Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCCD301T	Data Structures & Algorithms	3	0	0	3	40	60	100	3

Course Objective
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 student 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	**Apply:** Demonstrate and apply appropriate data structure to solve given problems.
CO4	**Create:** Design an algorithm using linear and nonlinear data structures to solve engineering problems.
CO5	**Create:** Design an appropriate hashing function for indexing large storage in different applications.

SYLLABUS

UNIT I: Abstract Data Types and Algorithms:
Introduction: Abstract Data Types (ADT), Concepts of Data Structure, Types of Data Structure- Linear, Nonlinear, Static, 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-selection sort, bubble sort, quick sort, merge 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, applications of stack: conversion from infix to prefix and postfix expression evaluation.
Queue ADT: Concept, operations, simple queue, circular queue, double-ended and priority queue, applications of queue.

UNIT IV: Linked Lists: Concept of Linked list, primitive operations, memory representation of linked lists- static and dynamic, types of linked list- singly linked list, circular linked list and doubly linked list, applications of linked list.
UNIT V: Trees: Tree terminologies, binary tree and its operations, tree traversal techniques, applications of tree traversal techniques, binary search tree (BST) and its operations, self-balancing tree, B+ tree and its operations, threaded binary trees, heap.
UNIT VI: Graphs and Hashing: **Graphs:** Introduction to Graphs, application of graphs, 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 Program Design in C, Robert L. Kruse, Bruce P. Leung, Clovis L. Tondo, 2nd Edition, 2006.
3.	Algorithm and Data Structures, M. M. Raghuwanshi, 2016, Alpha Science International Limited.

Reference Books:	
1.	Algorithms in a Nutshell, George T. Heineman, Gary Pollice & Stanley Selkow, 2nd Edition, 2016, O'Reilly Media, Inc.
2.	Introduction to the Design and Analysis of Algorithms, Anany Levitin, 3rd Edition, 2017, Pearson Education.
3.	Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, 3rd Edition, 2015, MIT Press.
4.	Data Structures and Algorithms: Concepts, Techniques and Application, G.A.V. Pai, 3rd Edition, 2012, Tata McGraw-Hill Education.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem Exam	Total	Duration (Hrs.)
N-PCCCD301P	Data Structures & Algorithms Lab	0	0	2	1	25	25	50	-

Course Objective
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 student will be able to:	
CO1	**Apply:** Apply appropriate abstract data type to solve basic computational problems.
CO2	**Apply:** Apply appropriate searching and sorting techniques for a given problem statement.
CO3	**Evaluate**: Choose appropriate data structures to solve given problems efficiently.
CO4	**Create:** Design applications using linear and nonlinear data structures with suitable algorithms.

A minimum of eight practicals based on the theory course Data Structures & Algorithms [N-PCCCD301T]

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, 2013, 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.)
N-PCCCD302T	Object Oriented Programming	3	0	0	3	40	60	100	3

Course Objective
The course helps to understand the fundamentals of object-oriented paradigm using Java programming and develop software as per industry standards.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Understand:** Understand the basic programming construct; realize the fundamental concepts of Object-Oriented Programming and string handling.
CO2	**Apply:** Apply the inheritance and interface concepts for enhancing code reusability.
CO3	**Apply:** Apply the concepts of Multithreading and Exception handling to develop efficient and error free codes
CO4	**Apply:** Apply the concepts of stream handling and use the data structure in the collection framework for solving real world problems.
CO5	**Create:** Develop a Java application using modern tools 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.
Fundamentals of Classes & Objects: Classes, Objects, Methods, Constructors, Array of Objects, Object as a Parameter, Reference Variables, 'this' keyword, Wrapperclasses, Nested Classes.
Encapsulation and access modifiers (public, private, protected).

UNIT-II: Inheritance and Polymorphism:
Inheritance: Single inheritance, Hierarchical Inheritance, Multilevel inheritance, Multiple inheritance.
Abstraction: abstract classes and methods, interfaces.
Polymorphism: Compile time Polymorphism, run time Polymorphism, Static and Dynamic Binding, method overloading and method overriding.

UNIT-III: Java Strings:
Immutable string, string comparison, string concatenation, searching string and modifying string, substring, stringbuffer class, stringbuilder class, tostring method, stringtokenizer class.

UNIT-IV: Exception Handling and Multithreading: **Exception Handling:** Exception types (checked, unchecked and uncaught exceptions), throw and throwskeywords. **Multithreading:** Fundamentals, Thread life cycle, ways of creating threads, creating multiple threads, Thread synchronization, Thread priorities, Inter Thread communication.
UNIT-V: Java Streams: **Java Streams:** Byte-oriented Streams, Character – Oriented Streams, File Handling operations, Reading and Writing Files, Serialization, De-serialization.
UNIT-VI: Java Packages and Frameworks: **Packages:** Package fundamentals, access protection, importing packages. **Frameworks:** Understanding the role of frameworks in software development, Overview of popular Java frameworks and their use cases. Advantages of using frameworks in Java programming.

Text Books:	
1.	Java - The Complete Reference, Herbert Schildt, 9th Edition, 2014, Oracle Press.
2.	Java: A Beginners Guide, Herbert Schildt, 8th Edition, 2011, McGraw-Hill Education.
3.	Programming with Java, E. Balagurusamy, 6th Edition, 2019, McGraw-Hill Education.
4.	Head First Java, Kathy Sierra, Bert Bates, 3rd Edition, 2022, O'Reilly Media Inc.
5.	Java 8 Programming Black Book, Santosh Kumar, 2nd Edition, 2015, Dreamtech Publications.

Reference Books:	
1.	The Java Language Specification, Bill Joy, Gilad Bracha, Guy L. Steele Jr., James Gosling, 10thEdition, 2000, Addison-Wesley.
2.	Core Java Volume I – Fundamentals, Cay S. Horstmann, 10th Edition, 2015, Prentice Hall.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCCD302P	Object Oriented Programming Lab	0	0	2	1	25	25	50	-

Course Objective
The course enables the learners to create robust applications using Java's object-oriented features, Java streams and class libraries.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Apply:** Demonstrate the concepts of classes, objects, members of a class and its relationships to solve a specific problem statement.
CO2	**Apply:** Make use of exception handling, file I/O, multithreading, collection frameworks, Spring boot 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.

A minimum of eight practicals based on the theory course Object Oriented Programming [N-PCCCD302T]

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

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCCD303T	Statistics for Data Science	3	1	0	4	40	60	100	3

Course Objectives

The course provides the foundations of probabilistic and statistical analysis used in various applications in data science and the concepts of linear algebra to model, solve, and analyze situations.

Course Outcomes

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

CO1	**Analyze:** Apply the concept of Statistics to analyze the data.
CO2	**Analyze:** Apply the various concepts of Probability to analyze the data.
CO3	**Apply**: Apply the various hypothetical tests and interpret the results.
CO4	**Understand**: Understand vector spaces and subspaces and apply their properties.

SYLLABUS

Unit- I: Basic Statistics:
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression–Rank correlation, multiple regression and correlation.

Unit- II: Theory of Probability:
Conditional Probability, Bayes Rule. Random variables: Discrete and Continuous random variables, Probability function and Distribution function. Joint distributions, Independent Random Variables, Conditional Distributions.

Unit -III: Mathematical Expectation:
Definition Mathematical Expectation. Functions of Random Variables, Variance and Standard Deviation, Moments, Moment generating function, Other measures of central tendency and dispersion, Skewness and Kurtosis.

Unit -IV: Probability Distribution:
Binomial distribution. Poisson distribution. Normal distribution, Relation between Binomial, Poisson and Normal distribution.

Unit –V: Test of Hypothesis-I:
Introduction-Testing of hypothesis-Null and alternative hypothesis-Errors, Level of Significance, test of significance for small samples- t-test for single mean, z- test for large samples.

Unit –VI: Test of Hypothesis-II:

F-test for comparison of variances, ANOVA Test, Chi square test for goodness for fit.

Text Books:
1. Higher Engineering Mathematics - B. S. Grewal, 44th Edition, 2020, Khanna Publication.
2. Advanced Engineering Mathematics- E. Kreyszig, 10th Edition, 2015, John Wiley & Sons Publication.
3. Theory & Problems of Probability and Statistics - M.R. Spiegal, 4th Edition, 2017, Schaum Series, McGraw Hill.
4. Testing Statistical Hypotheses - E. L. Lehmann and J. P. Romano, 4th Edition, 2019, Springer.

Reference Books:
1. Higher Engineering Mathematics - H. K. Dass, 3rd Edition, 2014, S. Chand Publication.
2. A Text book of Engineering Mathematics - N. P. Bali & M. Goyal, 9th Edition, 2014, Laxmi Publication Limited.
3. Engineering Mathematics - Ravish R. Singh & Mukul Bhatt, 1st Edition, 2009, Tata Mc-Graw Hill.

Course Code	Course Title	Hour/ Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCCD304P	Python Programming Lab	0	0	2	1	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 fundamentals of Python, control structure, string and functions to solve the given problems effectively.
CO2	**Apply:** Utilize the 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 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 for the given problem statement.

SYLLABUS
MODULE-I: Fundamentals of Python Programming: **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.
MODULE-II: Functions: **Python Function**: Defining a Function, calling a Function, Pass by reference vs value, Types of Function Arguments and Recursion. **Introduction to Pandas:** Data import, Data Export, Data Processing using Pandas.

MODULE-III: Data Structures:
Strings in Python: Creating string, Iterating Over Strings, String Slicing, Modify string, Concatenate String and String operations.
List in Python: Creation, iterating List, List slicing, Appending a list and List operations.
Tuple in Python: Understanding tuple, Slicing, Indexing and Tuple methods.
Set in Python: Understanding set, and Set operations.
Dictionary in Python: Understating Dictionary, Indexing, Dictionary operations, Comparison among List, Tuple, Set and Dictionary.

MODULE-IV: File Handling and Object-Oriented Programming:
File Handling: Introduction to files, file Object Attributes, File operations: open ( ), close ( ), read(), write( ), rename(), remove(), Positioning, Copying, Merging and Appending.
Introduction to Object Orientated Programming in Python.

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

Suggested References:

1. Python Programming Using Problem Solving Approach, Reema Thareja, 14th Edition, 2022, Oxford.
2. Python Data Science Handbook, Jake Vaderplas, 1stEdition, 2016, O'Reilly Media.
3. Django for APIs: Build web APIs with Python and Django, William S Vincent, 2018, Kindle Edition.
4. Effective Python: 90 Specific Ways to Write Better Python, Brett Slatkin, 2nd Edition, 2019, Addison-Wesley Professional.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-OECCD301T	Ethics & Data Privacy	3	0	0	3	40	60	100	3

Course Objectives

The course enables the students to understand the ethical theories and principles and learn how to apply to the domain of data privacy.

Course Outcomes

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

CO1	**Understand:** Understand the importance of ethics, data privacy, ethical challenges, ethical considerations, principles and requirements of data protection laws.
CO2	**Analyze:** Analyze bias, fairness, and accountability in data-driven decision-making, data governance frameworks for effective data handling.
CO3	**Analyze:** Analyze and interpret data protection laws and regulations, ensuring organizational compliance and ethical data handling practices.
CO4	**Apply:** Apply techniques for ensuring data privacy in real-world scenarios.
CO5	**Create:** Develop strategies and ethical decision-making frameworks for implementing practical data privacy measures.

SYLLABUS

UNIT-I: Overview of Ethics:

Overview of Ethics: Introduction to ethical theories (utilitarianism, deontology, virtue ethics) and their application in the context of data privacy. Fundamentals of Data Privacy: Definition of data privacy, importance, and key principles, exploring frameworks.

UNIT-II: Ethical Challenges in Data Science

Identifying ethical challenges in data collection, analysis, and interpretation, Discussing bias, fairness, and accountability in data-driven decision-making, Case studies and techniques from "Data Science Ethics: Concepts, Techniques, and Cautionary Tales"

UNIT-III: Practical Data Privacy

Fundamentals of data privacy and its significance in modern data-driven ecosystems, Techniques for ensuring data privacy in data collection, storage, and sharing, Practical examples and strategies.

UNIT-IV: Legal Frameworks for Data Privacy and Protection

Overview of data privacy laws and regulations globally, Understanding the principles and requirements of data protection laws, Case studies and interpretations from Data Privacy Laws and Data Protection

UNIT-V: Compliance and Governance in Data Handling
Implementing compliance measures to ensure adherence to data privacy laws, Establishing effective data governance frameworks for data handling, Best practices and guidelines for managing data ethically and securely.

UNIT-VI: Ethical Decision-Making in Data Science
Ethical considerations in designing and implementing data science projects, Strategies for addressing ethical dilemmas and conflicts in data-driven environments, Ethical decision-making frameworks and guidelines.

Text Books

1. Ethics and Data Science- DJ Patil, Hilary Mason, and Mike Loukides, O'Reilly Media, Inc.,2018.
2. Data Science Ethics: Concepts, Techniques, and Cautionary Tales,David Martens, Oxford, 2022.

Reference Books

1. Practical Data Privacy, Katharine Jarmul, O'Reilly Media, 2023.
2. Data Privacy Laws and Data Protection: Protecting Personal Data: Understanding Data Privacy Laws and Data Protection, Ajay Gautam, 2023.

Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs)
N-CEPCD301	Community Engagement Project (CEP)	0	0	4	2	50	-	50	-

The course is prepared considering the guidelines 'Fostering Social Responsibility & Community Engagement in Higher Education Institutions in India 2.0' issued by the UGC, New Delhi.

Objectives:

- To develop an **appreciation of rural culture, lifestyle and wisdom** amongst students.
- To learn about the status of various **agricultural and development programmes**.
- To understand the **causes of distress and poverty** faced by vulnerable households and **explore solutions** for the same.
- To apply classroom knowledge of courses to field realities and thereby **improve the quality of learning.**

Course Outcomes	
After successful completion of this course, the student will be able to:	
CO1	Gain an understanding **of rural life, Indian culture and ethos and social realities**.
CO2	Develop a sense of **empathy and bonds of mutuality** with the **local community.**
CO3	Appreciate **significant contributions of local communities** to **Indian society and economy.**
CO4	Learn to value the **local knowledge and wisdom** of the community.
CO5	Identify opportunities for contributing to **community's socio-economic improvements.**

Module No.	Module Title	Module Content	Assignment
1	***Appreciation of Rural Society***	Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages' (Gandhi), rural infrastructure.	Prepare a map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village.
2	***Understanding rural and local economy and livelihood***	Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labour.	Describe your analysis of the rural house hold economy, its challenges and possible pathways to address Circular economy and migration patterns.
3	***Rural and local***	Traditional rural and community organisations, Self-help Groups,	How effectively are Panchayati Raj and Urban Local Bodies (ULBs)

	Institutions	Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), Nagarpalikas and municipalities, local civil society, local administration.	institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual).
4	***Rural and National Development Programmes***	History of rural development and current national programmes in India: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM AwaasYojana, Skill India, Gram Panchayat Decentralised Planning, National Rural Livelihood Mission (NRLM), Mahatma Gandhi National Rural Employment Guarantee Act 2005 (MGNREGA), SHRAM, Jal Jeevan Mission, Scheme of Fund for Regeneration of Traditional Industries (SFURTI), Atma Nirbhar Bharat, etc.	Describe the benefits received and challenges faced in the delivery of one of these programmes in the local community; give suggestions about improving the implementation of the programme for the poor. Special focus on the urban informal sector and migrant households. **Note**-Each student selects one program for field visit

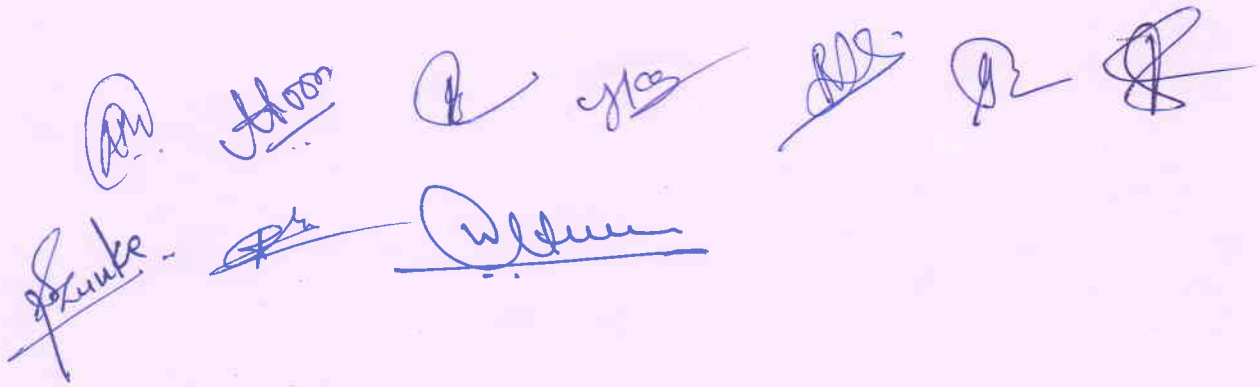
Note- The module 1 is compulsory, and from modules 2, 3 and 4, minimum one module must be opted.

Teaching Learning Methodology: It shall include classroom discussions, field visits/ field based practical activities under the supervision of faculty and assignments. Field diary must be maintained by each student.

Recommended field-based practical activities [Minimum one]:

- Interaction with Self Help Groups (SHGs) women members, and study their functions and challenges; planning for their skill-building and livelihood activities;
- Visit Mahatma Gandhi National. Rural Employment Guarantee Act 2005 (MGNREGS) project sites, interact with beneficiaries and interview functionaries at the work site;
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures;
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP);
- Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization;
- Visit Rural Schools/mid-day meal centres, study academic and infrastructural resources, digital divide and gaps;
- Participate in Gram Sabha meetings, and study community participation;
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries;
- Visit to local Nagarpalika office and review schemes for urban informal workers and migrants;
- Attend Parent Teacher Association meetings, and interview school drop outs;
- Visit local Anganwadi Centre and observe the services being provided;
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries;
- Organize awareness programmes, health camps, Disability camps and cleanliness camps;
- Conduct soil health test, drinking water analysis, energy use and fuel efficiency surveys and building solar powered village;
- Raise understanding of people's impacts of climate change, building up community's disaster preparedness;

- Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers, promotion of traditional species of crops and plants and awareness against stubble burning;
- Formation of committees for common property resource management, village pond maintenance and fishing;
- Identifying the small business ideas (handloom, handicaraft, khadi, food products, etc.) for rural areas to make the people self reliant.
- Any other activity as decided by the faculty mentor.



Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs)
N-FPCD301	Field Project (FP)	0	0	4	2	50	-	50	-

Course Objective
To provide students with practical, hands-on experience in applying theoretical knowledge to real-world situations, encouraging collaboration, and promoting society/ industry engagement.

Course Outcomes	
After successful completion of this course, the student will be able to:	
CO1	Apply theoretical knowledge to address real-world challenges.
CO2	Demonstrate proficiency in project planning and management.
CO3	Collaborate effectively in teams.
CO4	Analyze field data wherever necessary and generate evidence-based solutions.

Guidelines:

1. The department shall identify and list out various significant field areas of respective domains at the start of session.
2. The field projects shall be allocated to students in groups not exceeding the group size of 5 members as per their area of interest.
3. Each group shall be allocated a faculty mentor for supervision.
4. The project must have relevance to the industry/ society meeting the learning outcomes.
5. Field diary must be maintained by each student.

Dr. R. Jain

03/05/24 (Mrudula Nimbarte)

R. B. Talmale (Y. Varekar)

Dr. S. S. Badhiye (A. Charhan)

(S. A. Lunke)

Dr. V. P. Balpande

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem Exam	Total	Duration (Hrs.)
N-PCCCD401T	Operating System	3	0	0	3	40	60	100	3

Course Objective
The course empowers the learner with the fundamentals of Operating System, its design & development to provide the services and to give knowledge about various design issues and services.

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 Computer Architecture and Organization:
Overview of Organization and Architecture, organization of Von Neumann machine, Instruction codes, Computer Registers, Register Transfer Language, Computer Instructions and Phases of Instruction cycle, Instruction Formats, Instruction Set Categories-Addressing modes, Interrupts, Control unit, ALU.

UNIT II: Introduction to Operating System and Process Management:
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.
Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.
Process Scheduling: Scheduling Criteria, Types of Schedulers, Scheduling algorithms: Preemptive and Non-Pre-emptive, FCFS, SJF, RR, Priority Scheduling.

UNIT III: Process Synchronization:

Thread: Definition (User and Kernel), Various states, Multithreading: Benefits of threads, Concept of multi-threads, Multithreading Models, InterProcess Communication

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

Classical Synchronization Problems: Bounded Buffer, Reader-Writer Problem, Dining Philosopher Problem.

UNIT IV: Resource Management and Memory Hierarchy:

Introduction to Deadlock: Detection, Prevention, avoidance, recovery, Resource Allocation Graph (RAG), Necessary Conditions for Deadlock, Deadlock avoidance: Bankers' Algorithm

Memory Hierarchy, Semiconductor Memories, RAM (Random Access Memory), CAM (Content addressable memory, Read Only Memory (ROM), Cache Memory: Types of Caches, Cache misses, Mean memory access time, Performance considerations, Allocation: Contiguous Memory allocation, Fixed and variable partition.

UNITV: Memory Management and Virtualization:

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

Internal and External fragmentation, Compaction, Swapping, Segmentation.

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

UNITVI: File System Management and Storage 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.

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, 9th Edition, 2016, John Wiley & Sons.
2. Modern operating systems,Tanenbaum, Andrew. . Pearson Education, Inc., 2009.

Reference Books:

1. Modern Operating System, Andrew S. Tanenbaum, Herbert Bos, 4th Edition, 2015, Pearson Education.
2. Operating Systems - A Concept-Based Approach, Dhananjay M. Dhamdhere, 3rd Edition, 2012, McGraw-Hill Education.

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem Exam	Total	Duration (Hrs.)
N-PCCCD401P	Operating System Lab	0	0	2	1	25	25	50	-

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 evolution of OS functionality, layers and apply various types of system calls.
CO2	**Create:** Design scheduling algorithms to compute and compare various scheduling criteria.
CO3	**Analyze:** Analyze process scheduling, synchronization problems and memory management techniques under various situations to improve system performance.

A minimum of eight practicals to be performed based on the theory course Operating System [N-PCCCD401T].

Suggested References:

1. Modern Operating System, Andrew S. Tanenbaum, Herbert Bos, 4th Edition, 2015, Pearson Education.
2. Operating Systems Internals and Design Principles, William Stallings, 7th Edition, 2012, Pearson Education.
3. Operating Systems - A Concept-Based Approach, Dhananjay M. Dhamdhere, 3rd Edition, 2012, McGraw-Hill Education.
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.)
N-PCCCD402T	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.

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.

UNIT-III: Relational Data Model: Concept of relations, Schema-instance distinction, CODD's Rules. Relational Algebra: Unary and Binary Operators. Relational Calculus: Tuple relational calculus, Domain relational calculus **Integrity Constraints**: Domain Constraints, Referential Integrity, Assertions and Triggers.
UNIT-IV: Relational Database Design: **Introduction to Indexing**: Advantages, Evaluation Metrics, Types: Primary Indexing, Dense, Sparse, Clustering Index, Multi-Level, Secondary **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: **Query Processing:** Steps in Query Processing, Pipelining and Materialization, Query optimization types, Materialized View **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: **Concurrency Control**: Lock-based and timestamp-based protocols, Deadlock: Deadlock handling, detection and recovery. **Recovery System**: Failure classification, Log-Based Recovery, Shadow-Paging, Aries Algorithm, Checkpoints. 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, RamezElmasri, ShamkantNavathe, 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.)
N-PCCCD402P	Database Management System Lab	0	0	2	1	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 practicals to be performed based on the theory course Database Management System [N-PCCCD402T].

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.)
N-PCCCD403T	Fundamentals of Artificial Intelligence	3	0	0	3	40	60	100	3

Course Objective
The course impart artificial intelligence principles, techniques and its history. It also provides the basic knowledge representation, problem solving, and learning methods in solving engineering problems.

Course Outcomes	
After successful completion of this course, the students will be able to:	
CO1	**Understand**: Demonstrate knowledge of reasoning, uncertainty, and knowledge representation for solving real-world problems.
CO2	**Evaluate**: Evaluate Artificial Intelligence (AI) methods and describe their foundations.
CO3	**Apply**: Apply basic principles of AI in solutions that require problem-solving, inference, perception, knowledge representation and learning.
CO4	**Analyze**: Analyze and illustrate how search algorithms play a vital role in problem-solving.

SYLLABUS

UNIT I: Introduction: Evolution of AI, State of Art -Different Types of Artificial Intelligence-Applications of AI-Subfields of AI-Intelligent Agents- Structure of Intelligent Agents-Environments.

UNIT II: Problem Solving based on Searching:
Introduction to Problem Solving by searching Methods-State Space search, Uninformed Search Methods – Uniform Cost Search, Breadth First Search- Depth First Search-Depth- limited search, Iterative deepening depth-first, Informed Search Methods- Best First Search, A* Search.

UNIT III: Local Search and Adversarial Search:
Local Search algorithms – Hill-climbing search, Simulated annealing, Genetic Algorithm, Adversarial Search: Game Trees and Minimax Evaluation, Elementary two-players games: tic-tac-toe, Minimax with Alpha-Beta Pruning.

UNIT IV: Logic and Reasoning:
Introduction to Logic and Reasoning -Propositional Logic-First Order Logic-Inference in First Order Logic- Unification, Forward Chaining, Backward Chaining, Resolution.

UNIT V: Uncertain Knowledge and Reasoning: Quantifying Uncertainty- Bayes Rule -Bayesian Belief Network- Approximate Inference in Bayesian networks
UNIT VI: Classical planning, Planning as State-space search, Forward search, backward search, Planning graphs, Hierarchical Planning, Planning and acting in Nondeterministic domains – Sensor-less Planning, Multiagent planning.

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.

Reference Books	
1.	Alpaydin, E. 2010. Introduction to Machine Learning. 2nd Edition, MIT Press.
2.	Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, 1995, PHI.
3.	Artificial Intelligence -Structures and Strategies for Complex Problem Solving, G. F. Luger, 6th Edition, 2008, Pearson.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE Duration (Hrs.)
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	
N-OECCD401T	Game Development Using Python	3	0	0	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:
Virtual Reality, Game Genres, Common Aspects of Computer Games, Platforms. Aspects of Interesting Games.

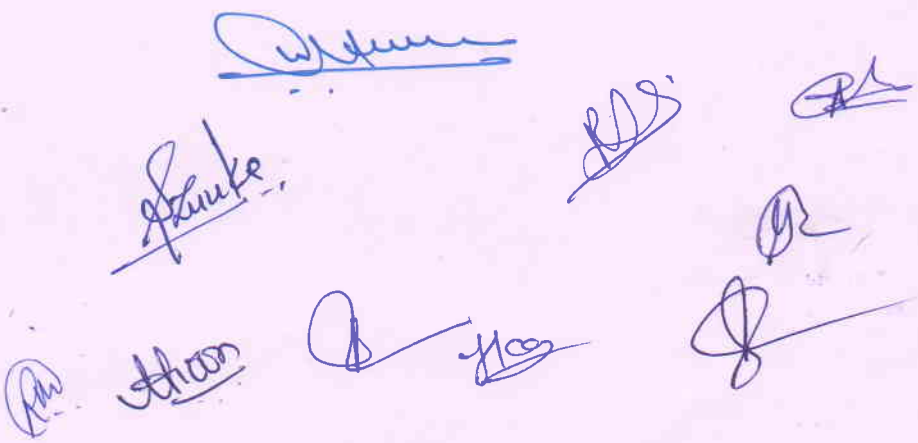
UNIT II: Working of Games:
Video Game Architecture, The Graphics System, The Audio System, Game Design, Playing the Game by the Rule, The Pong Game.

UNIT III: Graphics and Images:
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: Time and Intervals, Events. Randomness in Games, Generating Random Values, Simulating Reality and Intelligence.
UNIT V: Game AI: Collisions: Collision Detection, Polygonal Objects, Broad Phase Collision Detection, Narrow Phase Collision Detection, Collision Detection in the Boat Race.
UNIT VI: Navigation, Control and Sound: Navigation and Control: Basic Autonomous Control, Finite State Machines, Pathfinding, Stochastic Navigation. **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.
2. Programming Game AI By Example, Mat Buckland, 1st Edition, 2004, Jones and Bartlett Publishers.



Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-SECCD401P	Foundation of Data Science Lab	0	0	4	2	25	25	50	-

Course Objective
The lab course develops a comprehensive understanding of data science fundamentals, data handling techniques, statistical inference principles, and Extract, Transform, Load (ETL) processes.

Course Outcomes	
After successful completion of this course, the students will be able to:	
CO1	**Apply:** To solve real-world data science problems by applying computational thinking principles.
CO2	**Analyze** : Handling a challenges in unstructured data and techniques across various data types
CO3	**Evaluate:** Critically evaluate the importance of statistical methods in data science
CO4	**Create:** Design and construct comprehensive ETL workflows incorporating the Extract, Transform, and Load phases

SYLLABUS

MODULE I: Basics of Data Science:
Introduction to data science, the relation of data science to other fields, data science, and information science, computational thinking, skills and tools for data science, storing data, combining bytes into larger structures, creating data sets, identifying data problems, understanding data sources, exploring data models.

MODULE II: Data Handling:
Structured and unstructured data, challenges with unstructured data, data collection: open data and multimodal data, data preprocessing, data cleaning, data integration, data transformation, data reduction, data discretization.

MODULE III: Statistical Inference:
Need of statistics in data science, measures of central tendency: mean, median, mode, mid-range. Measures of dispersion: range, variance, mean deviation, standard deviation. Bayes theorem, basics and need of hypothesis and hypothesis testing, Pearson correlation, sample hypothesis testing, Chi-square tests, T-test.

MODULE IV: Extract, Transform, Load (ETL):
Introduction to ETL, ETL tools, Extract Phase, Transform Phase, Load Phase, ETL Automation, Performance Tuning and Optimization.

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

Suggested References:
1. An Introduction to Data Science, Jeffrey S. Saltz, Jeffrey M. Stanton, 2018, SAGE Publications
2. "The Data Warehouse ETL Toolkit: Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data" Ralph Kimball and Joe Caserta, John Wiley & Sons
3. Data Science from Scratch, Joel Grus, 2015
4. Practical Data Science with Python, Harsh N. Shah, 2023, Packt Publishing
5. A Hands-On Introduction to Data Science, Chirag Shah, 2020, Cambridge University Press
6. Data Science from Scratch, Joel Grus, 2015