II Year I Semester

Sl. No.	Course Code	Name of Course / Laboratory	No. of Periods per week			No. of Credits
			L	T	P	
1	MA4506	Probability and Statistics	3	0	0	3
2	CT4516	Artificial Intelligence	3	0	0	3
3	CT4511	Advanced Data Structures and Algorithm Analysis	3	0	0	3
4	CT4512	Object Oriented Programming Through Java	3	0	0	3
5	CT4513	Advanced Data Structures and Algorithms Lab	0	0	3	1.5
6	CT4514	Object Oriented Programming Through Java Lab	0	0	3	1.5
7	CT4515	Python Programming	0	1	2	2
8	DT4501	Design Thinking and Innovation	1	0	2	2
Total			**13**	**1**	**10**	**19**

II Year II Semester

Sl. No.	Course Code	Name of Course / Laboratory	No. of Periods per week			No. of Credits
			L	T	P	
1	UH4501	Universal human values – understanding harmony and Ethical human conduct	2	1	0	3
2	MA4511	Optimization Techniques	2	0	0	2
3	MA4505	Discrete Mathematics and Graph Theory	3	0	0	3
4	AM4501	Machine Learning	3	0	0	3
5	CT4517	Database Management Systems	3	0	0	3
6	CT4510	Digital Logic and Computer Organization	3	0	0	3
7	AM4502	Machine Learning Lab	0	0	3	1.5
8	CT4520	Database Management Systems Lab	0	0	3	1.5
9	CT4521	Full Stack Development-1	0	1	2	2
10	EN4501	Environmental Science	2	0	0	-
Total			**18**	**2**	**8**	**22**
Mandatory Community Service Project Internship of 08weeks duration during summer vacation						

PROBABILITY AND STATISTICS

(Common to IT and CSE(AI&ML))

II Year - I Semester

Lecture : 3	Internal Marks : 30
Credits : 3	External Marks : 70

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Course Objectives

- To familiarize the students with the foundations of probability and statistical methods
- To impart probability concepts and statistical methods in various applications of engineering

Course Outcomes

Upon successful completion of this course, the student should be able to

- classify the concepts of data science and its importance
- interpret the association of characteristics through correlation and regression tools
- apply discrete and continuous probability distributions
- construct sampling distributions, confidence intervals and to find maximum error of estimates for population parameters.
- apply the inference tests when the sample data is large and/or small.

Course Content

Unit – I: Descriptive statistics and methods for data science:

Data science – Statistics Introduction – Population vs Sample –Collection of data – primary and secondary data – Type of variable: dependent and independent Categorical and Continuous variables – Data visualization – Measures of Central tendency – Measures of Variability – Skewness – Kurtosis.

UNIT – II: Correlation and Regression:

Correlation – Correlation coefficient – Rank correlation.

Linear Regression: Straight line – Multiple Linear Regression - Regression coefficients and properties – Curvilinear Regression: Parabola – Exponential – Power curves.

UNIT – III: Probability and Distributions:

Probability– Conditional probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory:

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Point and Interval estimations – Maximum error of estimate – Central limit theorem (without proof) – Estimation using t, χ^2 and F-distributions.

UNIT – V: Tests of Hypothesis:

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Test of significance for large samples and Small Samples: Single and difference of means – Single and two proportions – Student's t- test, F-test and χ^2-test.

Text Books:

1. Miller and Freund's, " Probability and Statistics for Engineers", 7th Edition, Pearson, 2008.
2. S. C. Gupta and V.K. Kapoor, " Fundamentals of Mathematical Statistics", 11th Edition, Sultan Chand & Sons Publications, 2012.

Reference Books:

1. Shron L. Myers, Keying Ye, Ronald E Walpole, "Probability and Statistics Engineers and Scientists", 8th Edition, Pearson 2007.
2. Jay l. Devore, " Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage.
3. Sheldon M. Ross, " Introduction to probability and statistics Engineers and the Scientists", 4th Edition, Academic Foundation, 2011.

ARTIFICIAL INTELLIGENCE

II Year - I Semester

Lecture : 3	Internal Marks : 30
Credits : 3	External Marks : 70

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Course Objectives

- To learn the methods of solving problems using Artificial Intelligence.
- To introduce the concepts of Expert Systems.

Course Outcomes

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

- formulate problems using Artificial Intelligence representations.
- evaluate the effectiveness of heuristic search and game playing algorithms in different domains.
- design and implement knowledge bases that combine logical, semantic, and probabilistic representations
- apply resolution and explanation-based learning techniques to derive conclusions from logical premises.
- analyze case studies of prominent expert systems like MYCIN, DART, and XCON.

Course Content

UNIT - I

Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT - II

Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A*, AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

UNIT - III

Representation of Knowledge: Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, representing knowledge using rules. Reasoning under uncertainty, review of probability, Bayes' probabilistic interferences and dempster shafer theory.

UNIT - IV

Logic concepts: First order logic, Inference in first order logic, propositional vs. first order inference, unification & lifts, forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, Decision trees, Explanation based learning, Reinforcement Learning.

UNIT - V

Expert Systems: Architecture of expert systems, Roles of expert systems – Knowledge Acquisition Meta knowledge Heuristics. Typical expert systems – MYCIN, DART, XCON: Expert systems shells.

Text Books

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", 2nd Edition, Pearson Education.
2. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill

Reference Books

1. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence: a logical approach", Oxford University Press.
2. G.Luger, "Artificial Intelligence: Structures and Strategies for complex problem Solving", 4th Edition, Pearson.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.
4. Saroj Kaushik , "Artificial Intelligence", CENGAGE Learning.
5. Donald A. Waterman, "A Guide to Expert Systems", Pearson Education.

Online Learning Resources

1. https://ai.google/
2. https://swayam.gov.in/nd1_noc19_me71/preview

ADVANCED DATA STRUCTURES AND ALGORITHM ANALYSIS

(Common to CSE, IT, CSE(AI&ML) and AI&DS)

II Year - I Semester

Lecture : 3 | Internal Marks : 30

Credits : 3 | External Marks : 70

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Course Objectives

- To provide knowledge on advance data structures frequently used in Computer Science domain.
- To develop skills in algorithm design techniques popularly used.
- To understand the use of various data structures in the algorithm design.

Course Outcomes

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

- analyze the space and time complexity of algorithms and implement operations on AVL trees.
- implement graph traversal algorithms and perform operations on heap trees.
- apply divide and conquer and greedy methods to design solutions in practical applications.
- find optimal solution to the problems using dynamic programming.
- construct solutions to the problems using backtracking or branch and bound &explain the foundational concepts of NP-hard and NP-complete problems**.**

Course Content

UNIT – I:

Introduction: Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.
AVL Trees : Creation, Insertion, Deletion operations and applications

UNIT – II:

Heap Trees (Priority Queues): Min and Max Heaps, Operations and Applications
Graphs: Terminology, Representations, Basic Search and Traversals.

UNIT – III:

Divide and Conquer: The General Method, Quick Sort, Merge Sort, Strassen's matrix multiplication.
Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths

UNIT – IV:

Dynamic Programming: General Method, All pairs shortest paths, Single Source Shortest Paths – General Weights (Bellman Ford Algorithm), 0/1 Knapsack, Travelling Salesperson problem.

UNIT – V:

Backtracking: General Method, 8-Queens Problem, Sum of Subsets problem, Graph Coloring.
Branch and Bound: The General Method, 0/1 Knapsack Problem, Travelling Salesperson problem.
NP Hard and NP Complete Problems: Basic Concepts, Cook's theorem

Text Books

1. Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, , "Fundamentals of Data Structures in C++", 2nd Edition, Universities Press.
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Computer Algorithms/C++" 2nd Edition, University Press.

Reference Books

1. Robert Kruse, Bruce P.Leung, Clovis L. Tondo "Data Structures and program design in C", Pearson Education Asia.
2. Trembley & Sorenson, "An Introduction to Data Structures with Applications" McGraw Hill.
3. Donald E Knuth, Addison-Wesley, "The Art of Computer Programming" Vol. 1: Fundamental Algorithms, 1997.
4. Langsam, Augenstein & Tanenbaum, "Data Structures using C & C++", Pearson, 1995.
5. N.Wirth, "Algorithms + Data Structures & Programs", PHI
6. Horowitz Sahni & Mehta, "Fundamentals of Data Structures in C++", Galgottia Pub.
7. Thomas Standish, "Data structures in Java", Pearson Education Asia.

Online Learning Resources:

1. https://www.tutorialspoint.com/advanced_data_structures/index.asp
2. http://peterindia.net/Algorithms.html
3. Abdul Bari, Introduction to Algorithms (youtube.com)

OBJECT ORIENTED PROGRAMMING THROUGH JAVA

(Common to CSE, IT, CSE(AI&ML) and AI&DS)

II Year - I Semester

Lecture : 3 Internal Marks : 30

Credits : 3 External Marks: 70

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Course Objectives

- To identify Java language components and how they work together in applications.
- To learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
- To learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications.
- To understand how to design applications with threads in Java.
- To understand how to use Java APIs for program development.

Course Outcomes

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

- design, write, and debug Java programs using various data types, control statements, and operators
- apply object oriented concepts to build standard java application.
- utilize arrays, implement various inheritance techniques, and work with interfaces in Java to create object-oriented programs.
- build applications using packages, exception handling, Java I/O.
- develop dynamic applications with strings, multi-threading, JDBC and JFX.

Course Content

UNIT - I: Object Oriented Programming

Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

Data Types, Variables, and Operators: Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, **Introduction to Operators**, Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (- -) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

Control Statements: Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator?:, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

UNIT - II: Classes and Objects

Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Keyword this.

Methods: Introduction, Defining Methods, Overloaded Methods, Passing Arguments by Value and by Reference, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Attributes Final and Static.

UNIT - III: Arrays

Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays.

Inheritance: Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class-Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Final class and Methods.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

UNIT - IV: Packages and Java Library

Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto-boxing and Auto-unboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java(Text Book 2)

UNIT - V: String Handling in Java

Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread-Creation of New Threads, Thread States, Thread Priority-Synchronization, Deadlock and Race Situations, Inter-thread Communication - Suspending, Resuming, and Stopping of Threads.

Java Database Connectivity: Introduction, JDBC Architecture, Establishing JDBC Database Connections, ResultSet Interface

Java FX GUI: Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)

Text Books

1. Anitha Seth, B.L.Juneja,"JAVA one step ahead",Oxford.
2. Debasis Samanta, Monalisa Sarma, "Joy with JAVA: Fundamentals of Object Oriented Programming",Cambridge, 2023.
3. Paul Deitel, Harvey Deitel, "JAVA9 for Programmers",4th Edition,Pearson.

References Books

1. Herbert Schildt, "The complete Reference Java",11th Edition, TMH.
2. Y Daniel Liang, "Introduction to Java programming", 7th Edition, Pearson.

Online Resources

1. https://nptel.ac.in/courses/106/105/106105191/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview.

ADVANCED DATA STRUCTURES AND ALGORITHMS LAB

(Common to CSE, IT, CSE(AI&ML) and AI&DS)
II Year - I Semester

Practical : 3 | Internal Marks : 30
Credits : 3 | External Marks : 70

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Course Objectives

- To acquire practical skills in constructing and managing Data structures.
- To apply the popular algorithm design methods in problem-solving scenarios.

Course Outcomes

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

- perform operations on AVL trees, Heap Trees and Graphs.
- apply divide and conquer technique to sort the elements using Quick sort and Merge sort.
- design and analyze the time complexity of Greedy method to solve single source shortest path problem and job sequencing with deadlines.
- solve problems using dynamic programming, back tracking, branch and bound techniques.

Experiments Covering the Topics:

- Operations on AVL trees, Heap Trees
- Graph Traversals
- Sorting techniques
- Shortest path algorithms
- 0/1 Knapsack Problem
- Travelling Salesperson problem
- N-Queens Problem
- Job Sequencing

List of Experiments

Perform any 10 of the following Experiments

1. Construct an AVL tree for a given set of elements which are stored in a file. And implement insert and delete operation on the constructed tree. Write contents of tree into a new file using in-order.
2. Construct Min and Max Heap using arrays, delete any element and display the content of the Heap.
3. Implement BFT and DFT for given graph, when graph is represented by
   a) Adjacency Matrix b) Adjacency Lists
4. Implement Quick sort and observe the execution time for various input sizes (Average, Worst and Best cases).
5. Implement Merge sort and observe the execution time for various input sizes (Average, Worst and Best cases).
6. Implement Knapsack problem using Greedy Method
7. Compare the performance of Single Source Shortest Paths using Greedy method when the graph is represented by adjacency matrix and adjacency lists.
8. Implement Job sequencing with deadlines using Greedy strategy.
9. Write a program to solve 0/1 Knapsack problem Using Dynamic Programming.
10. Implement N-Queens Problem Using Backtracking.
11. Use Backtracking strategy to solve 0/1 Knapsack problem.
12. Implement Travelling Sales Person problem using Branch and Bound approach.

Reference Books

1. Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, "Fundamentals of Data Structures in C++", 2nd Edition, Universities Press
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Computer Algorithms/C++", 2nd Edition, University Press
3. Robert Kruse, "Data Structures and program design in C", Pearson Education Asia.
4. Trembley & Sorenson, "An Introduction to Data Structures with Applications", McGraw Hill .

Online Learning Resources

1. http://cse01-iiith.vlabs.ac.in/
2. http://peterindia.net/Algorithms.html

OBJECT ORIENTED PROGRAMMING THROUGH JAVA LAB

(Common to CSE,IT, CSE(AI&ML) and AI&DS)

II Year - I Semester

Practical : 3 Internal Marks: 30

Credits : 1.5 External Marks:70

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Course Objectives

- To practice object oriented programming in the Java programming language
- To implement Classes, Objects, Methods, Inheritance, Exception, Runtime Polymorphism, User defined Exception handling mechanism
- To illustrate inheritance, Exception handling mechanism, JDBC connectivity
- To construct Threads, Event Handling, implement packages, JavaFX GUI

Course Outcomes

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

- apply object oriented concepts in java programs.
- demonstrate inheritance and polymorphism concepts.
- implement user defined exceptions and multi-tasking applications.
- develop GUI,JDBC and event based applications.

Experiments covering the Topics:

- Object Oriented Programming fundamentals-data types, control structures
- Classes, methods, objects, Inheritance, polymorphism,
- Exception handling, Threads, Packages, Interfaces
- Files, I/O streams, JavaFX GUI

List of Experiments:

Exercise–1:

a) Write a JAVA program to display default value of all primitive data type of JAVA
b) Write a JAVA program that display the roots of a quadratic equation $ax^2+bx+c=0$.
c) Calculate the discriminate D and basing on value of D, describe the nature of root.

Exercise-2

a) Write a JAVA program to search for an element in a given list of elements using binary search mechanism.
b) Write a JAVA program to sort for an element in a given list of elements using bubble sort
c) Write a JAVA program using String Buffer to delete, remove character.

Exercise-3

a) Write a JAVA program to implement class mechanism. Create a class, methods and invoke them inside main method.
b) Write a JAVA program implement method overloading.
c) Write a JAVA program to implement constructor.
d) Write a JAVA program to implement constructor overloading.

Exercise-4

a) Write a JAVA program to implement single Inheritance
b) Write a JAVA program to implement multilevel Inheritance
c) Write a JAVA program for abstract class to find areas of different shapes

Exercise-5

a) Write a JAVA program give example for "super" keyword.
b) Write a JAVA program to implement Interface. What kind of Inheritance can be achieved?
c) Write a JAVA program that implements Runtime polymorphism

Exercise-6

a) Write a JAVA program that describes exception handling mechanism
b) Write a JAVA program Illustrating multiple catch clauses
c) Write a JAVA program for creation of Java Built-in Exceptions
d) Write a JAVA program for creation of user defined Exception

Exercise-7

a) Write a JAVA program that creates threads by extending Thread class. First thread display "Good Morning" every 1 sec, the second thread displays "Hello" every 2 seconds and the third display "Welcome" every 3 seconds, (Repeat the same by implementing Runnable)
b) Write a program illustrating isAlive and join()

Exercise–8

a) Write a JAVA Program to illustrate Daemon Threads.
b) Write a JAVA program to implement Producer Consumer Problem

Exercise– 9

a) Write a JAVA program that import and use the user defined packages
b) Without writing any code, build a GUI that display text in label and image in an Image View (use JavaFX)
c) Build a Tip Calculator apposing several JavaFX components and learn how to respond to user interactions with the GUI

Exercise– 10

a) Write a JAVA program that connects to a database using JDBC
b) Write a JAVA program to connect to a database using JDBC and insert values into it.
c) Write a JAVA program to connect to a database using JDBC and delete values from it

References Books:

1. Herbert Schildt, "The complete Reference Java",11th Edition,TMH
2. Anitha Seth,B.L.Juneja, "JAVA one step ahead",Oxford.

PYTHON PROGRAMMING

(Common to CSE,IT, CSE(AI&ML) and AI&DS)

II Year – I Semester

Tutorial : 1	Practical : 2	Internal Marks	: 30
Credits : 2		External Marks	: 70

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Course Objectives

- To introduce core programming concepts of python programming language.
- To demonstrate about python data structures like lists, tuples, sets and dictionaries.
- To impart knowledge of implementing functions, modules, and file handling methods in python programming and analyzing data sets using python libraries.

Course Outcomes

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

- demonstrate the fundamental concepts of python and use of control flow statements to write effective and readable code.
- develop python programs including functions, strings and lists for efficient problem solving.
- make use of python data structures for efficient data handling, and apply relevant methods to manipulate and retrieve data in python programs.
- apply object-oriented concepts to develop reusable code.
- apply NumPy for numerical computations and evaluate pandas for data analysis in python.

UNTI - I:

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook.

Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: if statement, if-else statement, if...elif…else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement.

Sample Experiments:

1. Write a program to find the largest element among three Numbers.
2. Write a Program to display all prime numbers within an interval
3. Write a program to swap two numbers without using a temporary variable.
4. Demonstrate the following Operators in Python with suitable examples.
   i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Ternary Operator vii) Membership Operators viii) Identity Operators
5. Write a program to add and multiply complex numbers
6. Write a program to print multiplication table of a given number.

UNIT-II:

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.

Sample Experiments:

1. Write a program to define a function with multiple return values.
2. Write a program to define a function using default arguments.
3. Write a program to find the length of the string without using any library functions.
4. Write a program to check if the substring is present in a given string or not.
5. Write a program to perform the given operations on a list:
   i. addition ii. insertion iii. slicing
6. Write a program to perform any 5 built-in functions by taking any list.

UNIT - III:

Dictionaries: Creating Dictionary, Accessing and Modifying key:value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement.

Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozen set.

Sample Experiments:

1. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
2. Write a program to count the number of vowels in a string (No control flow allowed).
3. Write a program to check if a given key exists in a dictionary or not.
4. Write a program to add a new key-value pair to an existing dictionary.
5. Write a program to sum all the items in a given dictionary.

UNIT - IV:

Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules.

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:

1. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
2. Python program to print each line of a file in reverse order.
3. Python program to compute the number of characters, words and lines in a file.
4. Write a program to create, display, append, insert and reverse the order of the items in the array.
5. Write a program to add, transpose and multiply two matrices.
6. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

UNIT - V:

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

Sample Experiments:

1. Python program to check whether a JSON string contains complex object or not.
2. Python Program to demonstrate NumPy arrays creation using array() function.
3. Python program to demonstrate use of ndim, shape, size, dtype.
4. Python program to demonstrate basic slicing, integer and Boolean indexing.
5. Python program to find min, max, sum, cumulative sum of array

6. Create a dictionary with atleast five keys and each key represent value as a list where this list contains atleast ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:
   a) Apply head () function to the pandas data frame
   b) Perform various data selection operations on Data Frame
7. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

Reference Books

1. Gowri Shankar S and Veena A., "Introduction to Python Programming", CRC Press, 2018.
2. S Sridhar, J Indumathi and V M Hariharan, "Python Programming", 2nd Edition, Pearson, 2024.
3. Y. Daniel Liang, "Introduction to Programming Using Python", Pearson, 2017.

Online Learning Resources/Virtual Labs

1. https://www.coursera.org/learn/python-for-applied-data-science-ai
2. https://www.coursera.org/learn/python?specialization=python#syllabus

DESIGN THINKING AND INNOVATION

(Common to CE, ME, IT, CSE (AI&ML) and IOT)

II Year – I Semester

Lecture : 1	Practical : 2	Internal Marks	: 30
Credits : 2		External Marks	: 70

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Course Objectives

- To develop a comprehensive understanding of design thinking, its history, principles, and application in various contexts, including product development and business innovation.
- To apply the design thinking process and tools to foster creativity, drive innovation, and address real-world challenges in both social and business settings.

Course Outcomes

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

- analyse the elements and principles of design.
- implement the design thinking process (empathize, analyze, ideate, and prototype) to drive inventions and social innovations.
- analyse the difference between innovation and creativity, to foster innovation within organization.
- create a comprehensive product design by forming and solving problems, setting product strategies, values, planning, and specifications, and evaluating case studies for practical insights.
- apply design thinking principles to redefine business strategies and address business challenges.

Course Content

UNIT I: Introduction to Design Thinking

Introduction to elements and principles of design, basics of design-dot, line, shape, form as fundamental design components - Principles of design - Introduction to design thinking, history of design thinking, new materials in industry.

UNIT II: Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brain storming, product development

Activity: Every student presents their idea in three minutes, every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT III: Innovation

Art of innovation, difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to innovation. Teams for innovation, measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, flow and planning from idea to innovation, debate on value-based innovation.

UNIT IV: Product Design

Problem formation, introduction to product design, product strategies, product value, product planning, product specifications. Innovation towards product design case studies.

Activity: Importance of modeling, how to set specifications, explaining their own product design.

UNIT V: Design Thinking in Business Processes

Design thinking applied in business & strategic Innovation, design thinking principles that redefine business – Business challenges: growth, predictability, change, maintaining relevance, extreme competition, standardization. Design thinking to meet corporate needs. Design thinking for startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Text Books

1. Tim Brown, "Change by Design", 1st Edition, Harper Bollins, 2009.
2. Idris Mootee, "Design Thinking for Strategic Innovation", 1st Edition, Adams Media, 2014.

Reference Books

1. David Lee, "Design Thinking in the Classroom", Ulysses press, 2018.
2. Shrrutin N Shetty, "Design the Future", 1st Edition, Norton Press, 2018.
3. William lidwell, Kritina holden, Jill butter, "Universal principles of design", 2nd Edition, Rockport Publishers, 2010.
4. Henry W. Chesbrough, "The Era of Open Innovation", MIT Sloan Management Review, 2003.
5. Anuja Agarwal, "Design Thinking: A Framework for Applying Design Thinking in Problem Solving", 1st Edition, Cengage learning India Pvt. Ltd., 2023

Online Learning Resources

1. https://nptel.ac.in/courses/110/106/110106124/
2. https://nptel.ac.in/courses/109/104/109104109/
3. https://swayam.gov.in/nd1_noc19_mg60/preview
4. https://onlinecourses.nptel.ac.in/noc2

UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT

(Common to CE, ME, IT, CSE(AI&ML), AI&DS and IOT)

II Year – II Semester

Lecture : 2	Tutorial : 1	Internal Marks	: 30
Credits : 3		External Marks	: 70

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Course Objectives

- To help understand the need, basic guidelines, content and process of value education.
- To facilitate the students to understand harmony at all the levels of human living, and live accordingly.
- To understand the harmony in nature and existence.
- To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life.

Course Outcomes:

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

- analyze the essentials of human values and skills, self-exploration, happiness and prosperity.
- evaluate coexistence of the "I" with the body.
- identify and evaluate the role of harmony in family, society and universal order.
- examine the holistic perception of harmony at all levels of existence.
- develop appropriate technologies and management patterns to create harmony in professional and personal lives.

Course Content

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT - I : Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1 : Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2 : Understanding Value Education

Tutorial 1 : Practice Session PS1 Sharing about Oneself

Lecture 3 : self-exploration as the Process for Value Education

Lecture 4 : Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2 : Practice Session PS2 Exploring Human Consciousness

Lecture 5 : Happiness and Prosperity – Current Scenario

Lecture 6 : Method to Fulfill the Basic Human Aspirations

Tutorial 3 : Practice Session PS3 Exploring Natural Acceptance

UNIT - II: Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7 : Understanding Human being as the Co-existence of the self and the body.

Lecture 8 : Distinguishing between the Needs of the self and the body

Tutorial 4 : Practice Session PS4 Exploring the difference of Needs of self and body.

Lecture 9 : The body as an Instrument of the self

Lecture 10 : Understanding Harmony in the self

Tutorial 5 : Practice Session PS5 Exploring Sources of Imagination in the self

Lecture 11 : Harmony of the self with the body
Lecture 12 : Programme to ensure self-regulation and Health
Tutorial 6 : Practice Session PS6 Exploring Harmony of self with the body

UNIT - III: Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)
Lecture 13 : Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14 : 'Trust' – the Foundational Value in Relationship
Tutorial 7 : Practice Session PS7 Exploring the Feeling of Trust
Lecture 15 : 'Respect' – as the Right Evaluation
Tutorial 8 : Practice Session PS8 Exploring the Feeling of Respect
Lecture 16 : Other Feelings, Justice in Human-to-Human Relationship
Lecture 17 : Understanding Harmony in the Society
Lecture 18 : Vision for the Universal Human Order
Tutorial 9 : Practice Session PS9 Exploring Systems to fulfill Human Goal

UNIT-IV : Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)
Lecture 19 : Understanding Harmony in the Nature
Lecture 20 : Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21 : Realizing Existence as Co-existence at All Levels
Lecture 22 : The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT - V: Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23 : Natural Acceptance of Human Values
Lecture 24 : Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25 : A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26 : Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28 : Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions:

UNIT I – Introduction to Value Education
PS1 Sharing about Oneself
PS2 Exploring Human Consciousness
PS3 Exploring Natural Acceptance

UNIT II – Harmony in the Human Being
PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self
PS6 Exploring Harmony of self with the body

UNIT III – Harmony in the Family and Society
PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

UNIT IV – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Readings:

Textbook and Teachers Manual

a. The Textbook: R R Gaur, R Asthana, and G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual: R R Gaur, R Asthana, and G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. A Nagaraj, "JeevanVidya: EkParichaya", JeevanVidya Prakashan, Amarkantak, 1999.
2. A. N. Tripathi, "Human Values", New Age International Publishers, 2004.
3. Annie Leonard, "The Story of Stuff", Free Press Publishers, 2010.
4. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth", 1st edition, Fingerprint Publishers, 2009.
5. E. F Schumacher, "Small is Beautiful", Vintage Publishers, 2010.
6. Cecile Andrews , "Slow is Beautiful", New Society Publishers, 2006.
7. J C Kumarappa, "Economy of Permanence", Sarva Seva Sangh Prakashan, 2017.
8. Pandit Sunderlal, "Bharat Mein Angreji Raj", Publications Division, M/O Information & Broadcasting, Govt. of India, 2016.
9. Dharampal,"Rediscovering India", Stosius Inc/Advent Books Division, 1983.
10. Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule", 15th edition, Educa Books, 2011.
11. Maulana Abdul Kalam Azad, "India Wins Freedom", 1st edition, Orient BlackSwan, 1988.
12. Romain Rolland, "Life of Vivekananda", 4th Impression edition, Advaita Ashrama press, 2010.
13. Romain Rolland, "Mahatma Gandhi**",** Maple Press , 2010.

Mode of Conduct:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

Online Resources:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDPSI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicteindia.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%202325%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-humanvalues/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

OPTIMIZATION TECHNIQUES

II Year - II Semester

Lecture : 2	Internal Marks : 30
Credits : 2	External Marks : 70

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Course Objective

- To find the best feasible solution to an optimization problem within given constraints to improve efficiency, performance, cost-effectiveness, or other desired outcomes in various engineering disciplines.

Course Outcomes

Upon successful completion of this course, the student should be able to

- formulate an optimization problem, and apply the methods such as Lagrange multipliers and Kuhn-Tucker conditions to find an optimal solution.
- apply classical optimization techniques to find an optimal solution.
- solve transportation problems first by initial solution methods and test for optimality in balanced transportation problems, addressing special cases.
- employ gradient and non-gradient methods to solve non-linear optimization problems, incorporating penalty functions to find an optimal solutions.
- utilize dynamic programming technique to inventory control, production planning, engineering design problems etc. to get an optimal solution.

Course Content

UNIT I: Introduction and Classical Optimization Techniques

Statement of an optimization problem, design vector, design constraints, constraint surface, objective function, objective function surfaces, and classification of optimization problems. Classical optimization techniques: single variable optimization, multi variable optimization without constraints, necessary and sufficient conditions for minimum/maximum, multivariable optimization with equality constraints. Solution by method of Lagrange multipliers, multivariable optimization with inequality constraints, Kuhn – Tucker conditions.

UNIT II: Linear Programming

Standard form of a linear programming problem, geometry of linear programming problems, definitions and theorems, solution of a system of linear simultaneous equations, pivotal reduction of a general system of equations, motivation to the simplex method.

UNIT III: Transportation Problem

Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method, testing for optimality of balanced transportation problems, Special cases in transportation problem.

UNIT IV: Nonlinear Programming

Unconstrained cases, One – dimensional minimization methods: Classification, Fibonacci method, Univariate method, steepest descent method. Constrained cases– Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method, Basic approaches of Interior and Exterior penalty function methods.

UNIT V: Dynamic Programming

Dynamic programming multistage decision processes, types, concept of sub optimization and the principle of optimality, computational procedure in dynamic programming, examples, illustrating the calculus method of solution, examples, illustrating the tabular method of solution.

Text Books

1. S. S. Rao, "Engineering optimization: Theory and practice", 3rd Edition, New Age International (P) Limited.
2. H. S. Kasana and K. D. Kumar, "Introductory Operations Research", Springer Pvt. Ltd.

Reference Books

1. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and systems Analysis", 3rd Edition, New Age International (P) Limited.
2. S. D. Sharma, "Operations Research", Kedarnath and Ramnath, Meerut.

DISCRETE MATHEMATICS AND GRAPH THEORY

(Common to IT and CSE(AI&ML))

II Year - II Semester

Lecture : 3	Internal Marks : 30
Credits : 3	External Marks : 70

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Course Objective

- To impart the knowledge on mathematical and combinatorial reasoning, relations, graphs and recurrence relations.

Course Outcomes

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

- verify the validity of mathematical arguments using propositional logic, predicate logic and truth tables.
- solve various problems related to principle of inclusion and exclusion of sets, relations and functions.
- apply combinatorial principles, techniques to solve counting problems and solve problems on recurrence relations.
- demonstrate various types of graphs with applications and determine the isomorphism of graphs.
- illustrate various types of trees and determine spanning / minimal spanning trees of given graphs.

Course Content

UNIT–I: Mathematical Logic

Propositional Calculus: Statements and Notations, Connectives, Well Formed Formulas, Truth Tables, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications, Normal Forms, Theory of Inference for Statement Calculus, Consistency of Premises, Indirect Method of Proof.

Predicate Calculus: Predicates, Predicative Logic, Statement Functions, Variables and Quantifiers, Free and Bound Variables, Inference Theory for Predicate Calculus.

UNIT-II: Set Theory

Sets: Operations on Sets, Principle of Inclusion-Exclusion.

Relations: Properties, Operations, Partition and Covering, Transitive Closure, Equivalence, Compatibility and Partial Ordering, Hasse Diagram.

Functions: Bijective, Composition, Inverse, Permutation and Recursive Functions, Lattice and its Properties.

UNIT-III: Combinatorics and Recurrence Relations

Combinatorics: Basics of Counting, Permutations, Permutations with Repetitions, Circular and Restricted Permutations, Combinations, Restricted Combinations, Binomial and Multinomial Coefficients and Theorems.

Recurrence Relations: Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots, Solving Inhomogeneous Recurrence Relations.

UNIT-IV: Graph Theory

Basic Concepts, Graph Theory and its Applications, Subgraphs, Graph Representations: Adjacency and Incidence Matrices, Isomorphic Graphs, Paths and Circuits, Eulerian and Hamiltonian Graphs.

UNIT-V: Multi Graphs

Multigraphs, Bipartite and Planar Graphs, Euler's Theorem, Graph Colouring and Covering, Chromatic Number, Spanning Trees, Prim's and Kruskal's Algorithms, BFS and DFS Spanning Trees.

Text Books

1. J. P. Tremblay and R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill.
2. C. L.Liu and D. P. Mohapatra, "Elements of Discrete Mathematics-A Computer Oriented Approach", 3rd Edition, Tata McGraw Hill.
3. Seymour Lipschutz and Marc Lars Lipson, "Theory and Problems of Discrete Mathematics", Schaum's Outline Series, 3rd Edition, Tata McGraw Hill.

Reference Books

1. J. L.Mott, A. Kandel and T. P. Baker, "Discrete Mathematics for Computer Scientists and Mathematicians", 2nd Edition, Prentice Hall of India.
2. Bernand Kolman, Robert C. Busby and Sharon Cutler Ross, "Discrete Mathematical Structures", PHI.
3. S. K. Chakraborthy and B.K. Sarkar, "Discrete Mathematics", Oxford, 2011.
4. K. H. Rosen, "Discrete Mathematics and its Applications with Combinatorics and GraphTheory", 7th Edition, Tata McGraw Hill.

MACHINE LEARNING

II Year - II Semester

Lecture : 3	Internal Marks : 30
Credits : 3	External Marks : 70

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Course Objective

- To familiarize with machine learning techniques and its different types (supervised and unsupervised) and understand their applications.

Course Outcomes

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

- demonstrate the strategies for deploying and operationalizing ML models in real-world applications.
- compare the performance of KNN and Radius Distance Nearest Neighbor algorithms with other classification and regression techniques.
- implement decision tree algorithms and Bayes classifier for classification and regression tasks.
- analyze the convergence properties of SVM and perceptron algorithm.
- evaluate the challenges and considerations in clustering large-scale and high-dimensional data.

Course Content

UNIT-I: Introduction to Machine Learning

Evolution of Machine Learning, Paradigms for ML, Learning by Rote, Learning by Induction, Reinforcement Learning, Types of Data, Matching, Stages in Machine Learning, Data Acquisition, Feature Engineering, Data Representation, Model Selection, Model Learning, Model Evaluation, Model Prediction, Search and Learning, Data Sets used.

UNIT-II: Nearest Neighbor-Based Models

Introduction to Proximity Measures, Distance Measures, Non-Metric Similarity Functions, Proximity Between Binary Patterns, Different Classification Algorithms Based on the Distance Measures ,K-Nearest Neighbor Classifier, Radius Distance Nearest Neighbor Algorithm, KNN Regression, Performance of Classifiers, Performance of Regression Algorithms.

UNIT-III: Models Based on Decision Trees

Decision Trees for Classification, Impurity Measures, Properties, Regression Based on Decision Trees, Bias–Variance Trade-off, Random Forests for Classification and Regression.

The Bayes Classifier: Introduction to the Bayes Classifier, Bayes' Rule and Inference, the Bayes Classifier and its Optimality, Multi-Class Classification | Class Conditional Independence and Naive Bayes Classifier (NBC)

UNIT-IV: Linear Discriminants for Machine Learning

Introduction to Linear Discriminants, Linear Discriminants for Classification, Perceptron Classifier, Perceptron Learning Algorithm, Support Vector Machines, Linearly Non-Separable Case, Non-linear SVM, Kernel Trick, Logistic Regression, Linear Regression, Multi-Layer Perceptrons (MLPs), Backpropagation for Training an MLP.

UNIT-V: Clustering

Introduction to Clustering, Partitioning of Data, Matrix Factorization | Clustering of Patterns, Divisive Clustering, Agglomerative Clustering, Partitional Clustering, K-Means Clustering, Soft Partitioning, Soft Clustering, Fuzzy C-Means Clustering, Rough Clustering, Rough K-Means Clustering Algorithm, Expectation Maximization-Based Clustering, Spectral Clustering.

Text Books

1. M N Murthy, V S Ananthanarayana, "Machine Learning: Theory and Practice", Universities Press (India), 2024

Reference Books:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Publication, 2017
2. Peter Harrington, "Machine Learning in Action", DreamTech
3. Pang-Ning Tan, Michel Stenbach, Vipin Kumar, "Introduction to Data Mining", 7th Edition, 2019.

Online Learning Resources

1. https://onlinecourses.nptel.ac.in/noc24_cs81/

DATABASE MANAGEMENT SYSTEMS

(Common to CSE, IT and CSE (AI&ML))

II Year - II Semester

Lecture : 3 Internal Marks : 30

Credits : 3 External Marks: 70

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Course Objectives

- To introduce database management systems and to give a good formal foundation on the relational model of data and Relational Algebra
- To introduce the concepts of SQL for storage, retrieval and manipulation of data in a relational database.
- To demonstrate the conceptual design and logical database design through normalization
- To provide an overview of transaction management, concurrency control and indexing.

Course Outcomes

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

- describe the importance of DBMS and derive a model in the form of ER diagram
- develop simple queries using SQL to manipulate the data in a relational model
- develop complex queries using SQL to manipulate the data.
- apply principles of normalization for designing a good relational database.
- demonstrate different techniques used in transaction management,concurrency control, crash recovery and indexing.

Course Content

UNIT - I

Introduction: Database system, Characteristics (Database Vs File System), Database Users, Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance; Three tier schema architecture for data independence; Database system structure.

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

UNIT - II

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, Relational Algebra. BASIC SQL: Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update).

UNIT - III

SQL: Basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions (Date and Time, Numeric, String conversion). Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, relational set operations.

UNIT - IV:

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency Lossless join and dependency preserving decomposition, (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF).

UNIT - V:

Transaction Concept: Transaction States, ACID properties, Concurrent Executions, Serializability, Recoverability, Testing for Serializability.
Concurrency Controls: Lock based protocols, timestamp-based protocols, Deadlocks.

Crash Recovery and Indexing: Failure Classification, Recovery Algorithms- differed update and immediate update, checkpoints, Indexing Techniques –B Trees, B+ Trees.

Text Books

1. Raghurama Krishnan, Johannes Gehrke, "Database Management Systems", 3rd Edition,TMH (For Chapters 2, 3, 4)
2. Silberschatz, Korth, Sudarsan, "Database System Concepts", 5th Edition, TMH.(For Chapter 1 and Chapter 5)

Reference Books

1. C J Date, "Introduction to Database Systems",8th Edition, Pearson.
2. Ramez Elmasri, Shamkant B.Navathe, "Database Management System", 6th Edition, Pearson
3. Corlos Coronel, Steven Morris, Peter Robb, "Database Principles Fundamentals of Design Implementation and Management", Cengage Learning.

Online Learning Resources

1. https://nptel.ac.in/courses/106/105/106105175/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01275806667282022456_shared/overview

DIGITAL LOGIC AND COMPUTER ORGANIZATION

(Common to CSE(AI&ML) and AI&DS)
II Year - II Semester

Lecture : 3	Internal Marks : 30
Credits : 3	External Marks : 70

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Course Objectives

- To provide students with a comprehensive understanding of digital logic design principles and computer organization fundamentals.
- To describe memory hierarchy concepts.
- To explain input/output (I/O) systems and their interaction with the CPU, memory, and peripheral devices.

Course Outcomes

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

- represent data in Binary form, minimize logical expressions and design logic circuits using logic gates.
- design combinational and sequential logic circuits.
- demonstrate basic structure and functional units of a computer.
- perform arithmetic operations on signed and unsigned numbers.
- explain input/output (I/O) systems and their interaction with the CPU, memory, and peripheral devices.

Course Content

UNIT – I:

Data Representation: Binary Numbers, Fixed Point representation. Floating Point representation. Number base conversions, Octal and Hexadecimal Numbers, Complements, Signed binary numbers, Binary codes

Digital Logic Circuits-I: Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic expressions. K-Map Simplifications (upto 4 variables), Combinational Circuits: Decoders, Multiplexers

UNIT – II:

Digital Logic Circuits-II: Sequential Circuits, Flip-Flops, Registers, Shift Registers: Uni-directional, Bi-directional, Universal, Binary counters, Ripple counters

UNIT – III:

Basic Structure of Computers: Functional units, Basic operational concepts, Bus structures, Multi processors, Multi computers, Von- Neumann Architecture.

Computer Arithmetic : Addition and Subtraction of Signed Numbers, Design of Full Adders, Multiplication of Positive Numbers, Signed-operand Multiplication, Integer Division, Floating-Point Numbers and Operations.

UNIT – IV:

Processor Organization: Fundamental Concepts, Execution of a Complete Instruction, Multiple-Bus Organization, Hardwired Control and Multi programmed Control.

The Memory Organization: Basic Concepts, Semiconductor RAM Memories, Read-Only Memories, Speed, Size and Cost, Cache Memories, Performance Considerations, Virtual Memories, Memory Management Requirements, Secondary Storage.

UNIT – V:

Input / Output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Buses- synchronous bus, asynchronous bus.

Text Books

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky, "Computer Organization", 6th Edition, McGraw Hill, 2023.
2. M. Morris Mano , "Digital Design", 6th Edition, Pearson Education, 2018.
3. William Stallings, "Computer Organization and Architecture", 11th Edition, Pearson, 2022.

Reference Books

1. M.Moris Mano, "Computer Systems Architecture", 3rd Edition, Pearson, 2017.
2. David A. Paterson, John L. Hennessy, "Computer Organization and Design", Elsevier, 2004.
3. Roth, "Fundamentals of Logic Design", 5th Edition, Thomson, 2003.

Online Learning Resources

1. https://nptel.ac.in/courses/106/103/106103068/

MACHINE LEARNING LAB

II Year - II Semester

Practical : 3 | Internal Marks : 30

Credits : 1.5 | External Marks : 70

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Course Objective

- To make use of data sets in implementing the machine learning algorithms

Course Outcomes

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

- design python programs for various learning algorithms.
- identify and apply machine Learning algorithms with appropriate data sets to solve real world problems.

List of Experiments

Perform any 10 of the following Experiments

1. Compute Central Tendency Measures: Mean, Median, Mode Measure of Dispersion: Variance, Standard Deviation.
2. Apply the following Pre-processing techniques for a given dataset.

   a) Attribute selection b) Handling Missing Values c) Discretization d) Elimination of Outliers
3. Apply KNN algorithm for classification and regression
4. Demonstrate decision tree algorithm for a classification problem and perform parameter tuning for better results
5. Demonstrate decision tree algorithm for a regression problem
6. Apply Random Forest algorithm for classification and regression
7. Demonstrate Naïve Bayes Classification algorithm.
8. Apply Support Vector algorithm for classification
9. Demonstrate simple linear regression algorithm for a regression problem
10. Apply Logistic regression algorithm for a classification problem
11. Demonstrate Multi-layer Perceptron algorithm for a classification problem
12. Implement the K-means algorithm and apply it to the data you selected. Evaluate performance by measuring the sum of the Euclidean distance of each example from its class center. Test the performance of the algorithm as a function of the parameters K.
13. Demonstrate the use of Fuzzy C-Means Clustering
14. Demonstrate the use of Expectation Maximization based clustering algorithm.

Reference Books

1. M N Murthy, V S Ananthanarayana, "Machine Learning Theory and Practice", Universities Press (India), 2024
2. Tom M. Mitchell, "Machine Learning", McGraw-Hill Publication, 2017
3. Peter Harrington, "Machine Learning in Action", DreamTech
4. Pang-Ning Tan, Michel Stenbach, Vipin Kumar, "Introduction to Data Mining", 7th Edition, 2019.

DATABASE MANAGEMENT SYSTEMS LAB

(Common to CSE, IT and CSE (AI&ML))

II Year - II Semester

Practical : 3 Internal Marks : 30

Credits : 1.5 External Marks: 70

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Course Objectives

- To populate and query a database using SQL (DDL,DML) Commands.
- To enforce integrity constraints on a database and to write queries using the concepts of SQL and PL/SQL.

Course Outcomes

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

- develop simple and complex queries using SQL.
- write PL/SQL programs including procedures, functions, cursors and triggers.

Experiments covering the topics

- DDL, DML, DCL commands.
- Queries, nested queries, built-in functions.
- PL/SQL programming-control structures.
- Procedures, Functions, Cursors, Triggers.

List of Experiments

Perform any 10 experiments in the following

1. Creation, altering and dropping of tables and inserting rows into a table (use constraints while creating tables) examples using Select command.
2. Queries (along with sub Queries) using Any, All, In, Exists, Not Exists, Union, Intersection, Constraints. (Ex: Select the roll number and name of the student who secured fourth rank in the class).
3. Queries using Aggregate functions (Count, Sum, Avg, Max and Min), Group By and Having.
4. Queries using Conversion functions (to_char, to_number and to_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length, substr and instr), date functions (Sysdate, next_day, add_months, last_day, months_between, least, greatest, truncate, round, to_char, to_date)
5.
    i. Create a simple PL/SQL program which includes declaration section, executable section and Exception-Handling section (Ex: Student marks can be selected from the table and printed for those who secured first class and an exception can be raised if no records were found)
    ii. Insert data into student table and use Commit, Rollback and Savepoint in PL/SQL block.
6. Develop a program that includes the features Nested IF, Case expression. The program can be extended using the Null-IF and Coalesce functions.
7. Program development using While Loops, numeric For Loops, nested loops using Error Handling, Built-In Exceptions, User defined Exceptions, Raise- Application Error.
8. Programs development using creation of procedures, passing parameters IN and OUT of Procedures.

9. Program development using creation of stored functions, invoke functions in SQL Statements and write complex functions.
10. Develop programs using features parameters in a Cursor, For Update Cursor, Where Current of clause and Cursor variables.
11. Develop Programs using Before and After Triggers, Row and Statement Triggers and Instead of Triggers.
12. Create a table and perform the search operation on table using indexing and non- indexing techniques.

Reference Books

1. Oracle: The Complete Reference by Oracle Press.
2. Nilesh Shah, "Database Systems Using Oracle", PHI, 2007.
3. Rick F Vander Lans, "Introduction to SQL", 4th Edition, Pearson Education,2007

FULL STACK DEVELOPMENT – 1

(Common to CSE, CSE(AI&ML) and AI&DS)

II Year - II Semester

Tutorial : 1 Practical : 2 Internal Marks : 30

Credits : 2 External Marks : 70

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Course Objectives

The main objectives of the course is

- To make use of HTML elements and their attributes for designing static web pages
- To build a web page by applying appropriate CSS styles to HTML elements
- To experiment with JavaScript to develop dynamic web pages and validate forms

Course Outcomes

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

- design web pages using HTML and CSS
- develop dynamic web pages and perform form validations using javascript.

Course Content

Experiments covering the Topics:

- Lists, Links and Images
- HTML Tables, Forms and Frames
- HTML 5 and Cascading Style Sheets, Types of CSS
- Selector forms
- CSS with Color, Background, Font, Text and CSS Box Model
- Applying JavaScript - internal and external, I/O, Type Conversion
- JavaScript Conditional Statements and Loops, Pre-defined and User-defined Objects
- JavaScript Functions and Events
- Node.js

Sample Experiments

1. Lists, Links and Images

a. Write a HTML program, to explain the working of lists.

Note: It should have an ordered list, unordered list, nested lists and ordered list in an unordered list and definition lists.

b. Write a HTML program, to explain the working of hyperlinks using <a> tag and href, target Attributes.

c. Create a HTML document that has your image and your friend's image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles.

d. Write a HTML program, in such a way that, rather than placing large images on a page, the preferred technique is to use thumbnails by setting the height and width parameters to something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique.

2. HTML Tables, Forms and Frames

a. Write a HTML program, to explain the working of tables. (use tags: <table>, <tr>, <th>,<td> and attributes: border, rowspan, colspan)

b. Write a HTML program, to explain the working of tables by preparing a timetable. (Note: Use <caption> tag to set the caption to the table & also use cell spacing, cell padding, border, rowspan, colspan etc.).

c. Write a HTML program, to explain the working of forms by designing Registration form. (Note: Include text field, password field, number field, date of birth field, checkboxes,

radio buttons, list boxes using <select>&<option> tags, <text area> and two buttons ie: submit and reset. Use tables to provide a better view).

d. Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame image, second frame paragraph, third frame hyperlink. And also make sure of using "no frame" attribute such that frames to be fixed).

3. HTML 5 and Cascading Style Sheets, Types of CSS

a. Write a HTML program, that makes use of <article>, <aside>, <figure>, <figcaption>,<footer>, <header>, <main>, <nav>, <section>, , tags.

b. Write a HTML program, to embed audio and video into HTML web page.

c. Write a program to apply different types (or levels of styles or style specification formats)- inline, internal, external styles to HTML elements. (identify selector, property and value).

4. Selector forms

a. Write a program to apply different types of selector forms.
b. Simple selector (element, id, class, group, universal).
c. Combinator selector (descendant, child, adjacent sibling, general sibling)
d. Pseudo-class selector
e. Pseudo-element selector
f. Attribute selector

5. CSS with Color, Background, Font, Text and CSS Box Model

a. Write a program to demonstrate the various ways you can reference a color in CSS.

b. Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.

c. Write a program using the following terms related to CSS font and text:

i. font-size ii. font-weight iii. font-style
iv. text-decoration v. text-transformation vi. text-alignment

d. Write a program, to explain the importance of CSS Box model using

i. Content ii. Border iii. Margin iv. padding

6. Applying JavaScript - internal and external, I/O, Type Conversion

a. Write a program to embed internal and external JavaScript in a web page.
b. Write a program to explain the different ways for displaying output.
c. Write a program to explain the different ways for taking input.
d. Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not

7. JavaScript Pre-defined and User-defined Objects

a. Write a program using document object properties and methods.
b. Write a program using window object properties and methods.
c. Write a program using array object properties and methods.
d. Write a program using math object properties and methods.
e. Write a program using string object properties and methods.
f. Write a program using regex object properties and methods.
g. Write a program using date object properties and methods.
h. Write a program to explain user-defined object by using properties, methods, accessors, constructors and display.

8. JavaScript Conditional Statements and Loops

a. Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words "LARGER NUMBER" in an information message dialog. If the numbers are equal, output HTML text as "EQUAL NUMBERS".

b. Write a program to display week days using switch case.

c. Write a program to print 1 to 10 numbers using for, while and do-while loops.

d. Write a program to print data in object using for-in, for-each and for-of loops.

e. Develop a program to determine whether a given number is an 'ARMSTRONG NUMBER' or not. [Eg: 153 is an Armstrong number, since sum of the cube of the digits is equal to the number i.e.,13 + 53+ 33 = 153]

f. Write a program to display the denomination of the amount deposited in the bank in terms of 100's, 50's, 20's, 10's, 5's, 2's & 1's. (Eg: If deposited amount is Rs.163, the output should be 1-100's, 1-50's, 1- 10's, 1-2's & 1-1's)

9. Javascript Functions and Events

a. Design a appropriate function should be called to display
- Factorial of that number
- Fibonacci series up to that number
- Prime numbers up to that number
- Is it palindrome or not

b. Design a HTML having a text box and four buttons named Factorial, Fibonacci, Prime, and Palindrome. When a button is pressed an appropriate function should be called to display
- Factorial of that number
- Fibonacci series up to that number
- Prime numbers up to that number
- Is it palindrome or not

c. Write a program to validate the following fields in a registration page
- Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
- Mobile (only numbers and length 10 digits)
- E-mail (should contain format like xxxxxxx@xxxxxx.xxx)

Reference Books

1. Robet W Sebesta, "Programming the World Wide Web", 7th Edition, Pearson, 2013.
2. John Dean, Jones & Bartlett Learning, "Web Programming with HTML5, CSS and JavaScript", 2019 (Chapters 1-11).
3. Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", 2nd edition, APress, O'Reilly.

Online Learning Resources

1. https://www.w3schools.com/html
2. https://www.w3schools.com/css
3. https://www.w3schools.com/js/
4. https://www.w3schools.com/nodejs
5. https://www.w3schools.com/typescript

ENVIRONMENTAL SCIENCE

(Common to CSE, IT and CSE(AI&ML))

II Year – II Semester

Lecture : 2	Internal Marks : 30
Credits : -	External Marks : 70

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Course Objectives

- To impart basic knowledge about the environment and natural resources.
- To develop an attitude of concern for biodiversity conservation and ecosystems.
- To acquire knowledge and skills on environmental pollution control.

Course Outcomes

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

- create awareness among the people in protection of environment and natural resources.
- analyze structure and functional attributes of an ecosystem and biodiversity conservation.
- identify the sources of environmental pollution, assess their effects and suggest suitable control measures.
- adopt sustainable management practices for various environmental issues.
- recognize the relationship between population growth and health.

Course Content

UNIT - I

Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance - Need for Public Awareness.

Natural Resources: Renewable and non-renewable resources - Natural resources and associated problems - Forest resources: Use and over - exploitation, deforestation, case studies - Timber extraction - Mining, dams and other effects on forest and tribal people - Water resources: Use and over utilization of surface and ground water - Floods, drought, conflicts over water, dams - benefits and problems - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources.

UNIT - II

Ecosystems: Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity And Its Conservation: Introduction and Definition: genetic, species and ecosystem diversity - Bio-geographical classification of India - Value of biodiversity: consumptive use, Productive use social, ethical, aesthetic and option values - Biodiversity at global, national and local levels - India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT - III

Environmental Pollution: Definition, causes, effects and control measures of:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Pollution case studies - Disaster management: floods, earthquake, cyclone and landslides.

UNIT - IV

Social Issues and the Environment: From Unsustainable to Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, watershed management - Resettlement and rehabilitation of people; its problems and concerns. Case studies - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies - Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and Control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation - Public awareness.

UNIT - V

Human Population and The Environment: Population growth, variation among nations. Population explosion - Family Welfare Programmes - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case studies.

Field Work: Visit to a local area to document environmental assets river/forest grassland/hill/mountain - Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds - river, hill slopes, etc.

Text Books

1. Erach Bharucha, "Text book of Environmental Studies for Undergraduate Courses", Universities Press (India) Private Limited, 2019.
2. Palaniswamy, "Environmental Studies", 2nd Edition, Pearson Education, 2014.
3. S.Azeem Unnisa, "Environmental Studies", Academic Publishing Company, 2021.
4. K.Raghavan Nambiar, "Text book of Environmental Studies for Undergraduate Courses (as per UGC model syllabus)", Scitech Publications (India) Pvt. Ltd, 2010.

Reference Books

1. Deeksha Dave and E. Sai Baba Reddy, "Textbook of Environmental Science", 2nd Edition, Cengage Publications, 2012.
2. M. Anji Reddy, "Textbook of Environmental Sciences and Technology", BS Publication, 2014.
3. J. P. Sharma, "Comprehensive Environmental Studies", Laxmi Publications, 2006.
4. J. Glynn Henry and Gary W. Heinke, "Environmental Sciences and Engineering", Prentice Hall of India Private Limited, 1988.
5. G. R. Chatwal, "A Text Book of Environmental Studies", Himalaya Publishing House, 2018.
6. Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science", 1st Edition, Prentice Hall of India Private Limited, 1991.

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2. https://www.edx.org/learn/environmental-science/rice-university-ap-r-environmental-science-part-3-pollution-and-resources?index=product&objectID=course-3a6da9f2-d84c-4773-8388-1b2f8f6a75f2&webview=false&campaign=AP%C2%AE+Environmental+Science++Part+3%3A+Pollution+and+Resources&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science.
3. http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
4. https://www.youtube.com/watch?v=5QxxaVfgQ3k