Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

NEP Compliant Structure & Syllabus of

Department of Computer Science and Engineering – Data Science Pattern

'A-24'

S. Y. B. Tech.

Effective from Academic Year 2025-26

Prepared by: - Board of Studies in Computer Science and Engineering –

Data Science

Approved by: - Academic Board, Vishwakarma Institute of Technology,

Chairman-Bos
Dr. Jaya Asin

Dean-Academics
Prof. Dr. P. N. Mahalle

Chairman-Academic Board
Prof. Dr. Rajesh Jalnekar

Contents

Program Outcomes

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, social and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Academic Information – Please visit www.vit.edu

Structure of Second Year CSE-DS for Academic Year 2025-26

Course Code	Course Name	Type	Teaching Learning Scheme				
			Th	Tut	Lab	Hrs. / Week	Credits
Module 3 - Semester 1I							
DS2009	DATABASE MANAGEMENT SYSTEM	DC	3	1	2	6	4
DS2010	DESIGN AND ANALYSIS OF ALGORITHMS	DC	2	0	2	4	3
DS2011	SYSTEMS PROGRAMMING AND OPERATING SYSTEM	DC	2	0	2	4	2
DS2012	MACHINE LEARNING	DC	2	0	2	4	3
MM0402	PROBABILITY AND STATISTICS	MDM	2	1	0	3	3
HS2003	FROM CAMPUS TO CORPORATE - 2	IEL	2			2	2
HS2004	REASONING AND APTITUDE DEVELOPMENT - 4	DC	1			1	1
DS2013	DESIGN THINKING - 2	SM		1		1	1
DS2014	ENGINEERING DESIGN AND INNOVATION - 2	SM			2	2	2

Assessment scheme

Course Code	Course Name	ESE TH (W)	ESE TH (O)	CVV	CP	LAB	GD/ PPT/ HA	MS E (O)	T1 (O)	T2 (O)	ESE	PRACT + CVV	Total
DS2009	DATABASE MANAGEMENT SYSTEM			20	30	10						40	100
DS2010	DESIGN AND ANALYSIS OF ALGORITHMS	40		20	30	10							100
DS2011	SYSTEMS PROGRAMMING AND OPERATING SYSTEM	40		30			30						100
DS2012	MACHINE LEARNING		40		30	10	20						100
MM0402	PROBABILITY AND STATISTICS						30		35	35			100
HS2003	FROM CAMPUS TO CORPORATE - 2		50					50					100
HS2004	REASONING AND APTITUDE DEVELOPMENT - 4										100		100
DS2013	DESIGN THINKING - 2										100		100
DS2014	ENGINEERING DESIGN AND INNOVATION - 2							30		70			100

Chairman-Bos

Dr. Dups Asin

Dean-Academics

Prof. Dr. P.N. Mahalle

Chairman-Academic Board

Prof. Dr. Rajesh Jalnekar

FF No: 654

DS2009: DATABASE MANAGEMENT SYSTEM

Course Prerequisites: Data structures, Linear Algebra & calculus

Course Objectives:
- To understand the fundamental concepts of database management.
- To provide a strong formal foundation in database concepts, technology and applications.
- To give systematic database design approaches covering conceptual design, logical design and an overview of physical design.
- To learn basic issues of transaction management and concurrency control.

Credits: 4

Teaching Scheme Theory: 3 Hours/Week
Tutorial: 1 Hour/Week
Lab: 2 Hours/Week

Course Relevance:
This course builds essential skills in designing, managing, and querying databases, which are the backbone of all modern software applications. DBMS knowledge is crucial for careers in software development, data analytics, AI, and enterprise systems. It enables students to handle real-world data efficiently.

SECTION-I

Unit-I:
Introduction To DBMS: Introduction to Database Management Systems, Advantages of a DBMS over file-processing Systems, Database-System purpose and applications, Levels of Database Systems, Database Languages, Data Models, Components of a DBMS and overall structure of a DBMS, Database Design and ER Model: Entity, Attributes, Relationships, Constraints, types of Keys, Design Process, Entity Relationship Model, ER Diagram, Design Issues, Extended E-R Features, converting E-R & EER diagram into tables.   **8 Hrs.**

Unit-II:
SQL : Characteristics and advantages, SQL Data Types and Literals, Data independence, DDL, DML, DCL, TCL, SQL Operators, Tables: Creating, Modifying, Deleting, Views: Creating, Dropping, Updating using Views, Indexes, SQL DML Queries: SELECT Query and clauses, Set Operations, Predicates and Joins, Set membership, Tuple Variables, Set comparison, Ordering of Tuples, Aggregate Functions, Nested Queries, Database Modification using SQL Insert, Update and Delete Queries. Implement all types of queries with the help of real- time application   **10 Hrs.**

PL/SQL: Introduction to Stored Procedures, Functions, Cursors, Triggers.   **3 Hrs.**

SECTION-2

Unit-III:
Relational Database Design: Relational Model: Basic concepts, Attributes and Domains, CODD's Rules, Functional Dependencies: Basic concepts, closure of set of functional dependencies, closure of attribute set, canonical cover, Decomposition: lossless join decomposition and dependency preservation, The Process of normalization, 1NF, 2NF, 3NF, etc.
Unit-IV: **8 Hrs**
Database Transactions: Basic concept of a Transaction, Transaction Management, Properties of Transactions, Concept of Schedule, Serial Schedule, Serializability: Conflict and View,

Testing conflict and view serializability, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods, Deadlocks.   **8Hrs**.

Advances in Databases: Introduction to NoSQL, Structured verses Unstructured data, Different NoSQL Data Models, NoSQL using MongoDB, Query optimization.   **5 Hrs**

List of Practical's:

1. Design any database with at least 3 entities and relationships between them. Apply DCL and DDL commands. Draw suitable ER/EER diagram for the system.

2. Design and implement a database and apply at least 10 different DML queries for the following task.

3. DML queries to execute the aggregate functions like count, sum, avg etc. on the suitable database. Use nested queries, group by and having clauses.

4. Perform a test for set membership (in, not in), set comparison (<some, >=some, <all etc.) and set cardinality (unique, not unique).

5. Execute DDL statements which demonstrate the use of views. Try to update the base table using its corresponding view. Also consider restrictions on updatable views and perform view creation from multiple tables

6. Choose an appropriate case study suitable for NOSQL database and create a database, implement Inserting and saving document, removing document, Updating document.

7. Execute at least 10 queries on any suitable MongoDB database that demonstrates following querying techniques: find and findOne, Query criteria, Type-specific queries.

8. Student group of size 3 to 4 students should decide the statement and scope of the project which will be refined and validated by the faculty considering the number of students in the group.

9. Draw and normalize the design up to at ER Diagram least 3NF in case of back end as RDBMS. Use recent platforms/database tools/engines like SQLite, LeetCode.

10. Suggested Directions for development of the mini project.

   A. Build a suitable GUI by using forms and placing the controls on it for any application. (E.g Student registration for admission, railway reservation, online ticket booking etc.). Proper data entry validations are expected.

   B. Develop two tier architecture and use ODBC/JDBC connections to store and retrieve data from the database. Make a user-friendly interface for system interaction. You may consider any applications like employee management system, library management system etc.

List of Tutorial: (Any 6)

1) Draw ER Diagram for any information system application
2) Draw Extended ER Diagram for any information system application
3) Convert ER Diagram to Relational Model
4) Convert EER Diagram to Relational Model
5) Solving the Queries using Relational Algebra

6) Normalization using Minimal Cover
7) Compare different database types of databases
8) Advanced SQL

List of Projects:

Student registration for admission, railway reservation, online ticket booking, employee management system, library management system etc. (not limited to this) Use of both Structured and non-structured database is applicable.

Assessment Scheme:

LAB	CP	CVV	PR
10	30	20	40

PR- External Practical Examination
HA - Home Assignment
CP - Course Project
CVV- Comprehensive Viva voice (external)

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan; ―Database System Concepts; 6th Edition, McGraw-Hill Education, 2011, 978-0073523323 (ISBN-13)
2. Ramez Elmasri, Shamkant B. Navathe; ―Fundamentals of Database Systems; 7th Edition, Pearson, 2021, ISBN-10, 9789332582705

Reference Books:

1. Thomas M. Connolly, Carolyn E. Begg, Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition; Pearson, ISBN-13: 978-9353438913
2. Raghu Ramakrishnan, Johannes Gehrke; ―Database Management Systems; 3rd Edition; McGraw Hill Education, ISBN 10: 0072465638 / ISBN 13: 9780072465631
3. Kristina Chodorow, MongoDB The definitive guide, O‘Reilly Publications, ISBN: 978-93-5110 269-4, 2nd Edition.
4. Dr. P. S. Deshpande, SQL and PL/SQL for Oracle 10g Black Book, DreamTech. ISBN-10. 8177227106 · ISBN-13. 978-8177227109

Research Articles:
1. Moussa Demba, "Algorithm for relational Database Normalization ", International Journal of Database Management Systems (IJDMS) Vol.5, No.3, June 2013.
2. Sindhubala Patel, Jitendra Choudhary, Govinda Patil "Revolution of Database Management System: A literature Survey", International Journal of Engineering Trends and Technology Volume 71 Issue 7, 189-200, July 2023 ISSN: 2231–5381 / https://doi.org/10.14445/22315381/IJETT-V71I7P218

Moocs Links and additional reading material:
1. https://onlinecourses.nptel.ac.in/noc26_cs72/preview
2. https://onlinecourses.nptel.ac.in/noc26_cs39/preview

Course Outcomes:
Student should be able to
1. Understand and Design E-R Model for given requirements and convert the same into database tables.

2. Apply database techniques such as SQL & PL/SQL using a real-time application.

3. Demonstrate database design concept such as normalization.

4. Demonstrate transaction management techniques in relational database System

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO:1	2		2											
CO:2	2		1		2				2	1	1			
CO:3					2									
CO:4					2									

CO attainment levels:

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:
Advanced databases, Big Data Management, Cloud Databases Database Administrator

Job Mapping:
Job Mapping: Database Engineer, SQL developer, PL/SQL developer etc.

DS2010: Design & Analysis of Algorithm

Course Prerequisites: Programming Paradigm Methodology, Advanced Data Structures
Course Objectives:
1. To understand algorithm efficiency and complexity analysis.
2. To learn classical algorithm design strategies such as divide and conquer, greedy, dynamic programming, and graph-based approaches.
3. To apply algorithmic principles to solve real-world computational and data-driven problems.
4. To introduce simple optimization and parallel computing concepts.

Credits: 3   **Teaching Scheme Theory: 2** Hours/Week
                                                              Lab: 2 Hours/Week

Course Relevance: Algorithms form the foundation of computer science and are essential for solving real-world computational problems. Understanding their design and analysis helps in developing efficient, scalable, and reliable software solutions. This course builds analytical and problem-solving skills necessary for advanced topics like Artificial Intelligence, Data Science, and Optimization.

SECTION-1

Unit-1:   **5 Hrs** **Introduction to Algorithms and Complexity Analysis**: Definition, characteristics, time and space complexity, asymptotic notations (O, Θ, Ω), recurrence relations, Master Theorem, and basic computational complexity (P, NP, NP-Complete, NP-Hard). **Unit-2:**   **5 Hrs** **Divide and Conquer Strategy:** Merge Sort, Quick Sort, Binary Search, Max–Min, Strassen's Matrix Multiplication. **Case Study: Compare sorting algorithms and analyze performance.** **Unit-3:**   **4 Hrs** **Introduction to Greedy Algorithms**: Huffman Coding, Activity Selection, Fractional Knapsack, Job Scheduling. **Case Study: Job scheduling problem using greedy approach.**

SECTION-2

| |
|---|
| **Unit-4**   **5 Hrs**
Dynamic Programming Technique: Principle of Optimality, Memorization, 0/1 Knapsack, Matrix Chain Multiplication, Longest Common Subsequence, Optimal BST, Traveling Salesperson Problem.
Case Study: Shortest path solution for travel optimization.
Unit-5   **5 Hrs**
Graph Algorithms: Representation (Adjacency Matrix/List), DFS, BFS, Dijkstra, Floyd-Warshall, Topological Sort, MST (Prim's, Kruskal's) and Ford-Fulkerson method.
Case Study: Recommendation and community detection basics.
Unit-6   **4 Hrs**
Backtracking, Branch & Bound, and Parallel Algorithms: N-Queens, Subset Sum, Graph Coloring, Hamiltonian Cycle, 0/1 Knapsack, TSP.
Case Study: Optimizing Delivery Routes for a Logistics Company Using Parallelized TSP and Branch & Bound |

List of Practical (Any 7):

1. Implement and compare Merge Sort and Quick Sort on students roll numbers; record execution times.
2. A college wants to schedule the maximum number of events in a single hall without time clashes. Apply the **Activity Selection / Job Scheduling** greedy algorithm. Display the selected events.
3. A student has a limited budget and wants to select items that maximize value. Solve this problem using the **0/1 Knapsack** dynamic programming approach.
4. Given a map of southeast US cities and distances, find the cheapest route from Memphis city to another. Implement **Dijkstra's Algorithm**.
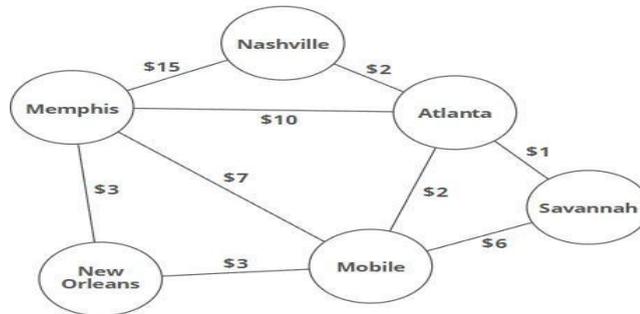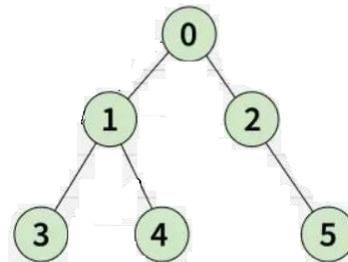

5. Solve the N-Queens problem using Backtracking.
6. Implement Branch and Bound for TSP on following graph and compare with the Greedy approach.
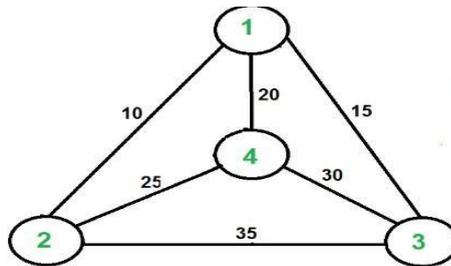
7. A company wants to connect all offices with minimum total cable length. Build a Minimum Spanning Tree using Kruskal's Algorithm. Offices map is shown below:
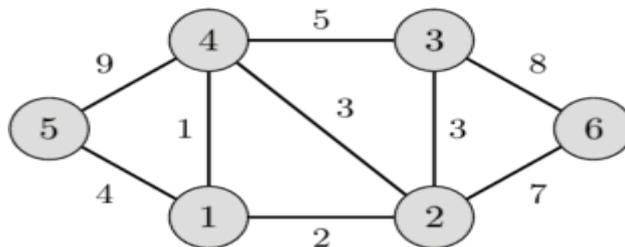
8. Perform Graph Traversal (DFS & BFS) on a given graph structure.

9. A website recommends products to users based on their connections with other users. Users connected directly or indirectly belong to the same community. Use adjacency list

Example: Users: **A, B, C, D, E, F**
Connections:
A ↔ B
B ↔ C
D ↔ E
F has no connection
10. Measure and visualize algorithm performance using Python's time module.

List of Projects:
1. Performance Comparison of Sorting Algorithms

2. Job Scheduling Optimizer Using Greedy Approach

3. Travel Route Optimization Using Dynamic Programming

4. Recommendation System Using Graph Algorithms

5. Feature Ranking in ML Using Greedy Techniques

6. Parallelized Matrix Multiplication Using Divide & Conquer

7. Cryptarithm Solver Using Backtracking

8. 0/1 Knapsack Problem Solver with Branch & Bound and Parallelization

Assessment Scheme:

ESE(W)	*CVV*	*Lab*	*CP*
40	*20*	*10*	*30*

ESE - End Semester Examination
CP - Course Project
CVV- Comprehensive Viva voice (internal)

Text Books:

1. Horowitz and Sahani, "Fundamentals of Computer Algorithms", Galgotia Publications, 4th edition. ISBN: 978-8175152571
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI. ISBN: 978-0262046305

Reference Books:

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Pearson, 3rd Edition. ISBN: 978-9332585485
2. S. Sridhar, "Design and Analysis of Algorithms", Oxford University Press. ASIN: B0FJ2V7N4T

MOOCS Links and Additional Reading Material:
NPTEL: Design and Analysis of Algorithms - IIT Madras
Coursera: Algorithms Specialization - Stanford University
GeeksforGeeks: Algorithm Tutorials and Practice Problems

Course Outcomes:

Student should be able to

1. Analyze problems and classify into N, NP, NP-Complete and NP Hard categories.
2. Implement efficient algorithms using divide and conquer.
3. Implement and analyze efficient algorithms using and greedy methods
4. Design dynamic programming solutions for optimization problems.
5. Develop Graph algorithm techniques for real life implications
6. Develop backtracking and branch & bound-based solutions for complex problems.

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO:1	3	2	3	2	1	1	-	-	1	1	1	2	-	2
CO:2	3	3	3	2	1	1	-	-	1	1	1	2	-	2
CO:3	3	3	3	3	1	1	-	-	1	1	1	2	2	2
CO:4	3	3	3	3	1	1	-	-	1	1	1	2	1	2
CO:5	3	3	3	3	1	1	-	-	1	1	1	2	2	2
CO:6	3	3	3	3	1	1	-	-	1	1	1	2	2	2

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	

Future Courses Mapping:

Artificial Intelligence, Machine Learning, Advanced Algorithms, Optimization Techniques

Job Mapping:

Software Developer, Data Analyst, Algorithm Engineer, AI/ML Engineer, Research and Development roles.

DS2011: SYSTEM PROGRAMMING AND OPERATING SYSTEMS

Course Prerequisites: Programming in C/C++, Computer Organization and Architecture, Data structures

Course Objectives:

1. To develop a strong foundation in operating system concepts including process management, multithreading, and CPU scheduling.

2. To enable analysis and application of concurrency control, deadlock handling, and memory management techniques.

3. To understand the architecture and working principles of system software components such as assemblers, macro processors, loaders, and linkers.

4. To introduce modern and emerging operating system paradigms relevant to virtualization, cloud-edge environments, and next-generation computing platforms.

Credits: 2   **Teaching Scheme Theory:** 2 Hours/Week
                                                  Lab: 2 Hours/Week

Course Relevance: Operating Systems and System Programming explain how software manages hardware resources and enables efficient system-level programming, concurrency, and process control, forming a foundation for advanced areas such as systems design, embedded systems, networking, and cyber security.

SECTION-I

Unit I: Operating System Fundamentals and Process Management   (7 Hrs.)
Operating system objectives and functions; evolution of operating systems; types of operating systems; developments leading to modern operating systems; virtual machines. Basics of BASH shell scripting: common shell commands and shell as a scripting language. Process management: concept of a process, process states, process description, and process control including process creation, waiting, program loading, and termination; execution of the operating system. Threads and multithreading: processes versus threads, concept and types of threads. CPU scheduling: types of scheduling, scheduling algorithms.

Unit II: Concurrency Control and Memory Management   (7 Hrs.)
Principles of concurrency in operating systems; process and thread synchronization; requirements for mutual exclusion. Mutual exclusion mechanisms: hardware support, operating system support using semaphores and mutexes, Classical synchronization problems including Producer–Consumer and Readers–Writer's problems. Deadlock concepts: principles of deadlock, deadlock prevention, and deadlock avoidance Memory management fundamentals: memory management requirements; memory partitioning techniques including fixed partitioning, dynamic partitioning, and buddy system; memory relocation; paging and segmentation

SECTION-II

Unit III: System Software Architecture and Program Translation Mechanisms (7 Hrs.)

Role and need of system software; major components of system software; language processing activities and basics of language translation. Assemblers: assembly language structure, simple assembly schemes, pass structure of assemblers, and design of a two-pass assembler.
 Macro processors: macro definition, expansion, nested macros, and advanced macro features; design of a two-pass macro processor.
Loaders and linkers: loader schemes (compile-and-go, absolute loader), relocation and linking concepts, self-relocating programs, relocating and direct linking loaders, overlay structures, and dynamic linking and loading.

Unit IV: - Advanced Operating System Paradigms   (7 Hrs.)

Virtualization fundamentals; Hypervisors – Type I and Type II; KVM, QEMU, and Xen overview. OS-level virtualization and containerization concepts; Docker, LXC, and system d-n spawn; virtual machines versus containers.
Operating systems for cloud and edge computing; serverless OS concepts; unikernels and lightweight operating systems. Mobile operating system internals – Android and iOS overview. Introduction to operating systems for quantum and neuromorphic computing.

List of Practical's:

1. Assume you are developing a command-line utility for a small organization that needs to maintain contact details on a Linux system. Write a shell program to implement an address book with options to create, view, insert, delete, and modify records using appropriate shell constructs and file handling.

2. Consider a system where computation is divided between parent and child processes for better control and modularity. Write a C program to demonstrate fork(), execve(), and wait() system calls. The parent process sorts an integer array and passes it to the child through execve(), where the child executes a new program to perform binary search. Illustrate zombie and orphan process states.

3. Assume a high-performance application that requires parallel computation to reduce execution time. Implement matrix multiplication using POSIX threads (pthread_create, pthread_join, pthread_exit). Each thread must return computed values, and the final result should be assembled by the main thread.

4. In a multi-process system, multiple producers and consumers access a shared buffer concurrently. Implement the Producer–Consumer problem using counting semaphores and mutex locks to ensure correct synchronization and mutual exclusion.

5. Assume an operating system managing concurrent access to limited shared resources. Implement any one classical synchronization problem—Bounded Buffer, Dining Philosophers, or Readers–Writers—using mutexes and semaphores, and demonstrate avoidance of race conditions.

6. Consider an operating system that must schedule multiple processes efficiently. Implement and compare FIFO, Round Robin, and Preemptive scheduling algorithms, and analyze their performance using waiting time and turnaround time.

7. Assume you are developing a system software tool to translate assembly language programs. Implement Pass I of a two-pass assembler to generate intermediate code, symbol table, and literal table.

8. Using the data generated in Pass I, the assembler must complete translation. Implement Pass II of the assembler to generate target machine code.

9. Consider an assembler that supports macro definitions for code reuse. Implement Pass I of a two-pass macro processor to process macro definitions and construct macro tables.

10. Macro calls must be expanded before final assembly. Implement Pass II of the macro processor to expand macros and generate the final expanded source program.

Textbooks:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, ISBN-10: 0-13- 380591-3, ISBN-13: 978-0-13-380591-8, 8th Edition ,2014
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, WILEY, ISBN 978-1-118-06333-0, 9th Edition, 2021
3. D. M. Dhamdhere, Systems Programming and Operating Systems, Tata McGrawHill, ISBN 13:978-0-07-463579-7, Second Revised Edition,2009
4. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Compilers Principles, Techniques and Tools, Addison Wesley, ISBN:981–235–885 - 4, Low Price Edition,2023
5. Operating Systems A Concept-Based Approach Dhananjay M. Dhamdhere McGraw-Hill ISBN 978–0–07–295769,2008

Reference Books:

1. Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition,2014
2. Tom Adelstein and Bill Lubanovic, Linux System Administration, O'Reilly Media, ISBN-10: 0596009526, ISBN-13: 978-0596009526, 2007
3. J. J. Donovan, Systems Programming, McGraw-Hill, ISBN 13:978-0-07-460482- 3, Indian Edition, 2017

Assessment Scheme:

ESE(TH)	CVV	GD/PPT
40	30	30

ESE – End semester examination

CVV – Oral Examination

GD/PPT- Group Discussion/ Power Point Presentation

Course Outcomes:

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

1. Apply operating system concepts to analyze process behavior, thread management, CPU scheduling, and basic shell-based system interaction.
2. Analyze and solve synchronization, deadlock, and memory management problems using appropriate OS mechanisms and techniques.
3. Analyze the design and functioning of system software components including assemblers, macro processors, loaders, and linkers.
4. Explain modern operating system paradigms including virtualization, containerization, and cloud-edge systems.

CO PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 13	PSO 14
CO:1	3	2	1	–	2	1	–	–	–	2	1	2	**2**	**2**
CO:2	3	3	2	2	2	–	–	–	–	1	1	2	2	2
CO:3	3	2	2	2	2	–	–	–	–	1	1	2	2	2
CO:4	2	2	2	1	3	–	–	–	1	2	2	2	2	2

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:
Compiler Design, Parallel & Distributed Computing, Cloud Computing Infrastructure

Job Mapping:
System Software Engineer, OS Developer, Embedded Systems, Cloud Engineer

FF No. : 654

DS2012: MACHINE LEARNING

Course Prerequisites: Mathematics

Course Objectives:
1. To understand nature of problems solved using machine learning techniques.
2. To apply classification and prediction algorithms to real-world datasets
3. To understand evolutionary, instance-based, and reinforcement learning paradigms
4. To design and implement advanced machine learning solutions for practical applications.

Credits: 3   **Teaching Scheme Theory: 2** Hours/Week
                                              Lab: 2 Hours/Week

Course Relevance: In the current era of AI transformation, knowledge of ML is essential for careers in data analytics, robotics, finance, bioinformatics, and software development. This course equips students with the ability to analyze data, identify patterns, and build predictive models that automate learning from experience without explicit programming. By understanding ML algorithms and their applications, learners develop critical problem-solving, analytical, and computational thinking skills.

SECTION-1

Unit 1: Introduction to Machine Learning:

Types of learning: Supervised, Unsupervised and semi-supervised, reinforcement learning techniques; Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models, Predictive and descriptive learning   **6Hrs**

Unit 2: Classification and Neural Models:

Classification: Basic Concepts, Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Rule Extraction from a Decision Tree; Multiclass Classification; Naive Bayesian Classification; Rule-Based Classification; Metrics for Evaluating Classifier Performance
Support Vector Machine, Artificial Neural Network and Recurrent Neural Networks:
Mathematical foundation, Design and implementation study of neural network systems to solve real world problems   **8 Hrs**

SECTION-2

Unit 3: Evolutionary and Instance-Based Learning:

Genetic Algorithms, Fuzzy Set Approaches; k-Nearest-Neighbor Classifiers, Case-Based Reasoning, Holistic learning and multi-perspective learning. Reinforcement learning: The Reinforcement Learning Problem; History of Reinforcement Learning; Elements of Reinforcement Learning; Example: Tic-Tac-Toe; Transfer learning   **7Hrs**

Unit 4: Advanced Machine Learning Applications:
Beyond machine learning-deep learning and bio inspired adaptive systems; Machine learning and Big data; Natural Language Processing; Healthcare Decision Support System; Computer Vision

                                                                  7Hrs

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List of Practical's:

1. Implement Decision Tree algorithms for credit card fraud detection.

2. Implement Reinforcement learning model for Tic Tac Toe.

3. Implement an Artificial Neural Network model for stock market prediction.

4. Implement Twitter Sentiment Prediction using Machine Learning techniques.

5. Implement a fuzzy based model for grading system in education domain.

6. Implement Medical diagnostics for detecting diseases using genetic algorithm

7. Build a machine learning model to predict crop yield using historical weather and soil data to assist farmers in decision-making

8. Develop a classification model to identify students at risk of dropping out based on academic performance and attendance records.

9. Implement a classifier to automate bank loan approval decisions using applicant financial and demographic data.

10. Design a machine learning model to predict customer churn for a telecom company using usage and billing data.

11. Create a predictive model to estimate disease risk using patient medical history and lifestyle attributes.

12. Develop a recommendation engine for an e-commerce platform based on customer purchase behavior.

13. Implement a regression model to predict traffic congestion levels using historical traffic flow and time-based data.

14. Build a forecasting model to predict daily energy consumption for smart grid optimization

15. Design a classification system to detect fraudulent job postings using textual and metadata features

16. Develop a machine learning model to predict air quality levels using environmental sensor data to support public health monitoring.

List of Projects:

1. Student Performance Prediction

2. House Price Prediction

3. Email Spam Detection

4. Iris Flower Classification

5. Customer Segmentation

6. Crop Recommendation System

7. Fake News Detection

8. Resume Screening and Job Role Recommendation System

9. Electric Vehicle Charging Demand Prediction

10. Online Review Rating Prediction System

List of Course Seminar Topics:

1. AI Bias and Fairness in Machine Learning Models

2. Explainable AI (XAI): Making Machine Learning Transparent

3. Machine Learning in Climate and Environmental Studies

4. Edge AI: Bringing ML to Mobile and IoT Devices

5. Federated Learning: Privacy-Preserving Machine Learning

6. Traffic Prediction and Smart City Applications

7. Predictive Maintenance using Machine Learning in Industry

Assessment Scheme:

GD/PPT	CP	LAB	ESE(O)
20	30	10	40

GD – Group Discussion
CP - Course Project
Lab – Lab
ESE(O) - End Semester Examination Online

Text Books:
1. Kevin P. Murphy, Probabilistic Machine Learning: An Introduction, MIT Press, 1st ed., 2022, ISBN: 9780262046824.
2. Ian. H. Witten, Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques",2nd Edition
3. Stephen Marsland, "Machine Learning: An Algorithmic Perspective" ,1st Edition.
4. Peter Flach, "Machine Learning: The Art and Science of Algorithms that make sense of data", Cambridge University Press, 1st Edition, 2012, ISBN No.: 978-1-316-50611-0
5 Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.
6.Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd ed., O'Reilly, 2023, ISBN: 9781098125974.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", PHI, 2nd edition, 2013, 978-0-262-01243-0 Kevin
2.Tom Mitchell, "Machine Learning", McGraw Hill, 1997, 0-07-042807-7
3. Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making" Wiley-IEEE Press,   ISBN: 978-0-470-91999-6.

MOOC Links and additional reading material
1. **Coursera Machine Learning Specialization (Andrew Ng, DeepLearning.AI)**
https://www.coursera.org/specializations/machine-learning-introduction
2..**NPTEL – Machine Learning (IIT Madras)**
https://nptel.ac.in/courses/106/106/106106139/
3. **NPTEL – Introduction to Machine Learning (IIT Kharagpur)**
https://nptel.ac.in/courses/106/105/106105152/
4. **NPTEL – Deep Learning (IIT Ropar)**
https://nptel.ac.in/courses/106/106/106106184/
5. **NPTEL – Reinforcement Learning (IIT Madras)**
https://nptel.ac.in/courses/106/106/106106143

Course Outcomes:
Student should be able to
1. Design and evaluate various machine learning algorithms

2. Use classification algorithms and evaluate their performance using appropriate metrics

3. Design solutions using evolutionary, instance-based, and reinforcement learning techniques.

4. Analyze and select suitable machine learning techniques for domain-specific applications

CO PO Map

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO:1	2	1	3	1	1	1	1	0	1	1	1	1	2	1
CO:2	2	2	3	2	2	1	1	0	1	1	1	1	3	1
CO:3	2	2	3	2	2	1	1	0	1	1	1	1	3	1
CO:4	2	2	3	2	2	1	1	0	1	1	1	1	3	1

CO Attainment Level:

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:
Artificial Intelligence, Machine Learning, Reinforcement Learning

Job Mapping:
Data Scientist, Machine Learning Technical Lead, Sales and Analytics, Higher Studies and Startups

FF No. : 654

MM0402: PROBABILITY AND STATISTICS

Course Prerequisites: Basic algebra, Calculus, Logical reasoning and basic problem-solving skills

Course Objectives:
- To introduce students to basic statistical concepts and probability theory.
- To enable students to model real-world uncertainty using probability distributions.
- To train students in inferential techniques such as estimation and hypothesis testing.
- To build foundational skills in analyzing relationships between variables using correlation and regression.

Credits: 3

Teaching Scheme Theory: 2 Hours/Week
Tutorial: 1 Hour/Week
Lab: 0 Hours/Week

Course Relevance: This course provides the mathematical foundation needed to analyze data, quantify uncertainty, and make evidence-based engineering decisions. It enables students to work effectively in fields such as data science, quality control, machine learning, reliability engineering, and research.

SECTION-1
Descriptive Statistics & Fundamentals of Probability: Types of data: qualitative, quantitative, discrete, continuous, Frequency distribution; visualizations (histogram, bar chart, box plot), Measures of central tendency: mean, median, mode, Measures of dispersion: variance, standard deviation, coefficient of variation, Basic probability rules: axioms, complement rule, addition rule, Conditional probability & independence, Bayes' theorem (simple engineering examples) 7 **Hrs**
Random Variables & Common Distributions: Random variables: discrete & continuous, Probability Mass Function (PMF), Probability Density Function (PDF), Cumulative Distribution Function (CDF), Expectation, variance, and properties, Discrete distributions: Bernoulli, Binomial, Poisson, Continuous distributions: Uniform and Exponential, Applications in engineering **7 Hrs**
SECTION-2
Normal Distribution & Sampling Theory: Normal distribution: standard normal, Z-scores, Applications of normal distribution (tolerances, quality control), Normal approximation to binomial & Poisson, Sampling: random sampling, sample mean, sample variance, Sampling distribution of sample mean, Standard error, Central Limit Theorem (CLT) – intuitive explanation with examples **7 Hrs**
Estimation, Hypothesis Testing, Correlation & Regression: Point estimation: properties of good estimators, Interval estimation: confidence interval for mean (σ known/unknown), Hypothesis testing: Null & alternative hypothesis, Type I & II errors, One-sample Z-test and t-test, Chi-Square (χ^2) Tests: Chi-square distribution, Test for goodness of fit, Test for independence of attributes, Applications in quality inspection and survey data, Analysis of Variance (ANOVA): Concept and assumptions of ANOVA, One-way ANOVA, F-test and interpretation, Engineering and experimental applications **7 Hrs**

List of Tutorial: (Any 6)

1. Descriptive Statistics for Factory Production A small factory records the daily production output of its machines for one week. Using the given data, students calculate the mean, median, and mode to understand the typical production level. Measures such as variance, standard deviation, and coefficient of variation are also computed to study how much the production varies from day to day and whether the process is stable.

2. Probability in Electrical Component Failure An electrical system uses components that may fail during operation. The probability of failure under normal and overloaded conditions is provided. Students solve numerical problems using basic probability rules and conditional probability to determine the chances of system failure. Bayes' theorem is used to update probabilities when additional information about operating conditions is known.

3.   Modeling Call Arrivals Using Discrete Distributions A customer support center receives a fixed number of calls during office hours. Students use Binomial and Poisson distributions to calculate the probability of receiving a certain number of calls in a given time period. The results are interpreted to understand workload planning and staffing requirements.

4. Reliability Analysis Using Exponential Distribution The lifetime of a machine part follows an exponential distribution. Students calculate the probability that the part fails within a specific time and find the expected life of the component. The numerical results are used to explain maintenance scheduling and replacement planning in engineering systems.

5. Normal Distribution in Quality Control The weights of packaged products follow a normal distribution with a known mean and standard deviation. Students calculate Z- scores and determine the percentage of products that fall outside acceptable limits. Based on the numerical results, they analyze whether the packaging process meets quality standards.

6. Hypothesis Testing for Process Verification A company claims that the average time taken to complete a manufacturing task meets a given standard. Using sample data, students frame the null and alternative hypotheses and perform a one-sample Z-test or t- test. The decision is made based on the calculated test statistic and significance level, and the result is interpreted in a practical context.

7. Chi-Square Test for Inspection Data (Tool-Based) A quality inspection department records the number of defective and non-defective items produced by different machines. Students use a statistical tool such as Excel or Python to perform the chi-square test for independence. The output from the tool is analyzed to decide whether product quality depends on the machine used.

8. One-Way ANOVA for Comparing Manufacturing Methods (Tool-Based) Three different manufacturing methods are tested to compare their average output. Students apply one-way ANOVA using Excel or Python to analyze the data. Based on the F-value and p- value obtained from the tool, they conclude whether there is a significant difference between the methods.

Assessment Scheme:

HA	T1(O)	T2(O)
30	35	35

HA - Home Assignment
T1(0) - Test 1 Online
T2(0) - Test 2 Online

Text Books:

1. J. L. Devore, Probability and Statistics for Engineering and the Sciences, 9th ed., Boston, MA, USA: Cengage Learning, 2016.
2. S. M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 5th ed., Amsterdam, Netherlands: Academic Press (Elsevier), 2014.
3. R. A. Johnson and G. K. Bhattacharyya, Miller and Freund's Probability and Statistics for Engineers, 9th ed., Harlow, U.K.: Pearson, 2017.

Reference Books:

1. R. E. Walpole, R. H. Myers, S. L. Myers and K. Ye, Probability and Statistics for Engineers and Scientists, 9th ed., Boston, MA, USA: Pearson, 2012.
2. C. R. Kothari and Gaurav Garg, *Research Methodology: Methods and Techniques*, 5th ed., New Delhi, India: New Age International Publishers, 2023.
3. W. W. Hines, D. C. Montgomery, D. M. Goldsman and C. M. Borror, Probability and Statistics in Engineering, 4th ed., Hoboken, NJ, USA: Wiley, 2003.
4. V. K. Rohatgi and A. K. Md. E. Saleh, An Introduction to Probability and Statistics, 2nd ed., New York, NY, USA: Wiley, 2001.
5. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, New Delhi, India: Sultan Chand & Sons, latest ed.

MOOC Links and additional reading material:
1. Probability and Statistics – IIT Kharagpur:
   https://onlinecourses.nptel.ac.in/noc23_ma83/preview
2. Engineering Statistics – IIT Bombay:
   https://onlinecourses.nptel.ac.in/noc23_ge25/preview?utm_source=chatgpt.com
3. Introduction to Probability – IIT Madras:
   https://onlinecourses.nptel.ac.in/noc25_mg35/preview?utm_source=chatgpt.com

Course Outcomes:
Course Outcomes:
Student should be able to
1. Explain descriptive statistics, probability concepts, and random variables.

2. Apply discrete and continuous probability distributions to engineering problems.

3. Perform statistical inference using estimation and hypothesis testing.

4. Analyze and interpret relationships in data using correlation and regression.

CO PO Map

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO:1	3	2			1					1		2	1	1
CO:2	3	3	1	1	1					1		2	2	2
CO:3	3	3	1	2	1			1		1		3	2	2
CO:4	3	3	2	2	2	1		1	1	2		3	3	3

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	

Future Courses Mapping:
Data Science, Machine Learning, AI & Neural Networks

Job Mapping:
Data Analyst, Quality Engineer, Machine Learning Engineer, Business Analyst, etc.

HS2003: CAMPUS To CORPORATE-2   **Teaching Scheme Theory: 2Hrs/Week**

	Total Hours	**128**	**32**	**32**	**32**	**32**				
VERTICAL	**TOPIC**	**Topic Hours**	**A**	**B**	**C**	**D**	**2hrs Module**	**2hrs Module**	**2hrs Module**	**2hrs Module**
COMPANIES & INDUSTRY	COMPANY ORGANIZATION	2				2	1. How company works as a full unit with many parts to it 2. Concepts of functions, departments, roles and hierarchies 3. Understand how things are dependent on each other 4. Understand changes in the org structure along with org growth			
COMPANIES & INDUSTRY	UNDERSTANDING COMPANIES	2	2				1. Understand how to Analyse a company based domains, customers, offering and strategy 2. Understand how to use this knowledge to contribute earlier and faster.			
COMPANIES & INDUSTRY	COMPANY CULTURE	2				2	1. Understand what does a culture mean 2. How to evaluate yourself for cultural fit. 3. Compare and contrast different company cultures			
COMPANIES & INDUSTRY	PROFESSIONALISM	4			2	2	1. Understand importance of professionalism 2. Understand examples of good professionalism and Indian nuances.	1. How to be a good Team Member 2. How to be a good Mentee		
COMPANIES & INDUSTRY	UNDERSTANDING COMPANY FINANCIALS(and AOP BUDGETING)	4			2	2	1. Understand components of company P&L and Balance Sheet 2. Be able to assess financial health of a company	1. How do companies build AOP. Top down and bottom up 2. Understand the funding avenues		
APPLICATION OF KNOWLEDGE	PRODUCT SOLUTIONING	6	2	2	2		1. Understand how products are envisioned considering the end customer. 2. Understand importance of creating right solution vs just building it.	1. Understand all facets, dependencies with other stakeholders and understand a good solutioning methodology	1. Solution a real-life Product ask	
APPLICATION OF KNOWLEDGE	PRODUCT MANAGEMENT	8	2	2	2	2	1. Understand product roadmap creation 2. Understand product growth strategies 3. Understand product discovery techniques	1. Understand backlog prioritization techniques 2. Be able to write requirement in details	1. Understand Requirements Flow 2. Write a PRD	1. PM role in Inside Out and OutsideIN 2. Career in PM 3. Roadmapping Technique
APPLICATION OF KNOWLEDGE	METRICS AND MEASUREMENTS	4	2	2			1. Understand how companies measure performance of A. Product B. Engineering C. Business 2. What are KPIs (Business and Operational)	1. Run a Case study based workshop and buildout KPIs , OKRs for a year. Understand how companies measure performance of A. Product B. Engineering C. Business 2. Trickle the KPI to individual Engineer level		
APPLICATION OF KNOWLEDGE	UNDERSTANDING UX AND UI	4		2	2		1. Understand what usability, user interaction design and consumer journeys mean	1. Compare and contrast UX with user interface. Use several industry examples 2. technique of building a good UX		
APPLICATION OF KNOWLEDGE	RELEASING A PRODUCT TO THE MARKET	4	2			2	1. Understand what it takes to release a product to the market by product and engineering teams	1. Understand what it takes for a product to be successful with the customer from external go-to- market perspective.		
APPLICATION OF KNOWLEDGE	QUALITY - UNDERSTANDING	6	2	2	2	0	1. Understand how to look at product quality	1. Understanding Testing and Test Automation	1. Build a Test Plan 2. Career options in	

	BEYOND THE THEORY						2. Understand how to approach building a good quality product		Quality	
APPLICATION OF KNOWLEDGE	SOURCE CODE CONTROL	2		2			1. Why is a SCCS needed 2. How do Industries use a SCCS 3. Create a repo and do a check-in/checkout			
APPLICATION OF KNOWLEDGE	CUSTOMER SUCCESS MANAGEMENT	4			2	2	1. Concept of Customer Success 2. What is CSAT, NPS, RATING, REVIEWs and how should one track Customer Value	1. Understand what issues mean in the industry 2. Understand how to identify and prioritize issues and ways to resolve them.		
APPLICATION OF KNOWLEDGE	SOFTWARE DELIVERY MODELS	2		2			1. Understand product delivery from engineering perspective 2. Understand how a deliver model is decided by the company 3. Understand delivery model vis-a-vis product maturity, constraints and nature (B2B, B2C)			
APPLICATION OF KNOWLEDGE	UNDERSTANDING DATA AND DATA ENGINEERING	4	2		2		1. Understand Data Engineering 2. Understand aspects and Data Engineering and how they are used in the industry	1. Understand Data Science 2. Understand aspects of Data Science and how they are used in the industry		
APPLICATION OF KNOWLEDGE	TECHNICAL ARCHITECTURE AND DESIGN PRINCIPLES	8	2	2	2	2	1. Understand standard architecture design patterns (Monoliths vs Micro Services)	1. Understand how to align product goals to technical architecture	1. Understand how architectural choices are made	1. Understand Scalability and Performance
APPLICATION OF KNOWLEDGE	SECURITY AND PRIVACY	4		2	2		1. Understand Security concepts (Threat, Vulnerability, Risk) 2. Understand about Threat Modelling	1. Understand about Security Engineering Approach 2. Be able to prepare security test plan		
APPLICATION OF KNOWLEDGE	CLOUD COMPUTING	4	2	2			1. Understand evolution of cloud 2. Understand how cloud computing is used in the industry 3. Understand how to compare and contrast cloud solutions	1. Understand the Cost of Cloud Computing 2. Understand different types of cloud services		
APPLICATION OF KNOWLEDGE	DEVOPS AND SITE RELIABILITY ENGINEERING	2				2	1. What is the Concept , Goal and Principles of DevOps 2. What is the Concept, Goal and Principles of SRE 3. Career Options in DevOps and SRE			
APPLICATION OF KNOWLEDGE	ARTIFICIAL INTELLIGENCE (AI) - THE EVOLUTION	8	2	2	2	2	1. Introduction to AI . AI is pervasive today . Origins of AI and ML . Potential and possibilities 2. Machine Learning. How is it different from traditional programs ?. Extensive practical applications over the last decade or so	3. Deep Learning. Computer Vision and Natural Language Processing	4. Transformers and LLM . NLP breakthrough	5. Gen AI. Current wave. AI Agents
PROFESSIONAL SKILLS	CONTINUOUS LEARNING AND IMPROVEMENT	2				2	1. Understand continuous learning and continuous improvement 2. Understand how to identify continuous improvement opportunities 3. Understand how to measure impact of continuous improvement			
PROFESSIONAL SKILLS	OWNERSHIP	2		2			1. Understand what it means by Leading an area 2. How do you take accountability and what is ownership and responsibility			
PROFESSIONAL SKILLS	TIME MANAGEMENT AND MULTITASKING	2	2				1. Understand the concept of time management and multi- tasking 2. Understand the size of the problem 3. Understand time management technique, relative prioritization and			

							effective follow-through			
PROFESSIONAL SKILLS	CURIOSITY AND INQUISITIVENESS	8	2	2	2	2	1. What is Curiosity and Understand the importance of asking questions 2. Review Industry Examples	1. Understand techniques of asking thought provoking questions 2. Tips and tricks to ask effective questions	1. What is Inquisitiveness 2. Review Industry Examples of being inquisitive at work 3. roleplay and handson workshop	1. How to build the habit of Being Inquisitive 2. roleplay and handson workshop
PROFESSIONAL SKILLS	ARTICULATION AND COMMUNICATION	8	2	2	2	2	1. Understand different types of communications 2. Understand barriers to communications 3. Understand why is articulation important	1. How do you do Impactful Introductions	1. How to make Effective presentations. Hands on Elevator Pitch 2. How to be good at stakeholder communication. Debate, Proposal , Agreements or otherwise	1. Techniques to communicate confidently, fearlessly yet respectfully 2. How to run small meetings culminating in decisions 3. How to address a large audience
PROFESSIONAL SKILLS	PROBLEM BREAKDOWN AND RESOLUTION USING MIND MAPS	8	2	2	2	2	1. What are mind maps 2. Tips on creating Mind Maps 3. Real-life case of Problem Breakdown	1. Prioritizing a long list . Concept and Technique 2. Live workshop on understanding constraints and prioritizing and long todo list	1. What are mind maps 2. Tips on creating Mind Maps 3. Real-life case of Problem Breakdown	1. Prioritizing a long list . Concept and Technique 2. Live workshop on understanding constraints and prioritizing and long todo list
PROFESSIONAL SKILLS	EFFECTIVE PROJECT AND PROGRAM MANAGEMENT	4	2		2		1. Understand the key concepts within project management 2. Understand key aspects of planning 3. Understand the link between planning and execution	1. Case study based Proj and Prog Management hands on workshop		
PROFESSIONAL SKILLS	DEVELOPING CRITICAL THINKING USING MENTAL MODELS	8	2	2	2	2	1. Why Critical Thinking 2. What are the barriers to Critical Thinking	1. Technique and Steps in Critical Thinking 2. Why Mental Models 3. Using Mental Models for sharper decisions	1. Technique and Steps in Critical Thinking 2. Why Mental Models 3. Using Mental Models for sharper decisions	1. Technique and Steps in Critical Thinking 2. Why Mental Models 3. Using Mental Models for sharper decisions
PROFESSIONAL SKILLS	CAREER MANAGEMENT - COLLEGES	2				2	1. Understand technique to evaluate company choices when one has multiple choices 2. How to structure your Resume and approach your Interview 3. Understand typical success factors in a successful career with real life examples			

HS2004: REASONING AND APTITUDE DEVELOPMENT-4

Credits: 1　　　　　　　　　　**Teaching Scheme Theory:** 1 Hours/Week

English Language

Familiarity with English Language, Ability to understand written text, spoken word and effective communication through written documents; Coverage of vocabulary to cope up with general and specific terminology, syntax and sentence structure, prevention of incorrect use leading to distortion in communication; synonyms, antonyms and contextual vocabulary, Grammar – Error identification, sentence improvement and construction, Reading Comprehension

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Logical Ability

Objective interpretation of things, ability to perceive and interpret trends to make generalizations; ability to analyze assumptions behind an argument or statement; Deductive reasoning: Assessment of ability to synthesize information and derive conclusions - Coding deduction logic, Data Sufficiency, Directional Sense, Logical word sequence, Objective reasoning, Selection and decision tables, puzzles; Inductive reasoning: Assessment of ability to learn by example, imitation or by trial – Analogy pattern recognition, Classification pattern recognition, Coding pattern recognition, Number series pattern recognition; Abductive reasoning: Critical thinking ability of seeing through logical weak links or loopholes in an argument or a group of statements; Critical reasoning: assessment of ability to think through and analyze logical arguments, assessment of ability to use logical constructs to offer reasoning in unfamiliar situations; Information Gathering and synthesis: Ability of locating information, information ordering, rule based selection and data interpretation, order and classify data, interpret graphs, charts, tables and make rule based deductions. Application of these approaches for using visual, numerical and textual data from single or multiple sources.

Quantitative Ability

Basic numbers – decimals and fractions, factorization, divisibility: HCF, LCM, Odd, even, prime and rational numbers. Application of algebra to real world, direct and inverse proportion, common applications – Speed-time -distance, Profit-loss, percentage, age relations, mixtures, other miscellaneous quantitative combination, exponentials and logarithms, permutations and combinations, probability. Spatial reasoning: Inductive – Missing portions, Sequence and series; Deductive analysis.

Reference Books:

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1. "English Grammar in Use" by Raymond Murphy, Cambridge University Press.
2. "Word Power Made Easy" by Norman Lewis, Goyal Publishers & Distributors.
3. "Objective General English" by S.P. Bakshi, Arihant Publications.
4. "English for Competitive Examinations" by K. Sinha, S. Chand Publishing.
5. "Essential English Grammar" by Philip Gucker, Wiley.
6. "English Idioms and Phrasal Verbs" by M.A. Yadav, Vikas Publishing House.
7. "The Oxford English Grammar" by Sidney Greenbaum, Oxford University Press.
8. "A Modern Approach to Verbal & Non-Verbal Reasoning" by R.S. Aggarwal, S. Chand Publishing, ISBN: 978-8121903409.
9. "Logical Reasoning and Data Interpretation for the CAT" by Nishit K. Sinha, Pearson India, ISBN: 978-8131709117.
10. "Logical Reasoning and Data Interpretation for the CAT" by Arun Sharma, McGraw Hill Education, ISBN: 978-0070709642.
11. "A New Approach to Reasoning Verbal and Non-Verbal" by B.S. Sijwali & Indu

Sijwali, Arihant Publications, ISBN: 978-9311124692.

12. "Quantitative Aptitude for Competitive Examinations" by R.S. Aggarwal, S. Chand Publishing, ISBN: 978-8121900637.

13. "How to Prepare for Quantitative Aptitude for the CAT" by Arun Sharma, McGraw Hill Education, ISBN: 978-0070709642.

14. "The Pearson Guide to Quantitative Aptitude for Competitive Examination" by Pearson, Pearson India, ISBN: 978-8131709117.

15. "Quantitative Aptitude for Competitive Examinations" by Abhijit Guha, Tata McGraw Hill Education, ISBN: 978-0070666653.

16. "Data Interpretation & Data Sufficiency" by R.S. Aggarwal, S. Chand Publishing ISBN: 978-8121903515.

17. "Quantitative Aptitude for Competitive Examinations" by S. Chand, S. Chand Publishing, ISBN: 978-8121903423

Assessment Scheme:

ESE
100

ESE – End semester examination

DS2013: DESIGN THINKING -2

Course Prerequisites: Problem Based Learning, Project Centric Learning
Course Objectives:
To provide ecosystem for students and faculty for paper publication and patent filing

Credits: 01   **Teaching Scheme: Tutorial 01 Hr./week**

SECTION-1
What is research? Importance of Paper Publication and Patents, Structure of Paper, Journal Publication, Publication in conference, Literature Review, Research Paper Writing, Journal, Ratings and Evaluation, How to rate a Journal? Intellectual property (IP), Research, Ethics, Entrepreneurship

SECTION-2
Structure of the paper ,Journal List (Top 50 Journals) ,Selection of the journal ,Use of various online journal selection tools ,Plagiarism checking ,Improving contents of the paper ,Patent drafting ,Patent search ,Filing of patent ,Writing answers to reviewer questions ,Modification in manuscript ,Checking of publication draft

Assessment Scheme:

ESE
100

ESE- End Semester Examination

Course Outcomes

The student will be able to
1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to Research
3. Apply the methodology of doing research and mode of itspublication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
						Program Outcomes (PO)								PSO	
CO1	1	1	1	1	1	--	--	--	--	--	--	1	1	2	2
CO2	1	1	1	1	1	--	--	--	--	--	--	1	1	2	2
CO3	2	2	3	3	2	2	1	2	2	3	--	1	1	3	3
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	3	3
CO5	1	1	1	1	1	--	--	--	--	--	--	1	1	2	2
CO6	2	2	2	2	2	2	1	3	2	3	--	1	1	3	3
C07	1	1	1	1	1	--	--	--	--	--	--	1	1	1	1
Average	**1.57**	**1.57**	**1.71**	**1.71**	**1.57**	**2.0**	**1.0**	**2.33**	**2.0**	**3.0**	**1.0**	**1.0**	**1.0**	**2.28**	**2.28**

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	
CO .7	

DS2014: ENGINEERING DESIGN AND INNOVATIONS-II

Course Prerequisites: Problem Based Learning

Course Objectives:
1. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student-centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.
6. To develop an ecosystem to promote entrepreneurship and research culture among the students

Credits: 2   **Lab:** 8 Hours/Week

Course Relevance: Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Along with course-based projects, curriculum can be enriched with semester long Engineering Design and Development courses, in which students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. To gain the necessary skills to tackle such projects, students can select relevant online courses and acquire skills from numerous sources under guidance of faculty and enrich their knowledge in the project domain, thereby achieving project centric learning. Modern world sustained and advanced through the successful completion of projects. In short, if students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquiry-based learning. Project centric learning will also redefine the role of teacher as mentor in the learning process. The PCL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to analyze, design and apply categories of Bloom's Taxonomy.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Engineering Design" are designed as a ladder to extend connectivity of software technologies to solve real word problem using interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:
Industry Communication Standards, Single Board Computers and IoT, Computational Biology (Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence, Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and Cyber Security etc).

Group Structure:
● There should be a team/group of 4-5 students.
● A supervisor/mentor teacher assigned to individual groups.
It is useful to group students of different abilities and nationalities together.

Selection of Project/Problem:
- Students must focus to initiate the task/idea. The idea inception and consideration shall be from following areas as a real-world problem:
- Health Care, Agriculture, Defense, Education, Smart City, Smart Energy, Swaccha Bharat Abhiyan, Environment, Women Safety.
- This is the sample list to start with. Faculty and students are free to include other areas which meet the society requirements at large.
- The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem/project within an articulated disciplinary subject frame/domain.
- A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases.
- By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.

Student's Role in PCL:
- Students must have ability to initiate the task/idea. They should not be mere imitators.
- They must learn to think.
- Students working in PCL must be responsible for their own learning.
- Students must quickly learn how to manage their own learning, instead of passively receiving instruction.
- Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
- Students in PCL are expected to work in groups.
- They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Developing Inquiry Skills:
- Students in PCL are expected to develop critical thinking abilities by constantly relating: What they read to do? What they want to do with that information?
- They need to analyze information presented within the context of finding answers.
- Modeling is required so that the students can observe and build a conceptual model of the required processes.
- Use the following mechanism to maintain the track of moving towards the solution. How effective is …….? How strong is the evidence for ………? How clear is ……?
- What are the justifications for thinking? Why is the method chosen?
- What is the evidence given to justify the solution?

Literature Survey – To avoid reinvention of wheel:
- It is integral part of self- directed learning
- Identify the information needed to solve a given problem or issue
- Be able to locate the needed information
- Use the information to solve the given problem effectively.
- Skills required by students in information literacy include:
- How to prepare the search? How to carry out the research
- Sorting and assessing of information in general

Use of Research Methodology: - investigation, collaboration, comprehension, application,

analysis, synthesize and evaluation
Focus on following skills while working in a team to reach to solution:
- Collaborative learning
- Interpersonal Skills
- Resources Evaluation
- Metacognitive Skills
- Reflection Skills

EDD Sample Case Studies: -
With the adaptation of industry communication standards, Raspberry Pi and Sensors, following projects can be taken up:
 1) Design a deployable product for soil moisture detection
2) Design a deployable product for temperature detection
3) Design a deployable product for pressure detection
3) Design a deployable product smoke detection
4) Design a deployable product for motion detection
5) Design a deployable product for collision detection
6) Design a deployable product for sound detection

Text Books:

1. A new model of problem-based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017
2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.
3. Stem Project based learning and integrated science, Technology, Engineering and mathematics approach. By Robert Robart Capraro, Mary Margaret Capraro

Reference Books:

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based and project-based learning in engineering. Rotterdam: Sense Publishers. 2007.
2. Project management core textbook, second edition, Indian Edition , by Gopalan.
3. The Art of Agile Development. By James Shore & Shane Warden.

MOOCs Links and additional reading material:

www.nptelvideos.in
https://worldwide.espacenet.com/

Assessment Scheme:

ESE
100

ESE – End semester examination

Course Outcomes:

On completion of the course, learner will be able to–
CO1:   Identify the real-life problem from societal need point of view
CO2:   Choose and compare alternative approaches to select most feasible one
CO3: Analyze and synthesize the identified problem from technological perspective CO4:
Design the reliable and scalable solution to meet challenges
CO5:   Evaluate the solution based on the criteria specified
CO6:   Inculcate long life learning attitude towards the societal problems

CO -PO Mapping

CO/PO													PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	2	2	2					3		2	2	2	3	3
CO2	2	2	3	2	2		2		3		2	2	2	3	3
CO3	2	2	3	2	3		2		3		2	2	2	3	3
CO4	2	2	3	2	3	3		2	3		2	2	2	3	3
CO5	2	2	3	2	3	2			3		2	2	2	3	3
CO6	2	2	3	3	2				3		3	2	3	3	3
Average	2.0	2.0	2.83	2.83	2.6	2.5	2.0	2.0	3.0	1.0	2.16	2.0	2.17	3.0	3.0

CO attainment levels

CO	Attainment level
CO .1	
CO .2	
CO .3	
CO .4	
CO .5	
CO .6	