements: General equation for bridge balance, Resistance balanced Wheatstone bridge, Variable voltage type measurements, Frequency type measurements.

UNIT-III
Process Controllers: What is a Controller, uses of Controllers, Open loop and closed loop Control, proportional, Analog and Digital methods of Control.
Controller Hardware: Analog and Digital Controllers, Pneumatic controllers, Integral, derivative, PI,PD,PID controllers.

UNIT-IV
Digital Computers as Process Controllers: Introduction, Information required by the computer, Information required by the process, Computer Interface electronics, Digital Computer input-output, computer processing of data, Digital Process control computer design, Computer programming.
Actuators: Electro mechanical - Linear motion and rotary motion solenoids, DC motors, AC motors and Stepped motors.

UNIT-V

Robots: What are robots, Robots and process Control systems, Degrees of freedom, factories of the future, Delivery, Disposal and transport systems, Sensing elements, Robot Classifications and Applications. Trouble shooting System failures: Preliminary steps and other troubleshooting aids.

Text Books:

1. Ronald P. Hunter, "Automated process control systems – concepts and Hardware", 2/e, PHI, 1987.
2. Norman A. Anderson, "Instrumentation for process measurement and Control", 3/e, CRC Press, 2005.

Suggested Reading:

1. Kuo B. C, "Automatic Control Systems", 9th edition
2. A.K Sawhney,"A course on Electrical and Electronic Measurements and Instrumentation".

22MEO05

RESEARCH METHODOLOGIES AND INTELLECTUAL PROPERTY RIGHTS
(Open Elective - III)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Nil

Course Objectives: This course aims to
1. Make the students to formulate the research problem
2. Identify various sources for literature review and data collection.
3. Prepare the research design
4. Equip the students with good methods to analyze the collected data
5. Introduce students to the concepts of innovation

Course Outcomes: Upon completion of this course, the students will be able to
1. Define research problem
2. Review and assess the quality of literature from various sources.
3. Understand and develop various research designs.
4. Collect and analyze the data using statistical techniques.
5. Apply creative thinking and innovative skills.

CO-PO & PSO Articulation Matrix

PO/PSO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	2	1	1	-	1	-	1	2	2	2	-	1	-
CO 2	-	2	1	2	1	1	1	1	3	2	2	-	-	-
CO 3	1	2	3	2	2	1	-	1	2	-	1	2	1	-
CO 4	2	2	-	3	2	-	-	-	2	1	1	1	1	-
CO 5	2	2	3	2	3	1	-	-	-	-	3	-	2	1

UNIT – I:
Research Methodology: Objectives, Motivation and Significance of Research, Types of Research, Research Methods versus Methodology, Research process, Criteria of Good Research, Problems Encountered by Researchers in India, Technique involved in defining a problem.

UNIT–II
Literature Survey: Importance of Literature Survey, Sources of Information Primary, Secondary and tertiary, Assessment of Quality of Journals and Articles, Information through Internet
Research writing: Format of the Research report, Writing a Synopsis, Dissertation, Research Proposal and Research Report

UNIT – III
Research Design: Meaning and Need of Research Design, Terminology used in Research Design, Features of a Good Research Design, Formulation of hypothesis, **O**perationalizing the research question, Different Research Designs – exploratory, descriptive, diagnostic and hypothesis testing research studies, Basic Principles of Experimental Design, Steps in Sample design

UNIT – IV
Data Collection and Analysis: Collection of primary dataObservation, Interview and Questionnaire methods, Secondary data, Measures of central tendency, Measures of dispersion, Measures of asymmetry, Important parametric tests z, t, F, ChiSquare, ANOVA significance.

UNIT – V
Innovation: Creativity, Innovation and its difference, Blocks for creativity and innovation, overcoming obstacles, Examples of innovation, Being innovative, Steps for Innovation, right climate for innovation, Design led innovation, Gross root innovation, Frugal and flexible approach to innovation.

Text Books:

1. C.R Kothari, “Research Methodology Methods & Technique”, New Age International Publishers, 2004.
2. R. Ganesan, “Research Methodology for Engineers”, MJP Publishers, 2011
3. The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008

Suggested Reading:

1. Vijay Upagade and Aravind Shende, “Research Methodology”, S. Chand & Company Ltd., New Delhi, 2009.
2. G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.
3. JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.

Online Resources:

1. https://archive.nptel.ac.in/courses/127/106/127106227/
2. https://archive.nptel.ac.in/courses/107/101/107101088/

22CEM01

ENVIRONMENTAL SCIENCE

Instruction	2L Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	0 Marks
Credits	Non-Credit

Course Objectives: To enable the students to

1. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
2. Become aware about the importance of eco system and biodiversity for maintaining ecological balance.
3. To identify the importance of interlinking of food chain.
4. Learn about various attributes of pollution management and waste management practices.
5. To make the students contribute for capacity building of nation for arresting and/or managing environmental disasters.

Course Outcomes: At the end of the course, student is able to

1. Identify various natural resources and effects of their over utilization.
2. Outline the working mechanism of ecosystem.
3. Illustrate the importance of bio-diversity conservation.
4. Identify remediation measures for environmental pollution through legislations.
5. Explain environmental issues and possible sustainable solutions.

CO-PO & PSO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	2	2	-	-	-	1	-	1	-
CO2	3	1	-	-	-	1	1	-	-	-	1	-	-	-
CO3	3	1	-	-	-	2	2	-	-	-	1	-	-	-
CO4	3	1	-	-	-	2	2	2	-	-	1	-	-	-
CO5	3	1	-	-	-	2	3	-	-		1	-	-	-

UNIT- I:

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT – II:

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT – III:

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT – IV:

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in

enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT – V:

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

Text Books:

1. Y. Anjaneyulu, "Introduction to Environmental Science", B S Publications, 2004.
2. Suresh K. Dhameja, "Environmental Studies", S. K. Kataria & Sons, 2009.

Suggested Reading:

1. C. S. Rao," Environmental Pollution Control Engineering", Wiley, 1991.
2. S. S. Dara, "A Text Book of Environmental Chemistry &Pollution Control", S. Chand Limited, 2006

E Resources:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2. https://archive.nptel.ac.in/courses/120/108/120108004/

22CAC20N

PROJECT PART – II

Instruction	8P Hours per week
Duration of End Examination	-
Semester End Examination	100 Marks
Continuous Internal Evaluation	100 Marks
Credits	4

The objective of 'Project: Part Phase - 2' is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership p. The assignment to normally include:

1. In depth study of the topic assigned;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Department Review Committee.

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

1. Demonstrate a sound technical knowledge of their selected topic.
2. Design engineering solutions to complex problems utilizing a systematic approach.
3. Conduct investigations by using research-based knowledge and methods to provide valid conclusions.
4. Create/select/use modern tools for the modelling, prediction and understanding the limitation of complex engineering solutions.
5. Communicate with engineers and the community at large in written and oral forms.
6. Demonstrate the knowledge, skills, and attitudes of a professional engineer.

Guidelines for awarding CIE (Max. Marks: 100)		
Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Department Review Committee (DRC)	10	Review 1
	15	Review 2
	25	Report Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Report Preparation
	10	Analytical/ Programming/Experimentation Skills
Publication	10	Quality of the work which may lead to ● Publication Submitted/ Published ● Products/ Prototypes/Working Models ● IPR(Patent) Submitted/ Published ● Projects showcased/ Presentations. ● Prizes won/ If any like best projects. ● Leading to a Start-Up

Guidelines for awarding SEE (Max. Marks: 100)		
Evaluation by	Max. Marks	Evaluation Criteria/Parameter
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the Project ● Innovation, ● Applications, ● Live Research Projects, ● Scope for further study, ● Applications to Society
	20	Viva-Voce