S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT
& RESEARCH, NAGPUR.
(An Autonomous Institute, Affiliated to RTMNU, Nagpur)
DEPARTMENT OF EMERGING TECHNOLOGIES (AI&ML and AI&DS)

# COURSE SYLLABUS

# FOR

# SEMESTER – III

# B. Tech.

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(W. E. F. 2022-23)

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PCCAM301T | Operating System | 4 | 0 | 0 | 4 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course empowers the learner with the fundamentals of Operating System, its design & development issues such as process scheduling, synchronization, deadlocks, memory management, I/O subsystems and protection to enhance their skills and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Interpret the concepts of operating systems to deal with computer hardware using its fundamental concepts. |
| CO2 | **Apply:** Utilize the concept of process management, synchronization and memory management in designing operating systems to resolve different issues. |
| CO3 | **Apply:** Apply various disk scheduling algorithms and concepts of system security for file management related problems. |
| CO4 | **Analyze:** Analyze process scheduling, synchronization problems and memory management techniques under various situations to improve system performance. |
| CO5 | **Analyze:** Examine the given scenario using the concepts of deadlock, system security, files and disk scheduling algorithms to solve the real-world problems. |

## SYLLABUS

**UNIT I: Introduction to Operating System**

Concepts and Generations of Operating systems, Services, Components, Types of Operating Systems, System Calls, Structure of an OS - Layered, Monolithic, Microkernel OS, Basic h/w support necessary for modern operating systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.

*Exposure to Android Studio and VMware as specialized Operating Systems.*

**UNIT II: Process Management**

**Processes:** Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.

**Process Scheduling:** Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria. Scheduling algorithms: Preemptive and Non-Pre-emptive, FCFS, SJF, RR, Priority Scheduling, Real Time scheduling: RM and EDF.

**Inter process Communication**: Message Passing, Shared Memory.

**UNIT III: Process Synchronization**

**Thread:** Definition, Various states, Multithreading: Benefits of threads, Concept of multi-threads, Multithreading Models.

**Critical Section problem**: Introduction, Race Condition, software and hardware solution, Peterson's solution, Semaphores, Monitors.

**Classical Synchronization Problems**: Bounded Buffer, Reader's & Writer Problem, Dining Philosopher Problem.

**UNIT IV: Deadlock & Protection**

**Deadlocks:** Definition, Necessary and sufficient conditions for Deadlock, Resource allocation graph, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

**Protection:** Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of Access matrix, Security problem.

**UNIT V: Memory Management**

Basic concept, Logical and Physical address, Memory allocation: Contiguous Memory allocation, Fixed and variable partition, Internal and External fragmentation, Compaction, Swapping, Segmentation.

**Paging:** Principle of operation, Page allocation, Hardware support for paging, Page table structuring technique, Protection and sharing, Advantages and Disadvantages of paging.

**Virtual Memory**: Basics of Virtual Memory, Demand paging, Page fault, Working Set, Dirty page/Dirty bit, Page Replacement algorithms: Optimal, First in First Out (FIFO) and Least Recently used (LRU), Thrashing.

**UNIT VI: File System Management**

**File Management**: Concept of File, Access methods, File types, File operation, Directory structures, directory implementation, File System structure, Allocation methods, Free-space management, efficiency and performance.

**Disk Management**: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, Disk formatting, Boot-block, Bad block, I/O devices, Device controllers and Device drivers.

**Introduction to Mobile and Smart OS:** Architecture & Overview of Android OS. Comparison of different OS. Recent Trend, Global Operating System Market.

| Text Books |
|---|
| 1. Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, 9th Edition, 2016, John Wiley & Sons. |

| Reference Books |
|---|
| 1. Modern Operating System, Andrew S. Tanenbaum, Herbert Bos, 4th Edition, 2015, Pearson Education.<br>2. Operating Systems Internals and Design Principles, William Stallings, 7th Edition, 2012, Pearson Education.<br>3. Operating Systems - A Concept-Based Approach, Dhananjay M. Dhamdhere, 3rd Edition, 2012, McGraw-Hill Education.<br>4. Operating Systems - Design Oriented Approach, Charles Crowley, 1st Edition, 2017, Mc. Graw Hill Education. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM302T | Fundamentals of Digital Electronics and Computer Architecture | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objectives |
|---|
| The course develops the logic for designing digital circuits, functional units of computer architecture and ability to improve performance of machine that enhances employability and entrepreneurship skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Apply:** Simplify the Boolean functions using Boolean algebra and K-maps to develop combinational circuits for input signals. |
| CO2 | **Analyze:** Analyze the concepts of sequential circuits to design bit cells using flip-flops. |
| CO3 | **Apply:** Make use of basic operational concepts of computer architecture and utilize computer arithmetic to perform various operations. |
| CO4 | **Apply:** Apply the knowledge of memory, I/O organization and pipelining for efficient peripheral communication and improving the performance of a system. |
| CO5 | **Analyze:** Analyze the improvement in performance of the system by using different types of memory and I/O devices. |

## SYLLABUS

**UNIT I: Fundamental Concepts of Digital Systems**

Introduction, number systems, logic gates and truth tables, minimization of combinational circuits using Boolean algebra, Karnaugh maps.

*Exposure of modern simulator for demonstrating logic gates.*

**UNIT II: Combinational Circuits**

Adders & subtractor (half & full), multiplexers, demultiplexers, encoders, decoders, code converters and their use in realizing Boolean functions.

*Exposure of modern simulator for demonstrating combinational circuits.*

**UNIT III: Sequential Circuits**

**Flip-flops (FF):** D, T, J-K, S-R, Master Slave (MS) J-K flip-flops, conversion of one FF to another FF, introduction of counters and registers as applications of flip-flops.

*Exposure of modern simulator for demonstrating sequential circuits.*

**UNIT IV: Basic Computer Structure and Arithmetic**

**Basic structure of computers:** Von Neumann vs. Harvard architecture, functional units, basic operational concepts, bus structures, instruction formats, addressing modes, execution of complete instructions, subroutines, hardwired and microprogrammed control.

**Computer arithmetic:** Introduction, addition and subtraction, Booth's multiplication algorithm, restoring and non-restoring division algorithms, floating point representation.

**UNIT V: Memory & I/O Organization**

**Memory organization**: Memory hierarchy, RAM, ROM and cache memory, memory mapping techniques, virtual memory, page replacement policies.

**Input-output organization:** Peripheral devices, input-output interface, modes of transfer, interrupts, direct memory access.

**UNIT VI: Central Processing Unit**

**Central processing unit:** The 8086 processor architecture, register organization, physical memory organization, general bus operation, concept of pipelining.

**Text Books**

1. Modern Digital Electronics, R. P. Jain, 4th Edition, 2010, McGraw Hill.
2. Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5th Edition, International Edition.
3. Advanced Microprocessors and Peripherals, K. M. Bhurchandi, A. K Ray, 3rd Edition, 2017, TMH.

**Reference Books**

1. Modern Digital Electronics, R. P. Jain, 4th Edition, 2010, McGraw Hill.
2. Microprocessors and Interfacing, D. V. Hall, SSSP Rao, 3rd Edition, 2006, Tata McGraw Hill.
3. Computer System Architecture, M. Morris Mano, 3rd Edition (Revised), 2017, Pearson.
4. Modern Computer Architecture and Organization: Learn X86, ARM, and RISC-V Architectures and the Design of Smartphones, PCs, and Cloud Servers, Jim Ledin, 1st Edition, 2020, Packt Publishing Ltd.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM303T | Data Structures & Algorithms | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objectives |
|---|
| The course develops programming skills to analyze linear and non-linear data structures and strengthen the ability to apply suitable data structure for the given real-world problem that helps to enhance employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Analyze:** Classify the appropriate abstract data type and analyze the efficiency of an algorithm based on time and space complexity. |
| CO2 | **Apply:** Select the appropriate searching and sorting techniques to solve given problems. |
| CO3 | **Create:** Design an algorithm using linear and nonlinear data structures to solve engineering problems. |
| CO4 | **Create:** Design an appropriate hashing function for indexing large storage in different applications. |
| CO5 | **Apply:** Demonstrate and apply appropriate data structure to solve given problems. |

## SYLLABUS

**UNIT I: Abstract Data Types and Algorithms**

**Introduction**: Basic terminologies, abstract data types (ADT) and their characteristics, concept of linear and nonlinear, static and dynamic.

**Algorithms:** Introduction to algorithms, characteristics of algorithms, analysis of algorithms, complexity of algorithms: space complexity, time complexity, asymptotic notations: Big-O, Theta and Omega.

**UNIT II: Sorting and Searching**

**Sorting:** Types- Internal and external sorting, general sorting concepts - sort order, stability, efficiency, number of passes, sorting methods - merge sort, quick sort, heap sort, shell sort, bucket sort, radix sort, application of sorting techniques, performance analysis and comparison.

**Searching:** Linear Search, binary search, applications of searching, performance analysis and comparison.

**UNIT III: Stacks and Queues**

**Stack ADT:** Concept, primitive operations, implementation of stacks, multiple stacks, applications of stack, need for prefix and postfix expressions, conversion from infix to prefix and postfix expression, evaluation of prefix and postfix expression using stack.

**Queue ADT:** Concept, operations, simple queue, circular queue, double-ended and priority queue, applications of queue.

**UNIT IV: Linked Lists**

Concept, primitive operations, representation of linked lists, types of linked list- singly linked list, circular linked list and doubly linked list, polynomial manipulations: addition and multiplication using linked list, generalized linked list (GLL).

**UNIT V: Trees**

Basic Tree terminologies, tree definition and properties, binary tree and its operations, binary search tree (BST) and its operations, threaded binary trees, AVL tree and its rotation, red black tree, splay tree, B-tree, B+ tree, tree traversal techniques, applications of tree traversal techniques.

**UNIT VI: Graphs and Hashing**

**Graphs:** Introduction to Graphs, applications of graph, representation of graphs, traversals techniques-DFS and BFS.

**Hashing:** Hash functions and hash tables, properties, simple hash function, methods for collision handling

**Text Books**

1. Fundamentals of Data Structures in C, Ellis Horowitz, Sartaj Sahani & Susan Anderson-Freed, 2nd Edition, 2012, Universities Press.
2. Data Structures and Algorithms: Concepts, Techniques and Application, G.A.V. Pai, 3rd Edition, 2012, Tata McGraw-Hill Education.

**Reference Books**

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin, 3rd Edition, 2017, Pearson Education.
2. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, 3rd Edition, 2015, MIT Press.
3. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, 2nd Edition, 2004, Course Technology Inc.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM303P | Data Structures & Algorithms Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | - |

| Course Objectives |
|---|
| The course develops programming skills to analyze and apply linear and non-linear data structures to solve real-world problems that enhances employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the students will be able to: | |
| CO1 | **Analyze:** Analyze the performance of various algorithms based on time and space complexity. |
| CO2 | **Apply:** Apply appropriate searching and sorting techniques for a given problem statement. |
| CO3 | **Create:** Design applications using linear and nonlinear data structures to solve engineering problems. |
| CO4 | **Evaluate**: Choose appropriate data structures to solve given problems efficiently. |

**A minimum of eight practical to be performed based on the theory course Data Structures and Algorithms [PCCAM303T].**

**Suggested References -**

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd Edition, PHI Learning.
2. Data Structures using C, K. Sharma, 2nd Edition, Pearson Education.
3. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, 2nd Edition, 2004, Course Technology Inc.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM304T | Object Oriented Programming | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

**Course Objectives**

The course develops programming skills using object-oriented programming concepts and apply them to design real-world applications to solve different problems that enhance employability and entrepreneurship.

**Course Outcomes**

After successful completion of this course, the students will be able to:

| | |
|---|---|
| CO1 | **Analyze:** Identify classes, objects and members of a class and its relationships to solve a specific problem statement. |
| CO2 | **Create:** Develop Java application programs using OOP principles, Java collection, java structuring, Multithreading & Exception Handling to solve real world problems. |
| CO3 | **Evaluate:** Select Java API, appropriate Framework & technologies to solve the complex problems. |
| CO4 | **Analyze:** Analyze the requirements to develop the software application using java programming. |
| CO5 | **Create:** Develop a java application using modern tools along with literature & submit a report with a team to solve societal problems. |

**SYLLABUS**

**UNIT-I: Introduction to OOP & Java**

Object-oriented concepts, need of Java programming, basics of Java: history, features, paradigms, programming constructs, static modifier, final modifier, difference between Java & other languages like C and C++.

**Fundamentals of Classes & Objects:** Identify classes and objects in real word application, declaring objects, assigning objects, reference variables, overloading methods, constructors, 'this' keyword, wrapper classes.

**Applications:** Object as a parameter, argument passing, command line arguments, returning object.

**Nested classes:** Inner classes, garbage collection, arrays.

*Exposure to modern Integrated Development Environment (IDE's) used in industry.*

**UNIT-II: Java Strings and Packages**

**String:** Immutable string, string comparison, string concatenation, searching string and modifying string, substring, stringbuffer class, stringbuilder class, tostring method, stringtokenizer class. Packages: Package fundamentals, access protection, importing packages.

**UNIT-III: Inheritance & Exception handling**

**Inheritance:** Types, abstract classes and methods, interfaces, method overriding.

**Exception Handling:** Exception types (checked, unchecked and uncaught exceptions), throw and throws keywords, creating user defined exceptions, built-in exceptions.

**UNIT-IV: Multithreading**

Fundamentals, Thread life cycle, ways of creating threads, creating multiple threads, isAlive(), join(), Thread synchronization, Thread priorities, inter Thread communication, methods for suspending, resuming and stopping threads.

*Use of multithreading in game development and other applications in industry.*

**UNIT-V: Java Streams and Collections**

**Java Streams**: Byte-oriented streams, character – oriented streams, reading and writing files, serialization. Collection Framework: Introduction, util package interfaces, List, Set, Map, List interface & its classes, Set interface & its classes, Map interface & its classes.

*Use of modern data structures for the development of different applications.*

**UNIT-VI: Java 8 & Spring Boot**

**Java 8**: Lambda expressions, method references, functional interfaces, stream API, forEach, Date/Time API, Java 8 security enhancements.

**Spring boot:** Definition, need, features of spring boot, web application development using spring boot to solve real world problems.

**Text Books**

1. Head First Java, Kathy Sierra, Bert Bates, 3rd Edition, 2022, O'Reilly Media Inc.
2. Object Oriented Programming in C++, E. Balaguruswamy, 7th Edition, 2017, McGraw-Hill Education.

**Reference Books**

1. C++: The Complete Reference, Herbert Shildt, 4th Edition, 2000, Tata McGraw Hill.
2. The Java Language Specification, Bill Joy, Gilad Bracha, Guy L. Steele Jr., James Gosling, 10th Edition, 2005, Addison Wesley.
3. Core Java Volume I – Fundamentals, Cay S. Horstmann, 10th Edition, 2015, Pearson.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM304P | Object Oriented Programming Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | -- |

| Course Objectives |
|---|
| The course provides opportunities to develop programming skills using object-oriented programming concepts and apply them to design real-world applications to solve different problems that enhance employability and entrepreneurship. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the students will be able to: | |
| CO1 | **Apply:** Demonstrate practical applications developed in Java to solve complex problems. |
| CO2 | **Apply:** Make use of exception handling, file I/O, multithreading, collection frameworks to develop java applications. |
| CO3 | **Create:** Develop object-oriented programming concepts using basic syntax of control structures, strings and functions for logic building activities. |
| CO4 | **Create:** Develop real world applications using Java collection API and Java class library to solve given use cases. |
| CO5 | **Create:** Develop a Spring boot application using java programming. |

**A minimum of eight practical to be performed based on the theory course Object Oriented Programming [PCCAM304T].**

| Suggested References |
|---|
| 1. Java -The Complete reference, Herbert Schildt, 11th Edition, 2020, McGraw Hill Education |
| 2. Java: A Beginner's Guide, Herbert Schildt, 8th Edition, 2018, McGraw Hill Education |
| 3. C++: The Complete Reference, Herbert Shildt, 2000, Tata McGraw Hill |
| 4. The Java Language Specification, Bill Joy, Gilad Bracha, Guy L. Steele Jr., James Gosling, 2005, Addison Wesley |

| Course Code | Course Title | Hour/ Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM305P | Python Programming Lab | 0 | 0 | 4 | 2 | 25 | 25 | 50 | -- |

| Course Objective |
|---|
| The course familiarizes the prospective engineers with fundamentals of Python Programming language, numpy library, panda library and Django web framework in order to enhance their skills, employability and explore entrepreneurship ideas. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Apply:** Apply knowledge of Python Scripting, control structure, string and functions to solve the given problems effectively. |
| CO2 | **Apply:** Utilize concepts of numpy, data structures, files and data frames to develop efficient solution for the given problems. |
| CO3 | **Analysis:** Analyze the problems using knowledge of object-oriented programming and Exception handling to develop useful applications. |
| CO4 | **Evaluate:** Select appropriate libraries and modules available in python programming to solve the given problem efficiently. |
| CO5 | **Create:** Design and Develop solutions using Python libraries and Web framework for the given problem statement. |

**SYLLABUS**

**MODULE-I: Fundamentals of Python Programming**

**Python Scripting:** Introduction to Python, Installation, Python IDLE, Scripting using Google Colab.

**Python Basics:** Data Types, Keywords, Variables, Operators, Expressions, Scope of variables and input () Function

**Control Structure:** If statement, If-else statement, If-elif-else, For Loop, Iterating Over a Range, While Loop, Else clause in Loop, Nesting of Loops.

**Introduction to Numpy**: Need of Numpy, Features, Creating Arrays, Array Indexing, Numpy Array operations.

*Exposure to Sublime Text for learning Python.*

**MODULE-II: String and Functions**

**Strings in Python:** Creating string, Character Extraction from String, Iterating Over Strings, String Slicing, Modify string, Concatenate String and String operations.

**Python Function**: Defining a Function, Calling a Function, Pass by reference vs value, Types of Function Arguments, Anonymous Function and Recursion.

*Exposure to Pycharm IDE*

**MODULE-III: Data Structures**

**List in Python:** Creation, iterating List, List slicing, Appending a list and List operations.

**Tuple in Python:** Understanding tuple, Iterating over tuple, Slicing, Indexing and Tuple methods.

**Set in Python:** Understanding set, Iterating over set and Set operations.

**Dictionary in Python:** Understating Dictionary, Iterating over dictionary, Indexing, Dictionary operations, Comparison among List, Tuple, Set and Dictionary.

*Exposure to Spyder IDE*

**MODULE-IV: File Handling and Dataframes**

**File Handling:** Introduction to files, file Object Attributes, File operations: open ( ), close ( ), read(), write( ), rename(), remove(), Positioning, Copying, Merging and Appending.

**Data frames in Python:** Introduction to Pandas, Data import, Data Export, Data Processing using Pandas.

*Exposure to Jupyter Notebook*

**MODULE-V: Object Oriented Programming and Exceptions Handling**

**Object Orientated Programming:** Classes, Objects, Attributes, Accessing attribute, Instantiation, Methods, Calling methods and Inheritance, Methods and Operator Overloading.

**Exception Handling**: Syntax Error, Exceptions, try clause, except clause, raise clauses, Handling and Raising an Exceptions.

*Exposure to VSCode*

**MODULE-VI: Web Framework**

**Introduction of Django:** Need of framework, Feature of Django Framework

**Project Set-Up:** Django Installation, Create Django Project, Virtual Environment Set Up, Explanation of different Configuration File

**URL Mapping:** Handle Request and Response, Handle static file.

Deployment of web application.

**A minimum of eight practical to be performed based on above modules.**

**Suggested References**

1. Learning Python, Mark Lutz, 4th Edition, 2000, O'Reilly Media.
2. Python Data Science Handbook, Jake Vaderplas, 1st Edition, 2016, O'Reilly Media.
3. Django for APIs: Build web APIs with Python and Django, William S Vincent, 2018, Kindle Edition.
4. Python: The complete Reference, Martin C Brown, 1st Edition, 2001, McGraw Hill.
5. Python Essential Reference, 4th Edition, 1999, Developer's Library.

21/07/22
Dr. M S Nimbarte

Dr. R. Jain
21/7/22

21/7/2022
S.A. Ladke

Md. Ashar

21/7/22
H.O.D. CSE

Dr. S. S. Badhe

21/07/22
Dr. Richa Malviya

S.R. Bodhe

21/7/22
(P. R. Tayade)

Shruti
(Shruti Jain)

# COURSE SYLLABUS

# FOR

# SEMESTER – IV

# B. Tech.

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(W. E. F. 2022-23)

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PCCAM401T | Discrete Mathematics & Graph Theory | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course provides the concepts such as logic and proofs, sets and functions, probability, group theory, graph theory, ring theory and other important discrete mathematical concepts to the learners. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Evaluate**: Identify the axioms of set theory, formulate the problem in the language of sets and perform set operations to solve them. |
| CO2 | **Apply**: Apply the various types & properties of Relations & Functions to solve real world problems. |
| CO3 | **Apply**: Apply the theorems on group theory & ring theory to solve problems and analyze the structures. |
| CO4 | **Apply**: Apply the concept of graph theory and trees to solve real world problems. |
| CO5 | **Apply**: Apply basic counting techniques to solve combinatorial problems. |

| SYLLABUS |
|---|
| **UNIT 1: Mathematical Logic**<br>Propositions and Logical Operations, Quantifiers, Conditional Statements and Tautologies, Methods of Proof, Principle of Mathematical Induction. Basic concepts of set theory, Operations on Sets, The power set. |
| **UNIT 2: Relation and Functions**<br>**Relations**: Ordered pairs, Product Sets and Partitions, Relations and Digraphs, Matrix of Relation, Properties of Relations, Equivalence Relations, Compatible Relation, Composition of Relations, Transitive Closure of a relation, Partial order relation, Hasse Diagrams.<br>**Functions**: Definition, Composition of functions, Types of Functions, Invertible Function, Permutation Function, Characteristics function of a set with Theorems. |
| **UNIT 3: Group Theory**<br>Binary Operations, Properties, Semi groups, Monoids, Isomorphism & Homomorphism, Groups (only definitions and examples) Subgroups and Homomorphism, Co sets and Lagrange's Theorem, Normal subgroups. |
| **UNIT 4: Ring Theory**<br>Rings, Fields, Integral Domain, Ring Homomorphism (definitions & examples), |

| |
|---|
| **Lattices**: Properties, Types of Lattices, Sub lattices, Isomorphic Lattices, Complemented & Modular Lattices (definitions & examples).<br>Optimization using Linear Programming Problems. |
| **UNIT 5: Graph Theory**<br>Basic concepts of Graph Theory, Digraphs, Basic definitions, Paths and Circuits, Reachability and Connectedness, Matrix representation of graphs, Sub graphs, Isomorphic digraphs, Euler's and Hamilton Path & Circuit (only definitions and examples).<br>**Trees**: Binary Tree, Labeled Trees, Undirected Trees, Spanning Trees of Connected Relations, Minimal Spanning Trees by Prim's Algorithm & Kruskal's Algorithm. |
| **UNIT 6: Combinatorics**<br>Generating Functions, Recurrence Relations,<br>**Counting**: Permutations & Combinations, Pigeonhole Principle with Simple Applications |

| **Text Books:** |
|---|
| 1. Discrete Mathematical Structures, Kolman, Busby & Ross, 6th Edition, 2019, PHI Publication. |
| 2. Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Kenneth H. Rosen's, 7th Edition 2011, McGraw-Hill Publishing. |
| 3. Discrete Mathematical Structures with Applications to Computer Science, Tremblay & Manohar, 35th Edition, 1997, Tata McGraw- Hill. |

| **Reference Books:** |
|---|
| 1. Discrete Mathematics for Computer Scientists & Mathematicians, Mott, Kandel, Baker, 2nd Edition, 2018, Pearson Publication. |
| 2. Elements of Discrete Mathematics, C.L. Liu, 3rd Edition, 1969, McGraw Hill |
| 3. Discrete Mathematics by Lipchitz & Lipson, 3rd Edition, 2007, Schaum's Series. |
| 4. Discrete Mathematics, R. Johnsonbaugh, 8th Edition, 2013, Pearson Publication. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM402T | Database Management System | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course empowers the learners to apply the concepts of traditional and modern database management systems to design and handle databases that enhances their development skills and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Interpret the fundamental and advanced concepts in the database to comprehend various database architectures. |
| CO2 | **Apply:** Make use of SQL, PL/SQL and NoSQL to perform different operations on database as per specified problem statement. |
| CO3 | **Apply:** Apply the concept of relational data model, integrity constraints, query processing, transaction management, indexing and normalization on database to solve given problem. |
| CO4 | **Analyze:** Analyze different database techniques to design efficient databases in different scenarios. |
| CO5 | **Create:** Design an appropriate ER diagram and respective database for given application. |

**SYLLABUS**

**UNIT-I: Introduction to Database**

Overview of Database Management Systems, Purpose, Limitations of File Processing System, Industrial Applications, Data Models, Types of Databases, Database Users, DBA, Data Abstraction, View, Data Independence, DBMS Architecture, Three Tier architecture, Keys

**ER Model**: Entity, Attributes, Relationships, ER Diagram, Weak & Strong Entity, Extended E-R Features, Database Development Life Cycle, Approaches to Building a Database, Challenges in Building a DBMS

*Exposure to open-source tool for designing ER Diagrams*

**UNIT-II: SQL AND PL/SQL**

**SQL:** Characteristics and advantages, SQL Data Types, DDL, DML, SQL Operators, order by, distinct, like, in, between, all, any, joins, set operations, aggregate functions, group by clause, having clause, Sub queries, alias, sequence, handling null values, CASE, single row functions. DCL, TCL

**PL/SQL:** Constant, variables, Operators, Control Structures, Loops, Procedures, Functions and Cursors, Triggers, Packages

*Exposure to LiveSQL to demonstrate SQL & PL/SQL*

| |
|---|
| **UNIT-III: Relational Data Model**<br>Concept of relations, Schema-instance distinction, CODD's Rules. Relational Algebra: Unary and Binary Operators. Relational Calculus: Tuple relational calculus, Domain relational calculus<br>**Integrity Constraints**: Domain Constraints, Referential Integrity, Assertions and Triggers<br><br>*Exposure to LiveSQL for demonstration of Integrity Constraints* |
| **UNIT-IV: Relational Database Design**<br>**Introduction to Indexing**: Advantages, Evaluation Metrics, Types: Primary Indexing, Dense, Sparse, Clustering Index, Multi-Level, Secondary<br>**Normalization**: Concepts of Functional dependency, Decomposition, closure of FD set, closure of attributes, 1NF, 2NF, 3NF, BCNF, 4NF, 5NF |
| **UNIT-V: Query Processing & Transaction Management**<br>**Query Processing:** Steps in Query Processing, Pipelining and Materialization, Query optimization types, Materialized View<br>**Transaction Management**: Basic concept of a Transaction, ACID Properties of Transactions, Concept of Schedule: Serial & Non-serial, Serializability: Conflict and View |
| **UNIT-VI: Concurrency Control & Recovery System**<br>**Concurrency Control**: Lock-based and timestamp-based protocols, Deadlock: Deadlock handling, detection and recovery.<br>**Recovery System**: Failure classification, Log-Based Recovery, Shadow-Paging, Aries Algorithm, Checkpoints.<br>Introduction of Advanced Concepts in Databases Management System. |

| **Text Books:** |
|---|
| 1. Database System Concepts, Silberschatz A., Korth H., Sudarshan S., 7th edition, 2019, Tata McGraw Hill. |
| 2. SQL, PL/SQL: The Programming Language of Oracle, Ivan Bayross, 4th Revised Edition, 2020, BPB Publication. |

| **Reference Books:** |
|---|
| 1. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2014, Tata McGraw Hill Publication. |
| 2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant Navathe, 7th Edition, 2016, Pearson. |
| 3. An Introduction to Database Systems, C J Date, 8th Edition, 2004, Pearson. |
| 4. NoSQL Distilled, Pramod J. Sadalage and Martin Fowler, 1st Edition, 2002, Addison Wesley. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM402P | Database Management System Lab | 0 | 0 | 4 | 2 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The course empowers the learner to apply the concepts of traditional and modern database management systems to design and handle databases that enhances their development skills and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Create:** Design an appropriate ER Diagram for a given problem by using different Open -Source tools. |
| CO2 | **Create:** Design, develop and modify the databases for any real-world problem using suitable queries. |
| CO3 | **Apply:** Construct SQL query for given problem statement using suitable SQL clause to retrieve data from database. |
| CO4 | **Apply:** Build connection between frontend and backend using appropriate procedure. |
| CO5 | **Create:** Develop a PL/SQL block to provide solutions for real world problems. |

**A minimum of eight practical to be performed based on the theory course Database Management System [PCCAM402T].**

| Suggested References: |
|---|
| 1. SQL: The Complete Reference, James Groff, Paul Weinberg and Andy Oppel, 3rd Edition, 2017, McGraw Hill. |
| 2. SQL, PL/SQL: The Programming Language of Oracle, Ivan Bayross, 2010, BPB Publication. |
| 3. MongoDB: The Definitive Guide, Kristina Chodorow, Michael Dirolf, 1st Edition, 2010, O'Reilly Publications. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM403T | Computer Networks | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objectives |
|---|
| The course provides the understanding of the fundamental concepts of data communication, components of computer networks, protocols at different layers and manage computer networking systems to improve technical knowledge. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Apply:** Apply the knowledge of analog and digital signals, transmission modes, signal conversion techniques in data communication. |
| CO2 | **Apply:** Select suitable routing protocol and congestion control mechanism to improve quality of service. |
| CO3 | **Analyze:** Analyze layer wise functioning of network architecture with different performance measures in communication networks. |
| CO4 | **Evaluate:** Evaluate the design issues of the data link layer using various techniques and protocols. |
| CO5 | **Understand:** Demonstrate the knowledge of modern network technologies used in network communication. |

## SYLLABUS

**UNIT-I: Data Communication Basics**

Process of data communication and its components: transmitter, receiver, medium, message, protocol, bandwidth, data transmission rate, analog and digital signals, Transmission modes: serial and parallel transmission, asynchronous and synchronous transmission, simplex, half-duplex and full-duplex communication, transmission media, switching techniques, circuit switching and packet switching.

**UNIT-II: Introduction to Computer Networks**

Introduction, network criteria, network topology, networking devices, categories of networks (LAN, MAN, WAN), wireless network (Bluetooth, Wi-Fi, WiMAX, Zigbee, Wi-Fi SON. Reference models: OSI reference model, TCP/IP model, comparison of models.

*Use of Packet Tracer Simulator to demonstrate the categories of networks.*

**UNIT-III: Data Link Layer**

Types of errors, framing: character and bit stuffing, error detection & correction methods. Flow control protocols: stop & wait ARQ, Go-Back- N ARQ, selective repeat ARQ, point to point protocol, Fiber Distributed Data Interface (FDDI), token bus, token ring. Multiple access protocols: random access, controlled access, channelization techniques.

*Use of data link simulators to demonstrate the concept of flow control protocols*

**UNIT-IV: Routing Protocols**

Routing: adaptive and non-adaptive techniques, static vs dynamic routing, routing table. Routing algorithms: shortest path algorithm, flooding, distance vector routing. Mobile routing algorithms: Destination Sequenced Distance Vector (DSDV) and Dynamic Source Routing (DSR), concept of wireless router.

*Use of Packet Tracer Simulator to demonstrate the routing algorithms.*

**UNIT-V: Network and Transport Layer**

Network Layer: ARP, RARP, IP, DHCP, ICMP, IPV6, unicast and multicast routing protocols. Congestion control algorithms: leaky bucket algorithm, token bucket algorithm, congestion control techniques.
Transport Layer: Process to process delivery, UDP, TCP, Quality of Service (QoS).

**UNIT-VI: Application Layer**

Application Layer: Domain Name System (DNS), Dynamic Domain Name System (DDNS), telnet, email, File Transfer Protocol (FTP), www, Hyper Text Transfer Protocol (HTTP), Simple Network Management Protocol (SNMP), Bluetooth, Firewalls.

**Text Books:**

1. Data Communications and Networks, Behrouz A. Forouzan, 5th Edition, 2013, Tata McGraw- Hill Publication.
2. Computer Networks, Andrew S. Tanenbaum, 5th Edition, 2011, Prentice – Hall India.

**Reference Books:**

1. Data and Computer Communication, William Stallings, 8th Edition, 2012, Pearson Education.
2. Data Communications and Computer Networks, Dr. T. Sreenivasulu, Dr. H. Shaheen, Dr. Rajasekar Rangasamy, 2018, VSRD Academic Publishing.
3. Computer Networks and Internets: With Internet Applications, Dougles E. Comer, M.S. Narayanan, Volume 1, 4th Edition, 2008, Pearson Education.
4. Computer Networks: A Systems Approach, Larry L. Peterson and Bruce S. Davie, 5th Edition, 2012, Morgan Kauffmann Publishers.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM403P | Computer Networks Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | -- |

| Course Objectives |
|---|
| The course provides the learners an understanding of the components of computer networks, protocols and manage computer systems using networking devices to improve their technical knowledge and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the students will be able to: | |
| CO1 | **Apply:** Use various network utility commands for checking the internet connectivity and the concepts of IPv4 addressing for assigning IP addresses to network machines. |
| CO2 | **Apply:** Apply network fundamentals to solve computational problems and estimate the performance to improve quality of service in computer networks. |
| CO3 | **Evaluate:** Evaluate the network performance with different routing algorithms. |
| CO4 | **Design:** Design of LAN using various wired, wireless networking devices & network cables to simulate networking scenarios. |

**A minimum of eight practical to be performed based on the theory course Computer Networks [PCCAM403T].**

**Suggested References:**

1. Data Communications and Networks, Behrouz A. Forouzan, 5th Edition, 2013, Tata McGraw- Hill Publication.
2. Computer Networks, Andrew S. Tanenbaum, 5th Edition, 2011, Prentice – Hall India.
3. Data and Computer Communication, William Stallings, 8th Edition, 2012, Pearson Education.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM404T | Fundamentals of Artificial Intelligence & Machine Learning | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables the students to understand the basic concepts of artificial intelligence and use suitable machine learning techniques for real-time applications to improve their employability and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Understand:** Illustrate the concepts of Artificial Intelligence and basics of machine learning, its trends and applications. |
| CO2 | **Apply:** Apply exploratory search techniques to solve problems in various domains. |
| CO3 | **Apply:** Make use of knowledge representation techniques to create a knowledge base for intelligent systems. |
| CO4 | **Understand:** Interpret the characteristics of machine learning that makes it useful to real-world problems. |
| CO5 | **Apply:** Make use of different linear methods for regression and classification for predicting possible outcome. |

## SYLLABUS

**UNIT I: Introduction to Artificial Intelligence**

Definition of AI, history & applications, artificial intelligence as representation & search, intelligent agents, agent architecture, production system, basics of problem solving: AI techniques, problem representation paradigms, defining problem as a state space representation, problem characteristics.

**UNIT II: Searching Techniques**

Uninformed search techniques, informed heuristic-based search, Hill-climbing, Best-First search, AND graph, problem reduction, AND-OR graph algorithm, constraint satisfaction problem.

**UNIT III: Knowledge Representation**

Paradigms, propositional logic, inference rules in propositional logic, knowledge representation using predicate logic, first order logic, backward chaining and forward chaining, semantic net, frames, script, ontology.

**UNIT-IV: Introduction to Machine Learning**

History of ML, Machine Learning Applications, Learning Types, ML Life cycle, AI & ML, dataset for ML, Data Pre-processing, Training versus Testing, Positive and Negative Class, Cross-validation.

| |
|---|
| **UNIT-V: Learning Techniques**<br>**Types of Learning:** Supervised, Unsupervised and Reinforcement Learning.<br>**Supervised:** Learning a Class from Examples, Types of supervised Machine learning Algorithms, **Unsupervised:** Types of Unsupervised Learning Algorithm, Dimensionality Reduction: Introduction, Subset Selection, and Introduction to Principal Component Analysis. |
| **UNIT-VI: Classification & Regression**<br>**Classification:** Binary and Multiclass Classification, Assessing Classification Performance, Handling more than two classes, Multiclass Classification-One vs One, One vs Rest.<br>**Regression:** Assessing performance of Regression, Error measures, Overfitting and Underfitting, Catalysts for Overfitting. |

| **Text Books** |
|---|
| 1. Artificial Intelligence - A Modern Approach, S. Russell, P. Norvig, 3rd Edition, 2015, Prentice Hall. |
| 2. Artificial Intelligence, Kevin Knight, Elaine Rich, Shivashankar B. Nair, 3rd Edition, 2017, McGraw Hill Education. |
| 3. Machine Learning, Mitchell Tom, 1997, McGraw Hill. |

| **Reference Books** |
|---|
| 1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, 1995, PHI. |
| 2. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, G. F. Luger, 6th Edition, 2008, Pearson. |
| 3. Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, MIT Press. |
| 4. Machine Learning –an Algorithmic Perspective, Stephen Marsland, 2nd Edition, 2014, CRC Press. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM405P | Machine Learning Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | -- |

| Course Objectives |
|---|
| The lab course develops skills to work with various python libraries for machine learning to solve real-world problems that helps to improve employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the students will be able to: | |
| CO1 | **Apply**: Make use of suitable python libraries as required for data preprocessing and analysis needed in machine learning. |
| CO2 | **Apply**: Apply the concepts of statistical-learning for scientific data processing using Sci-kit learn. |
| CO3 | **Apply**: Make use of various tools of Matplotlib for data analysis in machine learning. |

| MODULE | SYLLABUS |
|---|---|
| I | **Machine Learning using Scikit-learn**<br>Installing scikit-learn, Scikit-learn governance and decision-making, statistical-learning for scientific data processing, Working with Text Data, Choosing the right estimator, Fitting and predicting: estimator basics, Transformers and pre-processors, Pipelines: chaining pre-processors and estimators, Model evaluation, Automatic parameter searches, Dataset transformations, Dataset loading utilities, Computing with scikit-learn. |
| II | **Exploring Matplotlib**<br>Introduction, Environment Setup, Pyplot, API Simple Plot, PyLab module, Object-oriented Interface, Figure Class, Axes Class, Multiplots, Subplots() Function, Subplot2grid() function, Grids , Formatting Axes, Setting Limits, Setting Ticks and Tick Labels, Twin Axes, Bar Plot, Histogram, Pie Chart Various type of Plots, Three-dimensional Plotting, 3D Contour Plot, 3D Wireframe plot, 3D Surface plot, Working With Text, Mathematical Expressions, Working with Images, transforms. |

**A minimum of eight practical to be performed based on the above modules.**

| Suggested References |
|---|
| 1. Machine Learning: Step-by-Step Guide to Implement Machine Learning Algorithms with Python, Rudolph Russell, 2018, Createspace Independent Publishing Platform. |
| 2. Data Analysis from Scratch with Python-Step by Step Guide, Peters Morgan, 2016, AI Sciences LLC. |
| 3. Python Data Analytics - Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language, Fabio Nelli, 2015, Apress. |
| 4. Matplotlib, tutorialspoint, (https://www.tutorialspoint.com/matplotlib/index.htm). |

| Course Code | Course Title | Hour/ Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM406P | Professional Skills Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | -- |

| Course Objective |
|---|
| This course aims to provide a practical introduction to the R programming language. The learner will be comfortable operating in the R environment, including importing external data, manipulating data for specific needs, and running summary statistics in order to enhance their skills and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Understand the basic concepts of R programming for data analysis & demonstrate how to install and configure RStudio. |
| CO2 | **Apply:** Apply various data structures in R programming language for organizing the data. |
| CO3 | **Apply:** Make use of visualization libraries and plot various Graphs and perform variable analysis (Univariate, bivariate, multivariate) |
| CO4 | **Analyze:** Analyze the probability and probability distributions to solve a wide variety of problems. |

| MODULE | SYLLABUS |
|---|---|
| I | Introduction to Data, Information, Types of data, sources of data. Trends in data science.<br>**R Programming:**<br>Introduction, Installation of R and R studio. Basic Syntax and execution of various R commands to execute basic arithmetic, relational and logical operations on different variable. CRUD (Create, Read, Update and Delete) operations on various data structures such as Strings, Vectors, List, Matrix. |
| II | **Data Frames, Factors & Table in R Data Frames:**<br>Data Frames, creating a Data Frame, General Operations on Data Frames, expanding a Data Frame, Applying Functions to Data Frames.<br>**Factors & Tables:**<br>Introduction, creating a Factor, Factor Levels, summarizing a Factor, Ordered Factors, Converting Factors, Common Functions Used with Factors, Introduction to Tables and Creating Tables, Table-related Functions, Cross-tabulation. |
| III | **Descriptive and Inferential Statistics:**<br>Summary statistics, Graphs and Tables, perform EDA (Exploratory Data Analysis) using statistical concepts and Graphs in R, creating graphs and drawing inferences from results. Hypothesis Tests, Confidence Interval and Regression. Implementation of various tests such as Correlation, ANOVA, Z test, T test using R language. Comparison of descriptive and inferential statistics. |

| | |
|---|---|
| IV | **Probability Theory:**<br>Probability and Statistics, Probability distribution. Creation of Graphs to show distribution of data, understanding its skewness, finding outliers, calculating IQR and draw inferences. |

**A minimum of eight practical to be performed based on above modules.**

**Suggested References:**

1. R Programming for Beginners, Sandhya Arora, Latesh Malik, 2020, Universities Press.
2. Introduction to Statistics and Data Analysis with Exercises, Solutions and Applications in R, Christian Heumann, Michael Schomaker Shalabh, 2016, Springer.
3. Easy R Programming for Beginners, Felix Alvaro, 2016, Create Space Independent Publishing Platform.
4. R in Action: Data Analysis & Graphics in R, Dr. Rob Kabacoff, 2nd Edition, 2015, Manning Publication.

| Course Code | Course Title | Hour/ Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| OECAM401T | R-Programming | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course familiarizes the prospective engineers with fundamentals of R Programming for statistical analysis of data, in order to enhance their skills and employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Understand the basic concepts and operations of R programming for data analysis. |
| CO2 | **Apply:** Apply various data structures in R programming language for organizing the data. |
| CO3 | **Apply:** Make use of visualization libraries and plot various Graphs and perform variable analysis (Univariate, bivariate, multivariate) |
| CO4 | **Analyze:** Analyze data with the concepts of statistics and perform exploratory data analysis. |
| CO5 | **Apply:** Apply the concepts of probability distribution for drawing inferences from given data. |

## SYLLABUS

**UNIT-I: Introduction to Data Science and R Programming**

Introduction to Data, Information, Types of data, sources of data, Trends in the areas of data science. Introduction to R Programming: Installation of R and R studio, Basic Syntax and execution of various R commands, basic arithmetic, relational and logical operations on different variables.

**UNIT-II: Basic Operations**

CRUD (Create, Read, Update and Delete) operations on various data structures such as Strings, Vectors, List, Matrix.

**UNIT-III: Data Frames, Factors & Table in R**

Introduction to Data Frames, creating a Data Frame, General Operations on Data Frames, expanding a Data Frame, Applying Functions to Data Frames.

Factors & Tables: Introduction to Factors, creating a Factor, Factor Levels, summarizing a Factor, Ordered Factors, Converting Factors, Common Functions Used with Factors, Introduction to Tables and Creating Tables, Table-related Functions, Cross-tabulation.

| |
|---|
| **UNIT-IV: Descriptive Statistics**<br>Introduction to various Descriptive Statistics concepts such as summary statistics, Graphs and Tables, perform EDA (Exploratory Data Analysis) using statistical concepts and Graphs in R, creating graphs and drawing inferences from results. |
| **UNIT-V: Inferential Statistics**<br>Introduction to Inferential Statistics and its type such as Hypothesis Tests, Confidence Interval and Regression. Implementation of various tests such as Correlation, ANOVA, Z test, T test using R language. Comparison of descriptive and inferential statistics. |
| **UNIT-VI: Basic Probability**<br>Probability and Statistics, Probability distribution, Creation of Graphs to show distribution of data, understanding its skewness, finding outliers, calculating IQR and draw inferences. |

| **Text Books:** |
|---|
| 1. R Programming for Beginners, Sandhya Arora, Latesh Malik, 2020, Universities Press. |
| 2. Introduction to Statistics and Data Analysis with Exercises, Solutions and Applications in R, Christian Heumann, Michael Schomaker Shalabh, 2016, Springer. |

| **Reference Books:** |
|---|
| 1. Easy R Programming for Beginners, Felix Alvaro, 2016, Create Space Independent Publishing Platform. |
| 2. R in Action: Data Analysis & Graphics in R, Dr. Rob Kabacoff, 2nd Edition, 2015, Manning Publication. |

| CourseCode | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| HSMCME401P/ HSMCEE401P/ HSMCET401P/ HSMCCS402P/ HSMCAM401P/ HSMCAD401P/ | Soft Skills-I | 0 | 0 | 2 | 1 | 25 | 25 | 50 | - |

## Course Objective

The course empowers the learner to develop and nurture soft skills so as to enhance their employability quotient.

## Course Outcomes

After successful completion of this course the student will be able to:

| | |
|---|---|
| CO1 | **Understand:** Assimilate the concept of soft skills in their professional career to nurture the Employability skills. |
| CO2 | **Apply:** Apply grammatically correct structure in communication. |
| CO3 | **Apply:** To build competency for presentation skills. |
| CO4 | **Apply:** To make use of competency for professional correspondence. |

Dr. S. Anwar

Dr. V. A Sudani

## SYLLABUS

### MODULE 1: PROFESSIONAL READINESS ACQUISITION PROGRAM - (PRAP)

**1. Importance of Soft Skills:** Differentiate between hard and soft skills, Discipline specific skills Vs soft skills, Employability skills and its types, Learning & core values. The confidence grid, The power of thoughts, How Thoughts work, Anxiety, Decoding Self confidence , Self confidence cycle, Techniques, Protecting self Confidence, Building positive self Image, Affirmations.

**2. Time Management:** Time, Time Management, Need for time management, Benefits of time management, Obstacle of Time management, What can we do, How to use Time effectively, Set goals, Prioritize Work, Organizing the work, When to say No, Identifying, celebrating success.

**3. Presentation Skills:** Important Tips, Role of Power point presentation.

**4. Leadership Skills:** Leadership, Identifying the traits and skills of an effective leader, examine the role, understanding the limits of authority in a team leader's role.

**5. Team Work:** Objectives, What are Goals, Categorization of Goals, 5 Philosophies for goals, Types of goals?

**6. Conversational Skills:** Dialogues, Short Stories.

### MODULE 2 : ENGLISH LANGUAGE ACQUISITION PROGRAM(ELAP)

**1. Grammar in Action:** Subject-Verb Agreement, Idioms& Phrases, Common spoken Language errors, Direct-Indirect speech, Phrasal Verbs, Active Passive Voice.

**2.Written Communication & Formal Correspondence:** Notice Writing, Circular Writing, Technical Report Writing, Project Writing, e-mail etiquettes

**3. Comprehension:** Listening & Reading comprehension.

- All the contents of above modules shall be covered during the course of the practical sessions.
- Activities on the above modules must be conducted wherever applicable.

| Text Books Recommended |
|---|
| 1. The ACE of Soft Skills-Attitude, Communication and Etiquette for Success - Gopalaswamy Ramesh and Mahadevan Ramesh, 1st Edition, 2010, Pearson Publication. |
| 2. Corporate Softskills - Sarvesh Gulati, 5th Edition, 2012, Rupa & Co. Publication. |

| Reference Books Recommended |
|---|
| Soft skills - Know yourself and know the world - Dr. K. Alex, 2009, S. Chand Publication. |



Dr. S. Anwar

Dr. V. Asudani

# COURSE SYLLABUS

# FOR

# SEMESTER – V

# B. TECH.
# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

# (W. E. F. 2023-24)

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM501T | Theory of Computation | 3 | 1 | - | 4 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The learners will be able to understand the basic concepts of formal languages and various models of computation. Also, they will be able to design mathematical machines for real time problems which enhance logical thinking and improve employability. |

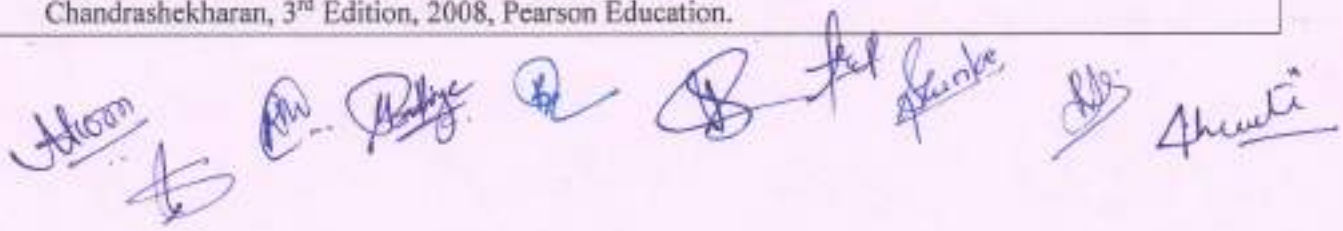
| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Understand:** Illustrate the basic concepts of formal languages and various models of computation. |
| CO2 | **Analyze:** Analyze the given automata or machines and find out its language. |
| CO3 | **Understand:** Demonstrate formal relationships among machines, languages and grammars |
| CO4 | **Analyze:** Analyze the decidability of a problem using a Turing machine. |
| CO5 | **Create:** Design automata, regular expression, push down automata and Turing Machine for a given language. |

| SYLLABUS |
|---|
| **UNIT I: Fundamentals of Languages and Finite Automata**<br>Alphabet, Symbols, Sets, Strings, Language, Operations, Relations, Chomsky hierarchy of languages, Design of Finite State Machines, Acceptance of strings and languages, Non-Deterministic Finite Automaton, Deterministic Finite Automaton, Equivalence between NFA and DFA, NFA with ε-transition, Minimization of FA, FSM with output. |
| **UNIT II: Regular Language and Grammar**<br>Regular sets, Regular expressions, Manipulation of regular expressions, Equivalence between RE and FA, Pumping Lemma for regular set, Closure properties of regular sets (Proofs not required), Regular grammars, Right linear and left linear regular grammars, inter-conversion between LLG & RLG, Equivalence between regular grammar and FA, Inter-conversion between RE and RG. |
| **UNIT III: Context Free Grammar**<br>Context free grammar, Derivation trees (Syntax tree and Parse tree), Ambiguous Grammar, Simplification of CFG, Context Free Language (CFL), Pumping Lemma for CFL, Closure properties of CFL, Normal Form of CFG: Chomsky Normal form, Greibach Normal form. |

| |
|---|
| **UNIT IV: Push Down Automata**<br>Definition and model of Push Down Automata (PDA), acceptance of CFL by empty Stack and by final state, Design of PDA (DPDA & NPDA) equivalence of CFL & PDA, Inter-conversion of PDA & CFG. |
| **UNIT V: Turing Machine**<br>Definition, Model of TM, Designing of Turing Machine as an accepter and as a transducer, types of Turing machines, Church's hypothesis, Linear bounded automata and context sensitive language. |
| **UNIT VI: Undecidability**<br>Decidability of problems, Recursive enumerable language, Recursive Language, Properties of Recursive enumerable language, Halting problem of Turing machine, Universal Turing Machine, Undecidability, primitive recursive functions, Posts Correspondence problem, Ackerman's function. |

| **Text Books** |
|---|
| 1. Introduction to Automata Theory Languages and Computation, Hopcroft H. E., Ullman J. D., 3rd Edition, 2008, Pearson Education. |
| 2. Introduction to languages and the Theory of Computation, John C. Martin, 3rd Edition, 2002, Mc-Graw Hill. |

| **Reference Books** |
|---|
| 1. Introduction to Theory of Computation, Michael Sipser, 3rd Edition, 2006, Cengage Learning. |
| 2. Theory of Computer Science: Automata, Languages and Computation, K. L. P. Mishra, Chandrashekharan, 3rd Edition, 2008, Pearson Education. |



| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PCCAM502T | Design & Analysis of Algorithms | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

## Course Objective

The course imparts knowledge of design and analysis of algorithms to improve problem solving capabilities and analytical skills to enhance employability.

## Course Outcomes

After successful completion of this course the student will be able to:

| | |
|---|---|
| CO1 | **Understand:** Explain the role of mathematical foundations in NP problem, decision and optimization problems, non-deterministic, graph-based and approximation algorithms. |
| CO2 | **Analyze:** Examine worst-case running times of searching and sorting algorithms using asymptotic analysis and amortized analysis. |
| CO3 | **Apply:** Make use of various methodologies to solve recurrence relations. |
| CO4 | **Apply:** Demonstrate various strategies like, divide and conquer, greedy, dynamic programming and backtracking for problem solving and basic traversal techniques for searching problems. |
| CO5 | **Evaluate:** Select suitable Data structure and algorithm to address the given situation. |

## SYLLABUS

**UNIT I: Recurrences and Asymptotic Notations**

Introduction: Algorithm definition, algorithm characteristics, principles of designing algorithms.
Performance Analysis: Space complexity, time complexity, asymptotic notations: big-oh notation, omega notation, theta notation.
Recurrence Relations: Solutions of recurrence relations using techniques of characteristic equation, generating functions, master method and substitution method.

**UNIT II: Divide and Conquer**

Basic strategy, matrix operations, Strassen's matrix multiplication, binary search, quick sort, merge sort, amortized analysis, application of amortized analysis, advanced data structures like Fibonacci heap, binomial heap, disjoint set representation.

**UNIT III: Greedy Method**

Basic strategy, fractional knapsack problem, application to job sequencing with deadlines problem, minimum cost spanning trees, single source shortest path – Prim's algorithm, Kruskal's algorithm and Dijkstra's algorithm, optimal search patterns, activity selection problem.

**UNIT IV: Dynamic Programming**

Basic strategy, multistage graphs, all pairs shortest path - Floyd Warshall algorithm, single source shortest paths-Bellman Ford algorithm, optimal binary search trees, traveling salesman problem, longest common subsequence problem, chained matrix multiplication.

**UNIT V: Basic Traversal and Search Techniques**

Search Techniques: Breadth first search and depth first search, connected components.
Backtracking: Basic strategy, 8-Queen's problem, graph coloring, Hamiltonian cycles.
Brach and Bound: 0/1 knapsack problem
Approximation algorithm: Introduction, vertex cover problem, subset sum problem.

**UNIT VI: NP-Completeness**

Basic concepts, non-deterministic algorithms, NP, P, NP-hard and NP-complete, decision and optimization problems, graph-based problems on NP Principle.

**Text Books**

1. Computer Algorithms, Horowitz, Sahani, Rajasekaram, 2008, Silicon Press.
2. Introduction to Algorithms, T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, 3rd Edition, 2009, PHI Learning.

**Reference Books**

1. Fundamentals of Algorithms, Brassard, Bratley, 1st Edition, 1995, Prentice Hall.
2. Design and Analysis of Algorithms, Aho, Ullman, Hopcroft, 1st Edition, 2002, Pearson Education.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PCCAM502P | Design & Analysis of Algorithms Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objectives |
|---|
| To choose the appropriate data structure and algorithm design strategy for a specific application and solve the problems in an intelligent and effective way to improve employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Apply:** Demonstrate the knowledge of basic data structures and use them for implementing the solution in a best suited way. |
| CO2 | **Evaluate:** Determine the computational complexity of an algorithm to perform particular task. |
| CO3 | **Evaluate:** Evaluate the performance of different algorithms when applied to a given problem. |
| CO4 | **Create**: Design code using various algorithms for solving problems. |

**A minimum of eight practical to be performed based on the theory course Design & Analysis of Algorithms [PCCAM502T].**

| Suggested References |
|---|
| 1. Computer Algorithms, Horowitz, Sahani, Rajasekaram, 2008, Silicon Press. |
| 2. Fundamentals of Algorithms, Brassard, Bratley, 1st Edition, 1995, Prentice Hall. |
| 3. Introduction to Algorithms, T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, 3rd Edition, 2009, PHI |
| 4. Design and Analysis of algorithms, Aho, Ullman, Hopcroft, 1st Edition, 2002, Pearson Education. |

| Course Code | Course Title | Hours/Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PCCAM503T | Software Engineering & Project Management | 2 | - | - | 2 | 20 | 30 | 50 | 2 |

**Course Objective**

The course enables students to understand both theoretical and methodological issues involved in modern software engineering and project management of software systems to improve their employability and technical skills.

**Course Outcomes**

After successful completion of this course the student will be able to:

| | |
|---|---|
| CO1 | **Understand:** Explain the basic concepts of Software Engineering & relate appropriate software models and technologies to bring out innovative and novelistic solutions for the software development. |
| CO2 | **Create:** Analyze and design the software architectures with the help of different UML diagrams. |
| CO3 | **Evaluate:** Determine an appropriate project management approach through an evaluation in accordance with business context and scope of the project. |
| CO4 | **Create:** Design various estimation levels of cost and effort required for Project Management. |

**SYLLABUS**

**UNIT I: Software Process**

Introduction: Evolution of Software Engineering, Layered Technology Approach, Characteristics of Software, Software Process Framework.

Perspective Process Models: Waterfall model, Incremental Model, RAD Model, Evolutionary Process model (Prototyping & Spiral Model), Agile Model for Software Development.

**UNIT II: System Analysis**

System Analysis: Requirement Engineering, Data modeling, Object-Oriented Analysis, Scenario-Based Modeling, Flow-Oriented Modeling, Class-based Modeling, Behavioral Model.

Design Concepts: Abstraction, Pattern modularity, Information hiding, Design classes, Refactoring.

**UNIT III: Project management**

Project Management: Introduction to Software Project Management, Project Planning, Project scheduling, Risk management, Change Management, Software reengineering, Restructuring Reverse engineering, Forward Engineering

**UNIT IV: Quality Management**

Quality Concepts: Software Quality, Software Reviews, Formal Technical Review, Software Reliability.

Quality Assurance Activities: SQA, Software Configuration Management, SCM Repository, SCM Process, Estimation.

Quality Standards: ISO 9000 and Companion ISO Standards, CMMI, Six Sigma.

| Text Books: |
|---|
| 1. Software Engineering-A Practitioner's Approach, Roger Pressman, 7th Edition, 2010, McGraw Hill. |
| 2. Software Engineering, Ian Sommerville, 9th Edition, 2011, Pearson Education Asia. |

| Reference Books: |
|---|
| 1. Fundamentals of Software Engineering, Rajib Mall, 3rd Edition, 2009, PHI Learning Private Limited |
| 2. Software Quality Assurance: From Theory of Implementation, Daniel Galin, 2nd Edition, 2012, Pearson Addison-Wesley. |
| 3. Software Engineering, David Gustafsan, Schaum's Series, 2002, Tata McGraw Hill. |
| 4. Software Project Management - Sanjay Mohapatra (Cengage Learning) |

| Course Code | Course Title | Hours /Week | | | Credits | Maximum Marks | | | ESE Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | |
| PCCAM503P | Software Engineering & Project Management Lab | - | - | 4 | 2 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The lab course enables students to understand the software engineering methodologies involved in the phases for project development to enhance their employability and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Explain the software engineering methodologies involved in the phases for project development. |
| CO2 | **Apply:** Apply appropriate software models and technologies to bring out innovative and novelistic solutions for the software development. |
| CO3 | **Analyze:** Analyze open-source tools used for implementing software engineering methods. |
| CO4 | **Create:** Develop product-prototypes implementing software engineering methods. |

**A minimum of eight practical to be performed based on the theory course Software Engineering & Project Management [PCCAM503T].**

| Suggested References: |
|---|
| 1. Software Engineering-A Practitioner's Approach, Roger Pressman, 7th Edition, 2010, McGraw Hill. |
| 2. Software Engineering, Ian Sommerville, 9th Edition, 2011, Pearson Education Asia. |
| 3. Software Quality Assurance: From Theory of Implementation, Daniel Galin, 2nd Edition, 2012, Pearson Addison-Wesley. |
| 4. Software Quality Engineering: Testing, Quality Assurance and Quantifiable, Jeff Tian, 2005, Wiley. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM504T | Neural Network & Fuzzy Logic | 2 | - | - | 2 | 20 | 30 | 50 | 2 |

| Course Objective |
|---|
| The course enables learners to understand fundamentals of artificial neural networks, fuzzy logic and acquire knowledge to deal with intelligent system related problems. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the student will be able to: | |
| CO1 | **Understand:** Illustrate the concepts of Neural Networks, Feedforward and feedback networks. |
| CO2 | **Understand:** Interpret the concepts of fuzzy logic and fuzzy arithmetic involved in various systems. |
| CO3 | **Apply:** Identify and describe Fuzzy Logic and Artificial Neural Network techniques in building intelligent machines. |
| CO4 | **Apply:** Apply Artificial Neural Network & Fuzzy Logic models to handle uncertainty and solve engineering problems. |

**SYLLABUS**

**UNIT I: Neural Networks**

History, Overview of biological neuro-system, mathematical models of neurons, ANN architecture, learning rules, Learning Paradigms-Supervised, Unsupervised, Semi-supervised and Reinforcement Learning, Learning Tasks, Applications of Artificial Neural Networks.

**UNIT II: Feedforward and Feedback Networks**

Introduction, Single-layer perceptron classifiers, Discriminant functions, linear machine and minimum distance classification, Multilayer feedforward networks, linearly non-separable pattern classification, Delta learning rule, Feedforward recall and error back-propagation training, Hopfield learning algorithm, Self-organizing Map.

**UNIT III: Fuzzy Logic**

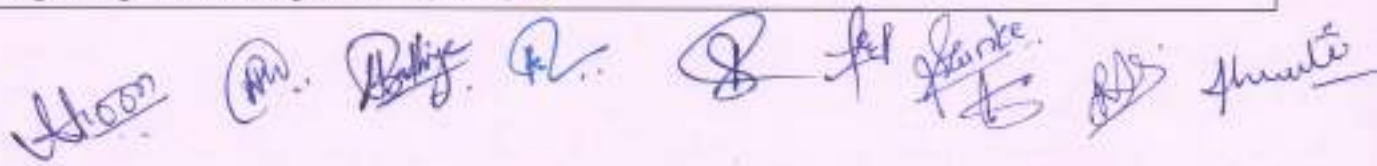
Introduction, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation, Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

**UNIT IV: Fuzzy Arithmetic**

Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations, Application of Fuzzy Logic, Fuzzy control, Fuzzy Inference Engines, Graphical Techniques of Inference, Fuzzification, Defuzzification.

| Text Books: |
|---|
| 1. Introduction to Artificial Neural System, J. M. Zurada, Jaico, 1st Edition, 1994, Publishing House, India. |
| 2. Fuzzy Logic with Engineering Applications, T. J. Ross, 3rd Edition, 2010, A John Wiley and Sons, Ltd., Publication |

| Reference Books: |
|---|
| 1. Fuzzy sets and Fuzzy logic, Theory and Applications, George J. Klir, Bo Yuan, Prentice Hall. |
| 2. Elements of Artificial Neural Networks, Kishan Mehrotra, C. K. Mohan, S. Ranka Penram, International Publishing (India). |
| 3. Neuro-Fuzzy and Soft Computing: A computational Approach to Learning & Machine Intelligence, Roger Jang, Tsai Sun, Eiji Mizutani, 2007, PHI |



| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| OECAM501T | Game Development using Python | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables the students to understand various elements of a game and game development using Python libraries to improve entrepreneurship and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Extend the knowledge of game, virtual reality and aspects of intersecting games to solve the given problems. |
| CO2 | **Apply:** Utilize concepts of graphics, images, navigation, control and sound for game development. |
| CO3 | **Analyze:** Analyze the problems using knowledge of looping game and simulating reality and intelligence to develop useful applications. |
| CO4 | **Apply:** Select appropriate collision detection methods available in Python programming to solve the given problem efficiently. |
| CO5 | **Create:** Design and Develop solutions using Python libraries and Python game development framework for the given problem statement. |

| SYLLABUS |
|---|
| **UNIT I: Games**<br>Virtual Reality, Game Genres, Common Aspects of Computer Games, Platforms. Aspects of Interesting Games. |
| **UNIT II: Working of Games**<br>Video Game Architecture, The Graphics System, The Audio System, Game Design, Playing the Game by the Rule, The Pong Game. |
| **UNIT III: Graphics and Images**<br>Pygame Essentials, Simple Static Drawing, Pixel Level Graphics, Lines and Curves, Polygons, Blitting, Drawing Text, Transparent Colors, Image Transformations, Pixels and Color, The C2H6O Jet Boat Race Game. |

| |
|---|
| **UNIT IV: The Game Loop**<br>Time and Intervals, Events. Randomness in Games, Generating Random Values, Simulating Reality and Intelligence. |
| **UNIT V: Game AI: Collisions**<br>Collision Detection, Polygonal Objects, Broad Phase Collision Detection, Narrow Phase Collision Detection, Collision Detection in the Boat Race. |
| **UNIT VI: Navigation, Control and Sound**<br>Navigation and Control: Basic Autonomous Control, Finite State Machines, Pathfinding, Stochastic Navigation.<br>**Sound**: Basic Audio Concepts, Introduction to Sound in Pygame, Creating Your Own Sounds, Positional Audio, Distance Attenuation, 2D Positional Sound. |

| **Text Books:** |
|---|
| 1. Game Development Using Python, James R. Parke, 2019, Mercury Learning & Information. |
| 2. Beginning Game Development with Python and Pygame: From Novice to Professional, Will McGugan , 1st Edition, 2007, Apress. |

| **Reference Books:** |
|---|
| 1. 3D Math Primer for Graphics and Game Development, Fletcher Dunn, 2nd Edition, 2011, A K Peters/CRC Press.<br>2. Programming Game AI By Example, Mat Buckland, 1st Edition, 2004, Jones and Bartlett Publishers. |

22/02/2023
Dr. M S Nimbarte

Dr. Richa Makhijani

Dr. S. S. Badhiye

Ms. Roshani Talmale

Dr. A Tayal 22/2/23

Md. Ashan

S. A. Tumte 22/2/2023

Dr. R. Jain 22/2/2023

# COURSE SYLLABUS

# FOR

# SEMESTER – VI

# B. TECH.
# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

# (W. E. F. 2023-24)

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM601T | Compiler Design | 4 | - | - | 4 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The learners will be able to explore the principles, algorithms, and data structures involved in the design of compilers. Also, they will be able to understand various phases of compilation and their working, which enhance logical thinking and improve employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Demonstrate various phases of compilation, with understanding of lexical analysis in compiler design. |
| CO2 | **Create:** Design Parsers using top-down and bottom-up parsing techniques for given grammar in syntax analysis. |
| CO3 | **Apply:** Make use of syntax directed translation schemes and construct Intermediate code for a given set of productions |
| CO4 | **Apply:** Make use of different code optimization and generation techniques on various intermediate codes to generate efficient target code. |
| CO5 | **Apply:** Choose a data structure for symbol table organization to store various attributes and apply different error recovery tools on parsers. |

| SYLLABUS |
|---|
| **UNIT I: Introduction to Compilers**<br>Introduction, Definition, phases & passes of compiler design, compiler writing tools, relation of compilation phases with formal languages.<br>Lexical Analysis: Introduction, tokens, pattern and lexemes, design of lexical analyzer, role of regular expression and finite automata in recognition of tokens, lexical errors. |
| **UNIT II: Syntax Analysis**<br>Introduction, Context free grammars (CFG), Ambiguous Grammars, Simplification of CFG, Top- down parser, design of predictive (LL(1)) parser, bottom-up parsing technique, Handle and Viable Prefix, LR parsing, Design of SLR, CLR, LALR parsers, Parser Conflicts, Implementation of Parsers. |
| **UNIT III: Intermediate Code Generation**<br>Syntax Directed Translation: Syntax directed definition, S-attributed and L-attributed definitions, translation schemes. |

| |
|---|
| Intermediate Code Generation: Intermediate forms of source programs - abstract syntax tree, polish notation and three address code, types of three address statements and its implementation, syntax directed translation into three-address code, translation of simple statements, Boolean expressions and flow-of-control statements, declarations and array reference. |
| **UNIT IV: Storage Allocation & Error Handling**<br>Symbol Table Management: Storage allocation and run time storage administration, symbol table management.<br>Error Detection and Recovery: Error recovery in LR parsing, Error recovery in LL parsing, automatic error recovery in YACC. |
| **UNIT V: Code Optimization**<br>Basic blocks and flow graphs, Local and global optimization techniques, loop optimization- control flow analysis, data flow analysis, Loop invariant computation, Induction variable removal, other loop optimization techniques, Elimination of Common sub expression, directed acyclic graph (DAG) and its applications. |
| **UNIT VI: Code Generation**<br>Problems in code generation, simple code generator, code generation using labelling algorithm and DAG, Heuristic DAG ordering, register allocation and assignment, Peephole optimization. |

| **Text Books:** |
|---|
| 1. Compilers Principles Techniques and Tools, Aho, Sethi, Ullman, 2nd Edition, 2008, Pearson education. |
| 2. Principles of Compiler Design, Alfred V. Aho, Jeffrey D. Ullman, 1977, Narosa Pub. House. |

| **Reference Books:** |
|---|
| 1. Compiler Design using Flex and Yacc, Vinu V. Das, 2008, PHI Publication. |
| 2. Compiler Design, O. G. Kakde, 2006, Laxmi Publications. |
| 3. Principles of Compiler Design, V. Raghavan, 2010, McGraw Hill Education (India). |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM602T | Deep Learning | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course will enable the students to understand and analyze deep learning techniques required for handling large amounts of datasets & able to use various algorithms for an application to improve employability and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Explain the concept of neural network, regularization, convolutional and recurrent neural network for deep learning. |
| CO2 | **Understand:** Illustrate various kinds of neural networks suitable for deep learning. |
| CO3 | **Analyze:** Analyze the various principal components and algorithms of deep learning. |
| CO4 | **Apply:** Identify the appropriate deep learning algorithms for various types of learning task in various domains. |
| CO5 | **Create:** Design an application using Convolutional and Recurrent Neural Networks. |

| SYLLABUS |
|---|
| **UNIT I: Introduction to Neural Networks**<br>Artificial Neural Networks Introduction, Basic Models of ANN, Important Terminologies, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Back-propagation Network, Associative Memory Networks, Training Algorithms for Pattern Association, BAM and Hopfield Networks. |
| **UNIT II: Learning Network**<br>Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks, Various Special Networks. |
| **UNIT III: Deep Learning Concepts**<br>Introduction to Deep Learning, Historical Trends in Deep learning, Deep Feed - forward networks, Gradient-Based learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms. |
| **UNIT IV: Regularization**<br>Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter Sharing and Tying, Injecting Noise at Input, Ensemble Methods, Dropout. |

| |
|---|
| **UNIT V: Convolutional Neural Networks**<br>The Convolution Operation, Motivation, Pooling, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation. |
| **UNIT VI: Recurrent Neural Networks**<br>Concept of Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, LSTMs, GRUs, Attention Mechanism and the Transformer Architecture |

| **Text Books:** |
|---|
| 1. Neural Networks and Deep Learning A Textbook, Charu C. Aggarwal, 2018, Springer International Publishing. |
| 2. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st Edition 2016, The MIT press. |

| **Reference Books:** |
|---|
| 1. Neural Networks and Learning Machines, Simon Haykin, 3 rd Edition, 2008, Pearson Prentice Hall. |
| 2. Deep Learning with TensorFlow, Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, 1st Edition, 2017, Packt Publishing. |
| 3. Hands-On Deep Learning Algorithms with Python, Sudharsan Ravichandiran, 2019, Packt Publishing Limited. |
| 4. Deep Learning: A Practitioner's Approach, Josh Patterson & Adam, 1st Edition, 2017, O'Reilly Media. |
| 5. Deep Learning from Scratch,Building with Python from First Principles, Seth Weidman, 1st Edition, 2019, O'Reilly Media. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PCCAM602P | Deep Learning Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The lab course will enable the students to analyze and apply various algorithms of Neural Networks for an application to improve employability and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Apply:** Identify the appropriate deep learning algorithms for various types of learning task in various domain. |
| CO2 | **Evaluate:** Apply and evaluate the deep learning techniques on various datasets. |
| CO3 | **Analyze:** Analyze the various principal components and algorithms of deep learning. |
| CO4 | **Create:** Design an application using Convolutional and Recurrent Neural Networks. |

**A minimum of eight practical to be performed based on the theory course of Deep Learning [PCCAM602T]**

| Suggested References: |
|---|
| 1. Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville, 1st Edition, 2016, The MIT press. |
| 2. Deep Learning with TensorFlow, Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, 1st Edition, 2017, Packt Publishing. |
| 3. Hands-On Deep Learning Algorithms with Python, Sudharsan Ravichandiran, 2019, Packt Publishing Limited. |

| Course Code | Course Title | Hours /Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PECAM601T | Optimization Techniques in ML | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course will enable the students to understand the fundamentals of mathematical optimization and computational tools for machine learning that improves technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Demonstrate the fundamentals of convex and non-convex optimization in machine learning. |
| CO2 | **Apply:** Apply regularized sparse optimization for statistical learning. |
| CO3 | **Analyze**: Categorize trade-off between time, data and accuracy for machine learning. |
| CO4 | **Analyze**: Analyze the first order and higher order methods for solving optimization problems in the context of machine learning. |
| CO5 | **Create:** Formulate scalable and accurate implementation of optimization algorithm for machine learning applications. |

| SYLLABUS |
|---|
| **UNIT I: Fundamentals of Convex Analysis**<br>Review of basic linear algebra and probability, convex sets and functions, Strong and weak duality, Constraint Qualification, Optimality conditions for machine learning problems (regressions, SVM, etc.) |
| **UNIT II: First-Order Methods**<br>Gradient descent convergence analysis, Convergence analysis for momentum-based acceleration methods: Heavy-ball, multi-step, Nesterov, FISTA, etc., Convergence speedup with conjugacy, Convergence analysis for sub-gradient methods, Stochastic (sub) gradient descent (convergences in probability and distribution, almost, sure convergence, parallelism, applications in deep learning, etc.) |
| **Unit III: Higher-Order Methods**<br>Newton's method: convergence analysis (exact/inexact step-sizes, self-concordance), applications in regressions, Quasi-Newton Theory (Secant methods), convergence proofs for BFGS/DFP, L-BFGS in machine learning. |

| |
|---|
| **Unit IV: Sparse/Regularized Optimization**<br>Regularized sparse optimization for machine/statistical learning: compressed sensing, LASSO, logistic regression, etc. Structured sparsity optimization for machine/statistical learning: low-rank matrix completion, nuclear norm regularization, inverse covariance inference, atomic norm regularization, etc. |
| **Unit V: Proximal and Operator Splitting**<br>Dual decomposition and decentralization, Method of multipliers and ADMM methods: convergence analysis and proofs, Proximal operators and proximal methods, Design and analysis of distributed algorithms. |
| **Unit VI: Nonconvex Optimization in Machine Learning**<br>Coordinate descent methods and convergence analysis, Special structured nonconvex optimization, Optimization landscape, Saddle point escape. |

| **Text Books:** |
|---|
| 1. Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, 1st Edition, 2020, Springer. |
| 2. Convex Optimization, S. Boyd and L. Vandenberghe, 7th Edition, 2009, Cambridge University Press. |

| **Reference Books:** |
|---|
| 1. Optimization for Machine Learning, Suvrit SRA, Sebastian Nowozin, Stephen J. Wright, 1st Edition, 2012, The MIT Press. |
| 2. Optimization in Machine Learning and Applications, Suresh Chandra Satapathy, Anand J. Kulkarni, 2019, Springer. |
| 3. Nonlinear Programming: Theory and Algorithms, M. Bazarra, H. D. Sherali, C.M. Shetty, 2006, John Wiley & Sons. |

| Course Code | Course Title | Hours /Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PECAM601P | Optimization Techniques in ML Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The lab course will enable the students to implement the fundamentals of mathematical optimization and computational tools for machine learning to improve technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Apply:** Apply regularized sparse optimization for statistical learning. |
| CO2 | **Analyze**: Categorize trade-off between time, data and accuracy for machine learning. |
| CO3 | **Analyze**: Analyze the first order and higher order methods for solving optimization problems in the context of machine learning |
| CO4 | **Create:** Design scalable applications that accurately implements the optimization techniques using machine learning algorithms. |

**A minimum of eight practical to be performed based on the theory course of Optimization Techniques in ML [PECAM601T]**

| Suggested References: |
|---|
| 1. Optimization for Machine Learning, Suvrit SRA, Sebastian Nowozin, Stephen J. Wright, 1st Edition, 2012, The MIT Press. |
| 2. Optimization in Machine Learning and Applications, Suresh Chandra Satapathy, Anand J. Kulkarni, 2019, Springer. |

| Course Code | Course Title | Hours /Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PECAM602T | Digital Image & Video Processing | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables the students to understand the basics of the digital image formation, visualization in spatial and frequency domains, and to provide an exposure to various image and video compression standards. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Demonstrate the fundamental concepts of digital image and video processing system and perform mathematical transformation on digital images and video. |
| CO2 | **Analyze:** Analyze the building blocks of compression system and select processing modules to enable efficient compression. |
| CO3 | **Apply:** Build image processing application such as motion estimation using suitable technique. |
| CO4 | **Create:** Design video processing application using appropriate filtering techniques. |
| CO5 | **Create:** Develop image processing application using suitable image enhancement technique. |

| SYLLABUS |
|---|
| **UNIT I: Introduction to Digital Image Processing**<br>Fundamentals of Elements of Digital Image, Image as Data, Pixels, Components of Digital Image, Types of Image Representation, Measures of Image, Neighbors of pixel adjacency connectivity, regions and boundaries, Distance measures, Applications of Digital Image Processing. |
| **UNIT II: Image Processing Techniques**<br>Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters. |
| **Unit III: Image Compression**<br>Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region-based segmentation |
| **Unit IV: Image Compression Fundamentals**<br>Image compression fundamentals: Coding redundancy, spatial and temporal redundancy.<br>Compression models: Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding, wavelet coding, JPEG standards. |

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| **Unit V: Basic Steps of Video Processing**<br>Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models, 3D motion models, Geometric Image formation, Photometric Image formation, sampling of video signals, filtering operations |
| **Unit VI: 2-D Motion Estimation**<br>2-D Motion Estimation: Optical flow, general methodologies, pixel-based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding. |

| **Text Books:** |
|---|
| 1. Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 3rd Edition, 2008, Pearson Education. |
| 2. Fundamentals of Digital Image Processing, Anil K. Jain, 2nd Edition 2002, PHI Publication. |

| **Reference Books:** |
|---|
| 1. Digital Image Processing, Kenneth R. Castleman,1st Edition, 2007, Pearson Education India. |
| 2. Digital Image Processing using MATLAB, Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 2nd Edition, 2011, McGraw-Hill Education. |
| 3. Digital Image Processing using Matlab, Gonzalez & Woods, 3rd Edition, 2020, Gatesmark Publishing. |

| Course Code | Course Title | Hours /Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continual Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| PECAM602P | Digital Image & Video Processing Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The course enables the students to understand the basics of the digital image formation, visualization in spatial and frequency domains, and to provide an exposure to various image and video compression standards. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Analyze:** Analyze the building blocks of compression system and select processing modules to enable efficient compression. |
| CO2 | **Apply:** Build image processing application such as motion estimation using suitable technique. |
| CO3 | **Create:** Design video processing application using appropriate filtering techniques. |
| CO4 | **Create:** Develop image processing application using suitable image enhancement technique. |

**A minimum of eight practical to be performed based on the theory course of Digital Image & Video Processing [PECAM602T]**

| Suggested References: |
|---|
| 1. Digital Image Processing, Kenneth R. Castleman, 1st Edition, 2007, Pearson Education India. |
| 2. Digital Image Processing using MATLAB, Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 2nd Edition, 2011, McGraw-Hill Education. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | |
| PECAM603T | Data Mining and Predictive Modeling | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables the students to understand the techniques of data mining, visualization and analysis using predictive models to determine future trends that enhances their employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Demonstrate the fundamental concepts of data mining, data preprocessing along with data visualization. |
| CO2 | **Apply:** Apply classical models, data modelling and visualization algorithms for future prediction. |
| CO3 | **Apply:** Identify the use of extracting models to predict future data trends through the classification and prediction to solve societal problems. |
| CO4 | **Analyze:** Analyze the data and choose relevant data mining techniques for mining frequent patterns, associations, cluster and correlation on relational data. |
| CO5 | **Evaluate:** Determine suitable regression, classification and clustering techniques for data analysis and visualization. |

| SYLLABUS |
|---|
| **UNIT I: Introduction Data Mining**<br>Basic concepts of data mining, Classification of Data Mining Systems, Knowledge data discovery process, Data mining functionalities, Data mining tasks primitives, Major issues in data mining. |
| **UNIT II: Data Preprocessing**<br>Types of data and data quality, need for preprocessing the data, Data cleaning, Data integration and transformation, Data reduction, discretization and concept hierarchy generation,<br>Exploring Data: Summary statistics, visualization, multidimensional data analysis. |
| **UNIT III: Association and Correlation Analysis**<br>Basic concepts, frequent patterns, association rules: support and confidence, Frequent itemset generation: Apriori algorithm, FP-Growth algorithm, Rule generation, Applications of association rules, Correlation analysis, Constraint-based association mining. |
| **UNIT IV: Classification**<br>Binary classification and multi-category classification, Bayes theorem and Naïve Bayes classifier, |

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| Association based classification, Rule based classifiers, Nearest neighbor classifiers, Decision Trees, Random Forest, Support Vector Machine, Model overfitting, Evaluation of classifier performance: cross validation, Ensemble Methods. |
| **UNIT V: Clustering Algorithms and Cluster Analysis**<br>Concept of clustering, measures of similarity, Categorization of major clustering algorithms: Partitioning methods, k-means, k-medoids, CLARANS, Hierarchical methods, agglomerative, divisive clustering, BIRCH, Density-based methods, Subspace clustering, DBSCAN, Graph-based clustering, MST clustering, Cluster evaluation, Outlier detection and analysis. |
| **UNIT VI: Predictive Modelling & Regression**<br>Exploratory data analysis for predictive modelling, modelling techniques for prediction of continuous and discrete outcomes, fundamental concepts of predictive modelling.<br>Regression techniques: linear, multivariate, non-linear, Cross-validation, model selection, overfitting, Logistic regression of binary variables, cross validation, confusion matrix, cost sensitive classification, ROC curves. |

| **Text Books:** |
|---|
| 1. Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber, 2nd Edition, 2006, Morgan Kaufmann Publishers. |
| 2. Applied Predictive Modeling, Max Kuhn, Kjell Johnson, 1st Edition, 2013, Springer. |

| **Reference Books:** |
|---|
| 1. Data Mining and Business Intelligence, Shinde and Chandrashekhar, 2015, Dreamtech Press. |
| 2. Modeling Techniques in Predictive Analytics: Business Problems and Solutions with R, Thomas W. Miller, 2013, Pearson |
| 3. Data Mining Techniques, Arun K Pujari, 3rd Edition, 2013, Orient Blackwan/Universities Press. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM603P | Data Mining and Predictive Modeling Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The lab course will enable the students to apply various tools and techniques of data mining, visualization and analysis using predictive models to determine future trends to enhance their technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this lab course the student will be able to: | |
| CO1 | **Apply:** Apply classical models, data modelling and visualization algorithms for future prediction. |
| CO2 | **Apply:** Identify the use of extracting models to predict future data trends through the classification and prediction to solve societal problems. |
| CO3 | **Analyze:** Analyze the data and choose relevant data mining techniques for mining frequent patterns, associations, cluster and correlation on relational data. |
| CO4 | **Evaluate:** Determine suitable regression, classification and clustering techniques for data analysis and visualization. |

**A minimum of eight practical to be performed based on the theory course Data Mining & Predictive Modeling [PECAM603T]**

| Suggested References: |
|---|
| 1. Data Mining and Business Intelligence, Shinde and Chandrashekhar, 2015, Dreamtech Press. |
| 2. Modeling Techniques in Predictive Analytics: Business Problems and Solutions with R, Thomas W. Miller, 2013, Pearson |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM604T | GPU Computing | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course provides the students an insight to popular CUDA programming model commonly used for implementing various aspects of parallel architecture and GPU programming that enhances employability. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Interpret the basic concepts of parallel computing, GPGPU, GPU computing for parallel programming. |
| CO2 | **Apply:** Identify the need of parallel architecture and know the evolution of modern GPU architecture. |
| CO3 | **Apply:** Make use of skills and modern engineering tools like CUDA programming and execution model to address data parallelism. |
| CO4 | **Analyze:** Examine the importance of memory, performance, floating point considerations and optimization in GPU computing. |
| CO5 | **Evaluate:** Evaluate the performance of various applications in well-known GPU computing scenarios. |

| SYLLABUS |
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| **UNIT I: Introduction Parallel Computing**<br>Review of Traditional Computer Architecture, Heterogeneous Parallel Computing, Architecture of a Modern GPU, Need of More Speed or Parallelism, Speeding Up Real Applications, Parallel Programming Languages and Models. |
| **UNIT II: Evolution of GPU Architectures**<br>Evolution of Graphics Pipelines, Fixed-Function Graphics Pipelines, Programmable Real-Time Graphics, Unified Graphics and Computing Processors, GPGPU, GPU Computing, Scalable GPUs, Recent Developments. |
| **UNIT III: Data Parallelism and CUDA**<br>Data Parallelism, CUDA Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Function Declarations, Kernel Launch, Predefined Variables, Runtime APIs. |

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| **UNIT IV: Execution Model**<br>CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix-Matrix Multiplication, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Querying Device Properties, Thread Scheduling and Latency Tolerance. |
| **UNIT V: Memories and Performance Considerations**<br>Memories: Importance of Memory Access Efficiency, Device Memory Types, Reducing Global Memory Traffic, Memory as a Limiting Factor to Parallelism.<br>Performance Considerations: Warps and Thread Execution, Global Memory Bandwidth, Dynamic Partitioning of Execution Resources, Instruction Mix and Thread Granularity. |
| **UNIT VI: Floating-Point Considerations and Applications**<br>Floating-Point Considerations: Floating-Point Format, Representable Numbers, Special Bit Patterns and Precision in IEEE Format, Arithmetic Accuracy and Rounding, Algorithm Considerations.<br>Applications: Applications of GPU Architecture like Gaming, Computer Vision, Optimizing GPU Applications. |

| **Text Books:** |
|---|
| 1. Programming Massively Parallel Processors a Hands-on Approach, David B. Kirk, Wen-mei W. Hwu, 3rd Edition, 2016, Morgan Kaufmann. |
| 2. Multicore and GPU Programming: An Integrated Approach, Gerassimos Barlas, 2nd Edition, 2022, Morgan Kaufmann. |

| **Reference Books:** |
|---|
| 1. Computer Architecture: A Quantitative Approach, John L. Hennessy, David A. Patterson, 5th Edition 2011, Morgan Kaufmann. |
| 2. Heterogeneous Computing with OpenCL 2.0, David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, 3rd Edition 2022, Morgan Kaufmann |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM604P | GPU Computing Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The course provides the students a hands-on approach to popular CUDA programming model commonly used for implementing various aspects of parallel architecture and GPU programming that enhances employability and entrepreneurship skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Apply:** Utilize the basic concepts of parallel computing, GPGPU, GPU computing for parallel programming. |
| CO2 | **Apply:** Make use of skills and modern engineering tools like CUDA programming and execution model for offloading work onto GPUs as accelerators for various applications. |
| CO3 | **Analyze:** Examine the importance of memory, performance, floating point considerations and optimization in GPU computing. |
| CO4 | **Evaluate:** Evaluate the performance of various applications in well-known GPU computing scenarios. |

**A minimum of eight practical to be performed based on the theory course GPU Computing [PECAM604T]**

**Suggested References:**

1. Programming Massively Parallel Processors a Hands-on Approach, David B. Kirk and Wen-mei W. Hwu, 3rd Edition, 2016, Morgan Kaufmann
2. Multicore and GPU Programming: An Integrated Approach, Gerassimos Barlas, 2nd Edition 2022, Morgan Kaufmann
3. Heterogeneous Computing with OpenCL 2.0 David R. Kaeli, Perhaad Mistry,Dana Schaa, Dong Ping Zhang, 3rd Edition, 2022, Morgan Kaufmann.
4. Computer Architecture: A Quantitative Approach, John L. Hennessy, David A. Patterson, 5th Edition, 2011, Morgan Kaufmann.

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM605T | Computer Vision | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables the learners to get familiar with various theoretical aspects of computer vision like image formation, measurement, analysis and recent trends for computing with images to enhance their technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Interpret and identify the role of computer vision to solve different problems. |
| CO2 | **Analyze:** Analyze various techniques of computer vision under different scenarios. |
| CO3 | **Analyze:** Examine the role of different pattern analysis techniques under various situations. |
| CO4 | **Apply:** Make use of skills and modern engineering tools like OpenCV to address image related applications. |
| CO5 | **Understand:** Infer the recent trends in computing to deal with computer vision problems. |

| SYLLABUS |
|---|
| **UNIT I: Introduction to Computer Vision**<br>Overview to Computer Vision (CV), Need of CV, brief history, Related Fields of CV, Applications, Tools for CV, Image formation: Geometric primitives and transformations, Photometric image formation, The digital camera. |
| **UNIT II: Image Processing**<br>Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization. |
| **UNIT III: Feature detection and Segmentation**<br>Feature detection and matching: Feature detectors, Feature descriptors, Edge detection, Hough transforms, Segmentation: Active contours, Split and merge. |
| **UNIT IV: Pattern Analysis**<br>Clustering: K-Means, K-Medoids, Mixture of Gaussians.<br>Classification: Discriminant Function, Supervised, Un-supervised, Semi supervised.<br>Classifiers: Bayes, KNN, ANN models.<br>Dimensionality Reduction: PCA, LDA |

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| **UNIT V: Introduction to OpenCv**<br>Overview of OpenCv, Benefits, Features of Opencv, Reading Images and Video, Basic functions in OpenCv: Blur, Edge Detection, Dilation, Erading, Resizing & Cropping, Shapes and Text, Contours detection. |
| **UNIT VI: Recent trends in Computer Vision**<br>Visual Question Answering, Domain Adaptation, Generative Adversarial Networks, 3D Object Understanding, Transfer Learning, Object Tracking. |

| **Text Books:** |
|---|
| 1. Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer International Publishing. |
| 2. Computer Vision - A Modern Approach International Edition, D. Forsyth, J. Ponce, 2015, Pearson Education. |
| 3. OpenCV Computer Vision with Python, Joseph Howse, 2013, Packt Publishing. |

| **Reference Books:** |
|---|
| 1. Dictionary of Computer Vision and Image Processing, Robert B. Fisher, Toby P. Breckon, Kenneth Dawson-Howe, Andrew Fitzgibbon, Craig Robertson, Emanuele Trucco, Christopher K. I. Williams, 2013, Wiley. |
| 2. Introductory Techniques for 3-D Computer Vision, Emanuele Trucco, AllessandroVerri, 1998, Prentice Hall. |
| 3. Computer and Robot Vision - Vol II, Robert M. Haralick, Linda G. Shapiro, 2002, Addison-Wesley. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM605P | Computer Vision Lab | 0 | 0 | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The course enables the learners to get familiar with various programming experiences by implementing computer vision and object recognition applications of computer vision to enhance their employability skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Illustrate the basic concepts and methods in image processing and computer vision. |
| CO2 | **Apply:** Identify, formulate and solve problems in image processing and computer vision. |
| CO3 | **Analyze:** Analyze existing feature detection, segmentation, pattern recognition techniques for computer vision systems. |
| CO4 | **Design:** Design and develop image processing algorithms for computer vision applications. |

**A minimum of eight practical to be performed based on the theory course Computer Vision [PECAM605T]**

| Suggested References: |
|---|
| 1. Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer International Publishing. |
| 2. Computer Vision - A Modern Approach International Edition, D. Forsyth, J. Ponce, 2015, Pearson Education. |
| 3. OpenCV Computer Vision with Python, Joseph Howse, 2013, Packt Publishing. |
| 4. Dictionary of Computer Vision and Image Processing, Robert B. Fisher, Toby P. Breckon, Kenneth Dawson-Howe, Andrew Fitzgibbon, Craig Robertson, Emanuele Trucco, Christopher K. I. Williams, 2013, Wiley. |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM606T | IoT & Machine Learning | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course will enable the students to develop an IoT application by applying various Machine learning algorithms and techniques to improve employability and technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Understand:** Interpret the concepts and utility of Internet of Things with Machine Learning. |
| CO2 | **Analyze:** Analyze various IoT Protocols and tools to develop desired application. |
| CO3 | **Apply:** Apply various Machine Learning algorithms and techniques on datasets collected by IoT devices to solve given problem. |
| CO4 | **Apply:** Apply various Neural networks and Bayesian analysis to solve classification problems. |
| CO5 | **Create:** Design an application using IoT & ML tools to solve the real-world problem. |

| SYLLABUS |
|---|
| **UNIT I: Introduction to Internet of Things**<br>Introduction to IoT, Conceptual Framework, Architectural view, Applications and scope of IoT with ML, M2M Communication. IoT sensors and actuators, radio frequency identification (RFID) technology, Overview of IOT supported Hardware platforms such as Arduino, Raspberry pi. |
| **UNIT II: IoT Protocols**<br>Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah, LoRaWAN, Constrained Nodes and Constrained Networks, Zigbee, Routing over Low Power and Lossy Networks, Supervisory Control and Data Acquisition, Constrained Application Protocol and Message Queueing Telemetry. Transport. |
| **UNIT III: Introduction of ML in IoT**<br>Introduction to Machine Learning, Need of ML in IoT, supervised learning, unsupervised learning, cost function. Regression: linear regression, loss function, least-squares fit, parameter estimation, statistical view on the regression, gradient descent, gradient descent for linear regression, logistic regression. |
| **UNIT IV: Instance-Based Learning**<br>Instance-Based Learning: k-Nearest neighbor algorithm, decision tree learning, random forest, ensemble learning, case-based learning. Rule based learning: propositional and first-order, over-fitting. |

| |
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| **UNIT V: Bayesian Networks & Clustering**<br>Bayesian Networks, inference in Bayesian Networks, Bayes Net Structure, learning unlabeled data: Expectation-Maximization, preventing over fitting, Gaussian mixture models, Introduction to clustering, hierarchical clustering, K-means clustering, hidden Markov models, Reinforcement learning, support vector machines. |
| **UNIT VI: Artificial Neural Networks**<br>Artificial neural networks: types of learning, activation functions, introduction of multilayer networks and back-propagation, recurrent networks, Probabilistic machine learning maximum likelihood estimation, MAP, Bayes classifiers Naive Bayes, Bayes optimal classifiers. |

| **Text Books:** |
|---|
| 1. Machine Learning, Subramanian Chandramouli, Saikat Dutt, Amit Kumar Das, 1st Edition, 2018, Pearson Education India. |
| 2. Hands-On Artificial Intelligence for IoT, Amita Kapoor, 2019, Packt Publishing. |

| **Reference Books:** |
|---|
| 1. Big data, IoT & Machine Learning: Tools and Applications, Rashmi Agrawal, Marcin Paprzycki, Neha Gupta, 1st Edition, 2021, CRC press. |
| 2. Programming the Internet of Things, Andrew King, 2021, O'Reilly Media |
| 3. Machine Learning in cognitive IoT, Neeraj Kumar, Anisha Makkar, 1st Edition, 2020, CRC Press. |
| 4. The Internet of Things, Samuel Greengard, 2015, The MIT Press |

| Course Code | Course Title | Hours / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem. Exam | Total | Duration (Hrs.) |
| PECAM606P | IoT & Machine Learning Lab | - | - | 2 | 1 | 25 | 25 | 50 | - |

| Course Objective |
|---|
| The lab course enables the students to develop an IoT application by applying various Machine learning algorithms and techniques to improve employability and relevant technical skills. |

| Course Outcomes | |
|---|---|
| After successful completion of this course the student will be able to: | |
| CO1 | **Analyze:** Analyze various IoT Protocols and tools to develop desired application. |
| CO2 | **Apply:** Apply various Machine Learning algorithms and techniques on datasets collected by IoT devices to solve given problem. |
| CO3 | **Apply:** Apply various Neural networks and Bayesian analysis to solve classification problems. |
| CO4 | **Create:** Design an application using IoT & ML tools to solve the real-world problem. |

**A minimum of eight practical to be performed based on the theory course of IoT & Machine Learning [PECAM606T]**

| Suggested References: |
|---|
| 1. Big data, IoT & Machine Learning: Tools and Applications, Rashmi Agrawal, Marcin Paprzycki, Neha Gupta, 1st Edition, 2021, CRC press. |
| 2. Programming the Internet of Things, Andrew King, 2021, O'Reilly Media |

| Course Code | Course Title | Hour / Week | | | Credits | Maximum Marks | | | ESE |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | Continuous Evaluation | End Sem Exam | Total | Duration (Hrs.) |
| OECAM601T | Basics of Human computer Interaction | 3 | - | - | 3 | 40 | 60 | 100 | 3 |

| Course Objective |
|---|
| The course enables students to gain theoretical knowledge and practical experience in the fundamental aspects of human perception, cognition and learning related to the design, implementation and evaluation of interfaces to enhance their technical skill. |

| Course Outcomes | |
|---|---|
| After successful completion of this course, the students will be able to: | |
| CO1 | **Understand:** Explain importance of Human computer Interaction (HCI) study and principles of user-centered design (UCD) approach. |
| CO2 | **Apply:** Develop understanding of human factors, models and paradigms in context of interactions in HCI design. |
| CO3 | **Create:** Design effective user-interfaces following a structured and organized UCD process. |
| CO4 | **Evaluate:** Evaluate usability of a user-interface design for given problems. |
| CO5 | **Apply:** Apply cognitive models for predicting human-computer-interactions. |

**SYLLABUS**

**UNIT I: Introduction of HCI**
Basics of HCI, Disciplines involved in HCI, Purpose of HCI, The psychology of everyday things, Principles of HCI, User-centered Design.

**UNIT II: Understanding the Human**
Input-output channels, Human memory, Thinking, Reasoning and Problem Solving, Human emotions, Individual differences, Psychology and Design.

**UNIT III: Understanding the Interaction**
Models of interaction, Ergonomics, Interaction styles, WIMP Interface, Interactivity, Context of interaction

**UNIT IV: HCI Design Process**
Interaction Design, Software Design Process, User focus, Scenarios, Navigation Design, Screen Design, Prototyping Techniques, Wire-Framing, Understanding UI Layer and Its Execution Framework, Model-View-Controller (MVC) Framework.

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| **UNIT V: HCI - Design Rules, Guidelines and Evaluation Techniques**<br>Principles that support usability, Design standards, Design Guidelines, Golden rules and heuristics, using toolkits, User interface management system (UIMS), Goals of evaluation, Evaluation Criteria, Evaluation through expert analysis, Evaluation through user participation, Choosing an Evaluation Method. |
| **UNIT VI: HCI Models and Theories**<br>Goal and task hierarchy model, Linguistic model, Physical and device models, Cognitive architectures, Hierarchical task analysis (HTA), Uses of task analysis, Diagrammatic dialog design notations, Computer mediated communication, Ubiquitous Computing, Finding things on web Future of HCI. |

| **Text Books** |
|---|
| 1. Human Computer Interaction, Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, 3rd Edition, 2008, Pearson Education |
| 2. Human-Computer Interaction - Fundamentals and Practice, Gerard Jounghyun Kim, 2015, CRC Press. |

| **Reference Books** |
|---|
| 1. 3D Math Primer for Graphics and Game Development, Fletcher Dunn, 2nd Edition, 2011, Taylor & Francis. |
| 2. Programming Game AI By Example, Mat Buckland, 1st Edition, 2005, Wordware Pub. |