



## Anantha Lakshmi Institute of Technology & Sciences

(Autonomous)

Itikalapalli(V), Near S.K. University-Ananthapuramu-515721

**B.TECH. IN CSE (DATA SCIENCE)**

**COURSE STRUCTURE & SYLLABUS**

**B. Tech II YEAR I SEMESTER**

**SEMSTER - III**

S. No.	Coursecodes	Course Name	Hours per			Credits
			L	T	P	
1.	24ALBTHS305T	Discrete Mathematics & Graph Theory	3	0	0	3
2.	24ALBT00301T	Universal Human Values – Understanding Harmony and Ethical Human Conduct	2	1	0	3
3.	24ALBTDS301T	Introduction to Data Science	3	0	0	3
4.	24ALBTCS301T	Advanced Data Structures & Algorithm Analysis	3	0	0	3
5.	24ALBTCS302T	Object Oriented Programming Through Java	3	0	0	3
6.	24ALBTDS301P	Data Science Lab	0	0	3	1.5
7.	24ALBTCS302P	Object Oriented Programming Through Java Lab	0	0	3	1.5
8.	24ALBTCS303	Python Programming	0	1	2	2
9.	24ALBTAC301	Environmental Science	2	0	0	-
<b>TOTAL</b>			<b>16</b>	<b>2</b>	<b>8</b>	<b>20</b>



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**B. Tech II YEAR II SEMESTER**

**SEMSTER - IV**

S. No.	Coursecodes	Course Name	Hours per			Credits
			L	T	P	
1.	24ALBT00403T	Optimization Techniques	2	0	0	2
2.	24ALBTHS403T	Statistical Methods for Data Science	3	0	0	3
3.	24ALBTDS401T	Data Engineering	3	0	0	3
4.	24ALBTCS402T	Database Management Systems	3	0	0	3
5.	24ALBTEC305T	Digital Logic & Computer Organization	3	0	0	3
6.	24ALBTDS401P	Data Engineering Lab	0	0	3	1.5
7.	24ALBTCS402P	Database Management Systems Lab	0	0	3	1.5
8.	24ALBTDS402	Exploratory Data Analysis with Python	0	1	2	2
9.	24ALBT00404T	Design Thinking & Innovation	1	0	2	2
<b>TOTAL</b>			<b>15</b>	<b>1</b>	<b>10</b>	<b>21</b>

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II Year B.Tech. CSE (DS) – I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**(24ALBTHS305T) DISCRETE MATHEMATICS & GRAPH THEORY  
(Common to CSE and all CSE allied branches)****Course Objectives:**

1. **To develop a fundamental understanding of mathematical logic and reasoning** through propositional and predicate calculus, logical connectives, normal forms, and inference theory.
2. **To apply concepts from set theory, combinatorics, and algebraic structures** to solve problems involving functions, permutations, combinations, lattices, and groups.
3. **To explore and analyse recurrence relations and graphs** using techniques such as generating functions and graph-theoretic concepts like trees, circuits, and graph isomorphism.

**Course Outcomes:**

<b>CO No.</b>	<b>Course Outcome Statement</b>	<b>Bloom's Level</b>
<b>CO1</b>	Understand logical connectives, tautologies, implications, and apply inference rules in propositional and predicate logic.	<b>Understand (L2)</b>
<b>CO2</b>	Apply set theory principles including functions, lattices, and algebraic structures to model and solve problems.	<b>Apply (L3)</b>
<b>CO3</b>	Analyze and solve problems using pigeonhole principle, inclusion-exclusion principle, and recursive functions.	<b>Analyze (L4)</b>
<b>CO4</b>	Apply combinatorial techniques like permutations, combinations, and binomial/multinomial theorems in discrete problems.	<b>Apply (L3)</b>
<b>CO5</b>	Solve recurrence relations using generating functions and characteristic roots method to analyze sequences and patterns.	<b>Analyze (L4)</b>
<b>CO6</b>	Understand and apply graph theory concepts such as trees, Euler/Hamiltonian graphs, and planar graphs to solve structural problems.	<b>Apply (L3)</b>

**UNIT I: Mathematical Logic**

Introduction, Statements and Notation, Connectives, Well-formed formulas, Tautology, Duality law, Equivalence, Implication, Normal Forms, functionally complete set of connectives, Inference Theory of Statement Calculus, Predicate Calculus, Inference theory of Predicate Calculus.

**UNIT II: Set theory**

The Principle of Inclusion- Exclusion, Pigeon hole principle and its application, Functions composition of functions, Inverse Functions, Recursive Functions, Lattices and its properties. Algebraic structures: Algebraic Systems-Examples and General Properties, Semi groups and Monoids, groups, sub groups, homomorphism, Isomorphism.

**UNIT III: Elementary Combinatorics**

Combinations and Permutations, Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions, Binomial Coefficients, The Binomial and Multinomial Theorems.



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**UNIT IV: Recurrence Relations**

Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence relations, Solving Recurrence Relations by Substitution and Generating functions, The Method of Characteristic roots, Solutions of Inhomogeneous, Recurrence Relations.

**UNIT V: Graphs**

Basic Concepts, Isomorphism and Subgraphs, Trees and their Properties, Spanning Trees, Directed Trees, Binary Trees, Planar Graphs, Euler's Formula, Multigraphs and Euler Circuits, Hamiltonian Graphs.

**Textbooks:**

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 2002.
2. Kenneth H. Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, 7th Edition, McGraw Hill Education (India) Private Limited.

**Reference Books:**

1. Joe L. Mott, Abraham Kandel and Theodore P. Baker, Discrete Mathematics for Computer Scientists & Mathematicians, 2nd Edition, Pearson Education.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science.

**Online Learning Resources:**

<http://www.cs.yale.edu/homes/aspnes/classes/202/notes.pdf>



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**II Year B.Tech. CSE (DS)–I Semester**

L	T	P	C
2	1	0	3

### (24ALBT00301T) UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT

(Common to All Branches of Engineering)

#### Course Objectives:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

#### Course Outcomes:

CO No.	At the end of the course, students will be able to	Bloom's Level
CO1	Describe the need, purpose, and content of value education and distinguish between happiness and prosperity.	Understand (Level 2)
CO2	Apply self-exploration and natural acceptance to understand the harmony between self and body and ensure self-regulation.	Apply (Level 3)
CO3	Analyze the distinction between physical needs and mental aspirations to ensure holistic well-being.	Analyze (Level 4)
CO4	Demonstrate the foundational values like trust and respect in human relationships and analyze the vision for a universal human order.	Analyze (Level 4)
CO5	Explain the harmony and interconnectedness among all four orders of nature and the holistic perception of existence.	Understand (Level 2)
CO6	Evaluate the implications of value-based education and ethics in professional life and formulate strategies for a sustainable human order.	Evaluate / Create (L5/6)

#### Course Topics

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1- hour 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



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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 fulfil 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 Fulfilment 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



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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 for UNIT I – Introduction to Value Education**

PS1 Sharing about Oneself  
PS2 Exploring Human Consciousness PS3 Exploring Natural Acceptance

**Practice Sessions for 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

**Practice Sessions for 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

**Practice Sessions for UNIT IV – Harmony in the Nature (Existence) PS10**

Exploring the Four Orders of Nature  
PS11 Exploring Co-existence in Existence

**Practice Sessions for 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, 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, 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



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COURSE STRUCTURE & SYLLABUS**

**Reference Books**

1. *JeevanVidya: EkParichaya*, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – PanditSunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

**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.



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**Online Resources**

1. <https://fdp-si.aicte-india.org/UHV-I%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%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%20I%20Teaching%20Material/D3-S2%20Respect%20July%202023.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%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf>
7. <https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf>
8. <https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385>  
[https://onlinecourses.swayam2.ac.in/aic22\\_ge23/preview](https://onlinecourses.swayam2.ac.in/aic22_ge23/preview)



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<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### (24ALBTDS301T) INTRODUCTION TO DATA SCIENCE

**Course Objectives:** From the course the student will learn

- Knowledge and expertise to become a data scientist.
- Essential concepts of statistics and machine learning that are vital for data science;
- Significance of exploratory data analysis (EDA) in data science.
- Critically evaluate data visualizations presented on the dashboards
- Suitability and limitations of tools and techniques related to data science process

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Describe the fundamental concepts of Data Science, its process, and the big data ecosystem.	Understand (L2)
CO2	Apply data science processes including data retrieval, cleansing, transformation, and model building.	Apply (L3)
CO3	Demonstrate machine learning applications using Python tools and techniques for large-scale data analysis.	Apply (L3)
CO4	Analyse NoSQL databases and Big Data processing frameworks for scalable data storage and decision-making.	Analyse (L4)
CO5	Develop text analytics applications using graph databases and Python tools like <code>nltk</code> and <code>SQLite</code> .	Create (L6)
CO6	Build interactive dashboards and prototype applications using visualization tools and real-world case studies.	Create (L6)

#### UNIT I:

Introduction to Data science, benefits and uses, facets of data, data science process in brief, big data ecosystem and data science

**Data Science process:** Overview, defining goals and creating project charter, retrieving data, cleansing, integrating and transforming data, exploratory analysis, model building, presenting findings and building applications on top of them

#### UNIT II

Applications of machine learning in Data science, role of ML in DS, Python tools like `sklearn`, modelling process for feature engineering, model selection, validation and prediction, types of ML, semi-supervised learning

**Handling large data:** problems and general techniques for handling large data, programming tips for dealing large data, case studies on DS projects for predicting malicious URLs, for building recommender systems



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**UNIT III:**

**NoSQL movement for handling Bigdata:** Distributing data storage and processing with Hadoop framework, case study on risk assessment for loan sanctioning, ACID principle of relational databases, CAP theorem, base principle of NoSQL databases, types of NoSQL databases, case study on disease diagnosis and profiling

**UNIT IV:**

Tools and Applications of Data Science: Introducing Neo4j for dealing with graph databases, graph query language Cypher, Applications graph databases, Python libraries like nltk and SQLite for handling Text mining and analytics, case study on classifying Reddit posts

**UNIT V:**

Data Visualization and Prototype Application Development: Data Visualization options, Cross filter, the JavaScript MapReduce library, Creating an interactive dashboard with dc.js, Dashboard development tools. Applying the Data Science process for real-world problem-solving scenarios as a detailed case study.

**Textbook:**

- 1) Davy Cielen, Arno D.B. Meysman, and Mohamed Ali, “Introducing to Data Science using Python tools”, Manning Publications Co, Dream tech press, 2016
- 2) Prateek Gupta, “Data Science with Jupyter” BPB publishers, 2019 for basics

**Reference Books:**

- 1) Joel Grus, “Data Science From Scratch”, OReilly, 2019
- 2) Doing Data Science: Straight Talk From The Frontline, 1 st Edition, Cathy O’Neil and Rachel Schutt, O’Reilly, 2013



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**II Year B.Tech. CSE (DS)–I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### (24ALBTCS301T) ADVANCED DATA STRUCTURES & ALGORITHM ANALYSIS (Common to CSE,CSM,CSD)

**Course Objectives:** The main objective of the course is to

- provide knowledge on advance data structures frequently used in Computer Science domain
- Develop skills in algorithm design techniques popularly used
- Understand the use of various data structures in the algorithm design

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

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Analyze the time and space complexity of algorithms using asymptotic notations and apply them in evaluating AVL and B-tree operations.	Analyze (L4)
CO2	Apply appropriate representations and algorithms for graphs and heaps in solving real-world problems using divide and conquer strategies.	Apply (L3)
CO3	Implement and evaluate divide and conquer algorithms such as Quick Sort, Merge Sort, and Strassen's Matrix Multiplication.	Evaluate (L5)
CO4	Apply greedy and dynamic programming approaches to optimization problems like shortest paths, knapsack, and TSP.	Apply (L3)
CO5	Develop solutions for combinatorial and constraint satisfaction problems using backtracking and branch & bound techniques.	Create (L6)
CO6	Explain NP-Hardness and NP-Completeness concepts and identify NP problems in graph and scheduling domains.	Understand (L2)

#### UNIT – I:

Introduction to Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.  
AVL Trees – Creation, Insertion, Deletion operations and Applications B-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, Connected Components and Biconnected Components, applications  
Divide and Conquer: The General Method, Quick Sort, Merge Sort, Strassen's matrix multiplication, Convex Hull

#### UNIT – III:

Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths  
Dynamic Programming: General Method, All pairs shortest paths, Single Source Shortest Paths – General Weights (Bellman Ford Algorithm), Optimal Binary Search Trees, 0/1 Knapsack, String Editing, Travelling Salesperson problem



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**UNIT – IV:**

Backtracking: General Method, 8-Queens Problem, Sum of Subsets problem, Graph Coloring, 0/1 Knapsack Problem  
Branch and Bound: The General Method, 0/1 Knapsack Problem, Travelling Salesperson problem

**UNIT – V:**

NP Hard and NP Complete Problems: Basic Concepts, Cook's theorem

NP Hard Graph Problems: Clique Decision Problem (CDP), Chromatic Number Decision Problem (CNDP),

Traveling Salesperson Decision Problem (TSP)

NP Hard Scheduling Problems: Scheduling Identical Processors, Job Shop Scheduling

**Textbooks:**

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

**Reference Books:**

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

**Online Learning Resources:**

1. [https://www.tutorialspoint.com/advanced\\_data\\_structures/index.asp](https://www.tutorialspoint.com/advanced_data_structures/index.asp)
2. <http://peterindia.net/Algorithms.html>
3. Abdul Bari, [1. Introduction to Algorithms \(youtube.com\)](https://www.youtube.com/watch?v=1. Introduction to Algorithms)



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<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### (24ALBTCS302T) OBJECT-ORIENTED PROGRAMMING THROUGH JAVA (Common to CSE, CSM, CSD)

**Course Objectives:** The learning objectives of this course are to:

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

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Apply Java syntax, data types, variables, operators, and control structures to develop basic programs using good programming style.	Apply (L3)
CO2	Design and implement Java classes and objects with constructors, method overloading, access control, and use of this keyword.	Create (L6)
CO3	Develop modular code using methods and apply recursion, nesting, and access control effectively in class-based programming.	Apply (L3)
CO4	Implement arrays, inheritance, and interfaces to support structured data and polymorphic behaviour in object-oriented Java applications.	Apply (L3)
CO5	Utilize Java packages, libraries, exception handling, and file I/O to build robust and reusable applications.	Apply (L3)
CO6	Create responsive Java applications using multithreading, JDBC database connectivity, and JavaFX for GUI-based program development.	Create (L6)

**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, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, **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.



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**UNIT II: Classes and Objects:** Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

**Methods:** Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static.

**UNIT III: Arrays:** Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three-dimensional Arrays, Arrays as Vectors.

**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, Interfaces and Inheritance.

**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, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, 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)



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**Text Books:**

1. JAVA one step ahead, Anitha Seth, B.L. Juneja, Oxford.
2. Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
3. JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4<sup>th</sup> Edition, Pearson.

**References Books:**

1. The complete Reference Java, 11<sup>th</sup> edition, Herbert Schildt, TMH
2. Introduction to Java programming, 7<sup>th</sup> Edition, Y Daniel Liang, 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](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview)



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**II Year B.Tech. CSE (DS) – I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>15</b>

### (24ALBTDS301P) DATA SCIENCE LAB

#### Course Objectives:

- The main objective of the course is to inculcate the basic understanding of Data Science and its practical implementation using Python.

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Apply NumPy for array creation, reshaping, slicing, stacking, and broadcasting operations.	Apply (L3)
CO2	Perform data manipulation and cleaning operations using Pandas.	Apply (L3)
CO3	Import, analyze, and manage data from various formats such as text, CSV, Excel, JSON, images, and databases.	Analyze (L4)
CO4	Implement data preprocessing techniques including feature scaling, encoding, and standardization.	Apply (L3)
CO5	Visualize data using various chart types with Matplotlib and construct meaningful insights.	Apply (L3)
CO6	Develop simple NLP applications using libraries such as NLTK, Sci-kit Learn, SpaCy, and perform web scraping tasks.	Create (L6)

#### List of Experiments

- Creating a NumPy Array
  - Basic ndarray
  - Array of zeros
  - Array of ones
  - Random numbers in ndarray
  - An array of your choice
  - Imatrix in NumPy
  - Evenly spaced ndarray
- The Shape and Reshaping of NumPy Array
  - Dimensions of NumPy array
  - Shape of NumPy array
  - Size of NumPy array
  - Reshaping a NumPy array
  - Flattening a NumPy array
  - Transpose of a NumPy array
- Expanding and Squeezing a NumPy Array
  - Expanding a NumPy array
  - Squeezing a NumPy array
  - Sorting in NumPy Arrays



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4. Indexing and Slicing of NumPy Array
  - a. Slicing 1-D NumPy arrays
  - b. Slicing 2-D NumPy arrays
  - c. Slicing 3-D NumPy arrays
  - d. Negative slicing of NumPy arrays
5. Stacking and Concatenating Numpy Arrays
  - a. Stacking ndarrays
  - b. Concatenating ndarrays
  - c. Broadcasting in Numpy Arrays
6. Perform following operations using pandas
  - a. Creating dataframe
  - b. concat()
  - c. Setting conditions
  - d. Adding a new column
7. Perform following operations using pandas
  - a. Filling NaN with string
  - b. Sorting based on column values
  - c. groupby()
8. Read the following file formats using pandas
  - a. Text files
  - b. CSV files
  - c. Excel files
  - d. JSON files
9. Read the following file formats
  - a. Pickle files
  - b. Image files using PIL
  - c. Multiple files using Glob
  - d. Importing data from database
10. Demonstrate web scraping using python
11. Perform following preprocessing techniques on loan prediction dataset
  - a. Feature Scaling
  - b. Feature Standardization
  - c. Label Encoding
  - d. One Hot Encoding
12. Perform following visualizations using matplotlib
  - a. Bar Graph
  - b. Pie Chart
  - c. Box Plot
  - d. Histogram
  - e. Line Chart and Subplots
  - f. Scatter Plot
13. Getting started with NLTK, install NLTK using PIP
14. Python program to implement with Python Sci Kit-Learn & NLTK
15. Python program to implement with Python NLTK/Spicy/Py NLPI.



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**Web References:**

1. <https://www.analyticsvidhya.com/blog/2020/04/the-ultimate-numpy-tutorial-for-data-science-beginners/>
2. <https://www.analyticsvidhya.com/blog/2021/07/data-science-with-pandas-2-minutes-guide-to-key-concepts/>
3. <https://www.analyticsvidhya.com/blog/2020/04/how-to-read-common-file-formats-python/>
4. <https://www.analyticsvidhya.com/blog/2016/07/practical-guide-data-preprocessing-python-scikit-learn/>
5. <https://www.analyticsvidhya.com/blog/2020/02/beginner-guide-matplotlib-data-visualization-exploration-python/6>.
6. <https://www.nltk.org/book/ch01.html>



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<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>

### (24ALBTCS302P) OBJECT-ORIENTED PROGRAMMING THROUGH JAVA LAB (Common to CSE, CSM, CSD)

**Course Objectives:** The aim of this course is to

- Practice object-oriented programming in the Java programming language
- Implement Classes, Objects, Methods, Inheritance, Exception, Runtime Polymorphism, User defined Exception handling mechanism
- Illustrate inheritance, Exception handling mechanism, JDBC connectivity
- Construct Threads, Event Handling, implement packages, Java FX GUI

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Develop programs using fundamental Java constructs such as data types, control structures, and operators.	Apply (L3)
CO2	Demonstrate the concepts of classes, objects, constructors, overloading, and inheritance to build object-oriented applications.	Apply (L3)
CO3	Implement abstraction and polymorphism using abstract classes, interfaces, and dynamic method dispatch.	Apply (L3)
CO4	Apply exception handling and multithreading concepts to build reliable and concurrent Java applications.	Analyse (L4)
CO5	Utilize packages, JavaFX GUI components, and event handling to design interactive desktop applications.	Create (L6)
CO6	Develop applications that interact with relational databases using JDBC for CRUD operations.	Apply (L3)

**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

**Sample 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  $ax^2+bx=0$ . Calculate the discriminant 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.



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**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 multi level 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 **is Alive** and **join ()**
- c) Write a Program illustrating Daemon Threads.
- d) Write a JAVA program Producer Consumer Problem

**Exercise – 8**

1. Write a JAVA program that import and use the user defined packages
2. Without writing any code, build a GUI that display text in label and image in an ImageView (use JavaFX)
3. Build a Tip Calculator app using several JavaFX components and learn how to respond to user interactions with the GUI

**Exercise – 9**

- 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



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**Textbooks:**

1. JAVA one step ahead, Anitha Seth, B.L. Juneja, Oxford.
2. Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
3. JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4<sup>th</sup> Edition, Pearson.

**References Books:**

1. The complete Reference Java, 11<sup>th</sup> edition, Herbert Schildt, TMH
2. Introduction to Java programming, 7<sup>th</sup> Edition, Y Daniel Liang, 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](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview)



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**COURSE STRUCTURE & SYLLABUS**

**II Year B.Tech. CSE (DS) – I Semester**

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### (24ALBTCS303) PYTHON PROGRAMMING (SKILL ENHANCEMENT COURSE) (Common to CSE, CSM, CSD)

**Course Objectives:** The main objectives of the course are to

- Introduce core programming concepts of Python programming language.
- Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
- Implement Functions, Modules and Regular Expressions in Python Programming and to create practical and contemporary applications using these

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Apply core Python programming concepts such as data types, operators, control structures, and exception handling.	Apply (L3)
CO2	Develop functions using various argument types and perform string and list manipulations using built-in methods.	Apply (L3)
CO3	Demonstrate the use of dictionaries, tuples, and sets for efficient data handling and manipulation.	Apply (L3)
CO4	Perform file operations and implement object-oriented programming concepts including inheritance and polymorphism.	Analyze (L4)
CO5	Use Python libraries like NumPy and Pandas for basic data analysis and demonstrate data visualization using Matplotlib.	Apply (L3)
CO6	Design and develop small-scale applications using a combination of Python features across data structures and libraries.	Create (L6)

**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.



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**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, Frozenset.

### Sample Experiments:

7. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
8. Write a program to count the number of vowels in a string (No control flow allowed).
9. Write a program to check if a given key exists in a dictionary or not.
10. Write a program to add a new key-value pair to an existing dictionary.
11. 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:

12. 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.
13. Python program to print each line of a file in reverse order.
14. Python program to compute the number of characters, words and lines in a file.
15. Write a program to create, display, append, insert and reverse the order of the items in the array.
16. Write a program to add, transpose and multiply two matrices.
17. 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.



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

**Sample Experiments:**

7. Python program to check whether a JSON string contains complex object or not.
8. Python Program to demonstrate NumPy arrays creation using array () function.
9. Python program to demonstrate use of ndim, shape, size, dtype.
10. Python program to demonstrate basic slicing, integer and Boolean indexing.
11. Python program to find min, max, sum, cumulative sum of array
12. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least 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
13. 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. Gowrishankar S, Veena A., Introduction to Python Programming, CRC Press.
2. Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2<sup>nd</sup>Edition, Pearson, 2024
3. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

**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>

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II Year B.Tech. CSE (DS) – I Semester**

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<b>2</b>	<b>0</b>	<b>0</b>	<b>-</b>

**(24ALBTAC301) ENVIRONMENTAL SCIENCE  
(Common to CSE, CSM, CSD)****Course Objectives:**

- To make the students to get awareness on environment.
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life
- To save earth from the inventions by the engineers.

**Course Outcomes:**

<b>CO No.</b>	<b>Course Outcome Statement</b>	<b>Bloom's Level</b>
<b>CO1</b>	Explain the multidisciplinary nature, scope, and importance of environmental studies and the need for public awareness.	Understand (L2)
<b>CO2</b>	Analyse the use, exploitation, and conservation of natural resources and evaluate associated problems.	Analyse (L4)
<b>CO3</b>	Describe ecosystem structure, functions, biodiversity concepts, and methods of conservation.	Understand (L2)
<b>CO4</b>	Identify various types of pollution, their causes, effects, and suggest preventive and control measures.	Apply (L3)
<b>CO5</b>	Examine environmental social issues and interpret related environmental laws, ethics, and movements.	Evaluate (L5)
<b>CO6</b>	Assess the impact of population growth on environment and propose sustainable development practices.	Evaluate (L5)

**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:

Forest ecosystem.

Grassland ecosystem

Desert ecosystem.

Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)



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Biodiversity and its Conservation : Introduction 0 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-spots 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, Cause, 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..

### Textbooks:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, “Environmental Studies”, Pearson education
3. S.Azeem Unnisa, “Environmental Studies” Academic Publishing Company
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, Scitech Publications (India), Pvt. Ltd.



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**COURSE STRUCTURE & SYLLABUS**

**References:**

1. Deeksha Dave and E.Sai Baba Reddy, “Textbook of Environmental Science”, Cengage Publications.
2. M. Anji Reddy, “Text book of Environmental Sciences and Technology”, BS Publication.
3. J.P. Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, “Environmental Sciences and Engineering”, Prentice Hall of India Private limited
5. G.R. Chatwal, “A Text Book of Environmental Studies” Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, “Introduction to Environmental Engineering and Science, Prentice Hall of India Private limited.



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**II Year B.Tech. CSE (DS)– II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

### (24ALBT00403T) OPTIMIZATION TECHNIQUES

#### Course Objectives:

- To provide the basic knowledge about Optimization, importance, application areas of in the industry, Linear Programming.
- To impart different optimization models under typical situations in the business organization like transportation, assignment.
- To understand the process of sequencing in a typical industry.
- To describe different game strategies under cut-throat competitive business environment
- To develop networks of activities of projects and to find out optimal modes of completing projects using network modelling evaluation techniques.

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Describe the nature, scope, and significance of optimization and formulate Linear Programming Problems for real-life scenarios.	Understand (L2), Apply (L3)
CO2	Solve Linear Programming Problems using Graphical, Simplex, Big-M, and Two-Phase methods for both maximization and minimization cases.	Apply (L3), Analyse (L4)
CO3	Analyse and solve Transportation and Assignment Problems using appropriate methods including Hungarian Algorithm and optimization techniques.	Apply (L3), Analyse (L4), Evaluate (L5)
CO4	Apply sequencing algorithms like Johnson's Algorithm to determine optimal job processing sequences across machines.	Apply (L3), Analyse (L4)
CO5	Examine game theory models and apply strategies like saddle point, dominance, and mixed strategies in two-person zero-sum games.	Analyse (L4), Evaluate (L5)
CO6	Construct network diagrams and determine the critical path using CPM and PERT techniques in project management scenarios.	Apply (L3), Analyse (L4)

#### UNIT - I

Introduction: Meaning, Nature, Scope & Significance of Optimization - Typical applications. The Linear Programming Problem – Introduction, Formulation of Linear Programming problem, Limitations of L.P.P, Graphical method, Simplex method: Maximization and Minimization model(exclude Duality problems), Big-M method and Two Phase method.

#### UNIT - II

Transportation Problem: Introduction, Transportation Model, Finding initial basic feasible solutions, Moving towards optimality, Unbalanced Transportation problems, Transportation problems with maximization, Degeneracy.

Assignment Problem – Introduction, Mathematical formulation of the problem, Solution of an Assignment problem, Hungarian Algorithm, Multiple Solution, Unbalanced Assignment problems, Maximization in Assignment Model.



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**UNIT - III**

Sequencing – Job sequencing, Johnsons Algorithm for n Jobs and Two machines, n Jobs and Three Machines, n jobs through m machines, Two jobs and m Machines Problems.

**UNIT - IV**

Game Theory: Concepts, Definitions and Terminology, Two Person Zero Sum Games, Pure Strategy Games (with Saddle Point), Principal of Dominance, Mixed Strategy Games (Game without Saddle Point), Significance of Game Theory in Managerial Application.

**UNIT - V**

Project Management: Network Analysis – Definition –objectives -Rules for constructing network diagram-Determining Critical Path – Earliest & Latest Times – Floats - Application of CPM and PERT techniques in Project Planning and Control – PERT Vs CPM. (exclude Project Crashing).

**Textbooks:**

1. Operations Research / R.Pannerselvam, PHI Publications.
2. Operations Research / S.D.Sharma-Kedarnath
3. Operations Research /A.M.Natarajan, P.Balasubramani,A. Tamilarasi/Pearson Education.
4. Engineering Optimization: Theory and practice / S.S.Rao, New Age International (P) Limited

**Reference Books:**

1. Quantitative Techniques in Management / ND Vohra, Tata McGraw Hill, 4th Edition, 2011.
2. Introduction to O.R/Hiller & Libermann (TMH).
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman. Pearson
4. Quantitative Analysis For Management/ Barry Render, Ralph M. Stair, Jr and Michael E. Hanna/
5. Operations Research / Wagner/ PHI Publications.

**Online Learning Sources**

[https://onlinecourses.swayam2.ac.in/cec20\\_ma10/preview](https://onlinecourses.swayam2.ac.in/cec20_ma10/preview)

[https://onlinecourses.nptel.ac.in/noc20\\_ma23/preview](https://onlinecourses.nptel.ac.in/noc20_ma23/preview)

[https://onlinecourses.nptel.ac.in/noc19\\_ma29/preview](https://onlinecourses.nptel.ac.in/noc19_ma29/preview)

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II Year B.Tech. CSE (DS)– II Semester****L    T    P    C**  
**3    0    0    3****(24ALBTHS403T) STATISTICAL METHODS FOR DATA SCIENCE****Course Objectives:**

- Understand the fundamental concepts of random variables, probability distributions, and estimation theory.
- Introduce methods for point estimation and discuss their properties.
- Learn the concepts and techniques for interval estimation.
- Understand hypothesis testing including types of errors, power, and test procedures.
- Gain hands-on exposure to small sample testing methods like t-test, F-test, and chi-square test.

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Explain the properties of probability distributions and concepts of estimators like unbiasedness and consistency.	Understand (L2)
CO2	Apply probability models such as Binomial, Poisson, and Normal to real-world problems.	Apply (L3)
CO3	Demonstrate the ability to estimate parameters using MLE, Method of Moments, and Least Squares.	Apply (L3)
CO4	Construct and interpret confidence intervals for means, variances, and proportions.	Apply (L3)
CO5	Analyze hypotheses using Neyman-Pearson Lemma and Likelihood Ratio Tests for standard distributions.	Analyze (L4)
CO6	Apply small sample tests such as t-test, F-test, and chi-square test for inference in various scenarios.	Apply (L3)

**UNIT I: Basic Concepts**

Random variables (discrete and continuous), probability density functions, properties, mathematical expectation. Probability distributions: Binomial, Poisson and Normal-their properties. Population, sample, parameter and statistic; characteristics of a good estimator; Consistency – Invariance property of Consistent estimator, Sufficient condition for consistency; Unbiasedness; Sufficiency.

**UNIT II: Point Estimation**

Point Estimation- Estimator, Estimate, Methods of point estimation – Maximum likelihood method (the asymptotic properties of ML estimators are not included), Large sample properties of ML estimator (without proof)- applications, Method of moments, method of least squares, method of minimum chi-square and modified minimum chi-square-Asymptotic Maximum Likelihood Estimation and applications.



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**UNIT III: Interval Estimation**

Confidence limits and confidence coefficient; Duality between acceptance region of a test and a confidence interval; Construction of confidence intervals for population proportion (small and large samples) and between two population proportions (large samples); Confidence intervals for mean and variance of a normal population; Difference between the mean and ratio of two normal populations.

**UNIT IV: Testing of hypotheses**

Types of errors, power of a test, most powerful tests; Neyman-Pearson Fundamental Lemma and its applications; Notion of Uniformly most powerful tests; Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions.

**UNIT V : Small sample tests**

Student's t-test, test for a population mean, equality of two population means, paired t-test, F- test for equality of two population variances, Chi-square test for goodness of fit and test for independence of attributes,  $\chi^2$  test for testing variance of a normal distribution.

**Textbooks:**

1. Miller and Freund, Probability and Statistics for Engineers, 7/e, Pearson, 2008.
2. Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference – Testing of Hypotheses, Prentice Hall of India, 2014

**Reference Books:**

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
2. S. Ross, a First Course in Probability, Pearson Education India, 2002.
3. W. Feller, an Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.
4. Robert V Hogg, Elliot A Tannis and Dale L. Zimmerman, Probability and Statistical Inference, 9th edition, Pearson publishers, 2013.

**Online Learning Resources:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_ma74/preview](https://onlinecourses.nptel.ac.in/noc21_ma74/preview)
2. [https://onlinecourses.nptel.ac.in/noc22\\_mg31/preview](https://onlinecourses.nptel.ac.in/noc22_mg31/preview)



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L	T	P	C
3	0	0	3

### (24ALBTDS401P) DATA ENGINEERING

#### Course Objectives:

- Explain basic concepts of Data Engineering
- Discuss about Data Engineering Life Cycle
- How to design Good Data Architecture

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Explain the key concepts of Data Engineering, its lifecycle, evolution, and role differences with Data Science.	Understand (L2)
CO2	Describe the responsibilities, skills, and activities of a Data Engineer in business and technical contexts.	Understand (L2)
CO3	Illustrate the phases of the Data Engineering Life Cycle and explain the major supporting undercurrents.	Apply (L3)
CO4	Apply principles of good data architecture and describe various data source systems including OLTP and OLAP.	Apply (L3)
CO5	Analyze data storage abstractions and ingestion strategies including batch and stream-based approaches.	Analyze (L4)
CO6	Design data models and transformations for analytics, machine learning, and real-time processing scenarios.	Create (L6)

**UNIT-I: Introduction to Data Engineering:** Definition, Data Engineering Life Cycle, Evolution of Data Engineer, Data Engineering Versus Data Science, Data Engineering Skills and Activities, Data Maturity, Data Maturity Model, Skills of a Data Engineer, Business Responsibilities, Technical Responsibilities, Data Engineers and Other Technical Roles.

**UNIT-II: Data Engineering Life Cycle:** Data Life Cycle Versus Data Engineering Life Cycle, Generation: Source System, Storage, Ingestion, Transformation, Serving Data.

**Major undercurrents across the Data Engineering Life Cycle:** Security, Data Management, DataOps, Data Architecture, Orchestration, Software Engineering.

**UNIT-III: Designing Good Data Architecture:** Enterprise Architecture, Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts.

**Data Generation in Source Systems:** Sources of Data, Files and Unstructured Data, APIs, Application Databases (OLTP), OLAP, Change Data Capture, Logs, Database Logs, CRUD, Source System Practical Details.



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**UNIT-IV: Storage:** Raw Ingredients of Data Storage, Data Storage Systems, Data Engineering Storage Abstractions, Data warehouse, Data Lake, Data Lakehouse.

**Ingestion:** Data Ingestion, Key Engineering considerations for the Ingestion Phase, Batch Ingestion Considerations, Message and Stream Ingestion Considerations, Ways to Ingest Data

**UNIT-V: Queries, Modeling and Transformation:** Queries, Life of a Query, Query Optimizer, Queries on Streaming Data, Data Modelling, Modeling Streaming Data, Transformations, Streaming Transformations and Processing.

**Serving Data for Analytics, Machine Learning and Reverse ETL:** General Considerations for serving Data, Business Analytics, Operational Analytics, Embedded Analytics, Ways to serve data for analytics and ML, Reverse ETL.

**Textbooks:**

1. Joe Reis, Matt Housley, Fundamentals of Data Engineering, O'Reilly Media, Inc., June 2022, ISBN: 9781098108304

**Reference Books:**

1. Paul Crickard, Data Engineering with Python, Packt Publishing, October 2020.
2. Ralph Kimball, Margy Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Wiley, 3rd Edition, 2013
3. James Densmore, Data Pipelines Pocket Reference: Moving and Processing Data for Analytics, O'Reilly Media, 1st Edition, 2021



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**II Year B.Tech. CSE (DS) – II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### (24ALBTCS402T) DATABASE MANAGEMENT SYSTEMS

(Common to CSE, CSM, CSD)

**Course Objectives:** The main objective of the course is to

- Introduce database management systems and to give a good formal foundation on the relational model of data and usage of Relational Algebra
- Introduce the concepts of basic SQL as a universal Database language
- Demonstrate the principles behind systematic database design approaches by covering conceptual design, logical design through normalization
- Provide an overview of physical design of a database system, by discussing Database indexing techniques and storage techniques

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Explain the characteristics of database systems, data models, and architecture including E-R modelling.	Understand (L2)
CO2	Apply relational model concepts and relational algebra for representing and manipulating data.	Apply (L3)
CO3	Write basic SQL queries to create, manipulate, and retrieve data from relational databases using constraints and joins.	Apply (L3)
CO4	Construct advanced SQL queries using nested subqueries, views, aggregation, grouping, and set operations.	Apply (L3)
CO5	Analyse database schema using normalization techniques and determine the appropriate normal form for given relations.	Analyse (L4)
CO6	Evaluate transaction properties, concurrency control mechanisms, and indexing techniques for efficient database management.	Evaluate (L5)

**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 and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

**Entity Relationship Model:** Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, 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, constraints (Domain, Key constraints, integrity constraints) and their importance, Relational Algebra, Relational Calculus. 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, view (updatable and non-updatable), relational set operations.



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**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), MVD, Fourth normal form(4NF), Fifth Normal Form (5NF).

**UNIT V: Transaction Concept:** Transaction State, ACID properties, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, lock based, time stamp based, optimistic, concurrency protocols, Deadlocks, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

**Introduction to Indexing Techniques:** B+ Trees, operations on B+Trees, Hash Based Indexing:

**Textbooks:**

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

**Reference Books:**

1. Introduction to Database Systems, 8<sup>th</sup> edition, C J Date, Pearson.
2. Database Management System, 6<sup>th</sup> edition, RamezElmasri, Shamkant B. Navathe, Pearson
3. Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

**Web-Resources:**

1. <https://nptel.ac.in/courses/106/105/106105175/>
2. [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_01275806667282022456\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01275806667282022456_shared/overview)



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### B.TECH. IN CSE (DATA SCIENCE) COURSE STRUCTURE & SYLLABUS

II Year B.Tech. CSE (DS)– II Semester

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3    0    0    3

#### (24ALBTEC305T) DIGITAL LOGIC & COMPUTER ORGANIZATION (Common to CSM & CSD)

**Course Objectives:** The main objective of the course is to

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

**Course Outcomes:**

CO No.	At the end of the course, students will be able to	Bloom's Level
CO1	Apply number system conversions and data representation techniques including binary, fixed-point, and floating-point formats.	Apply (Level 3)
CO2	Design and simplify digital logic circuits using basic and universal gates, K-map minimization, and implement combinational circuits.	Apply (Level 3)
CO3	Analyze sequential circuits like flip-flops, counters, and registers, and explain the structure and function of basic computer systems.	Analyze (Level 4)
CO4	Perform and evaluate arithmetic operations in processors including fast adders, multipliers, and floating-point units.	Evaluate (Level 5)
CO5	Analyze memory hierarchy concepts, including RAM, ROM, cache, and virtual memory with respect to performance and cost.	Analyze (Level 4)
CO6	Describe the architecture and functioning of I/O systems including DMA, buses, interrupts, and standard interfaces.	Understand (Level 2)

#### UNIT – I:

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

**Digital Logic Circuits-I:** Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic expressions. K-Map Simplification, Combinational Circuits, Decoders, Multiplexers

#### UNIT – II:

**Digital Logic Circuits-II:** Sequential Circuits, Flip-Flops, Binary counters, Registers, Shift Registers, Ripple counters

**Basic Structure of Computers:** Computer Types, Functional units, Basic operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers, Computer Generations, Von-Neumann Architecture



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**UNIT – III:**

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

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

**UNIT – IV:**

**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, Interface Circuits, Standard I/O Interfaces

**Textbooks:**

1. Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 6<sup>th</sup> edition, McGraw Hill, 2023.
2. Digital Design, 6<sup>th</sup> Edition, M. Morris Mano, Pearson Education, 2018.
3. Computer Organization and Architecture, William Stallings, 11<sup>th</sup> Edition, Pearson, 2022.

**Reference Books:**

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

**Online Learning Resources:**

<https://nptel.ac.in/courses/106/103/106103068/>



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<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>

### (24ALBTDS401P) DATA ENGINEERING LAB

#### Course Objective:

- The main objective of this course is to teach how build data engineering infrastructure and data pipelines.

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
<b>CO1</b>	Install and configure modern data engineering tools such as Apache NiFi, Airflow, PostgreSQL, Elasticsearch, and Kibana.	Apply (L3)
<b>CO2</b>	Perform file and database operations in Python, Airflow, and NiFi for data extraction and loading.	Apply (L3)
<b>CO3</b>	Clean, transform, and enrich data using Python and Airflow tools.	Apply (L3)
<b>CO4</b>	Construct and validate data pipelines including staging, idempotency, and atomicity.	Analyze (L4)
<b>CO5</b>	Monitor and version data pipelines using the NiFi Registry, REST APIs, and Git integration.	Analyze (L4)
<b>CO6</b>	Design and deploy end-to-end production-grade data pipelines with environment-specific configurations.	Create (L6)

#### Experiments:

1. Installing and configuring Apache NiFi, Apache Airflow
2. Installing and configuring Elasticsearch, Kibana, PostgreSQL, pgAdmin 4
3. Reading and Writing files
  - a. Reading and writing files in Python
  - b. Processing files in Airflow
  - c. NiFi processors for handling files
  - d. Reading and writing data to databases in Python
  - e. Databases in Airflow
  - f. Database processors in NiFi
4. Working with Databases
  - a. Inserting and extracting relational data in Python
  - b. Inserting and extracting NoSQL database data in Python
  - c. Building database pipelines in Airflow
  - d. Building database pipelines in NiFi



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5. Cleaning, Transforming and Enriching Data
  - a. Performing exploratory data analysis in Python
  - b. Handling common data issues using pandas
  - c. Cleaning data using Airflow
6. Building the Data Pipeline
7. Building a Kibana Dash Board
8. Perform the following operations
  - a. Staging and validating data
  - b. Building idempotent data pipelines
  - c. Building atomic data pipelines
9. Version Control with the NiFi Registry
  - a. Installing and configuring the NiFi Registry
  - b. Using the Registry in NiFi
  - c. Versioning your data pipelines
  - d. Using git-persistence with the NiFi Registry
10. Monitoring Data Pipelines
  - a. Monitoring NiFi in the GUI
  - b. Monitoring NiFi using processors
  - c. Monitoring NiFi with Python and the REST API
11. Deploying Data Pipelines
  - a. Finalizing your data pipelines for production
  - b. Using the NiFi variable registry
  - c. Deploying your data pipelines
12. Building a Production Data Pipeline
  - a. Creating a test and production environment
  - b. Building a production data pipeline
  - c. Deploying a data pipeline in production

**Reference Books:**

1. Paul Crickard , Data Engineering with Python, Packt Publishing, October 2020.



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**0**    **0**    **3**    **1.5**

### (24ALBTCS402P) DATABASE MANAGEMENT SYSTEMS LAB (Common to CSE, CSM, CSD)

**Course Objectives:** This Course will enable students to

- Populate and query a database using SQL DDL/DML Commands
- Declare and enforce integrity constraints on a database
- Writing Queries using advanced concepts of SQL
- Programming PL/SQL including procedures, functions, cursors and triggers.

**Course Outcomes:**

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Apply DDL, DML, and DCL commands to create and manipulate database schemas and records.	Apply (L3)
CO2	Develop and execute SQL queries, including nested queries and built-in functions for data retrieval and analysis.	Apply (L3)
CO3	Construct PL/SQL blocks using control structures, loops, and exception handling to solve real-world problems.	Create (L6)
CO4	Design and implement procedures, functions, and cursors for modular and efficient database applications.	Create (L6)
CO5	Develop and manage database triggers to automate operations based on data changes.	Apply (L3)
CO6	Establish connectivity between Java programs and databases using JDBC for performing CRUD operations.	Apply (L3)

**Experiments covering the topics:**

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

**Sample Experiments:**

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, NOTEXISTS, UNION, INTERSET, Constraints. Example:- 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, HAVING and Creation and dropping of Views.
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, trunc, round, to\_char, to\_date)



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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 and CASE expression. The program can be extended using the NULLIF and COALESCE functions.
7. Program development using WHILE LOOPS, numeric FOR LOOPS, nested loops using ERROR Handling, BUILT –IN Exceptions, USE 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.
13. Write a Java program that connects to a database using JDBC
14. Write a Java program to connect to a database using JDBC and insert values into it
15. Write a Java program to connect to a database using JDBC and delete values from it

**Text Books/Suggested Reading:**

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", Fourth Edition, Pearson Education, 2007



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**COURSE STRUCTURE & SYLLABUS**  
**II Year B.Tech. CSE (DS) – II Semester**

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### (24ALBTDS402) EXPLORATORY DATA ANALYSIS WITH PYTHON

#### Course Objectives:

- This course introduces the fundamentals of Exploratory Data Analysis
- It covers essential exploratory techniques for understanding multivariate data by summarizing it through statistical methods and graphical methods.

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Describe the importance of EDA, types of data, and tools used to perform exploratory analysis.	Understand (L2)
CO2	Apply various data visualization techniques using libraries like Matplotlib and Seaborn for effective analysis.	Apply (L3)
CO3	Transform and prepare datasets using merging, reshaping, handling missing data, and feature engineering techniques.	Apply (L3)
CO4	Perform descriptive statistics and statistical analysis like univariate, bivariate, multivariate and time series.	Analyze (L4)
CO5	Implement data preprocessing, build predictive models, and evaluate model performance using ML metrics.	Apply (L3)
CO6	Conduct case studies on real-world datasets and interpret insights through complete EDA and basic model development.	Create (L6)

#### UNIT-I

**Exploratory Data Analysis Fundamentals:** Understanding data science, The significance of EDA, Steps in EDA, Making sense of data, Numerical data, Categorical data, Measurement scales, Comparing EDA with classical and Bayesian analysis, Software tools available for EDA, Getting started with EDA.

#### Sample Experiments:

1. a) Download Dataset from Kaggle using the following link :  
<https://www.kaggle.com/datasets/sukhmanibedi/cars4u>  
 b) Install python libraries required for Exploratory Data Analysis (numpy, pandas, matplotlib,seaborn)
2. Perform Numpy Array basic operations and Explore Numpy Built-in functions.
3. Loading Dataset into pandas dataframe
4. Selecting rows and columns in the data frame



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**UNIT-II**

**Visual Aids for EDA:** Technical requirements, Line chart, Bar charts, Scatter plot using seaborn, Polar chart, Histogram, Choosing the best chart

**Case Study:** EDA with Personal Email, Technical requirements, Loading the dataset, Data transformation, Data cleansing, Applying descriptive statistics, Data refactoring, Data analysis.

**Sample Experiments:**

1. Apply different visualization techniques using sample dataset
  - a) Line Chart
  - b) Bar Chart
  - c) Scatter Plots
  - d) Bubble Plot
2. Generate Scatter Plot using seaborn library for iris dataset
3. Apply following visualization Techniques for a sample dataset
  - a) Area Plot
  - b) Stacked Plot
  - c) Pie chart
  - d) Table Chart
4. Generate the following charts for a dataset.
  - a) Polar Chart
  - b) Histogram
  - c) Lollipop chart
5. Case Study: Perform Exploratory Data Analysis with Personal Email Data

**UNIT-III**

**Data Transformation:** Merging database-style data frames, concatenating along with an axis, merging on index, Reshaping and pivoting, Transformation techniques, Handling missing data, Mathematical operations with NaN, Filling missing values, Discretization and binning, Outlier detection and filtering, Permutation and random sampling, Benefits of data transformation, Challenges.

**Sample Experiments:**

5. Perform the following operations
  - a) Merging Data frames
  - b) Reshaping with Hierarchical Indexing
  - c) Data Deduplication
  - d) Replacing Values
6. Apply different Missing Data handling techniques
  - a) NaN values in mathematical Operations
  - b) Filling in missing data
  - c) Forward and Backward filling of missing values
  - d) Filling with index values
  - e) Interpolation of missing values
7. Apply different data transformation techniques
  - a) Renaming axis indexes
  - b) Discretization and Binning
  - c) Permutation and Random Sampling
  - d) Dummy variables

**UNIT-IV**

**Descriptive Statistics:** Distribution function, Measures of central tendency, Measures of dispersion, Types of kurtosis, Calculating percentiles, Quartiles, Grouping Datasets, Correlation, Understanding univariate, bivariate, multivariate analysis, Time Series Analysis

**Sample Experiments:**

8. Study the following Distribution Techniques on a sample data
  - a) Uniform Distribution



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- b) Normal Distribution
- c) Gamma Distribution
- d) Exponential Distribution
  - e) Poisson Distribution
  - f) Binomial Distribution
- 9. Perform Data Cleaning on a sample dataset.
- 10. Compute measure of Central Tendency on a sample dataset
  - a) Mean b)Median c)Mode
- 11. Explore Measures of Dispersion on a sample dataset
  - a) Variance b) Standard Deviation c) Skewness d) Kurtosis
- 12. a) Calculating percentiles on sample dataset
  - b) Calculate Inter Quartile Range(IQR) and Visualize using Box Plots
- 13. Perform the following analysis on automobile dataset.
  - a) Bivariate analysis b)Multivariate analysis
- 14. Perform Time Series Analysis on Open Power systems dataset

**UNIT-V**

**Model Development and Evaluation:** Unified machine learning workflow, Data preprocessing, Data preparation, Training sets and corpus creation, Model creation and training, Model evaluation, Best model selection and evaluation, Model deployment

**Case Study:** EDA on Wine Quality Data Analysis

**Sample Experiments:**

- 15. Perform hypothesis testing using stats models library
  - a) Z-Test b)T-Test
- 16. Develop model and Perform Model Evaluation using different metrics such as prediction score, R2 Score, MAE Score, MSE Score.
- 17. Case Study: Perform Exploratory Data Analysis with Wine Quality Dataset

**Textbook:**

- 1. Suresh Kumar Mukhiya, Usman Ahmed, Hands-On Exploratory Data Analysis with Python, Packt Publishing, 2020.

**References:**

- 1. Ronald K. Pearson, Exploratory Data Analysis Using R, CRC Press, 2020
- 2. Radhika Datar, Harish Garg, Hands-On Exploratory Data Analysis with R: Become an expert in exploratory data analysis using R packages, Ist Edition, Packt Publishing, 2019

**Web References:**

- 1. <https://github.com/PacktPublishing/Hands-on-Exploratory-Data-Analysis-with-Python>
- 2. <https://www.analyticsvidhya.com/blog/2022/07/step-by-step-exploratory-data-analysis-eda-using-python/#h-conclusion>
- 3. <https://github.com/PacktPublishing/Exploratory-Data-Analysis-with-Python-Cookbook>



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<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>1</b>	<b>0</b>	<b>2</b>	<b>2</b>

### (24ALBT00404T) DESIGN THINKING & INNOVATION

(Common to CSE, CSM, CSD)

#### Course Objectives:

The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

#### Course Outcomes:

CO No.	After completion of the course, students will be able to	Bloom's Level
CO1	Describe the basic elements, principles of design, and the evolution of design thinking.	Understand (L2)
CO2	Illustrate the design thinking process using tools like empathy maps, journey maps, and flowcharts.	Apply (L3)
CO3	Develop and present product ideas using the design thinking approach.	Create (L6)
CO4	Differentiate between innovation and creativity and explain their organizational impact.	Analyse (L4)
CO5	Formulate product design strategies and specifications to solve real-world problems.	Create (L6)
CO6	Analyse how design thinking is applied in business processes, including startup strategies and prototype testing.	Analyse (L4)

#### 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, brainstorming, 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 modelling, how to set specifications, Explaining their own product design.



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**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.

**Textbooks:**

1. Tim Brown, Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons.

**Reference Books:**

1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritinaholden, Jill Butter.
4. Chesbrough.H, The Era of Open Innovation – 2013

**Online Learning Resources:**

<https://nptel.ac.in/courses/110/106/110106124/> <https://nptel.ac.in/courses/109/104/109104109/>  
[https://swayam.gov.in/nd1\\_noc19\\_mg60/preview](https://swayam.gov.in/nd1_noc19_mg60/preview)



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**COMMUNITY SERVICE PROJECT**

**.....Experiential learning through community engagement**

**Introduction**

- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development.
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will benefit with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and emerge as a socially responsible institution.

**Objective**

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

**Implementation of Community Service Project**

- Every student should put in 6 weeks for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.
- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, housewives, etc
- A logbook must be maintained by each of the students, where the activities undertaken/involved to be recorded.



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- The logbook has to be countersigned by the concerned mentor/faculty in charge.
- An evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.
- The Community Service Project should be different from the regular programs of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project reports should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training.

**Procedure**

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, to enable them to commute from their residence and return back by evening or so.
- The Community Service Project is a twofold one –
  - First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
  - Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –
    - Agriculture
    - Health
    - Marketing and Cooperation
    - Animal Husbandry
    - Horticulture
    - Fisheries
    - Sericulture
    - Revenue and Survey
    - Natural Disaster Management
    - Irrigation
    - Law & Order
    - Excise and Prohibition
    - Mines and Geology
    - Energy
    - Internet
    - Free Electricity
    - Drinking Water



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**EXPECTED OUTCOMES**

**BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS**

**Learning Outcomes**

- Positive impact on students' academic learning
- Improves students' ability to apply what they have learned in "the real world"
- Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development.
- Improved ability to understand complexity and ambiguity

**Personal Outcomes**

- Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
- Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills.

**Social Outcomes**

- Reduced stereotypes and greater inter-cultural understanding
- Improved social responsibility and citizenship skills
- Greater involvement in community service after graduation

**Career Development**

- Connections with professionals and community members for learning and career opportunities
- Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity.

**Relationship with the Institution**

- Stronger relationships with faculty
- Greater satisfaction with college
- Improved graduation rates

**BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS**

- Satisfaction with the quality of student learning
- New avenues for research and publication via new relationships between faculty and community
- Providing networking opportunities with engaged faculty in other disciplines or institutions
- A stronger commitment to one's research.



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**BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES**

- Improved institutional commitment.
- Improved student retention
- Enhanced community relations

**BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY**

- Satisfaction with student participation
- Valuable human resources needed to achieve community goals.
- New energy, enthusiasm and perspectives applied to community work.
- Enhanced community-university relations.

**SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT**

The following the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions, and modifications. Colleges are expected to focus on specific local issues for this kind of project. The students are expected to carry out these projects with involvement, commitment, responsibility, and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of project. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting should be ensured.

**For Engineering Students**

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries
12. Animals and species
13. Nutrition
14. Traditional health care methods
15. Food habits
16. Air pollution
17. Water pollution
18. Plantation
19. Soil protection
20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice



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23. Health care awareness programmes and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture
28. Access to safe drinking water
29. Geographical survey
30. Geological survey
31. Sericulture
32. Study of species
33. Food adulteration
34. Incidence of Diabetes and other chronic diseases
35. Human genetics
36. Blood groups and blood levels
37. Internet Usage in Villages
38. Android Phone usage by different people
39. Utilization of free electricity to farmers and related issues
40. Gender ration in schooling level- observation.

**Complimenting the community service project the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programs**

**Programs for School Children**

1. Reading Skill Program (Reading Competition)
2. Preparation of Study Materials for the next class.
3. Personality / Leadership Development
4. Career Guidance for X class students
5. Screening Documentary and other educational films
6. Awareness Program on Good Touch and Bad Touch (Sexual abuse)
7. Awareness Program on Socially relevant themes. Programs for

**Women Empowerment**

1. Government Guidelines and Policy Guidelines
2. Women's Rights
3. Domestic Violence
4. Prevention and Control of Cancer
5. Promotion of Social Entrepreneurship General

**Camps**

1. General Medical camps
2. Eye Camps
3. Dental Camps
4. Importance of protected drinking water
5. ODF awareness camp
6. Swatch Bharath
7. AIDS awareness camp



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8. Anti Plastic Awareness
9. Programs on Environment
10. Health and Hygiene
11. Hand wash programmes
12. Commemoration and Celebration of important days Programs for Youth Empowerment

1. Leadership
2. Anti-alcoholism and Drug addiction
3. Anti-tobacco
4. Awareness on Competitive Examinations
5. Personality Development Common Programs

**Programs**

1. Awareness on RTI
2. Health intervention programmes
3. Yoga
4. Tree plantation
5. Programs in consonance with the Govt. Departments like –
  - i. Agriculture
  - ii. Health
  - iii. Marketing and Cooperation
  - iv. Animal Husbandry
  - v. Horticulture
  - vi. Fisheries
  - vii. Sericulture
  - viii. Revenue and Survey
  - ix. Natural Disaster Management
  - x. Irrigation
  - xi. Law & Order
  - xii. Excise and Prohibition
  - xiii. Mines and Geology
  - xiv. Energy

**Role of Students:**

- Students may not have the expertise to conduct all the programmes on their own. The students then can play a facilitator role.
- For conducting special camps like Health related, they will be coordinating with the Governmental agencies.
- As and when required the College faculty themselves act as Resource Persons.
- Students can work in close association with Non-Governmental Organizations like Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.
- And also, with the Governmental Departments. If the program is rolled out, the District Administration could be roped in for the successful deployment of the program.
- An in-house training and induction program could be arranged for the faculty and participating



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**Timeline for the Community Service Project Activity Duration: 8 weeks**

**1. Preliminary Survey (One Week)**

- A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.
- A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.
- The Governmental agencies, like revenue administration, corporation and municipal authorities and village secretariats could be aligned for the survey.

**2. Community Awareness Campaigns (One Week)**

- Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmes to be conducted, spread over two weeks of time. The list of activities suggested could be taken into consideration.

**3. Community Immersion Programme (Three Weeks)**

**Along with the Community Awareness Programmes**, the student batch can also work with any one of the below-listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to experiential learning about the community and its dynamics. Programs could be in consonance with the Govt. Departments.

**4. Community Exit Report (One Week)**

- During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks' works to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that habitation. The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the University. Throughout the Community Service Project, a daily logbook need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.