Bansilal Ramnath Agarwal Charitable Trust's

# Vishwakarma Institute of Technology

*(An Autonomous Institute affiliated to Savitribai Phule Pune University)*

**Structure & Syllabus**

# B.Tech. Computer Science & Engineering

# (Artificial Intelligence and Machine Learning)

**With Effect from Academic Year 2026-27**

**Prepared by: - Board of Studies in CSE(AIML)**

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

**Chairman – BOS**

**Chairman – Academic Board**

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## Vision of the Institution

"To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development".

## Mission of the Institution

- To ensure that 100% students are employable and employed in Industry, Higher Studies, become Entrepreneurs, Civil / Defense Services / Govt. Jobs and other areas like Sports and Theatre.
- To strengthen Academic Practices in terms of Curriculum, Pedagogy, Assessment and Faculty Competence.
- Promote Research Culture among Students and Faculty through Projects and Consultancy.
- To make students Socially Responsible Citizens.

## Vision of the Department

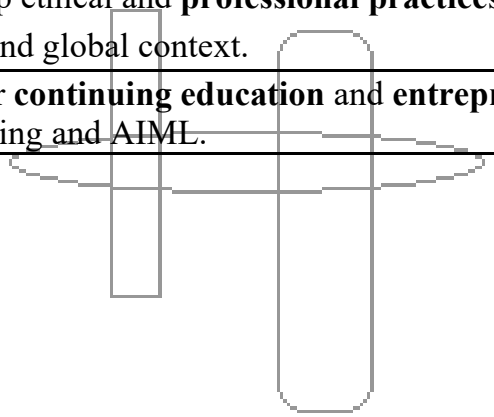
"To be an academic excellence center for developing globally competent engineers and researchers for holistic Socio-economic development".

## Mission of the Department

- To ensure students' **employability** and **entrepreneurial** skills through knowledge of principles of computing, Artificial Intelligence, Machine Learning and Soft skills.
- To enhance **academic excellence** through effectual course contents, rigorous hands-on and active participation of industry in the Artificial Intelligence and Machine learning domain.
- To cultivate **research culture** by investigating complex problems by using computing, Artificial Intelligence and Machine learning approach.
- To develop a sense of responsibility and ethics among students to make them **responsible citizens.**

## Program Educational Objectives (PEOs)

| PEO | PEO Focus | PEO Statements |
|---|---|---|
| PEO1 | **Core competence** | Demonstrate **core competence** in principles of computing and AIML based Technologies. |
| PEO2 | **Breadth** | Apply engineering knowledge to solve industry problems with creative and innovative **design**, development tools and AIML techniques. |
| PEO3 | **Professionalism** | Develop ethical and **professional practices** effectively to gain desired **soft skills** in social and global context. |
| PEO4 | **Learning Environment** | Aim for **continuing education** and **entrepreneurship** in emerging areas of computing and AIML. |



## Abbreviations used

- **WA** - Specifications of Graduate Attributes
- **WK** - Knowledge and Attitude Profiles
- **WP** - Complex Engineering Problems
- **EA** - Complex Engineering Activities
- **SDG** - Sustainable Development Goals
- **OBE** - Outcome Based Education

## List of Programme Outcomes [PO]

| PO | PO Statements |
|---|---|
| **PO1** | **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified inWK1 to WK4 respectively to develop the solution of **complex engineering problems.** |
| **PO2** | **Problem Analysis:** Identify, formulate, review research literature and analyze **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4) |
| **PO3** | **Design/Development of Solutions:** Design creative solutions for **complex engineering problems** and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5) |
| **PO4** | **Conduct Investigations of Complex Problems:** Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8). |
| **PO5** | **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6) |

| | |
|---|---|
| **PO6** | **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.(WK1,WK5& WK7). |
| **PO7** | **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| **PO8** | **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. (WK9) |
| **PO9** | **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences |
| **PO10** | **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. |
| **PO11** | **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8). |

## Complex Engineering Problems (WP)

Complex Engineering Problems must have characteristics WP1 and shall have some or all of WP2- WP7 given in the following table. WPs must be included in courses attaining PO1 to PO6. WP1 is compulsory, and at least two of WP2 to WP7 should be included.

| | |
|---|---|
| **Depth of knowledge Required** | **WP1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamental- based, first principles analytical approach |
| **Range of conflicting requirements** | **WP2:** Involve wide-ranging and/or conflicting technical, non-technical issues (such as ethical, sustainability, legal, political, economic, societal) and consideration of future requirements |
| **Depth of analysis required** | **WP3:** Have no obvious solution and require abstract thinking, creativity and originality in analysis to formulate suitable models |
| **Familiarity of issues** | **WP4:** Involve infrequently encountered issues or novel problems |
| **Extent of applicable codes** | **WP5:** Address problems not encompassed by standards and codes of practice for professional engineering |
| **Extent of stakeholder involvement and conflicting requirements** | **WP6:** Involve collaboration across engineering disciplines, other fields, and/or diverse groups of stakeholders with widely varying needs |
| **Interdependence** | **WP 7:** Address high level problems with many components or sub-problems that may require a systems approach |

## Complex Engineering Activities (EA)

| | |
|---|---|
| **Range of resources** | **EA1:** Involve the use of diverse resources including people, data and information, natural, financial and physical resources and appropriate technologies including analytical and/or design software |
| **Level of interactions** | **EA2:** Require optimal resolution of interactions between wide-ranging and/or conflicting technical, non-technical, and engineering issues |
| **Innovation** | **EA3:** Involve creative use of engineering principles, innovative solutions for a conscious purpose, and research-based knowledge |
| **Consequences to society and the environment** | **EA4:** Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation |
| **Familiarity** | **EA5:** Can extend beyond previous experiences by applying principles- based approaches |

## Knowledge and Attitude Profiles (WK)

| WK | WK Statements |
|---|---|
| **WK1** | A systematic, theory-based understanding of the **natural sciences** applicable to the discipline and awareness of relevant **social sciences**. |
| **WK2** | Conceptually-based **mathematics**, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. |
| **WK3** | A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline. |
| **WK4** | Engineering **specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. |
| **WK5** | Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports **engineering design and operations** in a practice area. |
| **WK6** | Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline. |
| **WK7** | Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development. |
| **WK8** | Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues. |
| **WK9** | Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes. |

## Sustainable Development Goals (SDG)

| SDG No. | Sustainable Development Goal (SDG) |
|---|---|
| SDG 1 | No Poverty |
| SDG 2 | Zero Hunger |
| SDG 3 | Good Health and Well-being |
| SDG 4 | Quality Education |
| SDG 5 | Gender Equality |
| SDG 6 | Clean Water and Sanitation |
| SDG 7 | Affordable and Clean Energy |
| SDG 8 | Decent Work and Economic Growth |
| SDG 9 | Industry, Innovation and Infrastructure |
| SDG 10 | Reduced Inequalities |
| SDG 11 | Sustainable Cities and Communities |
| SDG 12 | Responsible Consumption and Production |
| SDG 13 | Climate Action |
| SDG 14 | Life Below Water |
| SDG 15 | Life on Land |
| SDG 16 | Peace, Justice and Strong Institutions |
| SDG 17 | Partnerships for the Goals |

## Programme Specific Outcomes [PSO]

**Programme Specific Outcome Statements**

**PSO1:** Demonstrate competence in programming with sound knowledge of principles of computing.

**PSO2**: Formulate coherent design, execute proficient implementation, and conduct testing to solve real world problems using software paradigms and AIML methodologies.

**PSO3:** Adapt and exhibit skills in emerging domains of computer science, engineering and technology.

## Course Name Nomenclature as per NEP ( SY)

| | |
|---|---|
| BSC: Basic Science Course | MDOE: Multi-Disciplinary Open Elective |
| ESC: Engineering Science Course | CC: Co-curricular Course |
| PCC: Program Core Course | HSSM: Humanities Social Science and Management |
| PEC: Program Elective Course | IKS: Indian Knowledge System |
| ELC: Experiential Learning Course | FP: Field Project |
| MD: Multi Disciplinary | INT: Internship |

## Nomenclature for Teaching and Examination Assessment Scheme AY 2026-27

| Sr No. | Category | Head of Teaching/ Assessment | Abbreviation used |
|---|---|---|---|
| 1 | Teaching | Theory | Th |
| 2 | Teaching | Laboratory | Lab |
| 3 | Teaching | Tutorial | Tut |
| 4 | Teaching | Open Elective | OE |
| 5 | Teaching | Multi-Disciplinary | MD |
| 6 | Teaching | Computer Science | CS |
| 7 | Teaching | Machine Learning | ML |
| 8 | Assessment | Laboratory Continuous Assessment | CA |
| 9 | Assessment | Mid Semester Assessment | MSA |
| 10 | Assessment | End Semester Assessment | ESE |
| 11 | Assessment | Home Assignment | HA |
| 12 | Assessment | Course Project | CP |
| 13 | Assessment | Group Discussion | GD |
| 14 | Assessment | PowerPoint Presentation | PPT |
| 15 | Assessment | Class Test –1 | CT1 |
| 16 | Assessment | Class Test –2 | CT2 |
| 17 | Assessment | Mid Semester Examination | MSE |
| 18 | Assessment | End Semester Examination | ESE |
| 19 | Assessment | Written Examination | WRT |
| 20 | Assessment | Multiple Choice Questions | MCQ |
| 21 | Assessment | Laboratory | LAB |

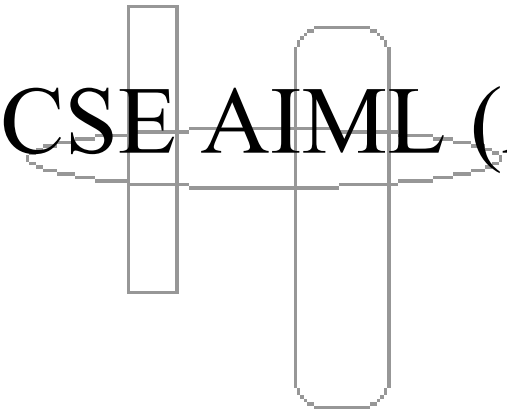
| **Title: Course Structure** | | | **FF No. 653** | |
|---|---|---|---|---|
| **Branch:** Computer Science & Engineering (AIML) | **Year:** S.Y. | **Academic Year.:** 2026-27 | **Semester Module:III** | **Pattern:26-27** |

| Sub No. | Subject Code | Subject Name | Teaching Scheme (Hrs/Week) | | | Examination Scheme | | | | | | | | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Lab | Tut | CVV | CP | LAB CA | GD/ PPT/ HA | MSE (W/O) | T1(W/O) | T2 (W/O) | ESE | ESE (W/O) | PRACT /CVV | Total | |
| S1 | ML2301 | PCC: Fundamentals of Data Structures | 3 | 2 | - | - | 20 | - | - | - | - | - | - | 40(W) | 40 | 100 | 4 |
| S2 | ML2302 | PCC: Database Management Systems | 2 | 2 | - | 20 | 30 | 10 | - | - | - | - | - | 40(W) | - | 100 | 3 |
| S3 | ML2303 | PCC: Object Oriented Programming | 2 | 2 | - | 20 | 30 | 10 | - | - | - | - | - | 40(W) | - | 100 | 3 |
| S4 | ML2304 | PCC: Digital Electronics and Microprocessor | 2 | 2 | - | 20 | 30 | 10 | - | 40(W) | - | - | - | - | - | 100 | 3 |
| S5 | MM0304 | MDM: Discrete Mathematics | 2 | - | 1 | 20 | 20 | - | 20 | 40(W) | - | - | - | - | - | 100 | 3 |
| S6 | HS2002 | EEMC: From Campus to Corporate-1 | 2 | - | - | - | - | | - | 50 | - | - | 50 | - | - | 100 | 2 |
| S7 | HS2001 | BSC: Reasoning and Aptitude Development-3 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 100 | 1 |
| S8 | ML2305 | PCC: Design Thinking-1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 100 | 1 |
| S9 | ML2306 | PCC: Engineering Design And Innovation - 1 | - | 2 | - | - | - | - | - | 30 | - | - | 70 | - | - | 100 | 2 |
| | | **Total** | **13** | **10** | **3** | **80** | **130** | **30** | **20** | **160** | **-** | **-** | **120** | **120** | **40** | **900** | **22** |

| **Title: Course Structure** | | | **FF No. 653** | |
|---|---|---|---|---|
| **Branch:** Computer Science & Engineering (AIML) | **Year:** S.Y. | **Academic Year.:** 2026-27 | **Semester Module:IV** | **Pattern:26-27** |

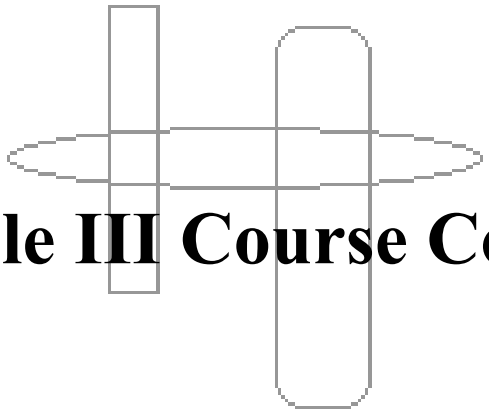
| Sub No. | Subject Code | Subject Name | Teaching Scheme (Hrs/Week) | | | Examination Scheme | | | | | | | | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Th | Lab | Tut | CVV | CP | LAB CA | GD/ PPT/ HA | MSE (W/O) | T1(W/O) | T2 (W/O) | ESE | ESE (W/O) | PRACT /CVV | Total | |
| S1 | ML2307 | PCC: Advanced Data Structures | 3 | 2 | - | - | 20 | - | - | - | - | - | - | 40(W) | 40 | 100 | 4 |
| S2 | ML2308 | PCC: Artificial Intelligence | 2 | 2 | - | 20 | 30 | 10 | - | - | - | - | - | 40(W) | - | 100 | 3 |
| S3 | ML2309 | PCC: Operating Systems | 2 | 2 | - | 20 | 30 | 10 | - | - | - | - | - | 40(W) | - | 100 | 3 |
| S4 | ML2310 | PCC: Automata Theory and Compiler Design | 2 | 2 | - | 20 | 30 | 10 | - | 40(W) | - | - | - | - | - | 100 | 3 |
| S5 | MM0302 | MDM: Data Visualization | 2 | - | 1 | 20 | 20 | - | 20 | 40(W) | - | - | - | - | - | 100 | 3 |
| | MM0303 | MDM: Internet of Things | | | | | | | | | | | | | | | |
| S6 | HS2003 | EEMC: From Campus to Corporate-2 | 2 | - | - | - | - | | - | 50 | - | - | 50 | - | - | 100 | 2 |
| S7 | HS2004 | BSC: Reasoning And Aptitude Development - 4 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 100 | 1 |
| S8 | ML2311 | CC: Design Thinking- 4 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 100 | 1 |
| S9 | ML2312 | Engineering Design And Innovation - 2 | - | 2 | - | - | - | - | - | 30 | - | - | 70 | - | - | 100 | 2 |
| | | **Total** | **13** | **10** | **3** | **80** | **130** | **30** | **20** | **160** | **-** | **-** | **120** | **120** | **40** | **900** | **22** |

# Syllabus CSE AIML (AY 2026-27)



# S.Y. Computer Science and Engineering (Artificial Intelligence &Machine Learning)

# AY 2026-27



# Module III Course Content

**Syllabus Template** **FF No.: 654-A**

# ML2301: Fundamentals of Data Structures

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 4 | CP: 20 Marks |
| Lectures : 3 Hrs/week | PR/CVV: 40 Marks |
| Practical : 2 Hrs/week | ESE (W): 40 Marks |
| Tutorial : - | |

| **Prerequisites:** | |
|---|---|
| ● | Basic programming Skills (C / C++) |
| **Course Objectives:** | |
| ● | To introduce the basic concepts of data structures and algorithms. |
| ● | To learn and understand linear and non-linear data structure constructs. |
| ● | To implement searching and sorting techniques using linear data structures. |
| ● | To understand how to solve problems using a step by step approach with the help of fundamental data structures. |
| ● | To associate data structures in developing and implementing efficient algorithms. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to- |
| 1. | Make use of single and multi-dimensional array for searching and sorting based applications. Analyze the algorithms to compute the time and space complexity. |
| 2. | Construct computer science applications with the help of dynamic storage representation. |
| 3. | Build computer science applications using stacks and queues. |
| 4. | Demonstrate the use of tree data structure to represent and manipulate hierarchically organized data in various applications. |
| 5. | Utilize graph data structure to design social media, network based and circuit applications. |
| 6. | Design and develop the single and multithreads applications by applying hash table and hash map techniques. |

| **Section1: Linear Data Structures** | **Topics/Contents** |
|---|---|

**Unit 1: Arrays** (7 Hours)

Concept of data, Abstract Data Types (ADT), Data Structure: Definition, Types (Linear and Non- Linear, Static and Dynamic, Persistent and Ephemeral). Difference between individual variables against Data Structures. Asymptotic Notations, Time and Space Complexity. Introduction to Array, Memory Representation and application of Single and Multidimensional arrays, Sparse Matrix. Concept of ordered list, storage representations of ordered list such as row major, column major and their address calculation. Searching and Sorting techniques: Linear Search, Binary search, Indexed Search, Fibonacci Search with Analysis. Sorting Techniques: Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Radix Sort, Quick Sort, Shell Sort, Bucket Sort with Analysis and passes.

**Unit 2: Linked Lists** (7 Hours)

Dynamic memory allocation, Singly Linked Lists, Doubly linked Lists, Circular linked lists and Generalized linked lists, Operations: Insertion (front, end and any location), Deletion (front, end and any location), Search, Traverse, Update, Applications of Linked list, Introduction to Vectors and Application.

**Unit 3: Stacks and Queues** (7 Hours)

Stack: Stack representation and Implementation using arrays and Linked lists. Applications of stack in Recursion, Expression conversions (infix, prefix and postfix) and evaluations. Queues: Representation and implementation using array and Linked lists, Types of queue: Linear Queue, Double Ended Queue, Circular Queue. Applications of Queues: Job Scheduling, Josephus problem etc.

| **Section2: Non-Linear Data Structures** | **Topics/Contents** |
|---|---|

**Unit 4: Trees** (7 Hours)

Basic terminology, representation using array and linked lists. Conversion from general tree to binary tree, Tree Traversals: Recursive and Non recursive, Operations on binary trees. Binary Search trees (BST), Threaded Binary Tree and traversals.

**Unit 5: Graphs** (7 Hours)

Terminology and representation using Adjacency Matrix and Adjacency Lists, Graph Traversals and Application: BFS and DFS, Connected graph, Bipartite Graph, Detecting Cycle in graph. Minimum Spanning tree: Prims and Kruskal's Algorithm, Shortest Path Algorithms, Union, Find.

| **Unit 6: Hashing** (7 Hours) | |
|---|---|
| Concepts-hash table, hash function, basic operations, bucket, collision, probe, synonym, overflow, open hashing, closed hashing, perfect hash function, properties of good hash function, Collision resolution strategies- open addressing and chaining, Hash table overflow- open addressing and chaining, extendible hashing, closed addressing and separate chaining | |
| **Text Books:** ***(As per IEEE format)*** | |
| 1 | *E. Horwitz , S. Sahani, Anderson-Freed, " Fundamentals of Data Structures in C", Second Edition, Universities Press* |
| 2 | *Y. Langsam, M.J. Augenstein, A.M.Tenenbaum, "Data structures using C and C++", Pearson Education, Second Edition.* |
| 3 | *Narasimha Karumanchi, "Data Structures and Algorithm Made Easy", Fifth Edition, CareerMonk publication.* |
| **Reference Books:** ***(As per IEEE format)*** | |
| 1 | *J. Tremblay, P. Soresan, "An Introduction to data Structures with applications", TMHPublication, 2nd Edition. 2.* |
| 2 | *E. Horowitz, S.Sahni; 'Fundamentals of Data structures'; Computer Science Press, Oct 1981. [Online] https://lpuguidecom.wordpress.com/wp-content/uploads/2017/04/fundamentals-of-data-structures-ell is-horowitz-sartaj-sahni.pdf.* |

**List of Practical's:**

1) To implement the different sorting algorithms.
2) To implement the linked list.
3) To implement any application of Stack data structure.
4) Implement various expression conversions using Stack.
5) To implement any application of Queue data structure.
6) To implement an algorithm to perform Binary Search Tree (BST) operations (Create, Insert, Delete and Traversals).
7) To implement an algorithm to perform various operations on Binary Tree (Mirror image, Height, Leaf node display, Level wise display etc.)
8) To implement an algorithm to perform various Tree traversals using Stack.
9) To implement Graph traversal: algorithms: Depth First Search and Breadth First Search.
10) To implement Prim's and Kruskals Algorithms to find a Minimum Spanning Tree (MST).
11) To implement Dijkstra's algorithm to solve a Single Source Shortest Path Problem.
12) To implement hashing algorithms.

**List of Project areas:**

1) Finding Nearest Neighbours.
2) Calendar Application using File handling.
3) Path finder in Maze.
4) Word Completion Using Trie.
5) Bloom Filters.
6) Different Management Systems (Eg: Library, Banking with advanced features)
7) Scheduling Applications and Simulation.
8) Shortest Path Applications. (Kirchhoff's Circuit, TSP with Scenarios).
9) Efficient Storage and Data Retrieval Systems.
10) Different Gaming Application.
11) Cash flow minimizer
12) Students Grade Checker

### CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 3 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| CO3 | 3 | 3 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| CO4 | 3 | 3 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| CO5 | 3 | 3 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| CO6 | 3 | 3 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 | - |
| **Avg** | **3.0** | **3.0** | **1.5** | **-** | **1.0** | 1.0 | **1.0** | **-** | **-** | **-** | **1.0** | **3.0** | **1.0** | **-** |

### CO – WK Mapping (Knowledge & Attitude Profiles)

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO2 | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO3 | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO4 | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO6 | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – WP Mapping (Complex Engineering Problems)

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO3 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO5 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | | ✓ |
| CO3 | ✓ | ✓ | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | | ✓ |
| CO5 | ✓ | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | | ✓ |

## CO – SDG Mapping (Sustainable Development Goals) Sample Table

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4, 9 | Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9). |
| CO2 | 9 | Supervised models power industrial and predictive applications (SDG 9). |
| CO3 | 3, 9 | Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9). |
| CO4 | 8, 9 | Classifiers enable fraud detection and economic applications (SDG 8, 9). |
| CO5 | 9 | Decision-tree and ensemble models support data-driven industry solutions (SDG 9). |
| CO6 | 9, 11 | Clustering / RL enable smart-city and resource applications (SDG 9, 11). |

**Syllabus Template** **FF No.: 654-A**

# ML2302: Database Management Systems

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 3 | CP: 30 Marks |
| Lectures : 2 Hrs/week | CVV: 20 Marks |
| Practical : 2 Hrs/week | Lab:10 Marks |
| Tutorial - | ESE (W): 40 Marks |

| **Prerequisites:** | |
|---|---|
| | Programming Fundamentals<br>Data Structures<br>Discrete Mathematics<br>Basic Problem Solving Skills |
| **Course Objectives:** | |
| 1. | To understand the fundamental concepts, architecture, and data modeling techniques used in modern database management systems. |
| 2. | To design efficient relational database schemas using entity-relationship modeling, functional dependencies, and normalization principles. |
| 3. | To develop database applications using SQL and PL/SQL for data definition, manipulation, retrieval, and database programming. |
| 4. | To analyze query processing, indexing, transaction management, concurrency control, and recovery mechanisms for efficient database operations. |
| 5. | To explore the architecture, design, and implementation of parallel, distributed, and cloud-based database systems. |
| 6. | To understand and apply NoSQL databases, Big Data storage systems, data warehousing, and emerging database technologies for real-world applications. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to |
| 1. | Design and draw ER and EER diagrams for real life applications. |
| 2. | Transform conceptual schema of high-level data model into implementation data model. |
| 3. | Apply the concepts of normalization to develop the quality relational data model. |
| 4. | Formulate queries in relational algebra, SQL and write PL/SQL blocks. |
| 5. | Acquainted with physical database file structures. |
| 6. | Identify the use of database techniques such as NOSQL |

| Section1: | Topics/Contents |
|---|---|

**Unit 1:**
**Introduction**: Need of Database Management Systems, Evolution, Database System Concepts and Architecture, Database Design Process
**Data Modeling**: Entity Relationship (ER) Model, Extended ER Model, Relational Model, Codd's Rules

**Unit 2:**
**Database Design**: Need of Normalization, Functional Dependencies, Inference Rules, Functional Dependency Closure, Minimal Cover, Decomposition Properties, Normal Forms: 1NF, 2NF, 3NF and BCNF, Multi-valued Dependency, 4NF, Relational Synthesis Algorithms

**Unit 3:**
**Query Languages**: Relational Algebra, SQL: DDL, DML, Select Queries, Set, String, Date and Numerical Functions, Aggregate Functions, Group by and Having Clause, Join Queries, Nested queries, DCL, TCL, PL/SQL: Procedure, Function, Trigger, Mapping of Relational Algebra to SQL

| Section2: | Topics/Contents |
|---|---|

**Unit 4:**
**Storage and Querying**: Storage and File structures, Indexed Files, Single Level and Multi Level Indexes; Query Processing, Query Optimization, Parquet file format.
**Transaction Management:** Basic concept of a Transaction, ACID Properties, State diagram, Concept of Schedule, Serializability – Conflict and View, Concurrency Control Protocols, Recovery techniques

**Unit 5:**
**Parallel and Distributed Databases:** Architecture, I/O Parallelism, Interquery, Intraquery, Intraoperation and Interoperation Parallelism, Types of Distributed Database Systems, Distributed Data Storage, Distributed Query Processing, Introduction to Elastic Search index. Introduction to Cloud Databases, Database as a Service (DBaaS)

**Unit 6:**
**NOSQL Databases and Big Data Storage Systems:** Introduction to NOSQL Databases, Types of NOSQL Databases, BASE properties, CAP theorem, Big Data, HADOOP: HDFS, MapReduce.
**Data Warehousing**: Architecture and Components of Data Warehouse, Warehouse Schemas, OLAP and OLTP.

| **Text Books:** *(As per IEEE format)* | |
|---|---|
| 1 | Abraham Silberschatz, Henry F. Korth, S. Sudarshan; "Database System Concepts"; 6th Edition, McGraw-Hill Education |
| 2 | Ramez Elmasri, Shamkant B. Navathe; "Fundamentals of Database Systems"; 7th Edition, Pearson |
| **Reference Books:** *(As per IEEE format)* | |
| 1. | Thomas M. Connolly, Carolyn E. Begg," Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition; Pearson |
| 2. | Raghu Ramakrishnan, Johannes Gehrke; "Database Management Systems", 3rd Edition; McGraw Hill Education |
| 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. |
| 5. | Ivan Bayross, SQL, PL/SQL: The Programming Language of Oracle, BPB Publication. 6. Reese G., Yarger R., King T., Williums H, Managing and Using MySQL, Shroff Publishers and Distributors Pvt. Ltd., ISBN: 81 - 7366 - 465 – X, 2nd Edition. |
| 6. | Dalton Patrik, SQL Server – Black Book, DreamTech Press. |
| 7. | Eric Redmond, Jim Wilson, Seven databases in seven weeks, SPD, ISBN: 978-93-5023-918-6. |
| 8. | Jay Kreibich, Using SQLite, SPD, ISBN: 978-93-5110-934-1, 1st edition. |

**List of Practical's:**

1) Create a database with appropriate constraints using DDL and populate/modify it with the help of DML.
2) Design and Execute "SELECT" queries using conditional, logical, like/not like, in/not in, between...and, is null/is not null operators in where clause, order by, group by, aggregate functions, having clause, and set operators. Use SQL single row functions for date, time, string etc.
3) Write equijoin, non equijoin, self join and outer join queries. Write queries containing single row / multiple row / correlated sub queries using operators like =, in, any, all, exists etc. Write DML queries containing sub queries. Study a set of query processing strategies.
4) Write PL/SQL blocks to implement all types of cursor.
5) Write useful stored procedures and functions in PL/SQL to perform complex computation.
6) Write and execute all types of database triggers in PL/SQL.
7)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.
8) Create a database with suitable example using MongoDB and implement Inserting and saving document, Removing document, Updating document
9) Execute at least 10 queries on any suitable MongoDB database that demonstrates following querying techniques: find and findOne, Query criteria, Type-specific queries

**List of Project areas:**

- Education and Learning Systems
- Healthcare and Medical Informatics
- Banking and Financial Systems
- Retail and E-Commerce Applications
- Smart City and Public Service Systems
- Cybersecurity and Digital Forensics
- Library and Information Management Systems
- Agriculture and Sustainability Applications
- Enterprise Resource Management Systems
- Travel and Hospitality Management Systems
- Sports and Event Management Systems
- AI and Data Analytics Applications
- Cloud and Distributed Database Systems
- NoSQL and Big Data Applications

### CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 2 | 3 | 3 | | 2 | | 2 | | | 2 | 2 | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 3 | | 2 | | 2 | | | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 3 | | | | 2 | | | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 2 | | | | | | 2 | | 3 | | |
| **CO5** | 2 | | 3 | | | | | | | | | 3 | | |
| **CO6** | 2 | | 3 | | | | 3 | | | | | 3 | | |
| **Avg** | 2 | 3 | 3 | 2 | 2 | - | 2.25 | - | - | 2 | 2 | 3 | 3 | 2 |

### CO – WK Mapping (Knowledge & Attitude Profiles)

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | ✓ | ✓ | ✓ | ✓ | | | | |
| **CO2** | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| **CO3** | | ✓ | ✓ | ✓ | ✓ | | | | |
| **CO4** | | ✓ | ✓ | ✓ | | ✓ | | | |
| **CO5** | | ✓ | ✓ | ✓ | | ✓ | | ✓ | |
| **CO6** | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |

## CO – WP Mapping (Complex Engineering Problems)

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | | ✓ | | | | |
| CO2 | ✓ | ✓ | ✓ | | | | |
| CO3 | ✓ | ✓ | ✓ | | | | |
| CO4 | ✓ | | ✓ | | | | |
| CO5 | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | | ✓ | | |
| CO2 | ✓ | ✓ | ✓ | | |
| CO3 | ✓ | ✓ | | | ✓ |
| CO4 | ✓ | ✓ | | | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – SDG Mapping (Sustainable Development Goals)

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 9 | Database design supports digital infrastructure and innovation. |
| CO2 | 9 | Efficient data models improve software infrastructure. |
| CO3 | 9 | Quality database design increases system efficiency. |
| CO4 | 9 | Database programming supports digital transformation. |
| CO5 | 9, 12 | Efficient storage and indexing optimize resource utilization. |
| CO6 | 9, 11 | Big Data, Cloud and NoSQL support smart cities and intelligent infrastructure. |

**FF No.: 654-A**

# ML2303: Object Oriented Programming

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 3 | CP: 30 Marks |
| Lectures : 2 Hrs/week | LAB: 10 Marks |
| Practical : 2 Hrs/week | CVV: 20 Marks |
| Tutorial : 0 Hrs/week | ESE: 40 Marks |

| **Prerequisites:** | |
|---|---|
| ● | C,C++. |
| **Course Objectives:** | |
| ● | Understand Object Oriented programming concepts. |
| ● | Model a given computational problem in Object Oriented fashion |
| ● | To develop problem solving ability using Object Oriented programming constructs like multithreading. |
| ● | Develop effective solutions using for real world problems using concepts such as file handling and GUI. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to |
| 1. | Understand the fundamental concepts of object-oriented programming and the features of Java.. |
| 2. | Apply object-oriented principles like classes, inheritance, polymorphism, and interfaces in Java. |
| 3. | Analyze the use of abstract classes, interfaces, and inner classes for efficient code reuse. |
| 4. | Develop Java programs using exception handling, multithreading, file I/O, and collection framework. |
| 5. | Design interactive Java applications using Swing and apply event-handling mechanisms. |
| 6. | Evaluate and implement Java 8 features such as lambda expressions and Stream API to enhance code quality. |

| **Section1:** | |
|---|---|
| **Unit1:Object-Oriented Programming and Java Basics** | **(4 Hours)** |
| Introduction to OOP: What is Object Oriented Programming (OOP)?, The need of OOP, Characteristics of OOP, Java overview: Classes and Objects, Java object storage, Access Modifiers, this reference, main method, Static vs Instance block, Static methods vs | |

| | |
|---|---|
| Instance methods in Java, Constructors in Java, Default constructor, Parameterized constructor | |
| **Unit 2: Arrays, Strings, and Methods** | **(5 Hours)** |
| Input and Output: Byte Stream vs Character Stream, use of Scanner Class. Arrays in Java: Arrays in Java, initialization, Default Array values, multi-dimensional array, java.util.Arrays class, string class, string buffer, string builder. Methods in Java: Methods, Parameters passing, Returning Multiple values. | |
| **Unit 3: Inheritance and Polymorphism** | **(5 Hours)** |
| Inheritance: Inheritance in Java, Types, Constructor in Inheritance, Using final with Inheritance, Accessing superclass member, Parent and Child classes having same data member, Base vs derived class reference, Polymorphism: Method Overloading, Overloading main(), Static vs Dynamic Binding, Method Hiding, Private and final methods, Passing and Returning Objects in Java. | |
| **Section :2** | |
| **Unit 4: Abstraction and Inner Types** | **(4 Hours)** |
| Interface and its usage, Abstract Class and its usage, Difference between Abstract Class and Interface, Nested Interface, Nested Class, Inner class, Anonymous | |
| **Unit 5: Exception Handling, Collections, and Multithreading-** | **(5 Hours)** |
| Exception Handling: Exceptions, types, types of handling exception, Checked vs Unchecked Exceptions, Throw and Throws, User-defined Exception, Collection in Java: Collections Class, Using Iterators, Iterator vs Foreach, ArrayList, Vector, Map, Set, Multithreading: Thread life Cycle, Thread Priority, Thread Methods | |
| **Unit 6: File Handling, GUI, and Java 8 Features** | **(5 Hours)** |
| File Handling: File Processing, Primitive Data Processing, Object Data Processing, Connecting Java with database (JDBC/ODBC)Java GUI: Swing, Components, Layout Manager: Flow, Border, Grid and Card, Label, Button, Choice, List, Event Handling (mouse, key), Java 8 feature: Lambda Expressions, Stream API, Functional Interfaces, Default and Static Methods in Interfaces, forEach() Method in Iterable, Optional Class, StringJoiner, Parallel Array Sorting | |
| **Text Books:** ***(As per IEEE format)*** | |
| 1 | Herbert Schildt, "JAVA- The Complete Reference", , 11th Edition, McGraw Hill Education |
| 2 | Cay S. Horstmann, "Core Java Volume I – Fundamentals", 13th Edition, Pearson Education. |
| **Reference Books:** ***(As per IEEE format)*** | |
| 1. | Thinking In Java – The Definitive Introduction to Object-Oriented Programming in the Language of the World-Wide Web", Bruce Eckel, Fourth Edition, Pearson Education, Inc. |
| 2. | "Java, java, Java – Object-Oriented Problem Solving", R. Morelli and R. Walde, 3rd edition, Pearson Education, Inc. |

| | |
|---|---|
| 3 | Java 8 in Action" by Raoul-Gabriel Urma, Mario Fusco, and Alan Mycroft |
| 4 | Head First Java" by Bert Bates and Kathy Sierra |
| 5 | Java 8 Lambdas and Streams" by O'Reilly Media (Madhusudhan Konda) |
| 6 | "Java, java, Java – Object-Oriented Problem Solving", R. Morelli and R. Walde, 3rd edition, Pearson Education, Inc. |

**List of Experiment's:**

1. Implement Student class using following Concepts ● All types of Constructors ● Static variables and instance variables ● Static blocks and instance blocks ● Static methods and instance methods
2. There is a class Adder which has two data members of type 1D int array and int variable. It has two functions: getdata and numsum. Function getdata accepts non-empty array of distinct integers from user in 1D int array data member and a targetsum in another data member. The function numsum adds any two elements from an input array which is equal to targetsum and return an array of resulting two elements, in any order. If no two numbers sum up to the target sum, the function should return an empty array. Note that the target sum is to be obtained by summing two different integers in the array; you can't add a single integer to itself in order to obtain the target sum. You can assume that there will be at most one pair of numbers summing up to the target sum. Use constructor. Use extra variables if needed Input: Array=[3,5,-4,8,11,1, targetsum=15 Output: [8,7] Input: Array=[3,5,-4,8,11,1,-1,6] targetsum=15 Output: [ ]
3. Write Java program to calculate area of triangle, square & circle using function overloading. Function parameter accept from user (Use function Overloading concepts and Inheritance).
4. Write a program for following exception, develop a suitable scenario in which the following exceptions occur: a. divide by zero b. Array index out of bounds exception c. Null pointer Exception.
5. Write a java program to solve producer-consumer problem where there are two producer threads and one consumer thread.
6. Write a java program for collection classes to manipulate and manage data and demonstrate usage of ArrayList, Vector, HashMap, and HashSet .Perform insert, delete, search, and iteration operations.
7. Implement various operations using JDBC Connectivity.
8. Display bank account information ( Use interface and inheritance using java).
9. Develop a GUI in java which reads, update the file.
10. Lambda Expressions and Functional Interfaces.
A. `Create a Functional Interface MathOperation with a method int operate(int a, int b). B. Use Lambda Expressions to define: a. Addition b. Subtraction c. Multiplication d. Division C. Create a method that accepts two integers and a MathOperation and returns the result. Sample Output: Addition of 10 and 5 = 15 Subtraction of 10 and 5 = 5 Multiplication of 10 and 5 = 50 Division of 10 and 5 = 2
11. Stream API and forEach() A. Given a list of names (e.g., List), perform the following using Streams: o Print all names using forEach() o Filter names starting with "A" o Convert

names to uppercase o Count names having more than 4 characters o Sort names alphabetically.
12. Default and Static Methods in Interfaces A. Create an interface Greeting with: a. A default method defaultGreeting() that prints “Hello!” b. A static method staticGreet() that prints “Welcome to Java 8!” c. An abstract method customGreeting(String name) B. Implement this interface in a class and demonstrate calling all methods.
13. Optional Class Usage A. Create a method getLength(String str) that:
o Returns the length of the string using Optional<string> .
Avoids NullPointerException if input is null.
Prints “Value is empty” if the input is not present
Sample Output: Input: "Java" → Length: 4 Input: null → Value is empty.

**List Course Projects:**
1. Airline reservation system
2. Course management system
3. Data visualization software
4. Electricity billing system
5. e-Healthcare management system
6. Email client software
7. Library management system
8.Network packet sniffer
9. Online bank management system
10. Online medical management system

**CO – PO / PSO Articulation Matrix**

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 2 | | 2 | 3 | | 3 |
| CO3 | 3 | 2 | 3 | 1 | 1 | | 2 | | | | | 3 | | 3 |
| CO4 | 3 | 3 | 3 | 1 | | | | | | | 2 | 3 | | 3 |
| CO5 | 3 | 3 | 3 | 1 | 1 | | | | 1 | | 2 | 3 | | 3 |
| CO6 | 3 | 2 | 3 | | | | | | | | | 3 | | 3 |
| Avg | 3 | 2.5 | 2.83 | 1.0 | 1.0 | 2.0 | 2.0 | 2.0 | 0.5 | | 2 | 3.0 | 0 | 3 |

### CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | | | |
| CO2 | ✓ | ✓ | ✓ | | | | | | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | | | | |
| CO4 | | ✓ | ✓ | ✓ | | | | | |
| CO5 | | | | ✓ | ✓ | ✓ | | | |
| CO6 | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

### CO – WP Mapping (Complex Engineering Problems) Sample Table

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | | | |
| CO2 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | | | | ✓ |

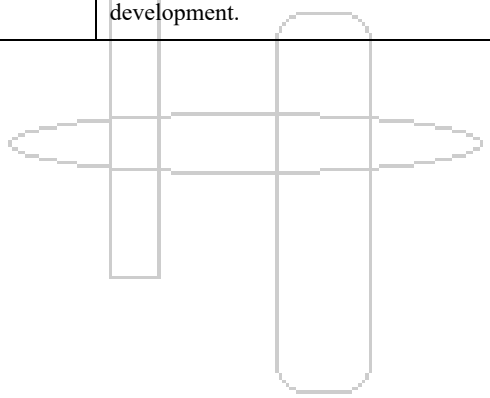
### CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | | ✓ |
| CO3 | ✓ | ✓ | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | | ✓ |
| CO5 | ✓ | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – SDG Mapping (Sustainable Development Goals) Sample Table

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| **CO1** | 4 | Develops foundational programming knowledge and object-oriented design skills using Java, supporting quality education and digital literacy. |
| **CO2** | 4, 9 | Strengthens software development competencies through inheritance, polymorphism, abstraction, and interface-based design for modern application development. |
| **CO3** | 8, 9 | Enhances problem-solving, efficient resource management, and concurrent programming skills through exception handling, collections, and multithreading relevant to industry applications. |
| **CO4** | 9 | Supports innovation and industry-oriented application development using file handling, database connectivity, GUI design, and event-driven programming. |
| **CO5** | 8, 9 | Builds modern programming capabilities through Java 8 features such as Lambda Expressions, Stream API, Functional Interfaces, and efficient software practices aligned with industry needs. |
| **CO6** | 9, 11 | Encourages development of reliable, scalable, and intelligent software solutions through project-based learning and real-world application development. |



**Syllabus Template** **FF No.: 654-A**

# ML2304: Digital Electronics and Microprocessor

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 3 | CVV: 20 Marks |
| Lectures : 2 Hrs/week | LAB: 10 Marks |
| Practical : 2 Hrs/week | CP: 30 Marks |
| Tutorial : - Hrs/week | MSE TH(W): 40 Marks |

| **Prerequisites:** | |
|---|---|
| ● | 1. Basic Electronics Engineering<br>2. Computer Organization and Architecture. |
| **Course Objectives:** | |
| ● | 1. To understand all the concepts of Logic Gates, Boolean Functions, Combinational Logic and Sequential Logic Circuits. |
| ● | 2. To design Combinational Logic and Sequential Logic Circuits |
| ● | 3. To study the fundamental concepts of Computer System and Microprocessor. |
| ● | 4. To gain knowledge of Processor Operating Modes. |
| ● | 5. To analyse the functioning of Microprocessor and Microcontroller. |
| ● | 6. To find the solutions for real world problems of processing. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to |
| 1. | Learn and illustrate the standard representation for logical functions. |
| 2. | Explore the knowledge of Digital logic circuits. |
| 3. | Design applications based on combinational and sequential circuits. |
| 4. | Demonstrate the concepts of microprocessor systems. |
| 5. | Adapt the knowledge based on microprocessor instructions. |
| 6. | Understand the concept of interrupts and its service routine. |

| **Section1:** | **Topics/Contents** |
|---|---|
| | **Unit 1: Digital Fundamentals(6 Hours)**<br>Number Systems – Decimal, Binary, Octal, Hexadecimal, Codes – Binary, BCD, Excess 3, Gray, Sum of products and product of sums, Minterms and Maxterms, Standard representation for logic functions, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions. |

**Unit 2: Combinational Digital Circuits(5 Hours)**
Adders, Subtractors, Multiplexers & De-multiplexers, Encoder: Priority encoders, Decoders,Parity generator and checker. BCD adder and subtractor.

**Unit 3: Sequential Circuits(5 Hours)**
Introduction of flip-flop (F.F), 1 bit memory cell, clocked S-R F.F., J-K F.F. race around condition, M/S J-K F.F, flip-flop truth table, excitation table, flip-flop conversion, flip-flop characteristics. T and D F.F, Design of 4 – bit UP-Down ripple counter using J-K flip-flop, Design of Synchronous 3 bit up/down counter, mod-n counters.

| **Section2:** | **Topics/Contents** |
|---|---|

**Unit4 : Introduction to 8086 microprocessor (4 Hours)**
Internal Architecture, Generation of physical address 8086, 8086 memory segmentation, Register Organization, Addressing modes: Immediate addressing,Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing, 8086 Instruction types, Instruction types, formats, timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. 8086 pin functions: Minimum & Maximum Mode System.

**Unit 5:Hardware Details of Pentium (4 Hours)**
Introduction, History of the Pentium processors, CPU Pin Description, RISC Concepts, Bus Operations, The Pentium's Superscalar Architecture, Pipelining, Branch Prediction, The Instruction & Data Caches, The Floating-Point unit.

**Unit 6: Interrupt Structure and Programmable Interval Timer (4 Hours)**
Interrupt Structure, Interrupt service Routine, Interrupt Vector Table, Hardware and Software Interrupts, INTR, NMI Interrupt Response, Execution of an ISR, Priority of Interrupts.

**Text Books:** ***(As per IEEE format)***


| | |
|---|---|
| 1 | R.P. Jain, **"**Modern Digital Electronics,"3rd Edition, Tata McGraw-Hill, 2003, ISBN 0 - 07 -049492 – 4. |
| 2 | Douglas Hall, "Microprocessors and Interfacing",2nd Edition, Tata McGraw Hill Publications, ISBN 0-07- 025742-6. |
| 3 | B. B. Brey, The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit Extensions: Architecture, Programming, and Interfacing, 8th ed. New Delhi, India: Pearson Education India, 2009. |
| 4 | "Advanced 80386, programming techniques ",James Turley , Tata McGraw Hill Publications, ISBN – 0-07- 881342-5. |

| **Reference Books:** *(As per IEEE format)* | |
|---|---|
| 1 | 1. Ray Duncan, "Advanced MS DOS Programming," 2nd Edition BPB Publications ISBN 0 –07 – 048677– 8. |
| 2 | M. Mano, "Digital Design", 3rd Edition, Pearson Education, 2002, ISBN - 81 - 7808 – 555 0. |
| 3 | A. Malvino, D. Leach, "Digital Principles and Applications", 5th Edition, Tata McGraw Hill, 2003, ISBN 0 - 07 - 047258 – 05. |

**List of Practical's (Minimum Six):**

1. Number system Conversion.
2. K-map and Quine McCluskey.
3. Verification of Logical Gates and Boolean Algebra.
4. Code converters e.g. Excess-3 to BCD and vice versa using logical gates.
5. Multiplexer - e.g. 16:1 Mux using 4:1 Mux (IC 74153).
6. Decoder – e.g. 2 bit comparator (IC 74138).
7. Synchronous Up /down counter using JK flip-flop.
8. Sequences detector using JK flip flop.
9. Study of 8086 Architecture and Execution of sample programs.
10. Write 8086 ALP to print given string on the screen.
11. Write 8086 ALP to find and count negative and positive numbers from signed arrays stored in memory.
12. Write 8086 ALP to access marks of 5 subjects stored in array and find overall percentage and display grade according to it.
13. Write 8086 ALP to perform block transfer operation. (Don't use string operations). Data bytes in a block stored in one array transfer to another array.
14. Write 8086 ALP for following operations on the string entered by the user.(Use Extern Far Procedure).
    a. String length
    b. Reverse of the String
    c. Palindrome

**List of Project areas:**

1. Weather Imaging CubeSat with Telemetry Transmission.
2. Ebike Speed Controller System.
3. Air Water Pollution Sensing Smart Watch.
4. Solar Sea Weather and Pollution Transmitter Buoy.
5. Coin Operated Water ATM with Bottle Dispenser.
6. Multiple Cities Load Shedding Using ARM
7. Wireless Biomedical Parameter Monitoring System Using ARM9
8. ARM and RFID Based Security System (Home, Office, Industrial)
9. Advanced Electronic Voting Machine (EVM) using ARM
10. Online Parallel Examination.
11. Machine Learning, Deep Learning, AI, Blockchain etc Based
12. Agriculture, Health Care, Education, Govt., Transportation, Banking, Insurance Based but not limited for.

## CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 1 | 3 | 1 | |
| CO2 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | 1 | 3 | 2 | |
| CO3 | 3 | 3 | 3 | 1 | 2 | - | - | - | - | - | 1 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 1 | - | 2 | - | - | - | - | - | 1 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 3 | - | - | - | - | - | 1 | 3 | 3 | 2 |
| CO6 | 3 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | 1 | 3 | 2 | 1 |
| Avg | 3 | 2.3 | 1.8 | 0.5 | 1.8 | 0.2 | - | - | - | - | 1.0 | 3.0 | 2.2 | 0.8 |

## CO – WK Mapping (Knowledge & Attitude Profiles)

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | | ✓ | ✓ | | | | | | |
| CO2 | | ✓ | ✓ | ✓ | | | | | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| CO4 | | ✓ | ✓ | ✓ | | ✓ | | | |
| CO5 | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| CO6 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |

## CO – WP Mapping (Complex Engineering Problems)

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | | | | | | |
| CO2 | ✓ | ✓ | | | | | |
| CO3 | ✓ | ✓ | ✓ | | | | ✓ |
| CO4 | ✓ | ✓ | | | | | |
| CO5 | ✓ | ✓ | ✓ | ✓ | | | |
| CO6 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | | | | |
| CO2 | ✓ | ✓ | | | |
| CO3 | ✓ | ✓ | ✓ | | ✓ |
| CO4 | ✓ | ✓ | | | ✓ |
| CO5 | ✓ | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – SDG Mapping (Sustainable Development Goals)

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4 | Develops foundational engineering knowledge and digital literacy. |
| CO2 | 4, 9 | Strengthens technical competencies in digital electronics. |
| CO3 | 9 | Supports innovation through digital circuit design and system development. |
| CO4 | 9 | Builds understanding of processor technologies used in modern industries. |
| CO5 | 8,9 | Enhances programming and problem-solving skills relevant to industry. |
| CO6 | 9, 11 | Supports development of reliable embedded and intelligent systems through interrupt management. |

**FF No.: 654-A**

# MM0304: Discrete Mathematics

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 3 | CVV: 20Marks |
| Lectures : 2 Hrs/week | CP: 20 Marks |
| Practical : 0 Hrs/week | GD/PPT- 20 Marks |
| Tutorial : 1 Hrs/week | MSE (W):40 Marks |

| | |
|---|---|
| **Prerequisites:** | Basic Mathematics |
| **Course Objectives:** | |
| ● | To understand fundamental concepts of discrete mathematics, including functions, relations, sets, graphs, and trees. |
| ● | To apply mathematical properties using the formal language of propositional and predicate logic. |
| ● | To construct recurrence relations to model and solve various combinatorial problems |
| ● | To apply advanced combinatorial techniques to solve complex counting problems. |
| ● | To analyze basic number theory topics and their applications in discrete structures. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to |
| 1. | Apply fundamental concepts of discrete mathematics—such as functions, relations, sets, graphs, and trees—to reason about computer algorithms and systems. |
| 2. | Formulate mathematical properties using the formal language of propositional and predicate logic. |
| 3. | Construct recurrence relations to model and solve various combinatorial problems. |
| 4. | Apply advanced combinatorial techniques to analyze and solve complex counting problems |
| 5. | Explain basic principles of modular arithmetic and illustrate their applications in computing. |
| 6. | Demonstrate an understanding of essential graph theory concepts and their real-world applications. |

| **Section1:** | **Unit 1: Set Theory and Logic** | **(5 Hours )** |
|---|---|---|
| Introduction and significance of Discrete Mathematics, Sets– Naïve Set Theory (Cantorian Set Theory), Axiomatic Set Theory, Set Operations, Cardinality of set, | | |

| |
|---|
| Principle of inclusion and exclusion. Types of Sets – Bounded and Unbounded Sets, Diagonalization Argument, Countable and Uncountable Sets, Finite and Infinite Sets, Countably Infinite and Uncountably Infinite Sets, Power set, Propositional Logic- logic, Propositional Equivalences, truth tables, Application of Propositional Logic Translating English Sentences, predicates and quantifiers, rules of inference, introduction to proofs: direct, contraposition, contradiction, counterexamples, principle of mathematical induction, strong induction, proving the correctness of programs |
| **Unit 2: Relations and Functions** **(4 Hours)** |
| Relations and their Properties, n-ary relations and their applications, Representing relations, Closures of relations, Equivalence relations, Partial orderings, Partitions, Hasse diagram, Lattices, Chains and Anti-Chains, Transitive closure and Warshall‘s algorithm. Functions- Surjective, Injective and Bijective functions, Identity function, Partial function, Invertible function, Constant function, Inverse functions and Compositions of functions, The Pigeonhole Principle. |
| **Unit 3: Counting principles** **(5 Hours)** |
| The Basics of Counting, rule of Sum and Product, Permutations and Combinations, Binomial Coefficients and Identities, Generalized Permutations and Combinations, Algorithms for generating Permutations and Combinations, Double counting, Pigeon-Hole Principle, generalized pigeon-hole principle, Some applications from: Ramsey theorem, Mantel’s theorem, Turan’s theorem, Erdos-Szekeres theorem, Inclusion Exclusion Principle: Counting with Venn Diagrams, counting Derangements, number of primes up to n, number of onto functions, Euler’s phi function. |
| **Section2: Unit 4: Modular Arithmetic** **(4 Hours)** |
| Divisibility and modular arithmetic, Division Algorithm, primes, greatest common divisor, Euclid’s Algorithm, extended Euclid’s algorithm, modular inversion, Fundamental Theorem of Arithmetic, Congruence’s, Fermat’s little theorem, Euler’s phi function, Chinese remainder theorem. |
| **Unit 5: Graph Theory** **(5 Hours)** |
| Introduction to Graphs, different representations, properties of incidence and adjacency matrices, directed/undirected graphs, connected components, degree of a vertex, paths, cycles in graph, Euler and Hamiltonian tours/graphs, the handshaking lemma, Single source shortest path Dijkstra's Algorithm, Planar Graphs, Graph Colouring, Trees, bipartite graphs (graph with only odd cycles, 2-colorable graphs), Planar graphs, Theorem on bound on number of edges. |
| **Unit 6: Trees** **(5 Hours)** |
| Introduction to trees, properties of trees, Binary search tree, tree traversal, decision tree, prefix codes and Huffman coding, cut sets, Spanning Trees and Minimum Spanning Tree, Kruskal’s and Prim’s algorithms, The Max flow- Min Cut Theorem (Transport network). |
| |

| **Text Books:** *(As per IEEE format)* | |
|---|---|
| 1 | "Discrete Mathematics and its applications" by Kenneth Rosen (William C Brown Publisher). |
| 2 | "Applied Combinatorics" by Alan Tucker (Wiley Publishing company). |
| 3 | "Combinatorics: Topics, techniques, algorithms" by Peter J. Cameron (Cambridge University Press). |
| 4 | Graph Theory by Reinhard Diestel (Springer Verlag Publishing Company) |
| **Reference Books:** *(As per IEEE format)* | |
| 1. | Elements of Discrete Mathematics by C. L. Liu |
| 2. | Introduction to Graph Theory by Douglas B. West |

**List of Tutorial's:**

1. Solving problems involving basic set theory.
2. Solving problems using propositional logic.
3. Solving problems related to relations and functions.
4. Solving problems using fundamental counting principles.
5. Solving problems involving binomial coefficient properties.
6. Solving problems on permutations and combinations
7. Solving problems using combinatorial proof techniques.
8. Solving problems through double counting methods.
9. Solving problems based on the pigeonhole principle.
10. Solving problems using the inclusion-exclusion principle.
11. Solving problems involving modular arithmetic.
12. Solving problems using recurrence relations.
13. Solving problems with generating functions.
14. Solving problems involving graphs and their characteristics.

**List of Project areas**

1. Smart Campus Navigation System
2. Graph Theory Applications in Google Maps
3. Boolean Algebra in Digital Circuits
4. Cryptography and Cybersecurity
5. Blockchain Technology and Graphs
6. Network Security using Graph Algorithms
7. Decision Trees in Machine Learning
8. Social Network Analysis using Graph Theory
9. Recommendation Systems in Netflix and Amazon
10. Scheduling Algorithms in Cloud Computing
11. Graph Databases (Neo4j) for AI Applications
12. Knowledge Graphs in Large Language Models (LLMs)
13. Combinatorial Optimization in Industry 4.0
14. Applications of Number Theory in Cryptography
15. Discrete Mathematics in Robotics and Autonomous Systems

### CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | | 2 | | | | | | | 2 | | | - |
| CO2 | 3 | 2 | | | | 1 | | | 2 | | 2 | 1 | | - |
| CO3 | 3 | 2 | 3 | | | | | | | | 2 | | | - |
| CO4 | 3 | 3 | 3 | 3 | | | | | | | 2 | | | - |
| CO5 | 3 | 3 | 1 | | | 1 | 2 | | 1 | | 2 | 1 | | - |
| CO6 | 3 | 3 | 3 | 2 | | 1 | | 1 | | | 2 | 1 | | - |
| Avg | 3 | 2.5 | 1.6 | 1.16 | | 0.5 | 0.3 | 0.1 | 0.5 | | 2 | 0.5 | 0 | - |

### CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | | | |
| CO2 | ✓ | ✓ | ✓ | | | | | | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | | | | |
| CO4 | | ✓ | ✓ | ✓ | | | | | |
| CO5 | | | | ✓ | ✓ | ✓ | | | |
| CO6 | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

### CO – WP Mapping (Complex Engineering Problems) Sample Table

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | |
| CO2 | ✓ | ✓ | ✓ | | | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | | | |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | | ✓ |
| CO3 | ✓ | ✓ | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | | ✓ |
| CO5 | ✓ | ✓ | ✓ | | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – SDG Mapping (Sustainable Development Goals) Sample Table

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4 | Develops foundational mathematical thinking, logical reasoning, proof techniques, and problem-solving skills through set theory and propositional logic, supporting quality education and analytical learning. |
| CO2 | 4, 9 | Strengthens analytical and computational competencies using relations, functions, lattices, and algorithmic methods that support mathematical modelling and innovation. |
| CO3 | 4, 8, 9 | Enhances critical thinking and quantitative decision-making through counting principles, combinatorics, and optimization approaches relevant to modern computational and industrial applications. |
| CO4 | 9 | Supports innovation and secure computational systems through modular arithmetic, number theory, Euclid's algorithm, and mathematical foundations used in computing and cryptography. |
| CO5 | 9, 11 | Builds capability in graph-based modelling, shortest path analysis, network design, and optimization techniques applicable to intelligent and sustainable infrastructure systems. |
| CO6 | 9, 11 | Encourages development of efficient and scalable computational solutions through trees, spanning trees, coding techniques, transport networks, and optimization methods for sustainable systems. |

**FF No.: 654**

## HS2002: FROM CAMPUS TO CORPORATE (FCTC-1)

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 02 | MSE: 50 Marks |
| Lectures : 2 Hrs/week | ESE: 50 Marks |

| **Course Objectives:** | |
|---|---|
| • | Understand the organizational structure, business domains, financial concepts, and functioning of companies in the corporate environment. |
| • | Develop knowledge of product management, user experience, quality assurance, customer success, security, and emerging technologies used in modern industries. |
| • | Apply analytical thinking, problem-solving, and decision-making techniques to address industry-oriented challenges through case studies and practical scenarios. |
| • | Enhance professional competencies including communication, presentation, teamwork, leadership, and interpersonal skills required in multidisciplinary work environments. |
| • | Develop project management, planning, prioritization, and execution skills for effective management of professional tasks and projects. |
| • | Cultivate professional ethics, adaptability, critical thinking, and lifelong learning to achieve continuous personal and professional growth. |
| **Course Outcomes:** | |
| | After completion of the course, student will be able to |
| 1. | Explain the organizational structure, business processes, financial concepts, and product development lifecycle in the corporate ecosystem. |
| 2. | Analyse workplace problems and recommend suitable solutions using concepts of product management, quality, customer success, security, and emerging technologies. |
| 3. | Apply critical thinking, problem-solving techniques, AI awareness, and project management principles to solve industry-oriented case studies. |
| 4. | Demonstrate effective communication, teamwork, leadership, and presentation skills while working in professional and multidisciplinary environments. |
| 5. | Apply project planning, prioritization, and management techniques for successful execution of professional assignments and collaborative projects. |
| 6. | Demonstrate professional ethics, social responsibility, adaptability, and lifelong learning necessary for continuous professional development in a dynamic corporate environment. |

**Vertical 1: COMPANIES & INDUSTRY**

**Topic 1: Understanding Companies**

- Understand how to analyse a company-based domains, customers, offering and strategy

- Understand how to use this knowledge to contribute earlier and faster.

**Topic 2: Understanding Company Financials (and AOP Budgeting)**

- Understand components of company P&L and Balance Sheet
- Be able to assess financial health of a company
- How do companies build AOP. Top down and bottom up
- Understand the funding avenues

**Vertical 2: Application Of Knowledge**

**Topic 1: Product Management**

- Understand product roadmap creation
- Understand product growth strategies
- Understand product discovery techniques
- Understand backlog prioritization techniques
- Be able to write requirements in detail

**Topic 2: Understanding UX And UI**

- Understand what usability, user interaction design and consumer journeys mean
- Compare and contrast UX with user interface. Use several industry examples
- technique of building a good UX

**Topic 3: Releasing A Product To The Market**

- Understand what it takes to release a product to the market by product and engineering teams
- Understand what it takes for a product to be successful with the customer from external go-to market perspective.

**Topic 4: Quality – Understanding Beyond The Theory**

- Understand how to look at product quality
- Understand how to approach building a good quality product
- Understanding Testing and Test Automation
- Build a Test Plan
- Career options in Quality

**Topic 5: Customer Success Management**

- Concept of Customer Success
- What is CSAT , NPS , RATING, REVIEWs and how should one track Customer Value
- Understand what issues mean in the industry
- Understand how to identify and prioritize issues and ways to resolve them.

**Topic 6: Security And Privacy**

- Understand Security concepts (Threat, Vulnerability, Risk)
- Understand about Threat Modelling
- Understand about Security Engineering Approach
- Be able to prepare security test plan

**Topic 7: Artificial Intelligence (AI) – The Evolution**

- Introduction to AI. AI is pervasive today. Origins of AI and ML Potential and possibilities
- Machine Learning. How is it different from traditional programs? Extensive practical applications over the last decade or so
- Deep Learning. Computer Vision and Natural Language Processing

**Vertical 3:** PROFESSIONAL SKILLS

**Topic 1: Curiosity And Inquisitiveness**
- What is Curiosity and Understand the importance of asking questions
- Review Industry Examples
- Understand techniques of asking thought provoking questions
- Tips and tricks to ask effective questions

**Topic 2: Articulation And Communication**
- Understand different types of communications
- Understand barriers to communications
- Understand why articulation is important
- How do you make Impactful Introductions

**Topic 3: Problem Breakdown and Resolution Using Mind Maps**
- What are mind maps
- Tips on creating Mind Maps
- Real-life case of Problem Breakdown
- Prioritizing a long list. Concept and Technique
- Live workshop on understanding constraints and prioritizing and long to-do list

**Topic 4: Effective Project And Program Management**
- Understand the key concepts within project management
- Understand key aspects of planning
- Understand the link between planning and execution
- Case study based Proj and Prog Management hands on workshop

**Topic 5: Developing Critical Thinking Using Mental Models**
- Why Critical Thinking
- What are the barriers to Critical Thinking
- Technique and Steps in Critical Thinking
- Why Mental Models
- Using Mental Models for sharper decisions

## CO-PO Mapping

| CO | Program Outcomes (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 2 | 2 | – | – | 1 | – | – | – | 1 | – | 1 | | | |
| CO2 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | – | – | 1 | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 1 | 3 | 2 | 2 | 2 | 1 | – | 2 | 1 | 2 | 2 | | | |
| **CO4** | – | 1 | – | – | – | – | 2 | 3 | 3 | 2 | 1 | | | |
| **CO5** | – | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | 2 | | | |
| **CO6.** | – | – | – | – | 1 | 2 | 3 | 2 | 2 | 1 | 3 | | | |
| **Average** | | | | | | | | | | | | | | |

**CO – WK Mapping (Knowledge & Attitude Profiles) Table**

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | - | - | - | - | - | - | - |
| **CO2** | - | ✓ | - | ✓ | - | ✓ | - | - | - |
| **CO3** | - | ✓ | - | ✓ | - | - | - | ✓ | - |
| **CO4** | - | - | - | - | - | - | - | - | ✓ |
| **CO5** | - | - | - | - | - | - | - | ✓ | ✓ |
| **CO6** | - | - | - | - | - | - | ✓ | ✓ | ✓ |

**CO – WP Mapping (Complex Engineering Problems) Table**

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| **CO1** | - | ✓ | - | - | - | - | ✓ |
| **CO2** | - | ✓ | - | ✓ | - | ✓ | - |
| **CO3** | - | - | ✓ | ✓ | - | - | - |
| **CO4** | - | - | - | - | - | - | - |
| **CO5** | - | ✓ | - | - | - | - | ✓ |
| **CO6** | - | ✓ | - | - | - | - | - |

**CO – EA Mapping (Complex Engineering Activities)**

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | - | - | - | - |
| CO2 | - | - | - | - | - |
| CO3 | - | ✓ | ✓ | - | - |
| CO4 | ✓ | ✓ | - | - | ✓ |
| CO5 | ✓ | ✓ | - | - | - |
| CO6 | - | - | - | ✓ | ✓ |

**CO – SDG Mapping (Sustainable Development Goals) Table**

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4, 8, 9 | Builds foundational understanding of organizational, financial, and product-lifecycle knowledge that prepares students for productive employment and industry participation. |
| CO2 | 8, 9 | Analyzing workplace problems via product management, quality, security, and emerging technology supports innovation-driven, industry-relevant solutions. |
| CO3 | 4, 9 | Develops critical thinking, problem-solving, and AI awareness through case studies — building future-ready skills and innovation capability. |
| CO4 | 4, 5, 17 | Builds communication, teamwork, and leadership for inclusive, multidisciplinary collaboration and stronger partnerships across diverse teams. |
| CO5 | 8, 17 | Develops project planning and management skills for successful execution of collaborative professional work. |
| CO6 | 4, 8, 16 | Cultivates professional ethics, social responsibility, and lifelong learning — reinforcing responsible conduct and good practice in the workplace. |

# HS2001 : Reasoning and Aptitude Development-3

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 1 | ESE : 100 Marks |
| Lectures : Hrs/week | |
| Practical : Hrs/week | |
| Tutorial : 1 Hrs/week | |

| | | |
|---|---|---|
| | **Section1:** | |
| | **Unit 1: English Language**<br>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<br><br>**Unit 2: Logical Ability**<br>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; Adductive 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. | |
| | **Section2 :** | |
| | **Unit 3: Quantitative Ability** | |

| | |
|---|---|
| | 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:** ***(As per IEEE format)***


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.

## CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 1 | 3 | - | 2 | - | 1 | - | 1 | - | 3 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 3 | 2 | 3 | - | 1 | - | 1 | - | 3 | 1 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | - | 1 | - | 1 | - | 3 | 1 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 3 | 1 | - | 1 | - | 2 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 3 | 2 | 1 | 2 | - | - | 1 | - | 1 | - | 3 | 3 | 2 |
| CO6 | 2 | 2 | 2 | - | 1 | 1 | - | - | - | 1 | - | 3 | 3 | 3 |
| **Avg** | **1.83** | **2.83** | **2.0** | **2.2** | **2.0** | **1** | **-** | **1** | **-** | **2.16** | **1.0** | **2.67** | **2.33** | **1.83** |

## CO – WK Mapping (Knowledge & Attitude Profiles)

*"✓ indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | - | - | ✓ | ✓ |
| CO2 | - | ✓ | ✓ | - | - | - | - | ✓ | - |
| CO3 | - | ✓ | ✓ | ✓ | - | - | - | ✓ | - |
| CO4 | - | - | - | - | - | - | ✓ | ✓ | ✓ |
| CO5 | - | ✓ | ✓ | ✓ | - | - | - | ✓ | - |
| CO6 | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ |

## CO – WP Mapping (Complex Engineering Problems)

*"✓ indicates the knowledge profile drawn upon by the CO.*

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | ✓ | - |
| CO2 | ✓ | - | ✓ | ✓ | - | - | - |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ |
| CO4 | - | ✓ | - | - | - | ✓ | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | - | - | - | ✓ |
| CO2 | ✓ | ✓ | ✓ | - | ✓ |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | - | - | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ |

## CO – SDG Mapping (Sustainable Development Goals)

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4 | SDG 4 – Quality Education |
| CO2 | 4,9 | SDG 4 – Quality Education, SDG 9 – Industry, Innovation and Infrastructure |
| CO3 | 4,8,9 | SDG 4 – Quality Education, SDG 8 – Decent Work and Economic Growth, SDG 9 – Industry, Innovation and Infrastructure |
| CO4 | 8,16 | SDG 8 – Decent Work and Economic Growth, SDG 16 – Peace, Justice and Strong Institutions |
| CO5 | 9,4 | SDG 9 – Industry, Innovation and Infrastructure, SDG 4 – Quality Education |
| CO6 | 4,8,9,17 | SDG 4 – Quality Education, SDG 8 – Decent Work and Economic Growth, SDG 9 – Industry, Innovation and Infrastructure, SDG 17 – Partnerships for the Goals |

**Syllabus Template** **FF No.: 654-A**

# ML2305: Design Thinking 1

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 1 | CP: Marks |
| Lectures : Hrs/week | GD/PPT/HA: Marks |
| Practical : Hrs/week | MSE (W/O): Marks |
| Tutorial : 1 Hrs/week | ESE (W/O):100 Marks |

| **Prerequisites:** | |
|---|---|
| ● | Course Prerequisites: Problem Based Learning, Project Centric Learning Course Relevance: |
| **Course Objectives:** | |
| ● | To provide ecosystem for students and faculty for paper publication and patent filing |
| **Course Outcomes:** | **[Publication of paper or patent]** |
| | After completion of the course, 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 its publication |
| 4. | Write a Research Paper based on project work |
| 5. | Understand Intellectual property rights |
| 6. | Use the concepts of Ethics in Research , Understand Entrepreneurship and Business Planning |

| **Section1:** | **Topics/Contents** |
|---|---|
| What is research?<br>Importance of Paper Publication and Patents<br>Importance of Paper Publication and Patents Structure of Paper<br>Journal Publication Publication in conference Literature Review Research Paper Writing<br>Journal Ratings and Evaluation How to rate a Journal?<br>Intellectual property (IP) Research Ethics Entrepreneurship | |
| **Section2:** | **Topics/Contents** |
| Structure of The paper Journal List (Top 50 Journals) Selection of the journal<br>Use of various online journal selection tools Plagiarism checking<br>Improving contents of the paper Patent drafting<br>Patent search Filing of patent<br>Writing answers to reviewer questions Modification in manuscript<br>Checking of publication draft | |

## CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 | 2 | 2 |
| CO2 | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | | 1 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 1 | 3 | 3 |
| CO5 | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | | 1 | 3 | 3 |
| Avg | 1.7 | 1.7 | 1.8 | 1.8 | 1.7 | 2.0 | 1.0 | 2.3 | 2.0 | 3.0 | 1.0 | 1.0 | 2.5 | 2.5 |

## CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ | | | | | ✓ |
| CO2 | | ✓ | ✓ | ✓ | ✓ | | | | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| CO4 | | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CO5 | | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| CO6 | ✓ | | | ✓ | | ✓ | | ✓ | ✓ |

## CO – WP Mapping (Complex Engineering Problems) Sample Table

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO6 | | | ✓ | | ✓ | ✓ | ✓ |

### CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | |
| CO2 | ✓ | ✓ | ✓ | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | |
| CO4 | | ✓ | ✓ | ✓ | ✓ |
| CO5 | | | ✓ | ✓ | ✓ |
| CO6 | | | | ✓ | ✓ |

### CO – SDG Mapping (Sustainable Development Goals) Sample Table

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4, 9 | Understanding the importance of research promotes quality education, scientific inquiry, innovation, and technological advancement for solving real-world problems. |
| CO2 | 4, 9 | Knowledge of research terminology and concepts strengthens analytical thinking, research competency, and innovation capabilities. |
| CO3 | 9, 17 | Applying research methodology and publishing research fosters innovation, knowledge dissemination, and collaboration among researchers and institutions. |
| CO4 | 4, 9, 17 | Writing research papers develops scientific communication, promotes lifelong learning, and contributes to global knowledge sharing through collaborative research. |
| CO5 | 9,12 | Understanding Intellectual Property Rights encourages innovation, protection of inventions, responsible use of knowledge, and sustainable technological development. |
| CO6 | 4, 16 | Applying research ethics promotes academic integrity, responsible conduct of research, transparency, fairness, and ethical decision-making. |

**Syllabus Template** **FF No.: 654-A**

# ML2306: Engineering Design & Innovation-1

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Credits : 2 | CP: Marks |
| Lectures : Hrs/week | GD/PPT/HA: Marks |
| Practical : 2 Hrs/week | MSE (W/O):30 Marks |
| Tutorial : Hrs/week | ESE (W/O):70 Marks |

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

| | |
|---|---|
| | After completion of the course, student will be able to |
| 1. | Identify the real life problem from societal need point of view |
| 2. | Choose and compare alternative approaches to select most feasible one |
| 3. | Analyze and synthesize the identified problem from technological perspective. |
| 4. | Design the reliable and scalable solution to meet challenges. |
| 5. | Evaluate the solution based on the criteria specified |
| 6. | Inculcate long life learning attitude towards the societal problems |

| **Section1:** | **Topics/Contents** |
|---|---|

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 on initiating the task/idea. The idea of 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 ar eas which meet society's 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 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.

**Teacher's Role in PCL:**

- Teacher is not the source of solutions rather he will act as the facilitator and mentor.
- To utilize the principles of problem solving, critical thinking and metacognitive skills of the students.
- To make the group aware about time management.
- Commitment to devote the time to solving student's technical problems and interested in helping students to empower them better.

**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 do 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 an 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 for the search? How to carry out research
- Sorting and assessing of information in general

**Use of Research Methodology:** - investigation, collaboration, comprehension, application, analysis, synthesize and evaluation

**Focus on the following skills while working in a team to reach to solution:**

- Collaborative learning
- Interpersonal Skills
- Resources Evaluation
- Metacognitive Skills
- Reflection Skills

| **Section2:** | **Topics/Contents** |
|---|---|

**EDD Sample Case Studies: -**

With the adaptation of industry communication standards, Raspberry Pi and Sensors, the 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
4) Design a deployable product smoke detection
5) Design a deployable product for motion detection
6) Design a deployable product for collision detection
7) Design a deployable product for sound detection

...**not limited to.....Faculty and students are free to include other areas which meet society's requirements at large.**

**Text Books:** ***(As per IEEE format)***


| | |
|---|---|
| 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 |
| 4 | A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017 |

| **Reference Books:** *(As per IEEE format)* | |
|---|---|
| 1 | De Graaff E, Kolmos A., red.: Management of change: Implementation of problembased 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 |

### CO – PO / PSO Articulation Matrix

*Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.*

| CO | Program Outcome (PO) | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 2 | 2 | 2 | 2 | | | | | 3 | | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 3 | 2 | 2 | | 2 | | 3 | | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | | 2 | | 3 | | 2 | 3 | 3 | 2 |
| CO4 | 2 | 2 | 3 | 2 | 3 | 3 | | 2 | 3 | | 2 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 2 | 3 | 2 | | | 3 | | 2 | 3 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 3 | 2 | | | | 3 | | 3 | 3 | 3 | 2 |
| Avg | 2.0 | 2.0 | 2.83 | 2.83 | 2.6 | 2.5 | 2.0 | 2.0 | 3.0 | 1.0 | 2.16 | 3.0 | 3.0 | 2.0 |

### CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

*'✓' indicates the knowledge profile drawn upon by the CO.*

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | | ✓ | ✓ | ✓ | ✓ | | | ✓ | |
| CO2 | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| CO4 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| CO6 | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |

## CO – WP Mapping (Complex Engineering Problems) Sample Table

| CO | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 |
|---|---|---|---|---|---|---|---|
| CO1 | ✓ | | | ✓ | | ✓ | ✓ |
| CO2 | ✓ | ✓ | | | | ✓ | |
| CO3 | ✓ | | ✓ | | ✓ | | |
| CO4 | ✓ | | | | ✓ | ✓ | |
| CO5 | ✓ | ✓ | ✓ | | | | |
| CO6 | ✓ | | | | | ✓ | ✓ |

## CO – EA Mapping (Complex Engineering Activities)

*'✓' indicates the activity attribute addressed by the CO*

| CO | EA1 | EA2 | EA3 | EA4 | EA5 |
|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | |
| CO2 | ✓ | ✓ | ✓ | ✓ | |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO6 | ✓ | ✓ | ✓ | | ✓ |

## CO – SDG Mapping (Sustainable Development Goals) Sample Table

| CO | SDG(s) Addressed | Justification / Linkage |
|---|---|---|
| CO1 | 4,9 | Identifies real-life societal problem and develops engineering knowledge for innovative solutions |
| CO2 | 4,9,12 | Evaluates and compares alternative solutions to select sustainable and resource efficient approaches |
| CO3 | 4,9,11 | Analyze engineering problems and synthesizes technological solutions for societal needs |
| CO4 | 4,9,11,13 | Designs reliable, scalable and sustainable engineering solutions addressing environmental and societal challenges |
| CO5 | 4,9,16 | Evaluates engineering solutions based on defined technical, ethical and quality criteria to ensure reliability and accountability |
| CO6 | 4,17 | Promotes lifelong learning, professional development, collaboration and commitment to solving societal problems |