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 2025-26

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

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

Chairman – BOS **Chairman – Academic Board**

INDEX

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.

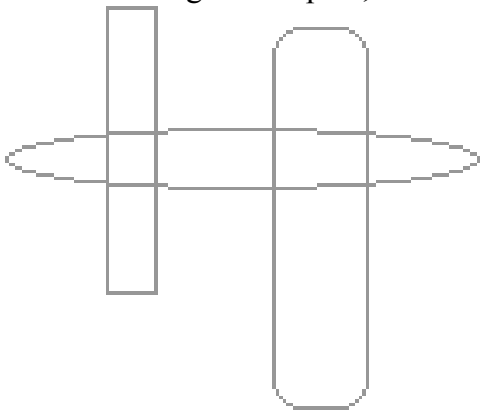
Knowledge and Attitude Profile (WK)

WK	WK Statements
WK1	A systematic, theory-based understanding of 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.



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 in WK1 to WK4 respectively to develop to 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, and 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.

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 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.

Program Specific Objectives (PSO)

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 (For FY and SY)

BSC: Basic Science Course

ESC: Engineering Science Course

PCC: Program Core Course

PEC: Program Elective Course

ELC: Experiential Learning Course

MD: Multi Disciplinary

MDOE: Multi-Disciplinary Open Elective

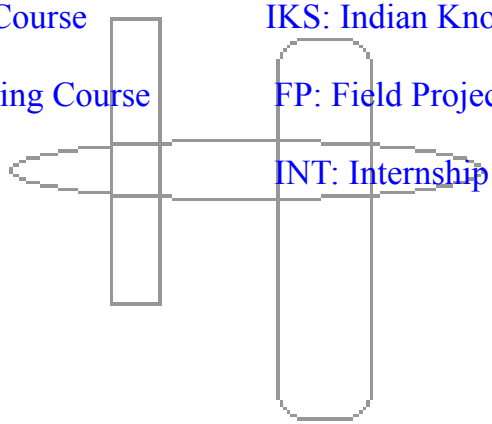
CC: Co-curricular Course

HSSM: Humanities Social Science and Management

IKS: Indian Knowledge System

FP: Field Project

INT: Internship



Nomenclature for Teaching and Examination Assessment Scheme AY 2025-26

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 (AI&ML) **Year:** S.Y. **A.Y.:** 2025-26 **Module:** III

Subject Head	Course	Credits
s01	ML2301 : Fundamentals of Data Structures	3
s02	ML2302 : Database Management Systems	3
s03	ML2303 : Object Oriented Programming	3
s04	ML2304 : Digital Electronics and Microprocessor	3
s05	MLM001 : Multidisciplinary Minor – MDM (Discrete Mathematics)	3
s06	HS2002 : From Campus to Corporate – I (HSSM)	2
s07	HS2001 : Reasoning and Aptitude Development	1
s08	ML2001 : Design Thinking – III	1
s09	ML2002 : Engineering Design and Innovation – III	2

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year:** S.Y. **A.Y.:** 2025-26 **Module:** III

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs /Week)				Examination Scheme										Total	Credits
			Th	Lab	Tut	CA	Test-1	MSA	Test-2	ESA								
						LAB (%)	CT1 (%)	MSE (%)	CT2 (%)	HA (%)	LAB (%)	Course Project (%)	PPT/ GD (%)	CVV (%)	ESE (%)			
S1	ML2301	PCC: Fundamentals of Data Structures	2	2	-	10	-	-	-	-	40	30		20		100	3	
S2	ML2302	PCC: Database Management Systems	2	2	-	10	-	-	-	-	-	30	-	20	40 (WRT)	100	3	
S3	ML2303	PCC: Object Oriented Programming	2	2	-	10	-	-	-	-	-	30	-	20	40 (WRT)	100	3	
S4	ML2304	PCC: Digital Electronics and Microprocessor	2	2	-	-	35 (WRT)	-	35 (WRT)	-	-	-	-	30		100	3	
S5	MLM001	MDM: Discrete Mathematics	2	-	1		35 (MCQ)		35 (MCQ)	30 (HA)	-	-	-	-	-	100	3	
S6	HS2002	EEMC: HSSM	2	-	-	-	-	50	-	-	-	-	-	-	50	100	2	
S8	SH2001	BSC: Reasoning and Aptitude Development	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	
S6	ML2001	CC: Design Thinking-3	-	-	1	-	-	-	-	-	-	-	-	-	100	100	1	
S7	ML2002	PCC: Engineering Design and Innovation-3	-	4	-	-	-	30	-	-	-	-	-	-	70	100	2	
		Total	**12**	**12**	**2**	**40**	**65**	**80**	**65**	**30**	**40**	**90**	**-**	**90**	**400**	**900**	**21**	

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year:** S.Y. **A.Y.:** 2025-26 **Module:** IV

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme											Credits
			Th	Lab	Tut	CA	Test-1	MSA	Test-2	ESA						Total	
						LAB (%)	CT1 (%)	MSE (%)	CT2 (%)	HA (%)	LAB (%)	CP (%)	PPT / GD (%)	CVV (%)	ESE (%)		
S1	ML2305	PCC: Advance Data Structures	2	2	-	10	-	-	-	-	-	30	-	20	40 (WRT)	100	3
S2	ML2306	PCC: Artificial Intelligence	2	2	-	10	-	-	-	-	-	30	-	20	40 (WRT)	100	3
S3	ML2307	PCC: Operating Systems	2	2	-	10	-	-	-	-	40	30	-	20		100	3
S5	ML2308	PCC: Theory of Computation	2	-	-		35 (WRT)		35 (WRT)	-	-	-	-	30		100	3
S6	MLM002	MDM: Data Visualization	2	-	1		35 (MCQ)		35 (MCQ)	30 (HA)	-	-	-	-	-	100	3
S7	HS2003	EEMC:HSSM	2	-	-	-	-	50	-	-	-	-	-	-	50	100	2
S8	ML2309	CC: Design Thinking-4	-	-	1	-	-	-	-	-	-	-	-	-	100	100	1
S9	ML2310	PCC: Engineering Design and Innovation-4	-	4	-	-	-	30		-	-	-	-	-	70	100	2
S10	SH2001	BSC: Reasoning and Aptitude Development	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1
		Total	**12**	**10**	**2**	**30**	**70**	**80**	**70**	**30**	**40**	**90**	-	**90**	**700**	**900**	**21**

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year:** T.Y. **A.Y.:** 2025-26 **Module: V**

Sub No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme									Credits
			Th	Lab	Tut	CA	MSA	ESA						Total	
						LAB (%)	MSE (%)	HA (%)	LAB (%)	CP (%)	PPT/GD (%)	CVV (%)	ESE (%)		
S1	ML3001	Computer Network Technology	2	2	1	10	-	-	50	20	-	20	-	100	4
S2	ML3002	Design and Analysis of Algorithms	2	2	1	10	-	20	-	20	-	20	30 (WRT)	100	4
S3	ML3003	Machine Learning	2	2	1	10	-	-	-	20	20 (PPT)	20	30 (MCQ)	100	4
S4	ML3004	Cloud Computing	2	2	1	10	-	-	-	20	20 (PPT)	20	30 (WRT)	100	4
S5	ML3005	Design Thinking – 5	-	-	-	-	-	-	-	-	-	-	100	100	1
S6	ML3007	Engineering Design & Innovation-5	-	12	-	-	30	-	-	-	-	-	70	100	6
S7	SH3001	Reasoning and Aptitude Development	-	-	-	-	-	-	-	-	-	-	-	-	1
S8	AC*	Audit Courses*	-	-	-	-	-	-	-	-	-	-	-	-	0
		Total	**8**	**20**	**4**	**40**	**30**	**20**	**50**	**80**	**40**	**80**	**360**	**700**	**24**

***Audit Courses for Third Year: Module -V and Module-VI:**

1. Industrial Robotics 2.0 --offered by SSIG Manufacturing, Pune

2. Smart City : – offered by SSIG Manufacturing, Pune

3.Data Engineering - Offered by Barclays,Pune

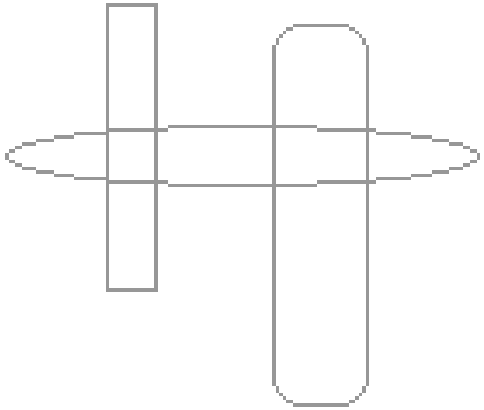
Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year:** T.Y. **A.Y.:** 2025-26 **Module: VI**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs / Week)			Examination Scheme									Credits
			Th	Lab	Tut	CA	MSA	ESA						Total	
						LAB (%)	MSE (%)	HA (%)	LAB (%)	CP (%)	PPT / GD (%)	CVV (%)	ESE (%)		
S1	ML3008	Software Engineering	2	2	1	10	-	-	-	20	20 (GD)	20	30 (WRT)	100	4
S2	ML3009	Cyber Security and Blockchain	2	2	1	10	-	20	-	20	-	20	30 (WRT)	100	4
S3	ML3010	Deep Learning	2	2	1	10	-	-	50	20	-	20	-	100	4
S4	Coursera	Coursera Courses*	-	-	-	-	-	-	-	-	-	-	100	100	4
S5	ML3011	Design Thinking – 6	-	-	-	-	-	-	-	-	-	-	100	100	1
S6	ML3012	Engineering Design and Innovation - 6	-	12	-	-	30	-	-	-	-	-	70	100	6
S7	SH3001	Reasoning and Aptitude Development	-	-	-	-	-	-	-	-	-	-	-	100	1
S8	AC*	Audit Courses*	-	-	-	-	-	-	-	-	-	-	-	-	0
		Total	**8**	**20**	**4**	**40**	**30**	**20**	**50**	**80**	**40**	**80**	**360**	**700**	**24**

Coursera Courses*

Subject Code	Subject Name	Subject Code	Subject Name
MD3101:	IBM Full Stack Software Developer	MD3135:	Salesforce Sales Development Representative
MD3102:	Meta Back-End Developer	MD3140:	SAP Technology Consultant
MD3113:	Google Data Analytics	MD3141:	AWS Cloud Technology Consultant
MD3120:	IBM Data Warehouse Engineer	MD3147:	AI Deep Learning
MD3121:	IBM DevOps and Software Engineering		
MD3126:	Meta iOS/Android Developer		



Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B.Tech** **A.Y.:** 2025-26 **Module: VIII (Course Work-Course Work)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme								Credits
			Th	Lab	Tut.	CA		MSA		ESA			Total	
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
OE1		LinkedIn Learning*	0							100			100	2
OE2	ML4003	Generative AI	2	-	-	10	-	30	-	30	-	30	100	2
OE3	ML4004 *(Swayam)	Deep Learning for Computer Vision	2	-	-	10	-	30	-	30	-	30	100	2
Major Project	ML4006	Major Project	0	20	-	-	-	30	-	70	-	-	100	9
		Design Thinking-7								100			100	1
		Total	**4**	**20**	-	**20**	-	**90**	-	**230**	-	**60**	**400**	**16**

LinkedIn Learning Courses*

Subject Code	Bucket-I Subject Name	Subject Code	Bucket-II Subject Name
MD4274	Large Language Models Skill Development	MD4282	Natural Language Processing Skill Development
MD4275	Mastering Microsoft Power BI	MD4283	Prompt Engineering Skills
MD4276	Generative AI Skills for Developers	MD4284	Essentials in Generative AI
MD4277	Career in Data Analysis	MD4285	Python in Finance
MD4278	Concepts of Data Visualization and Storytelling	MD4286	Understanding Quantum Computing
MD4279	AWS Certified Solutions Architect	MD4287	Foundational Maths for Machine Learning

MD4280	IT Security Specialist	MD4281	Technical Program Management

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B. Tech** **A.Y.:** 2025-26 **Module: VII (Internship - Internship)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme								Credits
			Th	Lab	Tut.	CA		MSA		ESA			Total	
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
S1	ML4232	Industry Internship	-	32	-	-	-	30	-	70	-	-	100	15
S1	ML4202	Research Internship	-	32	-	-	-	30	-	70	-	-	100	15
S2	----------	Design Thinking-7	-	-	-	-	-	-	-	100	-	-	100	1
		Total		**32**	-	-	-	**30**	-	**170**	-		**200**	**16**

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B.Tech A.Y.:** 2025-26 **Module: VIII (Internship - Internship)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme								Credits
			Th	Lab	Tut.	CA		MSA		ESA			Total	
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
S1	ML4232	Industry Internship	-	32	-	-	-	30	-	70	-	-	100	16
S1	ML4202	Research Internship	-	32	-	-	-	30	-	70	-	-	100	16
		Total		**32**	-	-	-	**30**	-	**170**	-		**200**	**16**

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B. Tech A.Y.:** 2025-26 **Module: VII (Course Work-Internship)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme							Total	Credits
			Th	Lab	Tut.	CA		MSA		ESA				
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
OE1	-	LinkedIn Learning*	0							100				
OE2	ML4002	Parallel Computing	2	-	-	10	-	30	-	30	-	30	100	2
	ML4003	Generative AI	2	-	-	10	-	30	-	30	-	30	100	2
OE3	ML4004 *(Swayam)	Natural Language Processing	2	-	-	10	-	30	-	30	-	30	100	2
	ML4005 *(Swayam)	Computer Vision	2	-	-	10	-	30	-	30	-	30	100	2
Major Project	ML4006	Major Project	0	20	-	-	-	30	-	70	-	-	100	10
		Total	**4**	**20**	**-**	**20**	**-**	**90**	**-**	**330**	**-**	**60**	**400**	**16**

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B.Tech** **A.Y.:** 2025-26 **Module: VIII (Course Work-Internship)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme							Total	Credits
			Th	Lab	Tut.	CA		MSA		ESA				
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
S1	ML4232	Industry Internship	-	32	-	-	-	30	-	70	-	-	100	16
S1	ML4234	International Internship	-	32	-	-	-	30	-	70	-	-	100	16
S1	ML4202	Research Internship	-	32	-	-	-	30	-	70	-	-	100	16
		Total	-	32	-	-	-	30	-	70	-	-	100	16

Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B.Tech A.Y.:** 2025-26 **Module: VII (Internship-Course Work)**

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme								Credits
			Th	Lab	Tut.	CA		MSA		ESA			Total	
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
S1	ML4232	Industry Internship	-	32	-	-	-	30	-	70	-	-	100	15
S1	ML4202	Research Internship	-	32	-	-	-	30	-	70	-	-	100	15
S2	----------	Design Thinking-7	-	-	-	-	-	-	-	100	-	-	100	1
		Total		**32**	-	-	-	**30**	-	**170**	-		**300**	**16**

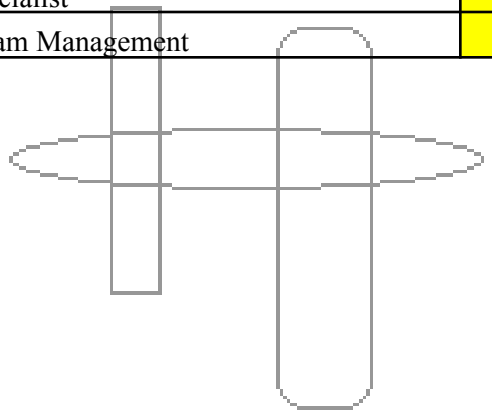
Title: Course Structure **FF No. 653**

Branch: Computer Science & Engineering (AIML) **Year: B.Tech** **A.Y.:** 2025-26 **Module: VIII (Internship-Course Work)**

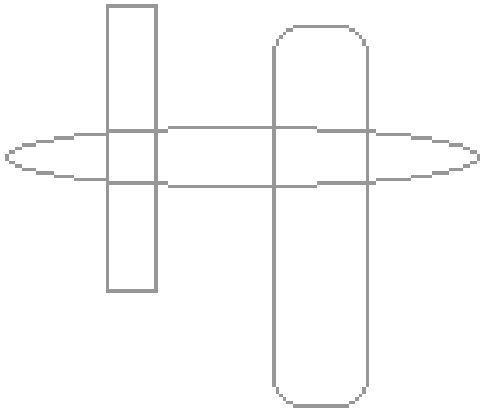
Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme								Credits
			Th	Lab	Tut.	CA		MSA		ESA			Total	
						HA (%)	LAB (%)	MSE (%)	PPT (%)	ESE (%)	GD (%)	Viva (%)		
OE1		LinkedIn Learning	0							100			100	2
OE2		Coursera	0	-	-	-	-	-	-	100	-		100	4
Major Project	ML4006	Major Project	0	20	-	-	-	30	-	70	-	-	100	10
		Total	**3**	**20**	-	-	-	**30**	-	**270**	-	-	**300**	**16**

LinkedIn Learning Courses*

Subject Code	Subject Name	Subject Code	Subject Name
MD4274	Large Language Models Skill Development	MD4282	Natural Language Processing Skill Development
MD4275	Mastering Microsoft Power BI	MD4283	Prompt Engineering Skills
MD4276	Generative AI Skills for Developers	MD4284	Essentials in Generative AI
MD4277	Career in Data Analysis	MD4285	Python in Finance
MD4278	Concepts of Data Visualization and Storytelling	MD4286	Understanding Quantum Computing
MD4279	AWS Certified Solutions Architect	MD4287	Foundational Maths for Machine Learning
MD4280	IT Security Specialist		
MD4281	Technical Program Management		

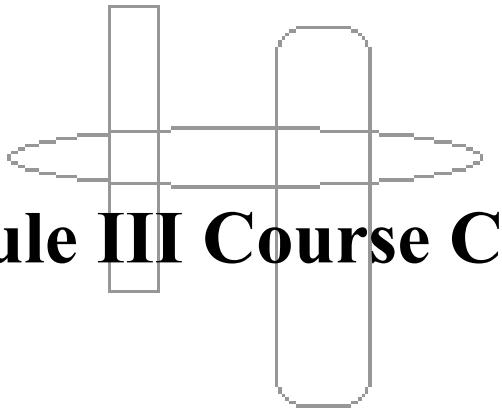


Syllabus CSE AIML (AY 2025-26)



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

AY 2025-26



Module III Course Content

FF No. : 654

ML2001: Fundamentals of Data Structures

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Basic programming Skills (C / C++)

Course Objectives:

1. To introduce the basic concepts of data structures and algorithms.
2. To learn and understand linear and non-linear data structure constructs.
3. To implement searching and sorting techniques using linear data structures.
4. To understand how to solve problems using step by step approach with the help of fundamental data structures.
5. To associate data structures in developing and implementing efficient algorithms.

Course Relevance:

This is a basic Course for Computer Engineering and allied branches. This course has a high relevance in all domains of computer engineering such as in Industries, research etc. as a basic prerequisite course. Data Structures are a crucial part of computer algorithms as they allow programmers to do data management efficiently. A wise selection of data structures can improve the performance of a computer program or algorithm in a more useful way.

Theory

Unit 1: Arrays **(6 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 with Analysis. Sorting Techniques: Bubble Sort, Insertion Sort, Merge Sort, Radix Sort, Quick Sort with Analysis and passes.

Unit 2: Linked Lists **(4 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 **(6 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. Applications of Queues: Job Scheduling, Josephus problem etc.

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).

Unit 5: Graphs **(5 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 **(2 Hours)**

Hashing techniques, Hash table, Hash functions. Collision handling and Collision resolution techniques.

Laboratory

List of Experiments

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.

Course Project

List of Course Projects

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
13) Digital Manuscript Version Tracker – Industry project
14) Yantra Generator (Matrix Project) - Industry project
15) Path to Liberation Simulator– Industry project
16) Chakra Stack Simulator– Industry project

Course Outcomes

The 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.

CO-PO Mapping

CO	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3									3		2
CO2	2	3	2									3		2
CO3	3	3	3				2	2				3	2	2
CO4	3	3	3	3			2	2				3	2	2
CO5	3	3	2									3		2
CO6	2	3	3									3		2
Average	2.5	3.0	2.66	3.0			2.0	2.0				3.0	2.0	2.0

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65

L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L3, CO2– L3, CO3 – L2, CO4 – L4, CO5 – L4 and CO6 – L5

Future Courses Mapping:

Advanced Data Structures, Design and Analysis of Algorithms, Compiler Design, Systems programming, Data Science and similar courses.

Job Mapping:

Data Structures is must necessary part of any core programming job. Without Data structures it is not possible to be good in Competitive coding. All Industries always look for a strong knowledge in Advanced Data structures. Without learning this course, one can't imagine a job in computer/IT related industries and research.

Text Books:

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:

J. Tremblay, P. Soresan, "An Introduction to data Structures with applications", TMHPublication, 2nd Edition.

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-ellis-horowitz-sartaj-sahni.pdf.

For MOOCs and other learning Resources

1. NPTEL Course "Data Structures And Algorithms", IIT Delhi, Prof. Naveen Garg

https://nptel.ac.in/courses/106102064

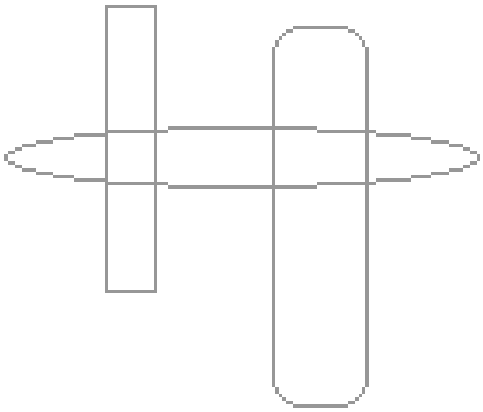
https://www.geeksforgeeks.org/data-structures/

https://www.youtube.com/watch?v=244YpoG1pqA&list=PLrikLQMZHuSonRoDheibeb9ffd9phWIyu&index=5

2. A. Bari 'Mastering Data Structures & Algorithms using C and C++';

3. Udemy; https://www.udemy.com/course/datastructurescncpp/?couponCode=IND21PM;

4. Packt - Course Instructors; 'Data Structures and Algorithms: The Complete Masterclass Specialization';
https://www.coursera.org/specializations/packt-data-structures-and-algorithms-the-complete-masterclass#courses;
5. https://classroom.volp.in/



FF No. :654

ML2002: Database Management Systems

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Data structures, Discrete Mathematics

Course Objectives:

1. To introduce the fundamentals of different data modelling techniques.
2. To design and development of relational database management systems.
3. To Study the theory behind database systems, the issues that affect their functionality and performance
4. To design of query languages and the use of semantics for query optimization.
5. To understand the latest trends of data management systems.

Course Relevance: The course emphasizes on the fundamentals of database modeling and design, the languages and models provided by the database management systems, and database system implementation techniques. The goal is to provide an in-depth and up-to-date presentation of the most important aspects of database systems and applications, and related technologies.

Theory

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

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.

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

List of Practicals: (Any Six)
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

10) Implement Map Reduce operation with suitable example using MongoDB.

List of Projects:
Designing and Implementing a Small-scale Relational DBMS
Phase 1: SQL interpreter
Phase 2: Persistent data management
Phase 3: Relational Operations
3. IBM DB2 Universal Database
4. Microsoft SQL Server

Text Books:
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:
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.
7. Dalton Patrik, SQL Server – Black Book, DreamTech Press.
8. Eric Redmond, Jim Wilson, Seven databases in seven weeks, SPD, ISBN: 978-93-5023-918-6.
9. Jay Kreibich, Using SQLite, SPD, ISBN: 978-93-5110-934-1, 1st edition.

Moocs Links and additional reading material:
https://nptel.ac.in/courses/106/105/106105175/
https://onlinecourses.nptel.ac.in/noc21_cs04/preview
https://www.datacamp.com/courses/introduction-to-sql
Oracle MOOC: PL/SQL Fundamentals - Oracle APEX

Course Outcomes:
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

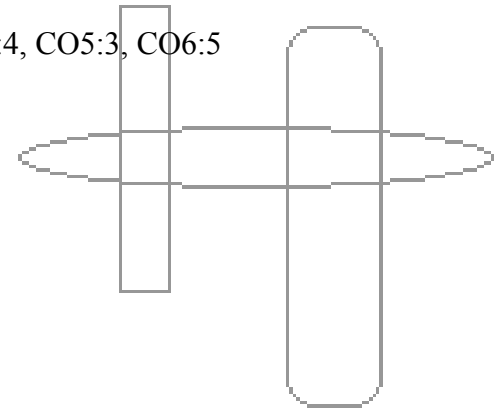
4) Formulate queries in relational algebra, SQL and write PL/SQL blocks.
5) Acquaint with physical database file structures
6) Identify the use of database techniques such as NOSQL

CO-PO Mapping - Department

	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3		2		2			2	2	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		
Average	**2.0**	**2.75**	**3.0**	**2.0**	**2.0**		**2.0**			**2.0**	**2.0**	**3.0**	**3.0**	**2.0**

CO attainment levels
CO1:1, CO2:4, CO3:2, CO4:4, CO5:3, CO6:5

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



Job Mapping:
Database Engineer
SQL developer
PL/SQL developer

FF No. :654

ML2003: Object Oriented Programming

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Objectives:

1. Understand Object Oriented programming concepts
2. Demonstrate Object Oriented programming concepts by writing suitable Java programs
3. Model a given computational problem in Object Oriented fashion
4. To develop problem solving ability using Object Oriented programming constructs like multithreading
5. Develop effective solutions using for real world problems using concepts such as file handling and GUI
6. Implement applications using Java I/O and event-based GUI handling principles

Course Relevance:

This is an important course for engineering students. It develops computational problem solving and logic building capability of students. Acquiring programming skills has a high relevance in all branches of Engineering. Once the student gains expertise in coding, this course proves to be beneficial to them to excel in industry demanding coding in specific software.

Theory

Unit 1: 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

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

List of Practical:

List of Experiments

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,-1,7] targetsum=15

   Output: [8,7]

   Input:

   Array=[3,5,-4,8,11,1,-1,6] targetsum=15

   Output: []

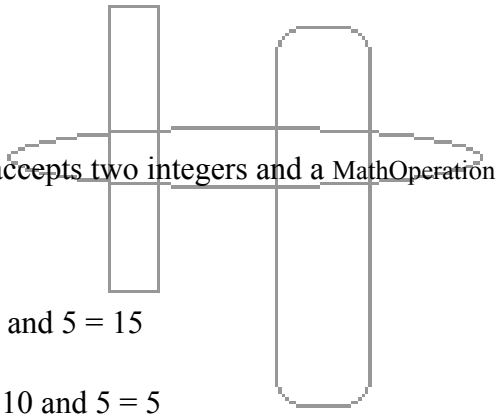
3. Write Java program to calculate area of triangle, square & circle using function overloading. Function parameter accept from user (Use function Overloading concepts and Inheritance).

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<String>), perform the following using **Streams**:

- Print all names using forEach()
- Filter names starting with "A"
- Convert names to uppercase
- Count names having more than 4 characters
- 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.

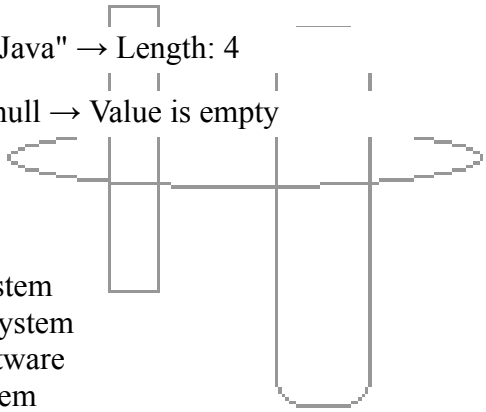
13. **Optional Class Usage**

A. Create a method getLength(String str) that:

- 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

Text Books:

1. Herbert Schildt, "JAVA- The Complete Reference", , 11th Edition, McGraw Hill Education

Reference Books:

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)

MOOCs Links and additional reading material:

1. **NPTEL: Programming in Java – Prof. Debasis Samanta (IIT Kharagpur)**
   Covers OOP, classes, inheritance, exception handling, GUI, JDBC, and Java 8 basics. https://nptel.ac.in/courses/106105191
2. **Coursera: Java Programming and Software Engineering Fundamentals – Duke University**
   Great for beginners; includes OOP, arrays, collections, file handling, and projects. https://www.coursera.org/specializations/java-programming
3. **GeeksforGeeks – Java Programming Language Tutorial**
   Detailed topic-wise articles on inheritance, arrays, multithreading, Java 8, collections, and more.
   https://www.geeksforgeeks.org/java/
4. **Oracle Java Tutorials (Official Documentation)**
   Authoritative source for understanding Java concepts, syntax, and features including Java 8.
   https://docs.oracle.com/javase/tutorial/
5. **Udemy: Java Programming Masterclass for Software Developers (Tim Buchalka)** *(Paid, often discounted)*
   Hands-on course that covers core Java, OOP, collections, Java 8, JDBC, and GUI with real projects.
   https://www.udemy.com/course/java-the-complete-java-developer-course/

Course Outcomes:

The student will be able to –

1.Understand the fundamental concepts of object-oriented programming and the features of Java.

1. Apply object-oriented principles like classes, inheritance, polymorphism, and interfaces in Java.
2. Analyze the use of abstract classes, interfaces, and inner classes for efficient code reuse.

3. Develop Java programs using exception handling, multithreading, file I/O, and collection framework.
4. Design interactive Java applications using Swing and apply event-handling mechanisms.
5. Evaluate and implement Java 8 features such as lambda expressions and Stream API to enhance code quality.

CO-PO Mapping:

	Program Outcomes (PO)												PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO 1	PSO 2	PSO 3
CO1	3	2	2										3		
CO2	3	3	3	1	1	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						2		3		3
CO6	3	2	3										3		3
Average	**3**	**2.5**	**2.83**	**1.0**	**1.0**	**2.0**	**2.0**	**2.25**			**2.0**		**3.0**	**3.0**	**3.0**

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortable-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L3, CO2– L3, CO3 – L2, CO4 – L4, CO5 – L4 and CO6 – L5

Future Courses Mapping:

Advanced Data Structures, Advanced Java, Spring Frame Work, Grails Frame Work

Job Mapping:

Java Programmer, Application Developer, Design Engineer, Senior Software Developer

FF No. :654

ML2004: Digital Electronics and Microprocessor

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites:

1. Basic Electronics Engineering
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 Relevance:

This is a basic Course for Computer Engineering and allied branches. This course has a high relevance in all domains of computer engineering such as in Industries research etc. as a basic prerequisite course. Microprocessor and Microcontroller is a crucial part of Computer System Hardware as they allow designer to design system efficiently. A wise selection of Microprocessor and Controller can improve the overall performance of a System.

Theory

Unit 1: Digital Fundamentals

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. Dont care conditions.

Unit 2 : Combinational Digital Circuits:

Adders, Subtractors Multiplexers & De-multiplexers, Encoder: Priority encoders, Decoders: 74138, ALU: 74181,

Parity generator and checker. BCD adder and subtractor.

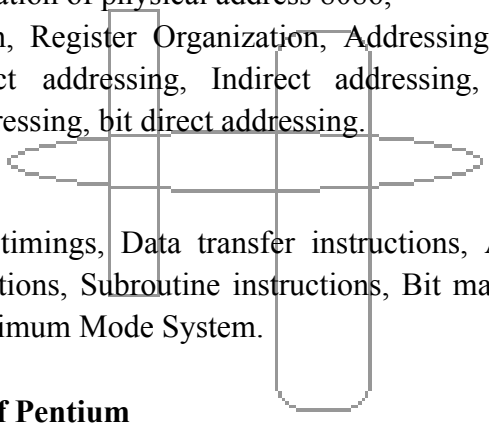
Unit 3: Sequential Circuit:

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 (IC - 7490, 7493).,

Unit 4: Introduction to 8086 microprocessor:

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

Introduction, CPU Pin Description, RISC Concepts, Bus Operations, The Pentium's Superscalar Architecture, Pipelining, Branch Prediction, The Instruction & Data Caches, The Floating-Point

Unit 6: Interrupt Structure and Programmable Interval Timer:

Interrupt Structure, Interrupt service Routine, Interrupt Vector Table, Hardware and Software Interrupts, INTR, NMI Interrupt Response, Execution of an ISR, Priority of Interrupts.8259 control word

List of Practical's (Minimum Six):

List of Practicals:

1. Verification of Logical Gates and Boolean Algebra.
2. Code converters e.g. Excess-3 to BCD and vice versa using logical gates.
3. Multiplexer - e.g. 16:1 Mux using 4:1 Mux (IC 74153).
4. Decoder – e.g. 2 bit comparator (IC 74138).
5. Synchronous Up /down counter using JK flip-flop.
6. Sequences detector using JK flip flop.
7. Study of 8086 Architecture and Execution of sample programs.
8. Write 8086 ALP to find and count negative and positive number from signed arraystored in memory and display magnitude of negative numbers.
9. Write 8086 ALP to access marks of 5 subjects stored in array and find overall percentage and display grade according to it.
10. 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.
11. 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 Course 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)
8. Online Parallel Examination.
9. Machine Learning, Deep Learning, AI, Blockchain etc Based
10. Agriculture, Health Care, Education, Govt., Transportation, Banking, Insurance Based but not limited for.

Text Books:

1. Douglas Hall, "Microprocessors and Interfacing",2nd Edition, Tata McGraw Hill Publications, ISBN 0-07- 025742-6.
2. "Advanced 80386, programming techniques " , James Turley , Tata McGraw Hill Publications, ISBN – 0-07- 881342-5
3. Intel 80386 Programmer's Reference Manual 1986, Intel Corporation, Order no.: 231630- 011, December 1995.
4. R.P. Jain, **"**Modern Digital Electronics,**"**3rdEdition, Tata McGraw-Hill, 2003, ISBN 0 - 07 - 049492 – 4.

Reference Books:

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.

MOOCs Links and additional reading material:

1. https://onlinecourses.nptel.ac.in/noc22_ee12/preview
2. https://www.mooc-list.com/course/interfacing-arduino-coursera
3. https://www.my-mooc.com/en/mooc/embedded-systems-shape-the-world-microcontroller-input-output/
4. https://onlinecourses.swayam2.ac.in/cec21_cs16/preview
5. https://www.youtube.com/watch?v=RLJmQWQwBJw

Course Outcomes:

The 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.

CO-PO Mapping:

CO	Program Outcomes (PO)											PSO		
	PO1	PO2	PO3	PO4	PO4	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	3	-
2	3	2	2	-	-	-	-	-	-	-	-	-	3	-
3	3	2	3	-	-	-	-	-	-	-	-	3	3	-
4	3	3	2	-	-	-	-	-	-	-	-	-	3	-
5	3	2	3	-	-	-	-	-	-	-	2	-	3	-
6	3	2	2	2	2	-	2	2	2	-	2	3	3	3
Avg	3	2.16	2.33	2.0	2.0	-	2.0	2.0	2.0	-	2.0	3.0	3.0	3.0

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0. L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L2, CO4 – L3, CO5 – L4 and CO6 – L5

Future Course Mapping:

Cloud Computing, Distributed System, Software Design and Modelling

Job Mapping:

Application Developers, System programmer

FF No. :654

MLM001: Discrete Mathematics

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites:
Basic Mathematics

Course Objectives:

1. To understand fundamental concepts of discrete mathematics, including functions, relations, sets, graphs, and trees.
2. To apply mathematical properties using the formal language of propositional and predicate logic.
3. To construct recurrence relations to model and solve various combinatorial problems.
4. To apply advanced combinatorial techniques to solve complex counting problems.
5. To analyze basic number theory topics and their applications in discrete structures.
6. To analyze foundational graph theory and tree concepts and their role in modelling discrete systems.

Course Relevance: Discrete Mathematics is a fundamental course that plays a critical role in computer science, engineering, and mathematics. It provides the essential theoretical foundation for understanding key concepts such as logic, set theory, combinatorics, graph theory, and algorithms. These concepts are directly applied in fields like software development, cryptography, database systems, and network design. The course also sharpens logical reasoning and problem-solving skills, which are vital for designing efficient algorithms and writing accurate programs. Additionally, discrete mathematics supports advanced topics in artificial intelligence, machine learning, and cybersecurity. Its emphasis on precise thinking and formal proof techniques makes it a crucial subject for academic research, technical careers, and competitive exams in the STEM fields.

Theory

Unit 1: Set Theory and Logic **(5 Hrs)**

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 Hrs)**

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 Hrs)**

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.

Unit 4: Modular Arithmetic **(4 Hrs)**

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 Hrs)**

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 Hrs)**

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).

Tutorials

List of Tutorials

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

Course Outcomes

The students 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.

CO-PO Mapping

	Program Outcomes (PO)											PSO		
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2		2							2	2		
CO2	3	2				1			2		2	2	1	
CO3	3	2	3								2	2		
CO4	3	3	3	3							2	2		
CO5	3	3	1			1	2		1		2	2	1	
CO6	3	3	3	2		1		1			2	2	1	
Average	**3**	**2.5**	**1.6**	**1.16**	**0**	**0.5**	**0.3**	**0.1**	**0.5**		**2**	**2**	**0.5**	**0**

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0. L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L2, CO4 – L3, CO5 – L4 and CO6 – L5

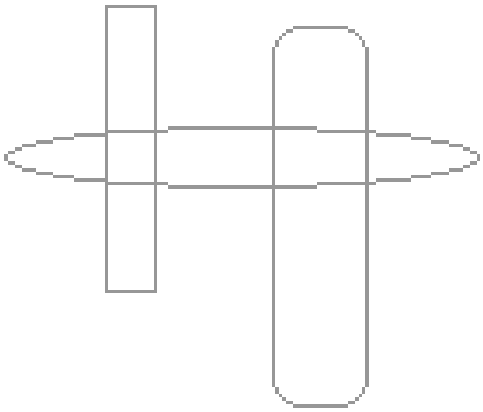
Future Courses Mapping: Data structures, Design and analysis of algorithms, Theory of Computation, Compiler Design, Artificial Intelligence, Machine Learning.

Job Mapping:

Wherever one wants to model a computer science problem concretely the use of discrete structures is essential. Due to abstract nature of the course, the principles learnt have wide applicability. In any job which requires algorithmic thinking, programming, use of data structures, the knowledge of discrete structures is very helpful.

Text Books:

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)
5. Introduction to Graph Theory by Douglas B. West (Prentice-Hall publishers)



FF No. :654

ML2001 and ML2309: Design Thinking 3 and 4

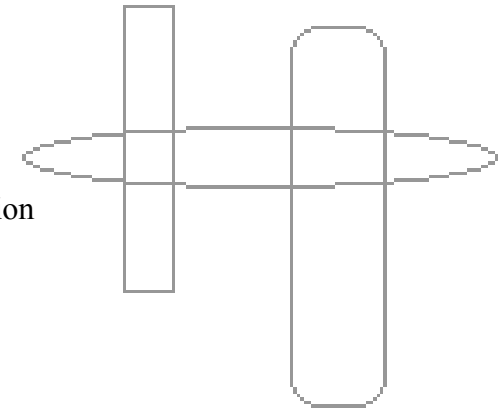
Credits: 01 **Teaching Scheme: Tutorial 01 Hr/week**

Course Prerequisites: Problem Based Learning, Project Centric Learning

Course Objective:
To provide ecosystem for students and faculty for paper publication and patent filing

Section 1: Topics/Contents

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



Section 2: Topics/Contents

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

Checking of publication draft

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

CO-PO Mapping:

	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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
C07	1	1	1	1	1	--	--	--	--	--	--	1	1	1
Average	**1.57**	**1.57**	**1.71**	**1.71**	**1.57**	**2.0**	**1.0**	**2.33**	**2.0**	**3.0**	**1.0**	**1.0**	**2.28**	**2.28**

CO Attainment levels:
Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0. L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L2, CO4 – L3, CO5 – L4 and CO6 – L5

ML2002 and ML2310: Engineering Design and Innovations-III and IV

Credits:.2

Lab: 2 hours/Week

Course Prerequisites: Problem Based Learning

Course Objectives:

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

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 open-ended question, challenge, or problem to research and respond to and/or solve. It brings students not only to know, understand and remember rather it takes them to analyze, design and apply categories of Bloom's Taxonomy.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. For all courses of ED, laboratory course contents of "Engineering Design" are designed as a ladder to extend connectivity of software technologies to solve real word problem using interdisciplinary approach. The ladder in the form of gradual steps can be seen as below:

Industry Communication Standards, Single Board Computers and IoT, Computational Biology (Biomedical and Bioinformatics), Robotics and Drone, Industry 4.0 (Artificial Intelligence, Human Computer Interfacing, 5G and IoT, Cloud Computing, Big Data and Cyber Security etc).

Group Structure:

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

Selection of Project/Problem:

- Students must focus 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 areas 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

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
3) Design a deployable product smoke detection
4) Design a deployable product for motion detection
5) Design a deployable product for collision detection
6) Design a deployable product for sound detection

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

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Bloom's Taxonomy.
To focus on the higher levels of the Booms Taxonomy analyze, apply, evaluate and create.

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

Reference Books: (As per IEEE format)

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

MOOCs Links and additional reading material: www.nptelvideos.in
https://worldwide.espacenet.com/

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

CO PO Mapping

	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2					3		2	2	3	3
CO2	2	2	3	2	2		2		3		2	2	3	3
CO3	2	2	3	2	3		2		3		2	2	3	3
CO4	2	2	3	2	3	3		2	3		2	2	3	3
CO5	2	2	3	2	3	2			3		2	2	3	3
CO6	2	2	3	3	2				3		3	3	3	3
Average	2.0	2.0	2.83	2.83	2.6	2.5	2.0	2.0	3.0	1.0	2.16	2.17	3.0	3.0

CO attainment levels: CO1 -4 CO2 –2 CO3-4 CO4-5 CO5 -1 CO6-3

FF No. : 654

SH2001, SH3001: Reasoning and Aptitude Development

Credits:.1

Lab:2 hours/Week

Unit 1: English Language

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

Unit 2: Logical Ability

Objective interpretation of things, ability to perceive and interpret trends to make generalizations; ability to analyze assumptions behind an argument or statement; Deductive reasoning: Assessment of ability to synthesize information and derive conclusions - Coding deduction logic, Data Sufficiency, Directional Sense, Logical word sequence, Objective reasoning, Selection and decision tables, puzzles; Inductive reasoning: Assessment of ability to learn by example, imitation or by trial – Analogy pattern recognition, Classification pattern recognition, Coding pattern recognition, Number series pattern recognition; 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

Unit 3: Quantitative Ability

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

Reference Books –

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.

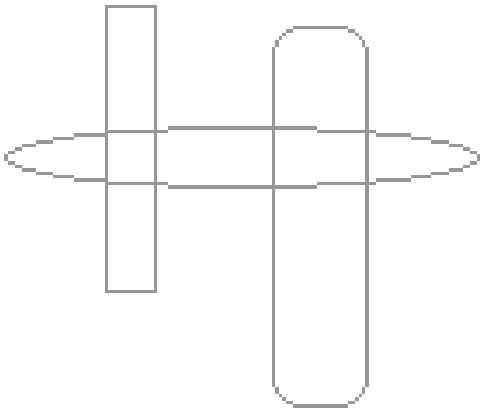
Course Outcomes – Upon completion of the course, the student will be able to –

1. Improve the reading, writing and verbal skills, and enhance comprehension and articulation abilities
2. Develop logical reasoning abilities, enabling them to make sound decisions in problem-solving scenarios
3. Develop mathematical aptitude as well as data interpretation abilities and use them in test cases and real world problems
4. Learn to apply approaches for optimum time-management, prioritization maximizing the accuracy

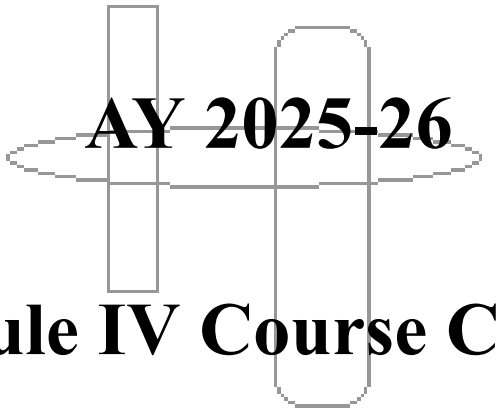
5. Learn data interpretation, apply mathematical skills to draw accurate conclusions
6. Apply their knowledge of English, reasoning and quantitative skills for planning, critical thinking and real world problem

CO-PO Mapping

	Program Outcomes (PO)										
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	1	3	-	2	0	1	0	1	0	3	1
CO2	2	3	2	3	0	1	0	1	0	3	1
CO3	2	3	2	3	0	1	0	1	0	3	1
CO4	2	3	2	2	3	1	0	1	0	2	1
CO5	2	3	2	1	2	0	0	1	0	1	0
CO6	2	2	2	-	1	1	0	0	0	1	0
Average	**1.83**	**2.83**	**2.0**	**2.2**	**2.0**	**1**	**0**	**1**	**0**	**2.16**	**1.0**



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



AY 2025-26

Module IV Course Content

FF No. :654

ML2305: Advanced Data Structures

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Data Structures, Basic programming Skills (C/C++).

Course Objectives:

1. To learn how and when to use data structures like AVL trees, red-black trees, B-trees, Fibonacci heaps, and others.
2. To apply advanced data structures to solve complex computational problems efficiently.
3. To gain hands-on experience in implementing and using these structures through programming assignments.
4. To foster the ability to design new data structures or improve existing ones for specialized needs.
5. To prepare students for algorithm-heavy roles that require knowledge of advanced structures.

Course Relevance:

The course on Advanced Data Structures is highly relevant for several reasons, particularly in the context of computer science, software engineering, and related fields. The course is essential for anyone aiming to build efficient, scalable, and optimized software systems or preparing for roles in software development, data science, and academia. Advanced data structures (e.g., segment trees, tries, B-trees, red-black trees, Fibonacci heaps) are essential for optimizing time and space complexity in complex algorithms. Understanding advanced data structures is crucial for solving high-level problems in coding competitions and technical interviews. Used in databases (e.g., B-trees in indexing), compilers (e.g., syntax trees), operating systems (e.g., scheduling queues), and networks (e.g., tries in routing). Key for designing scalable systems (e.g., caching systems, real-time data processing) where performance and memory management are critical. Advanced structures are often the basis for innovations in algorithms, machine learning, data mining, and bioinformatics.

Theory

Unit 1: Advanced Trees and Applications (8 Hours)

Threaded Binary Tree, AVL Tree, Red-Black Tree, Heap Tree, Huffman Tree. B-Tree, B+-Tree, Splay Tree, Van Emde Boas Tree, Fusion Tree, Dynamic Finger Search Trees with Time and Space Complexity Analysis

Unit 2: Priority Queues and Heaps (4 Hours)

Double Ended Priority queues, Leftist Trees, Binomial Heaps, Fibonacci Heaps, skew heaps, pairing heaps

Unit 3: Data Structures for Strings (4 Hours)

String Searching: preliminaries, the DAWG, the position Heaps, tries and compressed tries, Suffix Trees and suffix arrays, Dictionaries Allowing Errors in Queries.

Unit 4: Randomized Data Structures (6 Hours)

Preliminaries of randomized algorithm and probability theory, Skip Lists: Structural Properties of Skip Lists, Space Complexity of skip list. Treap: A Randomized Binary Search Tree

Unit 5: Multidimensional Spatial Data Structures (5 Hours)

Introduction, point data, region data and Rectangle data. Quad trees and Octrees: Quad trees for point data, spatial queries with region quad tree. Interval trees, Segment trees, Range trees, and Priority Search Trees. Binary Space Partitioning Trees, R-trees.

Unit 6: Miscellaneous Data Structures (3 Hours)

Google's Big Table, Data Structures for Sets: The Disjoint Set Union-Find Problem, Concurrent Data structures, Succinct Representation of Data Structures: Bit vector, Succinct Dictionaries, Tree Representations. Persistent data structures. Cache-Oblivious Data Structure.

Laboratory

List of Experiments

1. Assignment based on TBT creation and performing Stackless Traversals.
2. Assignment based on operations on AVL and RED-Black trees
3. Assignment based on B Trees and B+ Trees.
4. Assignment based on Priority Queues Application
5. Assignment based on tries.
6. Assignment based on Suffix Trees.
7. Assignment Based on Randomized Data Structures.
8. Assignment based on Quad trees and Oct trees
9. Assignment based on Interval trees, Segment trees, Range trees.
10. Assignment based on R-trees.
11. Assignment Based on Disjoint Set data structures.
12. Assignment based on concurrent data structures.
13. Assignment based on Succinct data structures.

Course Project

List of Course Projects

1) Performance Comparison of AVL and Red-Black Trees on Dynamic Data Sets
2) Visualizing Rotations in AVL and Red-Black Trees
3) Designing a Priority Queue System Using Red-Black Trees
4) Implementing a Self-Balancing Dictionary Using AVL Trees
5) Implementation of Binomial Heaps and Their Use in Priority Queues
6) Comparative Study: Binomial Heap vs Binary Heap vs Fibonacci Heap
7) Task Scheduling Simulation Using Binomial Heaps
8) Analysis of Union and Decrease-Key Operations in Binomial Heaps
9) Implementing a Simple Database Index Using B-Trees
10) File System Directory Management Using B+ Trees

11) Comparison of Search Performance: B-Tree vs B+ Tree on Disk-Based Data
12) Building a Block-Oriented Key-Value Store Using B+ Trees
13) Implementation and Performance Analysis of R-Trees for Spatial Indexing
14) Design and Application of KD-Trees for Nearest Neighbor Search
15) Spatial Query Optimization Using Quadtrees in 2D Geographic Data
16) Building a 3D Game World Using Octrees for Scene Management
17) Multidimensional Range Search Using Range Trees
18) Efficient Spatial Joins Using Grid-Based Indexing
19) Comparison of Spatial Indexing Techniques: R-Tree vs. QuadTree vs. KD-Tree
20) Real-Time Object Tracking Using Spatial Hashing
21) Clustering Geospatial Data Using k-d Trees and Voronoi Diagrams
22) Designing a Mini GIS Engine with Support for Spatial Queries

Course Outcomes

The student will be able to –

1) Analyse and implement advanced binary tree structures.
2) Model the real-world problem with the help of appropriate priority queues and heap data structure.
3) Construct and evaluate and string processing structures for real world applications.
4) Apply randomized data structures for optimized performance.
5) Model and query spatial and multidimensional data effectively.
6) Critically evaluate the specialized and modern data structures for complex real-world problems.

CO-PO Mapping

	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3									3		2
CO2	2	3	2									3		2
CO3	3	3	3				2	2				3	2	2
CO4	3	3	3	3			2	2				3	2	2
CO5	3	3	2									3		2
CO6	2	3	3									3		2
Average	2.5	3.0	2.66	3.0			2.0	2.0				3.0	2.0	2.0

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55
CO1 – L3, CO2– L3, CO3 – L2, CO4 – L4, CO5 – L4 and CO6 – L5

Future Courses Mapping:

Design and Analysis of Algorithms, Computational Geometry, Data Mining and Information Retrieval, Machine Learning and Data Science, Parallel and Distributed Computing, Compiler Design, Advanced Topics in Data Structures and Algorithms.

Job Mapping:

Students who have completed a course in Advanced Data Structures has a bright career paths and roles where the knowledge and skills from the course are directly applicable are Software Developer / Software Engineer, Data Engineer, Backend Developer, Database Developer / Administrator, Algorithm Engineer, Competitive Programmer , Coding Coach, Computer Science Researcher, System Programmer, Operating System Developer, Machine Learning Engineer / AI Engineer, Big Data Engineer / Cloud Engineer, Cybersecurity Analyst / Cryptography Engineer, Game Developer / Graphics Programmer.

This job mapping shows that Advanced Data Structures is a core competency across multiple high-demand domains in both industry and academia.

Text Books:

1. Sartaj Sahni, Dinesh P. Mehta; Handbook of Data Structures and Applications; 2nd edition, Chapman & Hall/CRC.

2. Fundamentals of Data Structures in C", E. Horwitz, S. Sahani, Anderson-Freed, Second Edition, Universities Press.

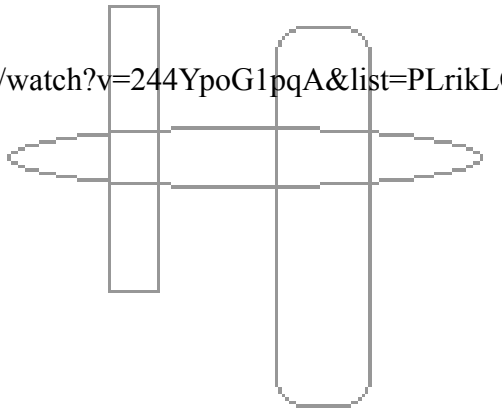
Reference Books:

1. T. Cormen, R.Rivest, C. Stein, C. Leiserson, "Introduction to Algorithms", Second Edition, PHI publication.

2. Peter Brass, Advanced Data Structures, First Edition, Cambridge University Press.

For MOOCs and other learning Resources

1. www.nptelvideos.in,
2. www.geeksforgeeks.org
3. https://www.youtube.com/watch?v=244YpoG1pqA&list=PLrikLQMZHuSonRoDheibeb9ffd9phWIyu&index=5
4. https://classroom.volp.in/
5. https://www.coursera.org/



FF No. : 654

ML2306: Artificial Intelligence

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites:

- A course on "Computer Programming and Data Structures"
- A course on "Mathematical Foundations of Computer Science"
- Some background in linear algebra, data structures and algorithms, and probability will be helpful

Course Objectives:

1. To learn the distinction between optimal reasoning Vs. human like reasoning
2. To understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
3. To learn different knowledge representation techniques.
4. To understand the applications of AI, namely game playing, theorem proving, and machine learning.

Course Relevance: Technologies driven by artificial intelligence (AI) have transformed industries and everyday life. The possibilities for AI applications are virtually unlimited and sought after in practically every industry segment.That's why global organizations are actively recruiting professionals with specialized skills and proficiencies needed to develop future AI technological innovations.

Theory

Unit-I : Fundamentals of Artificial Intelligence

Introduction: A.I. Representation, Non-AI & AI Techniques, Representation of Knowledge, Knowledge Base Systems, State Space Search, Production Systems, Problem Characteristics, Types of production systems, Turing Test. **Intelligent Agents**: Agents and Environments, concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation. **Formulation of problems**: Vacuum world, 8 queens, Route finding, robot navigation.

Unit-II Title: Uninformed Search Strategies

Uninformed Search Methods: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search, Comparison of Uninformed search Strategies.

Unit-III Title: Informed Search Methods:
Generate & test, Hill Climbing, Best First Search, A* and AO* Algorithm, Constraint satisfaction, Means Ends Analysis, **Game playing:** Minimax Search, Alpha-Beta Cut offs, Waiting for Quiescence

Unit-IV Title: Logical Agents:
Knowledge based agents, Wumpus world. **Propositional Logic**: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. **First order Logic**: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining.

Unit-V Title: Basics of PROLOG:

Representation, Structure, Backtracking. **Expert System**: Design, Implementation, Case study of Expert System in PROLOG

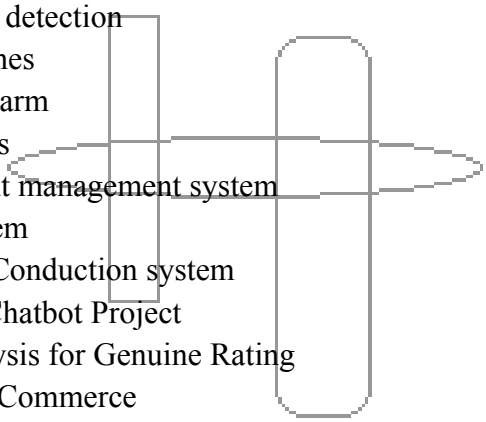
Unit-VI Title: Planning:
Blocks world, STRIPS, Implementation using goal stack, **Planning with state space search:** Forward state space search, Backward state space search, Heuristics for state space search. Partial Order Planning, Planning Graphs, Hierarchical planning, Least commitment strategy. Conditional Planning, Continuous Planning

List of Practical's

1. Implementation of AI and Non-AI technique by implementing any two player game
2. Implementation of Uninformed strategies
3. Implementation of Informed strategies
4. Implementation of CSP Problem
5. Implementation predicate logic using PROLOG
6. Implementation of Expert system using PROLOG

List of Course Project Topics (Sample topics)

1. Inventory management E Commerce
2. stock market price prediction
3. Object Identification / detection
4. Product Delivery Drones
5. Pick and drop robotic arm
6. Arrangement of blocks
7. Smart city water / light management system
8. Human Tracking system
9. Automatic Interview Conduction system
10. Student Information Chatbot Project
11. Product Review Analysis for Genuine Rating
12. Customer Targeted E-Commerce
13. College Enquiry Chat Bot
14. Artificial Intelligence HealthCare Chatbot System
15. Intelligent Tourist System Project



Text Books: (As per IEEE format)

1. Elaine Rich and Kevin Knight: "Artificial Intelligence." Tata McGraw Hill
2. Stuart Russell & Peter Norvig : "Artificial Intelligence : A Modern Approach", Pearson Education, 2nd Edition.
3. Deepak Khemani: "A First Course in Artificial Intelligence", Mc Graw Hill
4. Saroj Kaushik: "Artificial Intelligence" Cengage Publication

Reference Books: (As per IEEE format)

1. Ivan Bratko: "Prolog Programming For Artificial Intelligence", 2nd Edition Addison Wesley,1990.
2. Eugene, Charniak, Drew Mcdermott: "Introduction to Artificial Intelligence.", Addison Wesley
3. Patterson: "Introduction to AI and Expert Systems", PHI
4. Nilsson: "Principles of Artificial Intelligence", Morgan Kaufmann.
5. Carl Townsend, "Introduction to turbo Prolog", Paperback, 1987

MOOCs Links and additional reading material:

www.nptelvideos.in

Course Outcomes:

On the completion of course, students will able to

1. Understand the basics of the theory and practice of Artificial Intelligence as a discipline and about intelligent agents capable of problem formulation.
2. Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem.
3. Evaluation of different uninformed and informed search algorithms on well formulated problems along with stating valid conclusions that the evaluation supports.
4. Formulate a given problem to find solution using Propositional and First order logic.
5. Analyse the AI problem using different planning techniques.
6. Perform empirical evaluation of different algorithms on problem formalization, and state the conclusions that the evaluation supports.

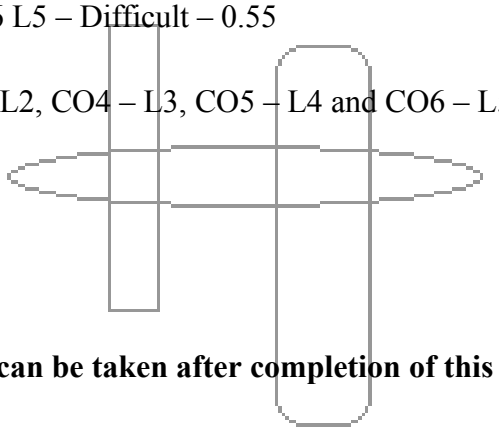
CO-PO Mapping:

CO	Program Outcomes (PO)											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CS3226.1	3											3	2	2
CS3226.2	3	2		1								3	2	2
CS3226.3	3	3		2								3	2	2
CS3226.4	3	3	3	2								3	3	2
CS3226.5	3	3		2								3	3	2
CS3226.6	3	3	3	2			3	2	2	2		3	3	2
Average	**3.0**	**2.8**	**3.0**	**1.8**			**3.00**	**2.00**	**2.00**	**2.00**		**3.0**	**2.5**	**2.0**

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0. L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L2, CO4 – L3, CO5 – L4 and CO6 – L5



Future Course Mapping:

Mention other courses that can be taken after completion of this course

Machine Learning

Job Mapping:

What are the Job opportunities that one can get after learning this course

AI Data Analyst, Data Scientist

ML2307: Operating Systems

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Computer Architecture & organization, Data Structure

Course Objectives:

1.To learn functions of Operating System
2.To learn the importance of concurrency and how to implement concurrent abstractions correctly in an OS.
3.To learn OS scheduling policies and mechanisms.
4.To deal with deadlock
5.To learn memory management schemes in various ways to improve performance, and how this impacts system complexity
6. To learn design & develop the Operating system from a scratch.

Course Relevance:

Unit-I Introduction to OS **[04 Hours]**

What is OS, Interaction of OS and hardware, Goals of OS, Basic functions of OS, OS Services, System Calls, Types of system calls.
Types of OS: Batch, Multiprogramming, Time sharing, Parallel, Distributed & Real-Time OS.

Unit-II Title: Process Management **[06 Hours]**

Process Concept, Process States: 2, 5, 7 state models, Process Description, Process Control.

Threads: Multithreading models, Thread implementations – user level and kernel level threads, Symmetric Multiprocessing.

Concurrency: Issues with concurrency, Principles of Concurrency

Mutual Exclusion: H/W approaches, S/W approach, OS/Programming Language support: Semaphores, Mutex and Monitors.

Classical Problems of Synchronization: Readers-Writer's problem, Producer Consumer problem, Dining Philosopher problem

Unit-III Title: Process Scheduling **[04 Hours]**

Uniprocessor Scheduling: Scheduling Criteria, Types of Scheduling: Preemptive, Non-preemptive, Long-term, Medium-term, Short-term.

Scheduling Algorithms: FCFS, SJF, RR, Priority.

Unit-IV Title: Deadlocks **[04 Hours]**

Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Deadlock Recovery

Unit-V Title: Memory Management **[06 Hours]**

Memory Management concepts: Memory Management requirements, Memory Partitioning: Fixed, Dynamic Partitioning, Buddy Systems, Fragmentation, Paging, Segmentation, Address translation.

Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit.

Virtual Memory: Concepts, Swapping, VM with Paging, Page Table Structure, Inverted Page Table, Translation Lookaside Buffer, Page Size, VM with Segmentation with combined paging and segmentation.

Page Replacement Policies: FIFO, LRU, Optimal, Clock.

Swapping issues: Thrashing

Unit-VI Title: I/O and File Management **[04 Hours]**

I/O management: I/O Devices - Types, Characteristics of devices, OS design issues for I/O management, I/O Buffering.

Disk Scheduling: FCFS, SCAN, C-SCAN, SSTF.

File Management: Concepts, File Organization, File Directories, File Sharing. Record Blocking, Secondary Storage Management, Free Space management, Security.

List of Practical's (Minimum Six to be performed out of 10):

1. Execution of Basic & Advanced Linux Commands.
2. Write shell script covering – basic arithmetic, control structures, loops, execution of Linux command in shell, command line arguments, functions and arrays.
3. Solve synchronization problems – Reader writer problem, Producer consumer problem & dinning philosopher problem using mutex & semaphore.
4. Implement CPU scheduling algorithms
5. Implement Banker's algorithm
6. Implement deadlock detection algorithm
7. Implement placement strategies.
8. Implement buddy system.
9. Implement page replacement algorithm
10. Implement disk scheduling algorithm

List of Course Project areas:

1.Design and implementation of a
i. CPU/ Machine Simulation
ii. Supervisor Call through interrupt
Design multi programming operating system phase 1
2.Design and implementation of a Multiprogramming Operating System: Stage II
i. Paging
ii. Error Handling
iii. Interrupt Generation and Servicing
iv. Process Data Structure
3.Design and implementation of a Multiprogramming Operating System: Stage III
i. I/O Channels& I/O buffering
ii. Multiprogramming
iii. I/O Spooling
4. Design multi programming operating system phase 1 with arithmetic & logical instructions
5.Design multi programming operating system phase 3 with swapping

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

1. Stalling William; "Operating Systems", 6thEdition, Pearson Education.
2. Silberschatz A., Galvin P., Gagne G.; "Operating System Concepts", 9th Edition, John Wiley and Sons.
3. D M Dhamdhere; "Systems Programming & Operating Systems"; Tata McGraw Hill Publications, ISBN – 0074635794
4. John J Donovan; " Systems Programming " ; Tata Mc-Graw Hill edition , ISBN-13978-0-07-460482-3

Reference Books: (As per IEEE format)

1. Silberschatz A., Galvin P., Gagne G ;"Operating System Principles" 7th Edition John Wiley and Sons.
2. YashavantKanetkar; "Unix Shell Programming", 2 nd Edition, BPB Publications.
3. Forouzan B. A., Gilberg R. F.; "Unix And Shell Programming", 1 st Edition, Australia Thomson Brooks Cole.
4. Achyut S. Godbole, Atu lKahate; "Operating Systems", 3 rd Edition, McGraw Hill.

MOOCs Links and additional reading material:

1. https://nptel.ac.in/courses/106105214
2. https://onlinecourses.nptel.ac.in/noc20_cs04/preview
3. https://archive.nptel.ac.in/courses/106/102/106102132/
4. https://onlinecourses.nptel.ac.in/noc21_cs72/preview

Course Outcomes:

The student will be able to –

1. Discuss the functions of a contemporary Operating system with respect to convenience, efficiency and the ability to evolve.
2. Implement concurrent abstractions correctly in an OS to solve real world problems.
3. Use various CPU scheduling algorithms to construct solutions to real world problems.
4. Corelate the mechanisms related to deadlock handling in real life situations.
5. Distinguish memory management schemes & file management systems in various ways to improve performance, and analyze the impact of it on system complexity.
6. Design & develop the Operating system from a scratch

CO-PO Mapping :

CO	Program Outcomes (PO)											PSO		
CO /PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2										3	2	
CO2	2	2	3	2			2	2				3	3	
CO3	2	3	3	2			2	2				3	2	
CO4	2	3		2								3	2	
CO5	2	3		1								3	2	
CO6	2	2	3	2		2	2	2	3	3.0	3.0	3	3	
Avg	**2**	**2.5**	**3.0**	**1.8**		**2.0**	**2.0**	**2.0**	**3.0**	**3.0**	**3.0**	**3.0**	**2.33**	

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L3, CO4 – L4, CO5 – L4 and CO6 – L5

Future Course Mapping:

Advanced Operating System, Distributed Operating System, Parallel Computing.

Job Mapping:

System Administrator, System Analyst

FF No. :654

ML2307 : Theory of Computation

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Introduction to discrete mathematics, proof techniques, basic familiarity with programing/computing.

Course Objectives:

1. Students will learn basic concepts such as alphabet, strings, Languages, Decision problems, etc and will be able to work with the abstract formal setup.
2. Students will be able to design deterministic/nondeterministic automata for regular languages, also he will be able to prove non regularity of languages through application of Pumping Lemma and Myhill-Nerode theorem.
3. Students will gain understanding of the role of non-determinism in Automata theory.
4. Students will be able to design Context free grammars, Push down automata for context Free Languages
5. Students will be able to design Turing Machines for various computational problems and see the equivalence of TM model with high level programming languages.
6. Students will be able to comprehend meaning of undecidability in the context of Turing Machine Model and understand the inherent limits of computation.

Course Relevance:

This is a foundational course for Computer Science and Engineering. The central theme of the course is to study what makes certain computational problems very hard and the others easy? Is there some concrete theoretical evidence for the exhibited hardness of the problems? The course explores these questions, first by introducing students to the abstract notion of computation and models of computation. Starting from very simple model of state machines to finally cumulating into the Turing machine model (which is a foundation of modern-day computers), several models in between are studied. For every model, questions such as, which computational problems can be/cannot be solved in the model? how efficiently a problem can be solved in a particular model? various closure

properties of model are studied. Throughout the course emphasis is given to proving things with concrete mathematical arguments.

The course is very important for understanding the concept of computation in more abstract set-up. Wherever one wants to formally talk about underlying model, the restrictions imposed by the model, what is the power and limitation of the model, the principles learnt in this course are useful. Due to abstract nature of the course, the principles learnt have wide applicability. The course is an essential prerequisite for several advanced courses such as Computational Complexity, Advanced Algorithms, Foundation of Logic, Quantum Computation, Parallel computation, Circuit Complexity etc. On more applied side: The Automata theoretic models, concept of Context Free Grammar and Pushdown Automata studied in the course are very important for Compiler design. The models discussed during the course have direct applications to several machine learning models, Natural Language processing, Artificial Intelligence, Functional Programming.

Once the student gains expertise in thinking abstractly about underlying models of computation it facilitates in systematic study of any other domain (in computer science or otherwise) which demands logical thinking and abstraction.

This course is also relevant for students who want to pursue research career in theory of computing, computational complexity theory, Natural Language Processing, advanced algorithmic research.

Theory

Unit-I Finite Automata **[4 Hours]**

Introduction to Automata, Computability and Complexity theory, Automaton as a model of computation, Central Concepts of Automata Theory: Alphabets, Strings, Languages. Decision Problems Vs Languages. Finite Automata, Structural Representations, Deterministic Finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, transition table, Language of DFA, construction of DFAs for Languages and proving correctness, Product construction, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Conversion of NFA with epsilon transitions to DFA, Applications and Limitation of Finite Automata.

Unit-II Regular and Non-Regular Languages **[6 Hours]**

Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleene's Theorem: Equivalence Regular expressions and DFAs (without proof), Closure properties of Regular Languages (union, intersection, complementation, concatenation, Kleene closure), Decision properties of Regular Languages, Applications of Regular expressions. Myhill-Nerode theorem and applications: proving non-regularity, lower bound on

number of states of DFA, State Minimization algorithm, Equivalence testing of DFAs. Non-Regular Languages, Revisiting Pigeon-Hole principle, Pumping Lemma for regular Languages.

Unit-III Context Free Grammars (CFG) [4 Hours]

Context Free Grammars: Definition, Examples, Derivation, Languages of CFG, Constructing CFG, correctness proof using induction. Closure properties of CFLs (Union, Concatenation, Kleene closure, reversal). Derivation trees, Ambiguity in CFGs, Removing ambiguity, Inherent ambiguity. Normal forms for CFGs: CNF and GNF (without proof). Decision Properties of CFLs (Emptiness, Finiteness and Membership). Applications of CFG.

Unit-IV Push Down Automata: [5 Hours]

Description and definition, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic, Non-deterministic PDAs, CFG to PDA construction (with proof). Equivalence of PDA and CFG (without proof). Intersection of CFLs and Regular language. Pumping lemma for CFLs, non-Context Free Languages, Chomsky hierarchy**.**

Unit-V Turing Machines: [5 Hours]

Basic model, definition, and representation, Instantaneous Description, Language acceptance by TM. Robustness of Turing Machine model and equivalence with various variants: Two-way/One-way infinite tape TM, multi-tape TM,non-deterministic TM, Universal Turing Machines. TM as enumerator. Recursive and Recursively Enumerable languages and their closure properties.

Unit-VI Introduction to Undecidability: [4 Hours]

Church-Turing Thesis and intuitive notion of Algorithm, Encoding for Turing machines and countability of set of all Turing machines. Existence of Turing unrecognizable languages via Cantor's diagonalization. Undecidability of Halting problem. Examples of undecidable problems: Post Correspondence Problem, Hilbert's 10th Problem, Tiling problem (without proof). Example of Turing unrecognizable language. Decision properties of R, RE languages.

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

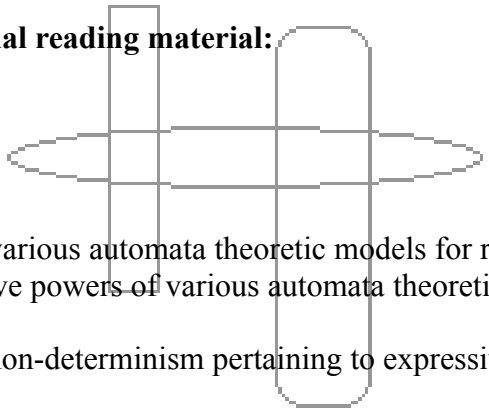
1.Hopcroft J, Motwani R, Ullman, Addison-Wesley, "Introduction to Automata Theory, Languagesand Computation", Second Edition, ISBN 81-7808-347-7.
2. Michael Sipser, Course Technology, "Introduction to Theory of Computation", Third Edition,ISBN-10: 053494728X.
3.. "Discrete Mathematics and its applications" by Kenneth Rosen (William C Brown Publisher)

Reference Books: (As per IEEE format)

1. J. Martin, "Introduction to Languages and the Theory of Computation", Third edition, Tata McGraw-Hill, ISBN 0-07-049939-x, 2003.
2. Daniel I. A. Cohen, "Introduction to Computer Theory", Wiley-Second Edition, ISBN-10 : 04711377

MOOCs Links and additional reading material:

www.nptelvideos.in



Course Outcomes:

The student will be able to –

1. Infer the applicability of various automata theoretic models for recognizing formal languages.
2. Discriminate the expressive powers of various automata theoretic and formal language theoretic computational models.
3. Illustrate significance of non-determinism pertaining to expressive powers of various automata theoretic models.
4. Comprehend general purpose powers and computability issues related to state machines and grammars.
5. Explain the relevance of Church-Turing thesis, and the computational equivalence of Turing machine model with the general-purpose computers.
6. Grasp the theoretical limit of computation (independent of software or hardware used) via the concept of undecidability.

CO-PO Mapping:

CO	Program Outcomes (PO)											PSO		
CO /PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	1								3	2	
CO2	2	3	2				2					3	2	
CO3	2	3	2	2			2					3	2	
CO4	2	3							1			3	2	
CO5	2	3	2									3	2	
CO6	2	3		1								3	2	
Avg	**2**	**3**	**2.33**	**1.33**	**0**	**0**	**2**	**0**	**1**	**0**	**0**	**3**	**2.0**	

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L2, CO2 – L3, CO3 – L3, CO4 – L4, CO5 – L5 and CO6 – L5

Future Course Mapping:

Compiler design, Computational Complexity theory, Computability theory, Advanced Algorithms, Natural Language Processing, Artificial Intelligence

Job Mapping:

The principles learnt in the course have wide applicability, in domains like Compiler design, Programming languages design, Machine learning, Natural Language processing, etc. Any job that involves modeling and systematic study of some systems, background of Theory of Computation is useful. Understanding the course content is helpful in developing a systematic and structured approach towards programming. The programming/algorithm design abilities lie at the heart of computer science and are useful for several job profiles in the computer industry. If a student wants to pursue higher education/ research in Computer Science, this course is essential.

FF No. :654

MLM002 : Data Visualization

Teaching Scheme:

Theory: 2 Hours/Week; **Laboratory: 2/Week**

Total Credits: 3

Syllabus

Course Prerequisites: Fundamentals of Python Programming

Course Objectives:

1. Identify the different types of data and create data visualization
2. Transform raw data into understandable format and conduct exploratory analysis
3. Use python and R libraries for data preprocessing and visualization
4. Use knowledge of perception and cognition to evaluate visualization design alternatives.
5. Design and evaluate results of exploratory data analysis.
6. Apply data transformation and paraphrase the results for documentation.

Course Relevance: Data visualization is the graphical representation of data and information using visual elements such as charts, graphs, maps, and info graphics. It involves the creation of visual representations that help people understand and interpret complex data sets more easily. Data visualization is widely used across various industries and domains to communicate data-driven insights, patterns, and trends effectively.

Theory

Unit-I Introduction and Describing Data **[04 Hours]**

Importance of analytics and visualization in the era of data abundance. Review of probability, statistics and random processes. -Brief introduction to estimation theory. Sources of Data, Process for

Making Sense of Data, Observations and Variable, Types of Variables, Central Tendency, Distribution of the Data, Need of Data wrangling Methods, Confidence Intervals, Hypothesis Test

Unit-II Data Manipulation **[06 Hours]**

Installing and using Pandas, Introduction of Pandas Objects, Data Indexing and Selection, Operating on Data in Pandas, Handling Missing Data, Hierarchical Indexing, Combining Datasets: Concatenation and Append, Combining Datasets: Merge and Join, Aggregation and Grouping, Pivot Tables, Vectorized String Operations, Working with Time Series, High-Performance Pandas.

Unit-III Data Visualization **[04 Hours]**

Visualization Design Principles, Tables, Univariate Data Visualization, Multivariate Data Visualization, Visualizing Groups, Dynamic Techniques General Matplotlib Tips, Two Interfaces for the Price of One, Simple Line Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binning, and Density, Customizing Plot Legends, Customizing Color bars, Multiple Subplots, Text and Annotation, Customizing Matplotlib.

Unit- IV Visualization Using Seaborn **[06 Hours]**

Introduction to Seaborn: Seaborn functionalities and usage, Spatial Visualizations and Analysis in Python, R Programming: Bar plot, Plotting categorical data, Stacked bar plot, Histogram, plot () function and line plot, Pie chart / 3D pie chart, Scatter plot, Box plot.

Unit-V Information visualization **[04 Hours]**

Clustering Techniques, Dimension reduction, PP, MDS, graph visualization techniques for big data, visual analytics, Statistical methods, Information theory for big data visualization.

Unit-VI Applications of Data Visualizations **[04 Hours]**

Business Intelligence, Data Exploration and Analysis, Presentations and Reporting, Geographic Information Systems (GIS), Healthcare and Medicine, E-commerce and Customer Analytics.

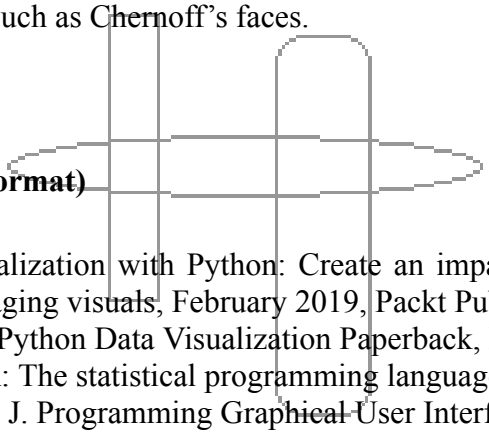
List of Tutorials (13):[CO's Mapped]

1. Study installation and configuration of Tableau
2. Data Visualization using statistical inference methods
3. Hypothesis Testing: Null and Alternative
4. Predictive data Visualization with Python
5. Clustering and Time-series analysis using Scikit- learn sklearn, metrics, Confusion matrix, AUC-ROC Curves, Elbow plot
6. Linear Regression

7. Data visualization using ggplot
8. Scala
9. Dashboard
10. Application

List of Course Project Topics:

1. Movie recommendation system
2. Customer Segmentation using Machine Learning
3. Sentiment analysis
4. Uber Data analysis
5. Loan prediction
6. HVAC needs forecasting
7. Customer relationship management
8. Clinical decision support systems
9. Fraud detection
10. Visualization techniques such as Chernoff's faces.



Text Books: (As per IEEE format)

1. Mario Dobler, Data Visualization with Python: Create an impact with meaningful data insights using interactive and engaging visuals, February 2019, Packt Publishing
2. Kirthi Raman, Mastering Python Data Visualization Paperback, Publishing
3. Gardener M, Beginning R: The statistical programming language, WILEY. (2017).
4. Lawrence, M., & Verzani, J. Programming Graphical User Interfaces in R. CRC press. (ebook)

Reference Books: (As per IEEE format)

1. Kieran Healy Chen, Data Visualization– A Practical Introduction Paper back–Import, 4 Jan 2019.
2. Chun-houh, Wolfgang Karl Härdle, and Antony Un win, Eds, Handbook of data visualization. Springer Science & Business Media.
3. Cotton, R., Learning R: a step-by-step function guide to data analysis, O'reilly Media Inc.

MOOCs Links and additional reading material:

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/data-visualization-with-r/
2. https://www.coursera.org/learn/datavisualization

Course Outcomes:

The student will be able to –

1. Understanding fundamental principles and concepts behind effective data visualization.
2. Design and Classify different data visualization techniques.
3. Analyze exploratory data analysis using visualization.
4. Design and evaluate Python and R programming libraries for data visualization
5. Evaluate and apply data transformations Techniques.
6. Develop a visualization intensive project.

CO-PO Mapping:

CO	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2			2								3	2	3
CO2	2	2		2							3	3	2	3
CO3	3	3	2		2	3						3	2	3
CO4	3	3	2	1	2	3	3	3				3	2	3
CO5	3		2	3								3	2	3
CO6	3		2						3		3	3	2	3
Average	3	3	1	1	1	1	1	1	1	1	0	3.0	2.0	3.0

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75
L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L2, CO3 – L3, CO4 – L4, CO5 – L4 and CO6 – L5

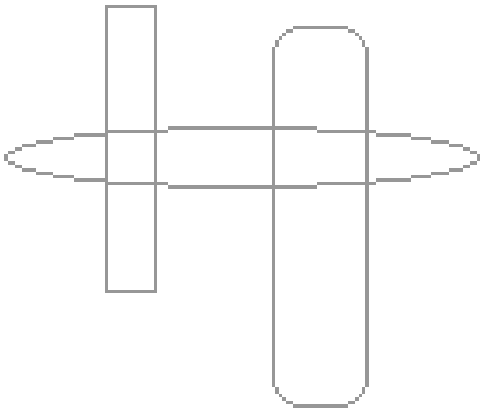
Future Course Mapping:
Mention other courses that can be taken after completion of this course:

Database Management Systems, Data Analytics, Software Engineering, Machine Learning, Deep Learning, Fuzzy Logic.

Job Mapping:

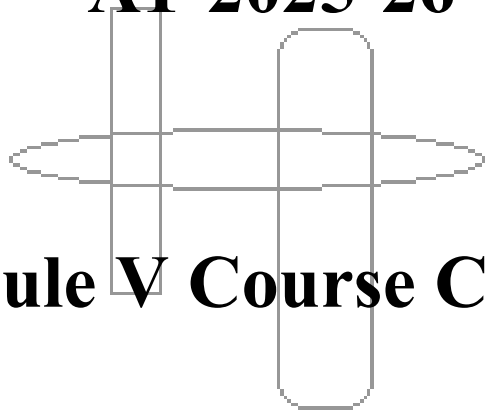
Job opportunities that one can get after learning this course are as:

Application developer, power BI developer-data visualization, data visualization engineer, data visualization expert, data analytics, specialist-visualization, software development engineer-data visualization, data visualization designer, senior analyst-visualization, Scientist.



T.Y. B.Tech. Computer Science &Engineering (Artificial Intelligence and Machine Learning)

AY 2025-26



Module V Course Content

FF No. :654

ML3001: Computer Network Technology

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Prerequisites: Operating System, Database Management Systems

Course Objectives:

1. To learn transmission mediums, networking devices and topologies used in the Internet
2. To learn networking standards, IP packet switching and routing used in the Internet
3. To learn transport layer and application layer protocols used in the Internet
4. To learn front end technologies for website development
5. To learn single page applications development using REACT
6. To learn REST API based enterprise website development using REACT, Node JS, Spring Boot with different database technologies

Course Relevance:

The key technology of the information age is communications. Computer network is a truly global area of study, both because the technology enables global communication over telephone lines and the Internet. Computer Networks and web technologies are the backbone of all IT infrastructures and their applications in the world. These technologies and applications often emerge in communication within countries of countries and spread rapidly around the world. Most of the jobs available in the IT industries are web technology related.

Theory

Unit-I Networking Fundamentals and Physical Layer **[04 Hours]**

Network Organizations and Architectures: What is computer Networks, Network Topologies: Mesh, Star and Hierarchical, Types of Computer Networks: LAN, MAN, WAN, PAN, Internet, internet and Intranet. Client-Server; Peer -to- Peer. Network Architecture Modes: Infrastructure and Ad-hoc mode.

Reference Models: OS and TCP/IP. Design Issues for Layers.

Physical Layer: Transmission Mediums: Air, Vacuum, Cat5, Cat5e, Cat6, Cat6a, Cat7, Cat8, OFC - Single and Multicore.

Networking Devices Wired and Wireless: NIC, Repeater, Bridge, Switch, Modem, Router, Gateways and Access Point.

Unit-II Medium Access Control and Network Layer **[04 Hours]**

Medium Access Control: Legacy Standard: 10 Mbps IEEE 802.3 Standard(Ethernet), High Speed Ethernet Standards: Fast, Gigabit and 10Gigabit.

Wireless Standards: IEEE 802.11a/b/g/n/ac, IEEE 802.15, IEEE 802.15.4 and IEEE 802.16 Standards, CSMA/CA

Switching Techniques and IP Addressing: Circuit, Message and Packet Switching. Logical Addressing: IPv4 and IPv6

Network Layer Protocols: Internet Protocol (IP), Internet Control Message Protocol(ICMP)

Unit-III Transport Layer and Application Layer **[05 Hours]**

Transport Layer Protocols: Transmission Control Protocol (TCP), User Datagram Protocol (UDP)

Services: Berkeley Sockets, Connection Establishment, Connection Release

Application Layer: Domain Name System (DNS) and File Transfer Protocol (FTP)

WWW: Hyper Text Transfer Protocol (HTTP1.1/1.2/2.0) and HTTPS with SSL.

Email: SMTP, MIME, POP3 and Webmail.

Unit-IV Client-Side Technologies **[09 Hours]**

HTML5: structure of html document, HTML elements: headings, paragraphs, line break, links, frames, lists, tables, images and forms **CSS3.0:** Styles, colors, fonts and Text Alignments

Java Script: Basics of Document Object Model (DOM), Variable Declarations: Using var, let, and const, Reserved Keywords, Objects and Classes, Understanding Functions: Declarations, Expressions, Arrow Functions, Event Handling- Browser Events and Event Listeners, Form Validation, AJAX

React

Introduction to React, React component, JSX, Render function, Component API, Component lifecycle, State, Props, Mixins, Component composition, Pass data from parent to child, Pass data from child to parent, Component styling, Forms, Events, Refs, Keys, Router, Flux, Redux

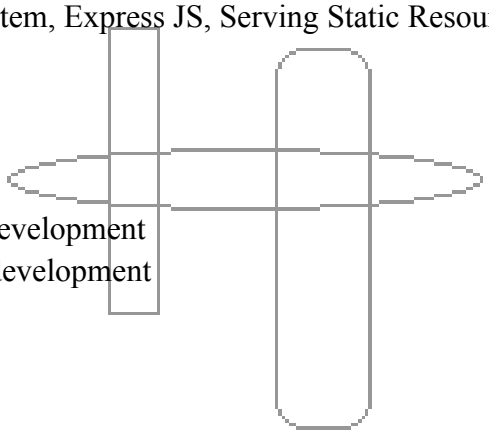
Unit-V Spring Boot **[05 Hours]**

Spring Framework, Spring Boot Framework, Installing Spring Boot, Build Tool Maven/Gradle/Ant, Core Features, Spring Security, Web Applications, JPA for database connectivity, working with SQL and NoSQL, Messaging, Testing, Deploying Spring Boot Applications, Monitoring and Testing. POSTMAN Tool for API testing.

Unit-VI NodeJS **[[03 Hours]**

Introduction to Node JS, Installation of Node JS, Node JS Modules, Node Package Manager (NPM), Creating Web server, File System, Express JS, Serving Static Resources, Database connectivity.

List of Tutorials (13):



List of Tutorials (13):

1. Use of XML in web development
2. Use of JSON in web development
3. Learning JQuery
4. Learning JQuery
5. Learning Bootstrap
6. Learning Bootstrap
7. Learning PHP
8. Learning PHP
9. Learning MySQL
10. Learning MySQL
11. Learning Mongo DB
12 Learning Mongo DB
13. Learning REST API

List of Practical's (Minimum Six):

Unit-I and Unit II: Use two turn of lab

1a) Setting up small wired computer network:

Set up a small wired network of 2 to 4 computers using Hub/Switch/. It includes Preparation of Cables and setting up wired network.

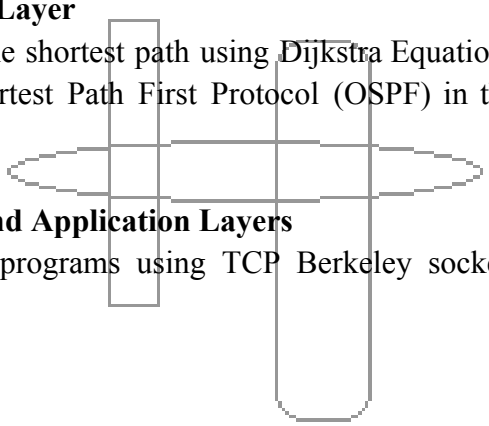
1b) Setting up small wireless computer network and hands-on networking command:

Set up a small wired network of 2 to 4 computers using access point and ask students to access it on their wireless gadgets.

Hands on for network commands - ping, pathping, ipconfig/ifconfig, arp, netstat, nbtstat, nslookup, route, traceroute/tracert, nmap.

Unit-II MAC and Network Layer

2) Write a program to find the shortest path using Dijkstra Equation for Link State Routing Protocol which is used by Open Shortest Path First Protocol (OSPF) in the Internet for the network flow provided by instructor.



Unit-III Transport Layer and Application Layers

3a) Write the client server programs using TCP Berkeley socket primitives for wired /wireless network for following

a. to say Hello to Each other

b. File transfer

3b) Write the client server programs using UDP Berkeley socket primitives for wired /wireless network for following

a. to say Hello to Each other

b. Calculator (Trigonometry)

3c) Understanding protocol stack of Intranet

Analyze packet formats of Ethernet, IP, TCP and UDP captured through Wireshark for wired networks.

Unit-IV Client-Side Technologies

4) Design and develop a website using toggleable or dynamic tabs or pills with bootstrap and JQuery to show the relevance of SDP, EDI, DT and Course projects in VIT.

Unit-V Springboot

5) Design and develop a responsive website to prepare one semester result of VIT students using REACT, Springboot and MySQL/ MongoDB/Oracle. Take any four subjects with MSE Marks (30%) ESE Marks (70%).

Unit-VI NODE JS

6) Design and develop a responsive website for an online book store using REACT, Node JS/ PHP and MySQL/ MongoDB/Oracle having 1) Home Page2) Login Page 3) Catalogue Page: 4) Registration Page: (database)

List of Course Project areas: Networking

1. Design and deploy website for TCP based Multithreaded HTTP client server for accessing student activity data in the institute.
2. Design and deploy website for TCP based Multithreaded FTP client server to share institute level notices.
3. Design and deploy website for UDP based Multithreaded TFTP client server for your class
4. Design and deploy website for TCP based Multithreaded SMTP and POP3 mail client server for your campus.
5. Design and deploy website for TCP based Multithreaded Chat client server for your class.
6. Design and deploy website for UDP based Multithreaded Chat client server for your class.
7. Design and deploy website for UDP based Multithreaded Audio Conferencing client server for computer engineering department.
8. Design and deploy website for UDP based Multithreaded Video Conferencing client server for computer department
9. Design and deploy website to demonstrate implementation of RIP/OSPF/BGP using Packet Tracer
10. Design and deploy website to simulation of AODV routing protocol using Packet Tracer/ NS3/OMNet

List of Course Project areas: Web Technology

1. Develop a responsive web application for Student Grievance System
2. Develop a responsive web application for Workflow Management System for MNC
3. Develop a responsive Gaming Website
4. Develop a responsive web application to help farmers to solve their farming problems
5. Develop a responsive web application for GST Billing Software for Small Business
6. Develop a responsive web application for online Crime Reporting System using PHP
7. Develop a responsive web application for online College Voting System

8. Develop a responsive web application for online Loan Processing System for Farmers.
9. Develop a responsive web application for restaurant food order management
10. Develop a responsive web application for e-book shop
11. Develop a responsive web application for on-line music store
12. Develop a responsive web application for guest visiting management to your society
13. Develop a responsive web application for web search engine

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

1. Andrew S. Tanenbaum, "Computer Networks",5th Edition, PHI, ISBN 81-203-2175-8.
2. Kurose, Ross "Computer Networking a Top Down Approach Featuring the Internet", Pearson; 6th edition (March 5, 2012), ISBN-10: 0132856204
3. Frouzan B., "Data Communications and Networking", 5th edition, Tata McGraw- Hill, Publications, 2006

Reference Books (Networking) :(As per IEEE format)

1. Matthew S. Gast "802.11 Wireless Networks", O'Reilly publications; 2nd Edition.
2. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols" Prentice Hall, 2004
3. Holger Karl and Andreas Willing, "Protocols and Architectures for Wireless Sensor Networks", Wiley, ISBN: 0-470-09510-5

Text Books (Web Technology): (As per IEEE format)

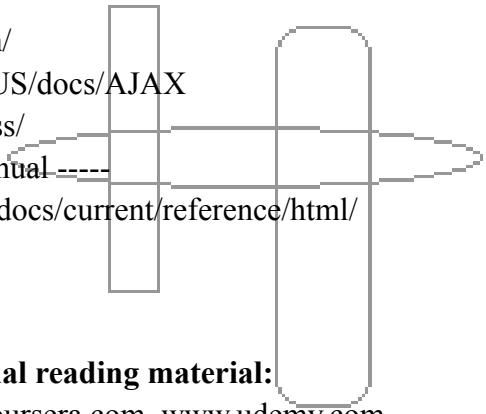
1. Kumar, A., Web technologies, CRC press, 2019
2. Gupta, R., Internet & Web Technologies, Engineering Handbook, 2019
3. Martin, M.G., Programming for Beginners: 6 Books in 1 – Swift+PHP+Java+Javascript+Html+CSS: Basic Fundamental Guide for Beginners, independently published, 2018
4. Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5, O'Reilly Media; 5th edition, 2018
5. Kohli, S., Web Technologies, PPB Publications, 2015
6. Adam Bretz& Colin J Ihrig, "Full Stack Javascript Development with MEAN", SPD, First Edition 2015, Indian Reprint September 2015
7. GiulioZambon, "Beginning JSP, JSF and Tomcat", Apress Publication, Second Edition, 2013
8. Jeremy McPeak& Paul Wilton," Beginning JavaScript", Wrox Publication, Fifth Edition, 2015
9. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
10. Robert W. Sebesta: Programming the World Wide Web, 4th Edition, Pearson education, 2008

Reference Books (Web Technology) :(As per IEEE format)

1. Marty Hall, Larry Brown,"Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
3. Chris Bates: Web Programming Building Internet Applications, 3rd Edition, Wiley India, 2006.
4. Xue Bai et al: The web Warrior Guide to Web Programming, Thomson, 2003

MOOCs Links and additional reading material:

1. www.w3.org
2. HTML, The Complete Reference
3. www.htmlref.com
4. w3schools.org
5. php.net/ https://jquery.com/
6. developer.mozilla.org/en-US/docs/AJAX
7. www.tutorialspoint.com/css/
8. PHP: Data Structures - Manual -----
9. docs.spring.io/spring-boot/docs/current/reference/html/
10. nodejs.org/en
11. react.dev



MOOCs Links and additional reading material:

www.nptelvideos.in, www.coursera.com, www.udemy.com

Course Outcomes:

The student will be able to –

1. Select topology, essential components of physical layer and networking devices to design computer networks.
2. Build wired and wireless intranet with correct communication and service frameworks.
3. Develop Client-Servers by the means of correct standards, protocols and technologies
4. Build single page applications using REACT as a reusable UI component technology
5. Write Web API/RESTful API application programming interface to communicate with Springboot as a server side technology.
6. **[Group Assignment]** Design and develop three tier enterprise application using client side, server side and back end technologies

CO-PO Mapping:

CO	Program Outcomes (PO)											PSO			
CO/PO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3	
CO1	3	**3**	2	1	-	2	-	-	1	-	-	-	-	-	
CO2	3	2	**3**	1	3	2	2	2	1	-	-	3	3	-	
CO3	3	3	3	**1**	3	2	-	**2**	1	-	-	3	3	-	
CO4	3	3	3	1	3	**2**	-	2	1	-	-	3	3	-	
CO5	3	2	3	1	3	2	-	2	**1**	-	-	3	3	-	
CO6	3	3	3	2	3	3	-	3	3	2	2.0	3	**3**	**2**	
Avg	**3**	**2.83**	**3**	**1.16**	**3**	**2.16**	**2**	**2.2**	**1.33**	**2.0**	**2.0**	**3**	**3**	**2**	

Attainment Levels: 2, 3,4, 3, 4, 4

CO Attainment levels:

Weights for attainment levels: L1 – Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L3, CO3 – L4, CO4 – L3, CO5 – L4 and CO6 – L4

Future Course Mapping:

High Speed Networks, Wireless Networks, Mobile Networks, Network Security, Cyber Security, Cloud Computing, Distributed System, Mobile Application Development

Job Mapping:

Network Engineer, Network Stack Developers, Application Developer, Software Engineer, Web Developer, IT Engineer, UI Developer

FF No. :654

ML3002: Design and Analysis of Algorithms

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Prerequisites: Basic courses on programming, data structures, discrete structures, theory of computing.

Course Objectives:

1. Students will gain understanding of asymptotic notations and will be able to apply suitable mathematical techniques to find asymptotic time and space complexities of algorithms.
2. Students will develop the ability to formulate computational problems in the abstract and mathematically precise manner.
3. Student will gain understanding of different algorithm design paradigms such as divide and conquer, dynamic programming, greedy, backtracking and will apply suitable paradigm for designing algorithms for computational problems.
4. Students will develop understanding of notions of NP-hardness and NP-completeness and their relationship with the intractability of decision problems.
5. Students will design randomized, approximation algorithms for some computational problems.
6. Students will be able to incorporate algorithm design principles, data structures and provide efficient solutions for complex computational problems.

Course Relevance:

This is a foundational course for Computer science and Engineering. This course develops algorithmic thinking capability of students. Designing algorithms using suitable paradigm and analysing the algorithms for computational problems has a high relevance in all domains where computer science plays a crucial role (equally in Industry as well as research). This course is also an essential pre-requisite for advanced domain specific algorithmic courses such as Algorithmic Graph Theory, Algorithmic Number Theory, Computational Geometry, Motion planning and Robotics, etc, to give a few examples. Once the student gains expertise in Algorithm design and in general gains

ability of Algorithmic thinking, it facilitates in systematic study of any other domain (in computer science or otherwise) which demands logical thinking. This course is also relevant for students who want to pursue research career in theory of computing, computational complexity theory, advanced algorithmic research.

UNIT1- Introduction to time and space complexity

Algorithm definition, insertion sort running time calculation, Notations Theta, big O, big Omega, little o notations with examples. Space complexity definition and examples like matrix multiplication, bubble sort, factorial computation recursive and iterative version. Recurrence relations and finding time complexity using substitution method, recursion tree and master theorem. Proof of correctness of algorithms.

UNIT 2- Divide and conquer

General strategy of divide and conquer examples binary search, quick sort-best case, worst case and average case time complexities, merge sort and analysis, finding majority element and analysis, Order statistics- finding simultaneous maximum and minimum, selection problem.

UNIT 3:- Dynamic programming

General strategy, Fibonacci sequence example dynamic and recursive with comparison. Travelling salesman problem by dynamic programming. And 0-1 knapsack problem using dynamic programming.

UNIT 4:- Greedy strategy

General approach, fractional knapsack problem using greedy method, Job scheduling/sequencing using greedy approach examples, Huffman coding, minimum spanning tree-Kruskal's and Prim's algorithm

UNIT 5:- Backtracking strategy

General approach, N-queens problem using backtracking, graph coloring problem with examples

UNIT 6:- Complexity classes and Randomized algorithms

Introduction to P, NP, NPC and NP-Hard problems and their interrelations, Randomized algorithms- Las Vegas and Monte Carlo simple examples

List of Lab assignments DAA

1. Implementation and timing analysis of matrix multiplication for square matrices
2. Implementation and analysis of quick sort
3. Finding out majority element from an array

4. Compare dynamic programming and divide and conquer using Fibonacci sequence
5. Huffman coding using Greedy strategy
6. Knapsack using dynamic programming

Text Books:

1. Cormen, Leiserson, Rivest and Stein "Introduction to Algorithms", 3rd edition, 2009. ISBN 81-203-2141-3, PHI
2. Horowitz and Sahani, Fundamentals of computer Algorithms, Galgotia, ISBN 81-7371-612-9
3. Jon Kleinberg, Eva Tardos "Algorithm Design", 1st edition, 2005. ISBN 978-81-317-0310-6, Pearson
4. Dasgupta, Papadimitriu, Vazirani "Algorithms", 1st edition (September 13, 2006), ISBN-10:9780073523408, ISBN-13: 978-0073523408, McGraw-Hill Education

Reference Books:

1. Anany Levitin, "Introduction to the Design & Analysis of Algorithm", Pearson, ISBN 81-7758-
835-4.
2. Gilles Brassard, Paul Bratle, Fundamentals of Algorithms, Pearson, ISBN 978-81-317-1244-3.
3. Motwani, Raghavan "Randomized Algorithms", 1st edition (August 25, 1995), ISBN-10:0521474655, ISBN-13: 978-0521474658, Cambridge University Press
4.Vazirani, "Approximation Algorithms", ISBN-10: 3642084699, ISBN-13: 978-3642084690,Springer (December 8, 2010)

CO Statements:

The student will be able –
1) To formulate computational problems in abstract and mathematically precise manner
2) To design efficient algorithms for computational problems using appropriate algorithmic paradigm.
3) To analyze asymptotic complexity of the algorithm for a complex computational problem using suitable mathematical techniques.
4) To differentiate among Complexity classes, and understand their interrelation
5) To establish NP--completeness of some decision problems, grasp the significance of the notion of NP--completeness

6) To incorporate appropriate data structures, algorithmic paradigms to craft innovative scientific solutions for complex computing problems

CO-PO Mapping:

CO	Program Outcomes (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO 1	PSO 2	PSO 3	
1	2	3	2	1			2						3		2	
2	2	3	3	1			2						3		2	
3	2	3	2	1			2						3		2	
4	2	3	3	1			2						3		2	
5	2	3	3	1			2						3		2	
6	2	3	3	1			2						3		2	
Avg	2	3	2.66	1.0			2.0						3		2	

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L1, CO2 – L3, CO3 – L2, CO4 – L3, CO5 – L4 and CO6 – L5

Future Course Mapping:

Advanced Algorithms, Computational Complexity, Computational Geometry, Algorithmic Number Theory, Algorithmic Graph Theory

Job Mapping:

Algorithm design lie at heart of any Computer Science/Engineering application. Once the student gains expertise in Algorithm design and in general gains ability of Algorithmic thinking, it facilitates in systematic studying any other domain (in computer science or otherwise) which demands logical thinking. Algorithm design is an essential component of any job based on programming. All Industries in computer Engineering always look for a strong knowledge in Algorithm design and Data structures. If student wants to pursue higher education/ research in Computer Science, this course is must.

FF No. :654

ML3003: Machine Learning

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Prerequisites:
Linear Algebra, Statistics, Calculus and programming language.

Course Objectives:
1. To learn the concepts, techniques and building blocks of machine learning.
2. To learn mathematics for implementing machine learning algorithms.
3. To learn the supervised, unsupervised and reinforcement learning techniques.
4. To learn use of computational learning theory
5. To learn feature reduction on real life problems.
6. To learn Machine Learning models and implement them in real life scenarios for different applications.

Course Relevance:
Machine Learning (ML) is currently one of the hottest buzzwords in tech and with good reason. The last few years have seen several techniques that have previously been in the realm of science fiction slowly transformed into reality. The importance of ML has been increasing as a growing number of companies are using these technologies to improve their products and services, evaluate their business models, and enhance their decision-making process.

Unit-I: Introduction of Machine Learning **[4 Hours]**
What is Machine Learning, Types of Learning: Supervised, Unsupervised, Reinforcement. Learning System, Well posed learning problem, Issues in machine learning. Concept Learning: Concept Learning, General-to-Specific Ordering: Task, search, Find S algorithm, Version space and the candidate elimination algorithm, List-then-eliminate algorithm, Bias, Variance, Underfitting, Overfitting, Inductive bias, Evaluation, Training, Testing, Cross-validation: Error Analysis, Error Metrics, Precision and recall.

Unit-II : Supervised Learning: **[4 Hours]**
Feature Engineering: Preprocessing of data: Normalization and Scaling, Standardization, Rationale and Basics: Learning from Observations, Bias. Metrics for assessing regression, Metris for assessing classification, classification vs regression task.

Unit-III : Statistical Learning **[4 Hours]**
Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, K-Nearest Neighbor Classifier. Linear Regression with Least Square Error Criterion, Logistic Regression

for Classification Tasks, Neural network for supervised and unsupervised learning, Case study on KNN and logistic regression.

Unit-IV : Naive Bayes and Support Vector Machine [4 Hours]

Bayes Theorem: Naive Bayes' Classifiers, Multinomial Naïve Bayes. Support Vector Machine (SVM)- Linear Support Vector Machines, Linear Classification, Kernel based classification, Non- linear Examples. Support Vector Regression. Case study on Naive Bayes and Support Vector Machine.

Unit-V: Decision Trees and Ensemble Learning [6 Hours]

Decision Tree Learning: Representation, Basic decision tree learning algorithm, Issues in decision tree learning. Introduction to Meta Classifier: Concepts of Weak and eager learner, Ensemble methods, Bagging, Boosting, Random Forests. Case study on decision tree.
Dimensionality Reduction Techniques-Various Feature Selection Techniques (Wrapper, Filter and Embedded method) Sequential Forward Selection, Sequential Backward Selection. Introduction to Dimensionality Reduction, Principal Component Analysis (PCA).

Unit-VI: Unsupervised and Reinforcement learning [6 Hours]

Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness. Hierarchical Clustering, Agglomerative Clustering, Case study on clustering. Rule Based Models: Rule learning for subgroup discovery, Association rules mining – Apriori Algorithm, Confidence and Support parameters. Reinforcement Learning: Exploration, Exploitation, Rewards, Penalties, Markov Decision Process, Q-Learning and Bellman Equation.

Practical List

Write a Python code to implement the following algorithm using a standard dataset..

1. Linear Regression
2. Logistic Regression
3. KNN
4. Naive Bayes
5. Random forest Algorithm
6. Support vector machine
7. Decision Tree
8. Random Forest
9. PCA - Principal Component Analysis-Finding Principal Components, Variance and Standard Deviation calculations of principal components
10. K-means clustering
11. Hierarchical Clustering
12. MBA Rule based learning
13. Hidden markov model

List of Course Projects: USE the UCI ML or KDD Repository or any other dataset

1 Stock Market Price Prediction
2 Housing Prices Prediction
3 Sign Text Identification
4 Iris Flowers Classification
5 Fake News Detection
6 Product Delivery Drones
7 Smart City Water / Light Management System
8 Human Tracking System
9 Automatic Interview Conduction System
10 Student Information Chatbot Project.
11 Product Review Analysis for Genuine Rating.
12 Customer Targeted E-Commerce
13 MNIST Digit Classification
14 Bit coin Price Predictor
15 Credit Card Fraud Detection
16 Customer Segmentation
17 Design and apply ML techniques to solve real life problems

List of Course Seminar Topics:

1. Streaming Machine Learning Techniques
2. Error Analysis In Machine Learning
3. Parallel Infrastructures Such As Map-Reduce For ML
4. Ensemble Learning
5. Backpropagation Algorithm.
6. Practical Techniques For Reducing The Memory Requirements: Feature Hashing
7. Support Vector Machine
8. Practical Techniques For Reducing The Memory Requirements: Bloom Filters
9. Genetic Algorithm
10. Regression Analysis
11. K Means Algorithm
12. Decision Tree Learning Algorithm
13. Bayesian Learning, Bayes Theorem and Naïve Bayes Theorem.
14. Hidden Markov Model,
15. Principal Component Analysis (PCA)
16. Recommender Systems
17. Occam's Razor Principle and Overfitting Avoidance Heuristic Search in inductive Learning

List of Course Group Discussion Topics:

1 Machine Learning And Artificial Intelligence
2 Machine Learning And Data Science
3 Machine Learning Applications
4 Machine Learning Future
5 Machine Learning After 10 Years / 2030
6 Supervised Learning Techniques And Unsupervised Learning Techniques
7 Reinforcement Learning
8 Recommender Systems
9 Will Automation and ML Reduce Or Increase Jobs.
10 Cashless Economy Using ML
11 ML In Covid-19 Situations

List of Design based Home Assignments:

Design:
1. Heart Disease Prediction Using Machine Learning Algorithms
2. Detection Based Project For Social Cause
3. Classification Based Project For Social Cause
4. Clustering Based Project For Social Cause
5. Optimization Based Project For Social Cause
6. Recommender Systems Based Project For Social Cause
7. Identification Based Project For Social Cause
8. Machine Learning-Based Student's Native Place Identification For Real-Time

Case Study:
1. How Auto industry is preparing For The 4th Industrial Revolution using ML
2. How Indian Retail Giant Is Using ML to Prepare for the 4th Industrial Revolution
3. Rolls-Royce and Google Partner to Create Smarter, Autonomous Ships Based On ML
4. The Amazing Ways Tesla Is Using Machine Learning and Big Data
5. The Incredible Ways John Deere Is Using Machine Learning To Transform Farming

Blog

1. Machine Learning for Sentiment Analysis
2. Machine Learning for Character Recognition
3. Machine Learning for Heart Disease Detection
4. Machine Learning for Chatbot Development
5. Machine Learning for Agriculture
6. Machine Learning for Medical Field

Surveys
1. Adaption of Machine Learning ML AI in 2020
2. Machine Learning in Industry
3. Machine Learning in Digital Marketing
4. Machine Learning in Military
5. Machine Learning after Covid-19

Assessment Scheme: Ensures 360 degree assessment and covers all aspects of Bloom's Taxonomy.
Laboratory Continuous Assessment: 100 Marks converted to 10 Marks
Course Project: End Semester Examination: 100 Marks converted to 20 Marks
Presentation: End Semester Examination: 100 Marks converted to 20 Marks
Theory: End Semester Examination (Written): 60 Marks converted to 30 Marks
Comprehensive Viva Voce: End Semester Examination: 100 Marks converted to 20 Marks

Text Books:
1. T. Mitchell, "Machine Learning", McGraw-Hill, 1997.
2. Anup Kumar Srivastava, Soft Computing, Alpha Science International limited. 2009.

Reference Books:
1. Ethem Alpaydin, "Introduction to Machine Learning", MIT press, 2004.
2. Jacek M. Zurada, "Introduction to Artificial neural System", JAICO publishing house,2002.

MOOCs Links and additional reading material:
1 www.nptelvideos.in
2 www.coursera.com

Course Outcomes:
On the completion of course, student will able to
1. Demonstrate knowledge learning algorithms and concept learning
2. Develop various supervised machine learning algorithms in a wide range of real-world applications.
3. Understand a wide variety of Statistical learning algorithms and apply on different applications
4. Analyze the concept of Support Vector Machines, Naive Bayes Classifiers for learning linear and non-linear Classifiers
5. To analyze Decision Tree algorithms to solve problems of real world.
6. Demonstrate understanding of unsupervised learning, Reinforcement learning and their applications.

CO-PO Mapping:

	Program Outcomes (PO)												PSO			
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	3	2	3	1		1	1	1		2	2	2	3	
CO2	3	3	3	2	3	2		1	1	1		2	2	3	3	
CO3	2	3	3	3	3	2		1	1	1		2	2	3	3	
CO4	3	3	3	3	3	2		1	1	1		2	2	3	3	
CO5	3	3	3	3	3	2		1	1	1		2	2	3	3	
CO6	3	3	3	3	3	2		1	1	1		2	2	3	3	
Average	**3**	**3**	**3**	**2.66**	**3**	**1.83**		**1**	**1**	**1**		**2**	**3.0**	**2.83**	**3**	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
CO Attainment levels:
Co1 - Level 1
Co2 - Level 2
Co3 - Level 3
Co4 - Level 5
Co5 - Level 4
Co6 - Level 3

Future Course Mapping:
Soft Computing, Deep Learning

Job Mapping:
ML Scientist, ML Designer, ML Architectural Design, ML Developer, ML Data Analyst

FF No. : 654

ML3004: Cloud Computing

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Prerequisites: Operating Systems, Computer Networks, Database Management System

Course Objectives:

1. To become familiar with cloud computing and its ecosystem
2. To acquire basics of virtualization and its importance
3. To evaluate in-depth analysis of Cloud Computing capabilities and its services.
4. To configure and implement storage services.
5. To analyze different cloud-based services to meet a set of given requirements.
6. To design security aspects for cloud computing

Course Relevance: Cloud computing to enable transformation, business development and agility in an organization.

Unit-I Introduction to Cloud Computing **[4 Hrs]**

Recent trends in computing, Cluster computing, Distributed computing ,Evolution of cloud computing, Cloud versus traditional architecture, Cloud Computing Architecture, Google Cloud architecture, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Public cloud, Private cloud, Hybrid cloud, Community cloud

Unit-II Virtualization **[6 Hrs]**

Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine (VM), Compute options in the cloud, Exploring IaaS with Compute Engine,

Configuring elastic apps with auto scaling, Basics of virtualization and implementation challenges. System virtualization technologies-architectures and internals. KVM, Xen, VMware. Amazon Elastic Compute Cloud EC2 as computing service.

Memory virtualization-virtualization techniques, ballooning, deduplication and sharing. Network and storage virtualization, Virtual machine migration and replication techniquespre-copy and post-copy techniques, applicability to system availability.

Unit-III Cloud Services **[4 Hrs]**

Service Oriented Architecture (SOA), Web services, Web 2.0, Web OS. Introduction to IaaS, PaaS, SaaS. Cloud Platform and Management, Exploring PaaS with App Engine, Event driven programs with Cloud Functions, Containerizing and orchestrating apps with Google Kubernetes Engine Software as a Service (SaaS) Docker flow, orchestration with Docker, dynamic linking and legacy linking of containers. The GCP Console, understanding projects, Billing in GCP, Install and configure Cloud SDK, Use Cloud Shell, GCP APIs.

Unit-IV Cloud Storage **[4 Hrs]**

Storage options in the cloud, Structured and unstructured storage in the cloud, unstructured storage using Cloud Storage, SQL managed services, Exploring Cloud SQL, Cloud Spanner as a managed service, NoSQL managed service options, Cloud Datastore, a NoSQL document store, Cloud Bigtable as a NoSQL option. OpenStack: NOVA, Neutron, Keystone Cinder, Swift and Glances, VMware Suit, Apache Cloud Stack, Data Lakes, Snowflake.

Unit-V Service Management **[4 Hrs]**

Service Level Agreements (SLAs), Billing and accounting, Billing in GCP Cloud Security: Introduction to security in the cloud, the shared security model, Encryption options, Authentication and authorization with Cloud IAM, Identify Best Practices for Authorization using Cloud IAM., Introduction to configuration and management tools Ansible, Architecture of DevOps.

Unit-VI Cloud Network and Security **[6 Hrs]**

Introduction to networking in the cloud, defining a Virtual Private Cloud, Public and private IP address basics, Google's network architecture, Routes and firewall rules in the cloud, Multiple VPC networks, building hybrid clouds using VPNs, interconnecting, and direct peering, Different options for load balancing. Introduction to security in the cloud, the shared security model, Encryption options,.

List of Tutorials (Any Thirteen)

List of Tutorials:

Unit-I Introduction to Cloud Computing

1)Install VirtualBox/VMware Workstation with different Linux or Windows Operating Systems.

2) Study Google Cloud Architecture.

Unit-II Virtualization

3) Find a procedure to launch virtual machine

4) Find a procedure to transfer the files from one virtual machine to another virtual machine.

Unit-III CloudServices

5) Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.

6)Install Google App Engine. Create Hello World App and other simple web applications using python/java.

Unit-IV Cloud Storage

7) Launch the Web Applications using GAE launcher.

8) Install Hadoop single node cluster and run simple applications like wordcount.

Unit-V Service Management

9) Use AWS Pricing Calculator: Create estimate for EC2 Compute cost for VM instance. Use region closest to you. Find On demand cost and compare the pricing for other regions.

Unit-VI Cloud Network and Security

9) Launch EC2instane and explore Public/Private/Elastic IP

Practicals:

List of Practical's (Any Six)

Unit-I Introduction to Cloud Computing

1) To setup AWS accounts and launch instances.

Unit-II Virtualization

2) To install an OS using VirtualBox/ VMWare Workstation. Add Storage to create new virtual disk.

3) To Deploy Virtual Machine on hypervisor such as KVM, ESXi. Take Backup and Migrate them.

Unit-III Cloud Services

4) To use Infrastructure as a Service to facilitates for creating and deleting compute resources. Create network and attach volumes to run instances.

5) To install docker on window/linux and build docker image from docker hub.

6) Deploy a stateless/stateful application on Kubernetes cluster.

Unit-IV Cloud Storage

7) To work on different Cloud Storage Services.

Unit-V Service Management

8)To create login into AWS and use S3 Bucket Service for storage.

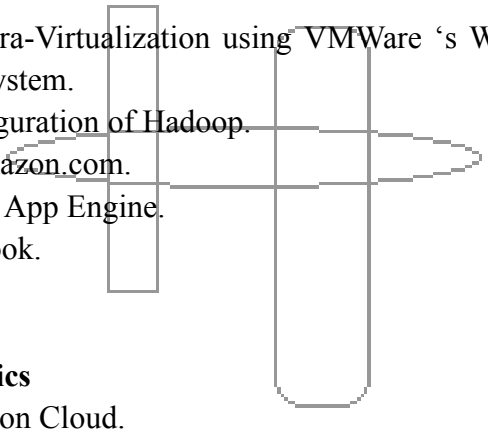
Unit-VI Cloud Network and Security

9) Develop elastic services for dynamic load scenario using AWS APIs. Build load balancer and explore on scalability, fault detection and performance.

Course Projects:

List of Course Project Topics

1. Creating Google Account to store files and programs.
2. Creating Account to Store Images.
3. Creating a Warehouse Application in SalesForce.com
4. Creating an Application in SalesForce.com using Apex programming Language.
5. To study and implement Web services in SOAP for JAVA Applications.
6. Implementation of Para-Virtualization using VMWare 's Workstation/ Oracle's Virtual Box and Guest Operator System.
7. Installation and Configuration of Hadoop.
8. AWS Case Study: Amazon.com.
9. Case Study of Google App Engine.
10. Case Study of Face book.



Seminars:

List of Course Seminar Topics

1. Storage Cost Optimization on Cloud.
2. Cloud Security and Cryptography
3. Infrastructure as a Code (IAC)
4. Cloud Computing in Healthcare
5. Serverless
6. Deployment of Microservices in Kubernetes Engine
7. RPA Using AWS Cloud
8. Cloud Trends in Supporting Ubiquitous Computing
9. Mobile Cloud Computing
10. Modern Data Center Architecture

Group Discussion:

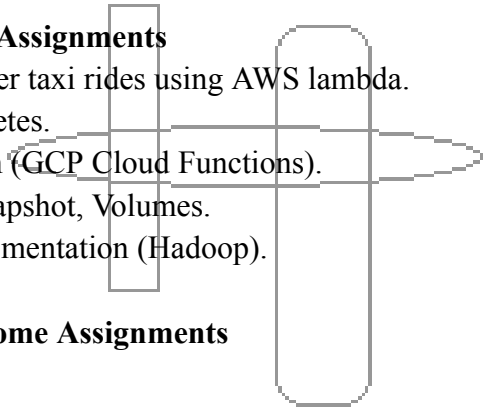
List of Group Discussion Topics

1. Data Storage Security in Cloud
2. Cloud Services for SMB's.
3. Monitoring Services Provided by GCP and AWS.
4. Docker and Kubernetes.
5. SaaS vs FaaS (Function as a service).
6. Hybrid Cloud.
7. GCP Vs AWS Web Service Architecture.
8. Cloud based security issues and threats.
9. Authentication and identity.
10. Future of Cloud-Based Smart Devices.

List of Home Assignments:

List of Design Based Home Assignments

1. Serverless Web App to order taxi rides using AWS lambda.
2. Deploying App on Kubernetes.
3. Serverless web Application (GCP Cloud Functions).
4. Demonstration of EBS, Snapshot, Volumes.
5. Single Node Cluster Implementation (Hadoop).



List of Case Study Based Home Assignments

1. PayU Migration to AWS.
2. Cloud object storage.
3. Deployment and Configuration options in AWS.
4. Deployment and Configuration options in Microsoft Azure.
5. Deployment and Configuration options in GCP.

List of Blog Based Home Assignment

1. Comparing design of various cloud computing platforms.
2. AWS EKS and Google Cloud Functions.
3. App Engine.
4. Cloud Endpoints.
5. Cloud Pub/Sub.

List of Survey Based Home Assignments

1. Disaster Recovery in Cloud Computing.
2. Cloud Economics.
3. Data archiving solutions.
4. Salesforce.
5. Dropbox.

Assessment Scheme: Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Bloom's Taxonomy.

Laboratory Continuous Assessment: 100 Marks converted to 10 Marks
Course Project: End Semester Examination: 100 Marks converted to 20 Marks
Presentation: End Semester Examination: 100 Marks converted to 20 Marks
Theory: End Semester Examination (MCQ): 60 Marks converted to 30 Marks
Comprehensive Viva Voce: End Semester Examination: 100 Marks converted to 20 Marks

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

1. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, "Cloud Computing for Dummies", Wiley,India.
2. Ronald Krutz and Russell Dean Vines, "Cloud Security", Wiley-India
3. Gautam Shroff. "Enterprise Cloud Computing", Cambridge

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

1. Barrie Sosinsky, "Cloud Computing Bible", Wiley India
2. Antohy T Velte, et.al, "Cloud Computing : A Practical Approach", McGraw Hill.
3. Michael Miller, "Cloud Computing", Que Publishing.
4. Tim Malhar, S.Kumaraswammy, S.Latif, "Cloud Security & Privacy", SPD,O'REILLY
5. Scott Granneman, "Google Apps", Pearson

MOOCs Links and additional reading material:

https://nptel.ac.in/courses/106/105/106105167/
https://swayam.gov.in/nd1_noc20_cs55/preview
https://www.coursera.org/specializations/cloud-computing
https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/
https://aws.amazon.com/what-is-cloud-computing/
https://www.ibm.com/in-en/cloud/learn/cloud-computing

Course Outcomes:

On the completion of course, student will able to

1. Describe the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Explain the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Identify problems, and explain, analyze, and evaluate various cloud computing solutions.
4. Choose the appropriate technologies, algorithms, and approaches for the related issues.
5. Display new ideas and innovations in cloud computing.
6. Collaboratively research and write a paper on the state of the art (and open problems) in cloud computing.

CO-PO Map:

CO	Program Outcomes (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO 1	PSO 2	PSO 3	
CS3226.1	2	1			1								2	2	3	
CS3226.2	2	2	1	1	1								2	2	3	
CS3226.3	3	2	2	2	2		3	3					2	2	3	
CS3226.4	3	2	2	2	3	3			3				2	2	3	
CS3226.5	3	3	1	3	3				1		2		2	2	3	
CS3226.6	2	2	1	3	1					3			2	2	2	
Average	2.50	2.00	1.40	2.20	1.83	3.00	3.00	3.00	2.00	3.00	2.00		2.0	2.0	2.83	

CO attainment levels:

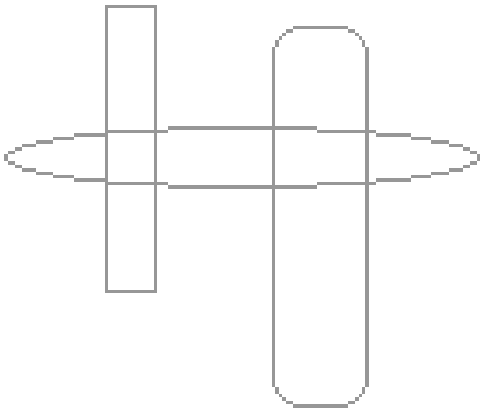
Attainment Levels:1,2,3,5,4,3

Future Course Mapping:

After completing this course different certifications courses in cloud be taken such as AWS, Azure, Google cloud certifications. One can go for higher studies in specialization of cloud computing and allied subjects

Job Mapping:

Cloud Architect, Cloud Engineer, Cloud Administrator, Solutions Architect - Cloud Computing - AWS / Kubernetes, Cloud Computing Technical Consultant, Associate Cloud Computing Engineer, Cloud Computing Trainer

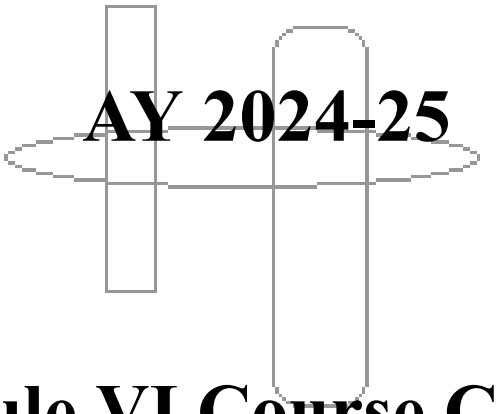


Syllabus Template **FF No. : 654**

Coursera Courses [VI] **Credits: 4**

Sr. No.	Course code	Specialization Name	Link
1	MD3101:	IBM Full Stack Software Developer	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/ibm-full-stack-cloud-developer?source=search
2	MD3103	IBM Back-End Developer	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/ibm-backend-development?source=search
3	MD3116	IBM Data Engineering	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/ibm-data-engineer?source=search
4	MD3118	IBM Data Science	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/ibm-data-science?source=search
5	MD3120:	IBM Data Warehouse Engineer	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/salesforce-sales-operations?source=search
6	MD3121:	IBM DevOps and Software Engineering	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/microsoft-cybersecurity-analyst?source=search
7	MD3130	IBM Mainframe Developer	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/data-warehouse-engineering?source=search
8	MD3135:	Salesforce Sales Development Representative	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/ibm-data-science?source=search
9	MD3142	Google UX Design	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/google-ux-design?source=search

T.Y. B.Tech. Computer Science & Engineering (Artificial Intelligence and Machine Learning)



AY 2024-25

Module VI Course Content

FF No. :654

ML3008:Software Engineering

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Objectives:

1. To summarize capabilities and impact of software development process models and justify process maturity through application of Software Engineering principles and practices,
2. To differentiate feasible and competing system requirements, indicating correct real world problem scope and preparing stepwise system conceptual model,
3. To formulate system specifications by analyzing user-level tasks and compose software artifacts using agile principles, practices and scrum framework,
4. To compose system analysis and design specifications using UML diagrams,
5. To design a system architecture and map it with a suitable architectural style,
6. To comprehend the nature of design patterns and apply these patterns in system design.

Course Relevance:

Given that Software Engineering is built upon the foundations of Computer Science as well as Computer Engineering, a Software Engineering curriculum can be focused on two perspectives - a Computer Science-first or Software Engineering-first perspective. Software engineering spans the entire software lifecycle. It involves creating high-quality and reliable programs in a systematic, controlled, and efficient manner using formal methods for specification, analysis, design and evaluation of proposed systems. It requires suitable software development techniques and processes that successfully scale to large applications, which should satisfy timing, size, and security requirements all within acceptable application/project budgets and deadlines. For these reasons, Software Engineering requires both the analytical and descriptive tools and techniques developed in Computer Science and the rigor that the Computer Engineering discipline brings to the reliability and

trustworthiness of the systems that software developers design and implement, while working as a cohesive team.

Unit-I Software Engineering Paradigms: **05 Hours**

Process Models: Code-and-Fix Model, Waterfall Model, Rapid Application Development Model, Incremental Model, Evolutionary Model and Others.

Unit-II Requirements Engineering: **05 Hours**

Requirements Engineering Tasks, Requirement Elicitation Techniques, Functional, Non- Functional and Domain Requirements, Requirements Characteristics, Eliminating Requirement Ambiguities, Conflict Identification and Resolution, Requirement Qualities, Requirement Specification, System Scope Determination and Feasibility Study.

Unit-III Agile Methodology: **04 Hours**

Landscape of Agile and Planned Methods, Definition - Scrum, Scrum Origins, Scrum Framework, Agile Principles, Sprints, Requirements, User Stories, Product Backlog, Roles: Product Owner, Scrum Master, Development Team, Managers, Scrum Team Structures, Scrum Planning.

Unit-IV Static and Dynamic Interaction Modeling: **05 Hours**

Static Behavior: Use Case, Use Case Diagram, Class Diagram, Component Diagram, Deployment Diagram, Dynamic Behavior: Sequence Diagram, Collaboration Diagram, Activity Diagram, Communication Diagram, Interaction Diagrams.

Unit-VSoftware Architecture Design: **05 Hours**

Design Model, Design Qualities, Characteristics of Design Activities, Design Principles, Cohesion and Coupling, Software Architecture Vs Software Design, Software Reuse, Design Heuristics, Layered Architecture, Client-Server Architecture, Pipe-Filter Architecture, Model-View Controller Architecture.

Unit-VI Design Patterns: **04 Hours**

Definition, Describing Design Pattern,
Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype
Structural Patterns: Adapter, Bridge, Composite, Decorator, Façade,
Behavioral Patterns: Chain of Responsibility, Command, Interpreter.

List of Tutorials:

1. Requirement Engineering,
2. System Requirement Specification,
3. Scrum Artifacts,
4. User Stories and Use Cases,
5. Product Backlog Development,
6. Burn-up and Burn-down Chart Development and Management,
7. Software System Analysis and Design: UML Static Diagram,
8. Software System Analysis and Design: UML Dynamic Diagram,
9. Software Architecture Design,
10. Use of Design Patterns,
11. Software Testing,
12. Automated Testing,
13. Project Management Techniques.

List of Practicals (Minimum SIX):

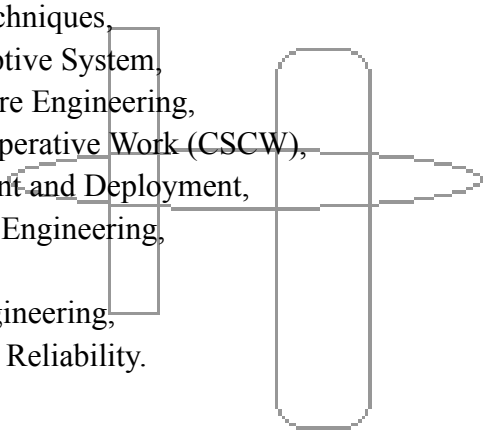
1. To prepare a Statement Of Work (SOW) document, which addresses the vision, goals and objectives of the real-world problem.
2. To prepare a Software Requirement Specification (SRS) document, based on several types of system requirements, such as functional and non-functional requirements.
3. To document a product backlog for the project aimed at maintaining a prioritized queue of project requirements.
4. To develop a Sprint-plan and Sprint-design indicating detailed activity planner accommodating user story points.
5. To prepare Class Collaboration-Responsibility (CRC) cards for the Conceptual classes traced from the system analysis phase.
6. To develop a static structure of the target system with a Class Diagram using all components of it.
7. To decompose and organize the problem domain area into broad subject areas and identify the use cases to show them in a Use Case Diagram.
8. To depict the dynamic behavior of the target system using Sequence Diagram. The Sequence diagram should be based on the scenarios generated by the inter-object Communication.
9. To depict the dynamic behavior using a detailed Activity Diagram.
10. To prepare an Architecture Diagram with appropriate design patterns. Suitable Architectural Styles shall be selected and the structural elements shall be well-documented.

List of Course Projects:

1. Automated Parking Lot Identifier,
2. Healthcare Software,
3. Financial Application,
4. Appraisal System,
5. Smart Project Administrative System,
6. Translator for Agriculture System,
7. Development of Applications using Agile Methodology,
8. Development of SMART Mobile Applications,
9. Graphics-based Password Identification System
10. System Security Application

List of Course Seminar Topics:

1. Mobile Apps and App Store Analysis,
2. Automated Reasoning Techniques,
3. Autonomic and Self-Adaptive System,
4. Component-based Software Engineering,
5. Computer-Supported Cooperative Work (CSCW),
6. Configuration Management and Deployment,
7. Crowd-Sourced Software Engineering,
8. Cyber-Physical System,
9. Data-driven Software Engineering,
10. Dependability, Safety and Reliability.



List of Home Assignments:

Design:

1. Software Visualization
2. Specification and Modeling Languages
3. Tools and Environments
4. Traceability
5. Ubiquitous and Pervasive Software Systems

Case Study:

1. Software Economics and Metrics
2. Machine Learning in Software Engineering
3. Software Evolution and Maintenance
4. Software Modeling and Design

5. Software Product Lines

Blog

1. Mining Software Engineering Repositories
2. Model-driven Engineering
3. Parallel, Distributed and Concurrent systems
4. Recommendation Systems
5. Refactoring

Surveys

1. Reverse Engineering
2. Safety-Critical Systems
3. Security, Privacy and Trust
4. Software Architecture
5. Software Reuse
6. Software Testing

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

1. Ian Sommerville, 'Software Engineering',Pearson, 10th Edition, 2017, ISBN-13: 978-9332582699.
2. Kenneth Rubin, 'Essential SCRUM: A Practical Guide To The Most Popular Agile Process', Addison-Wesley, 2012, ISBN-13: 978-0-13-704329-3.
3. Tom Pender, 'UML Bible', John Wiley & Sons, 2003, ISBN - 0764526049

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

1.Soren Lauesen,'Software Requirements: Styles and Techniques, Addison Wesley, 2002, ISBN 0201745704.
2. Dean Leffingwell,'Agile Software Requirements', Addison-Wesley, 2011, ISBN-13: 978-0-321-63584-6.
3. Grady Booch, James Rambaugh, Ivar Jacobson, 'Unified Modeling Language User's Guide', 2nd Edition, Addison- Wesley 2005, ISBN – 0321267974.
4. Erich Gamma, Richard Helm, Ralph Johnson,'Design Patterns: Elements of Reusable Object-Oriented Software', Addison-Wesley Professional, 1994, ISBN-13: 978-0201633610.
5. Paul Clements, Felix Bachmann, Len Bass, David Garlan, 'Documenting Software Architectures: Views and Beyond', Addison-Wesley Professional, 2003, ISBN-13: 9780201703726.

MOOCs Links and additional reading material:

www.nptelvideos.in, www.coursera.com, www.udemy.com

Course Outcomes:

The student will be able to –

1. Compare Software Development Process Models and justify process maturity through application of Software Engineering principles and practices,
2. Differentiate competing and feasible system requirements identifying problem scope in the real-world,
3. Apply agile principles and practices through scrum framework,
4. Design UML diagrams through efficient system analysis, using identified design specifications
5. Formulate system architecture as per a suitable architectural style,
6. Apply relevant design patterns for effective system design.

CO-PO Map:

	Program Outcomes (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	2	3	2									3	2	3		
2	2	3	2									3	2	3		
3	3	2	3		3	2	2	2			2	3	2	3		
4	3	2	3		3	2	2	2	2		2	3	2	3		
5	3	2	3		3	2	2	2			2	3	2	3		
6	3	2	3		3	2	2	2		3	2	3	2	3		
Average	2.66	2.33	2.66		3	2	2	2	2.0	3.0	2.0	3.0	2.0	3.0		

CO Attainment levels

Weights for attainment levels: L1 - Easy- 0.75 L2 - Comfortable - 0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

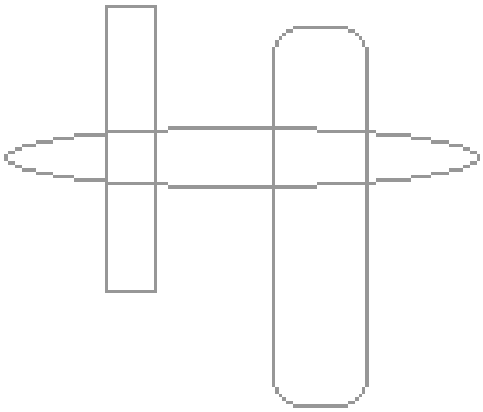
CO1 – L1, CO2 – L2, CO3 – L3, CO4 – L4, CO5 – L4 and CO6 – L5

Future Course Mapping:

Software testing and Quality Assurance, Service-Oriented Software

Job Mapping:

Application Architect, Project Designer, SCRUM Role Player, Project Manager



FF No. : 654

ML3009:: Cyber Security and Blockchain

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Prerequisites: Computer Networks

Course Objectives:

1. Apply cryptographic techniques and security protocols to secure systems and networks.
2. Identify, resolve, and mitigate programming bugs and cyber threats.
3. Design secure systems using blockchain technology and ensure application security.
4. Understand and apply cloud security and physical security principles.
5. Integrate AI in cyber security and develop business continuity and disaster recovery plans.
6. Implement ethical hacking practices and perform effective penetration testing.

Course Relevance:
Cyber Security teaches how to protect operating systems, networks, and data from cyber attacks, monitor systems, and mitigate threats, aiming to develop skills to prevent attacks and protect data privacy.

Unit 1: Information security

- **Key Security Properties:** Confidentiality, Integrity, Availability.
- **Risk Management:** Understanding governance policies, frameworks, laws, regulations, guidelines, and compliance.
- **Symmetric Key Cryptography:** Role of random numbers and nonce in security, importance of prime numbers, GCD, Euclid's Algorithm, Extended Euclid's algorithm.
- **Data Encryption Standard (DES):** Block cipher, stream cipher, Feistel structure, block cipher modes, S-DES, attacks on DES, S-AES, AES.

- **Public Key Cryptography:** RSA algorithm, key generation, attacks on RSA.
- **Elliptic Curve Cryptography (ECC):** Elliptic curves over real numbers and Zp, elliptic curve arithmetic.

Unit 2: Network Security

- **Certificates and Hashing:** Properties of hash functions, HASH + SALT, hashing algorithms (SHA1, SHA2).
- **Authentication and Authorization:** Network access control (SHA-512, Kerberos, and multifactor authentication).
- **Transport-Level Security:** Web security considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS standard, Secure Shell (SSH) application, IPSec.
- **Application Security:** Security by design, writing secure code, static and dynamic application security testing (SAST and DAST), interactive application security testing (IAST), Integrated Security in DevOps, OWASP, Application Security Services,

Unit3: Cyber Attacks and Penetration Testing (06 Hours)

- **Cyber Ethics:** Threats, threat modeling, injections, sniffing, and types of attacks.
- **Security Vulnerabilities:** risk, attack types, countermeasures.
- **Protocol Vulnerabilities:** DoS and DDoS, session hijacking, ARP spoofing.
- **Software Vulnerabilities:** Phishing, buffer overflow, cross-site scripting attack, ransomware, SYN-flooding, SQL-injection, DNS poisoning.
- **Penetration Testing:** Difference from automated vulnerability scans, objectives and limitations of a pen test, scoping and planning pen tests, executing pen tests and managing findings. Introduction to SDL (Secure Development Lifecycle) – Merging Security into SDLC,

Unit 4 : Physical Security and Forensics (04 Hours)

- **Physical Security:** Physical access types, crime prevention through environmental design (CPTED).
- **IoT Security:** Definitions of OT, IoT, IIoT, and ICS, most widely used protocols in IoT environments (MQTT and CoAP).
- **Business Continuity (BC):** RTP/RPO, RTO, MTPD, ISO 22301 standard for business continuity management, importance, differences between BCMS and DRMS, risk management, testing, maintenance., Operation Resilience,
- **Digital Forensics:** Introduction to digital forensics, data recovery, OS forensics, email crimes and violations, cyber forensics.

Unit 5 :Cloud Security

Principles / Key Concepts of Cloud Security: Overview of cloud security principles and key concepts.

- **Threats and Risks in Cloud Security:** Diverse types of threats and risks associated with cloud security.
- **Importance of Security Measures in Cloud Security:** Importance of implementing security measures in cloud environments.
- **Solutions for Cloud Security:** Effective solutions to address cloud security challenges.

Role of AI in Cyber Security: Examination of how AI is integrated into cyber security.

- **Challenges and Opportunities of AI in Cyber Security:** Analysis of the challenges and opportunities presented by AI in the field of cyber security.

Unit 6 : Introduction to Blockchain

- **Decentralized Systems & Distributed Ledger Technology:** Blockchain computing power, hash, and Merkle tree with hands-on examples.
- **Use-Cases of Blockchain:** Different types of blockchain including public and private blockchain, consensus and types of consensus with examples.
- **Smart Contracts:** Need for smart contracts, developing smart contracts, programming basics of Solidity (data types) and advanced Solidity, EVM in relation to smart contracts and gas price, running and debugging smart contracts in Remix, deploying and debugging smart contracts with Truffle.

List of Tutorials (13)

1.Mathematical background for cryptography: modulo arithmetic, GCD (Euclid's algorithm), algebraic structures (Groups, Rings, Fields, Polynomial Field).

2.Chinese remainder theorem.

3. Diffie-Hellman key exchange: Algorithm, Key exchange protocol, Attack.

4. ECC over Diffie-Hellman key exchange.

5. Study of certificates and hashing algorithms.

6. Network access control and transport-level security.

7. Security by design and writing secure code.

8. Static and dynamic application security testing.

9. Study of Snort.

10. Nessus: a Security Vulnerability scanning tool.

11. Metasploit/Ollydbg.

12. Testing for Brute Force Password.

13. Testing for SQL Injection.

14. Computer forensics, Facebook forensic, mobile forensic, cyber forensic, digital forensic.

15. Source Code Analysis Tools.

16. OWASP Zed Attack Proxy (ZAP).

17. Study of various types of Blockchain, Connecting the Metamask wallet with the local Ganache network.

18. Simulation of Blockchain.

19. Creating Smart Contract using Solidity and Remix IDE.

20. Study of DOA and DAPP.

List of Practicals (Minimum Six)

Section-I:

- Simplified DES implementation.
- Simplified AES implementation.

- Encryption and Decryption by RSA algorithm.
- Implementation of ECC over Diffie Hellman Key Exchange Protocol.

- Implementation of authentication algorithms.
- Implementation of SHA.

Section-II:

- Acquisition of System Information/ RAM/Volume Shadow Copy/Detecting Encryption in information.
- Vulnerabilities finding in Mobile/ computer/ digital devices.
- Forensic of Disc Image/ Registry/ Meta data/ RAM.
- Digital forensic of images.
- Forensics of Video alteration.
- Implement and demonstrate the use of the following in Solidity: Variable, Operators, Loops, Decision Making, Strings, Arrays, Enums, Structs.
- Implement and demonstrate the use of the following in Solidity: Functions, Function Modifiers, View functions, Pure Functions, Mathematical functions, Cryptographic functions.
- Use Geth to configure a private Blockchain node in our machine.
- Cryptography in Blockchain, Merkle root tree hash.
- Creating Transactions using Solidity and Remix IDE.
- Case Study on Hyperledger Fabric.

List of Course Project areas:

Course Project 01 Statement: Design a System to develop a analyzer which will differentiate between different vulnerability and packets entered using it. This system will detect the intrusions coming through the vulnerabilities.

Course Project 02 Statement: Securing Video Conferencing App for online meetings

Course Project 03 Statement: Steganography for Image/Video/Files

Course Project 04 Statement: Secure Image display on online social media.

Course Project 05 Statement: Secure transfer of government subsidies to farmers/BPL people/ students etc

Course Project 06 Statement: Authentication of users for various applications for integrity, availability, confidentiality.

Course Project 07 Statement: Implementing a system for detecting the modification of videos/images on social media

Course Project 08 Statement: Secure App for online exams detecting Keystroke and camera movements.

Course Project 09 Statement: A system to detect the difference between the voice edited in the audio/video

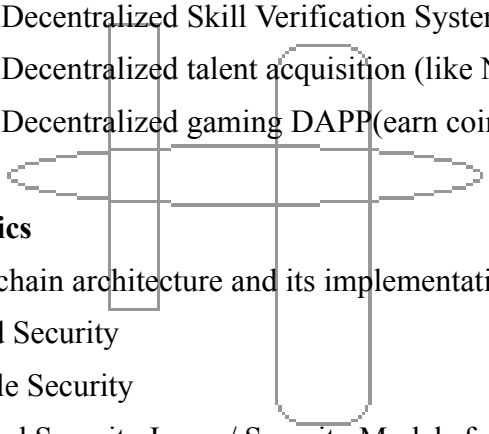
Course Project 10 Statement: A System to check the vulnerabilities in the websites.

Course Project 11 Statement: Decentralized (Uber)Peer to Peer Carpooling

Course Project 12 Statement: Decentralized Skill Verification System

Course Project 13 Statement: Decentralized talent acquisition (like Nokari.com)

Course Project 14 Statement: Decentralized gaming DAPP(earn coin through game)



List of Course Seminar Topics

Seminar 01 Statement: Blockchain architecture and its implementation

Seminar 02 Statement: Cloud Security

Seminar 03 Statement: Mobile Security

Seminar 04 Statement: IoT and Security Issues/ Security Models for IoT

Seminar 05 Statement: Dark web

Seminar 06 Statement: Docker Security

Seminar 07 Statement: Access control methods for online social media and various organizations

Seminar 08 Statement: Security of Android Vs IOS

Seminar 09 Statement: Machine learning and SCADA Security

Seminar 10 Statement: Security Applications for Smart

List of Design Based Home Assignments

HA_D 01 Statement: Design a secure system using cryptography techniques for security of multimedia files.

HA_D 02 Statement: Design a secure system using steganography for hiding data files in image/video

HA_D 03 Statement: Design a system for educational institutes using authentication and authorization techniques, also give details about the access control policies that must be implemented for the design of system by various places.

HA_D 04 Statement: Design a secure system using SSL/TLS/IPSec for the various organizations

HA_D 05 Statement: Design a system for the analysis of cyber crime using various cyber forensic techniques and compare each technique with respect to integrity, confidentiality, availability

List of Case Study Based Home Assignments

HA_CS 01 Statement: How to improve the security of social media? Write a detail case study

HA_CS 02 Statement: Find out the vulnerability issues in educational institutes websites/online systems and give solutions to these problem. Perform a detailed case study of the various issues.

HA_CS 03 Statement: Write a detail case study about the banking security flows and solutions to these flows.

HA_CS 04 Statement: Give a detail case study of the antivirus system giving the flows and solutions to it.

HA_CS 05 Statement: Perform the detail case study of various operating systems used for mobile devices and give a secure solution to one for widely used OS.

List of Blog Based Home Assignment

HA_Blog 01 Statement: Dark Web

HA_Blog 02 Statement: Crypto currency and Economy

HA_Blog 03Statement:.Cybercrime and solutions

HA_Blog 04 Statement: Authentication and Access control for social media

HA_Blog 05 Statement: Cyber forensic and Cyber laws

List of Survey Based Home Assignments

HA_Survey 01 Statement: Survey on various blockchain related issues/ cryptocurrency/ application systems developed using blockchain

HA_Survey 02 Statement: Survey on various authentication and access control methods for different applications

HA_Survey 03 Statement: Steganography and Biometric Systems for authentication

HA_Survey 04 Statement: Survey of various attacks and its effect on Indian economy and its analysis

HA_Survey 05 Statement:Problems over Integer Lattices: A Study

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

1. William Stallings, "Cryptography and Network Security-Principles and Practices" 6th Edition, Pearson Education, 2014, ISBN13:9780133354690.
2. Bernard Menezes, "Network Security and Cryptography", 1st Edition, Cengage Learning, 2010, ISBN 81-315-1349-1.
3. Raef Meeuwisse, "Cybersecurity for Beginners", 2nd Edition, Cyber Simplicity, 2017, ISBN-9781911452157
4. AmbadasTulajadasChoudhari, Arshad SarfarzAriff, Sham M R, "Blockchain for Enterprise Application Developers" Willey publications, ISBN: 9788126599967,2020

Hyperledger Fabric - https://www.hyperledger.org/projects/fabric

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

1. M. Speciner, R. Perlman, C. Kaufman, "Network Security: Private Communications in a Public World", Prentice Hall, 2002
2. Michael Gregg, "The Network Security Test Lab: A Step-By-Step Guide", Dreamtech Press, 2015, ISBN-10:8126558148, ISBN-13: 978-8126558148.
3. Matt Bishop, "Computer Security: Art and Science", 1st Edition, Pearson Education, 2002, ISBN 0201440997.
4. Charlie Kaufman, Radia Perlman and Mike Spencer, "Network security, private communication in a public world", 2nd Edition, Prentice Hall, 2002, ISBN 9780130460196.
5. V.K. Pachghare, "Cryptography and Information Security", 2nd Edition, PHI, 2015, ISBN-978-81-203-5082-3.
6. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Bashir, Imran,2017.

Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016

MOOCs Links and additional reading material:

1. Cryptography And Network Security By Prof. Sourav Mukhopadhyay, IIT Kharagpur Cryptography and Network Security - Course (nptel.ac.in)
2. Information Security and Cyber Forensics By Prof. Pratosh Bansal Devi Ahilya Vishwavidyalaya, Indore, Information Security and Cyber Forensics - Course (swayam2.ac.in)
3. Blockchain and its Applications By Prof. Sandip Chakraborty, Prof. Shamik Sural IIT Kharagpur Blockchain and its Applications - Course (nptel.ac.in)

Course Outcomes:

The student will be able to –

1. Demonstrate cryptographic techniques using a mathematical approach by examining nature of attack.
2. Design a secure system for protection from the various attacks for 7 layer model by determining the need of security from various departments of an organization
3. Justify various methods of authentication and access control for application of technologies to various sections of industry and society.
4. Identify and establish different attacks on the system.
5. Estimate future needs of security for a system by researching current environment on a continuous basis for the benefit of society.
6. Analyze the need of Decentralized system and implement using blockchain technology.

CO-PO Map:

CO	Program Outcomes (PO)												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3	
1	3	3		3	2	2		3	1				3		1	
2	3	2	3	2			2	3	3	3	2					
3	2	3	3		1	2		3	1						1	
4	3	3	1	3	3	3	3	3	1					3	1	
5	2	2	3	2	1		2		3	3	3					
6	3	2	1	1	3	3	3	3			3			3	3	
Avg	2.6	2.5	2.2	2.2	2	2.5	2.5	3	1.8	3	2.67		3	3	1.5	

CO Attainment levels:

Attainment Levels: 3,4, 2, 1, 5, 3

Future Course Mapping:

Cloud Computing and Security, IoT Security, Ethical Hacking &Cyber Forensics

Job Mapping:

Security Engineer/Network Security Engineer

Information Security Analyst

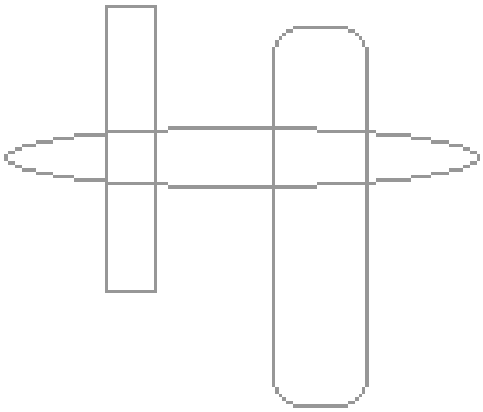
Cyber Security Analyst

Cyber Security Associate

Manager-Information Security Services

Security Consultant

Penetration Testing Engineer



FF No. :654

ML3010: DEEP LEARNING

Teaching Scheme

Theory: 2 Hours/Week **Lab: 2 Hours/Week**

Tutorial: 1 Hours/Week

Credits: 4

Course Objectives:

1. To understand the basic neural network architectures and learning algorithms
2. To understand the Forward and backward propagation NN and techniques to improve network performance
3. To understand the importance of deep learning and is variants
4. To understand the basics of sequential models of NN
5. To build deep nets with applications to solve real world problem

Course Relevance:

Deep learning is revolutionizing the technology and business world today. It is a subfield of machine learning concerned with algorithms to train computers to perform tasks by exposing neural networks to large amounts of data, its analysis and prediction. It is an incredibly powerful field with capacity to execute feature engineering on its own, and uses multiple neural network layers to extract patterns from the data. Top applications of Deep learning involve, self-driving cars, natural language processing, robotics, finance, and healthcare

Section 1: Topics/Contents

Unit-I: Fundamentals of Neural Network [4 Hours]

Foundations of neural networks and deep learning, Difference between Artificial intelligence , Machine learning and Deep learning Logistic regression as a neural network, Single Layer Neural Network, Multilayer Perceptron: Linearly separable, linearly non-separable classes
logistic regression cost function, logistic regression gradient descent,

Unit-II: Training, Optimization and Regularization of Deep Neural Network [6 Hours]

Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function

Optimization Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp

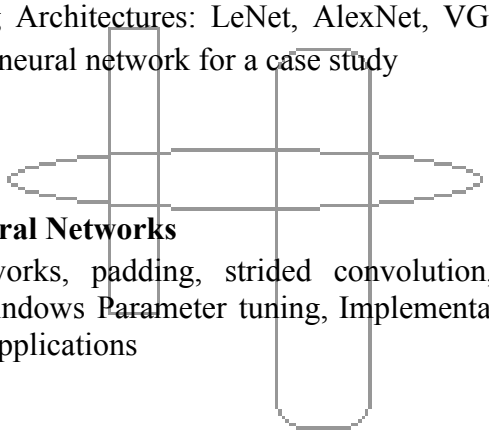
Hyperparameter tuning batch normalization, data augmentation

Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output

Unit-III Title: Deep Neural Network [4 Hours]

Deep learning vs Machine Learning, Deep learning frameworks, Types of Deep Learning, Applications, Deep Learning Architectures: LeNet, AlexNet, VGG, GoogLeNetResNet, inception networks, Implementation of neural network for a case study

Section 2:Topics/Contents



Unit-IV: Convolutional Neural Networks [5 Hours]

Convolutional Neural Networks, padding, strided convolution, pooling layers, convolutional implementation of sliding windows Parameter tuning, Implementation of neural network for a case study, case study: Real time applications

Unit-V: Sequencing Modeling [5 Hours]

Sequence modeling: recurrent nets RNN architecture, bidirectional RNNs, Long Short Term Memory (LSTM) ,Vanishing and exploding gradient problem, Auto encoders, Applications & use cases.

Unit-VI: Recent Trends and Applications of Deep Learning [4 Hours]

Applications of Deep Learning : object detection and classification, face recognition, voice recognition, Semantic Analysis, Introduction to Generative AI Models: Generative Adversarial Networks (GANs), Architecture, Difference between Discriminative and Generative Models, Introduction to LLM

List of Practical :

1. Implementing Feed-forward neural networks with Keras and TensorFlow
    a. Import the necessary packages
    b. Load the training and testing data (MNIST/CIFAR10)
    c. Define the network architecture using Keras
    d. Train the model using SGD
    e. Evaluate the network
    f. Plot the training loss and accuracy
2. Multiclass classification using Deep Neural Networks: Example: Use the OCR letter recognition dataset https://archive.ics.uci.edu/ml/datasets/letter+recognition
3. Convolutional neural network (CNN) of plant disease and design a plant disease detection system using CNN.
4. Build the Image classification by dividing the model into the following stages:
    a. Loading and preprocessing the image data
    b. Design the Model Architecture
    c. Training the model
    d. Estimating the model's performance
    e. Comparative analysis on different optimizer
    f. Save the Model
5. Object detection using Transfer Learning of CNN architectures .
    g. Load in a pre-trained CNN model trained on a large dataset
    h. Freeze parameters(weights) in the model's lower convolutional layers
    i. Add a custom classifier with several layers of trainable parameters to model
    j. Train classifier layers on training data available for the task
    k. Fine-tune hyperparameters and unfreeze more layers as needed
6. Recurrent neural network (RNN) Use the Google stock prices dataset and design a time series analysis and prediction system using RNN.
7. Build and train a CNN model to classify X-ray images into categories (e.g., pneumonia vs. normal). Implement data preprocessing, augmentation, and evaluation metrics.
8. Binary classification using Deep Neural Networks Example: Classify movie reviews into positive" reviews and "negative" reviews, just based on the text content of the reviews. Use IMDB dataset
9. Linear regression by using Deep Neural network: Implement Boston housing price prediction problem by Linear regression using Deep Neural network. Use Boston House price prediction dataset.

10. Implement transfer learning using a pre-trained model (e.g., VGG16, ResNet) and fine-tune it for a new image classification task.
11. Use MNIST Fashion Dataset and create a classifier to classify fashion clothing into categories.
12. Build a deep learning model to segment brain tumors from MRI scans, identifying tumor regions in the brain.
13. Develop a deep learning model to classify skin lesions into various types of skin cancer (e.g., melanoma, basal cell carcinoma, etc.).

List of Seminar Topics:

1. Deep learning for Stock Market Clustering
2. Application of Deep Networks in health care
3. Credit card fraud detection
4. Classification of skin cancer with deep neural networks
5. ALEXNET
6. VGGNET
7. Accelerating Deep Network Training by Reducing Internal Covariate Shift
8. Deep learning applications for predicting pharmacological properties of drugs
9. GAN (Generalized Adversarial network)
10. Auto encoders
11. LSTM

List of Course Group Discussion Topics:

1. Recurrent or Recursive Networks for sequential Modeling?
2. Initializing network weights vs performance
3. Difficulty of training deep feedforward neural networks
4. Hyperparameter tuning: Is there a rule of thumb?
5. Problem of overfitting: How to handle it?
6 Which cost function: Least squared error or binary cross entropy?
7. How to tackle with loss of corner information in CNN
8. Need of hundred classifiers to solve real world classification problem
9. Which optimization: Batch gradient descent of stochastic gradient descent
10. Activation functions: Comparison of trends
11. Remedy of problem of vanishing gradient and exploding gradient in RNN

List of Design based Home Assignments:

Design:

1. Deep learning for library shelf books identification
2. Development of control system for fruit classification based on convolutional neural networks
3. Classifying movie review using deep learning
4. Sentiment analysis of the demonetization of economy 2016 India
5. Predicting Students Performance in Final Examination
6. Identify and Apply deep learning algorithm to solve real life problems

Case Study:

1. Deep learning for security
2. Bag of tricks for efficient text classification
3. Convolutional Neural Networks for Visual Recognition
4. Deep Learning for Natural Language Processing
5. Scalable object detection using deep neural networks

Blog

1. Brain tumor segmentation with deep neural networks
2. Region-based convolutional networks for accurate object detection and segmentation
3. Human pose estimation via deep neural networks
4. Content Based Image Retrieval
5. Visual Perception with Deep Learning
6. Music genre classification system

Surveys:

1. Machine translation using deep learning - survey
2. Shaping future of radiology using deep learning
3. Training Recurrent Neural Networks
4. Text generation with LSTM
5. Deep learning applications in Biomedicine

Text Books:

1. Goodfellow, I., Bengio, Y., and Courville, A., Deeep Learning, MIT Press, 2016.
2. C., M., Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books:

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

MOOCs Links and additional reading material:

1. www.nptelvideos.in
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs11
3. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs50

Course Outcomes:

The student will be able to –

1) **Analyze** the foundational principles of neural networks and deep learning,
2) Apply a basic convolutional neural network using a deep learning framework
3) Analyze the impact of different performance-improving techniques on neural network training.
4) Design the RNN architectures and evaluate the performance
5) Evaluate the applications of deep learning by assessing their effectiveness and justifying their use in various real-world scenarios.
6) Illustrate the architecture of Generative Adversarial Networks (GANs) and Large Language Models (LLMs)

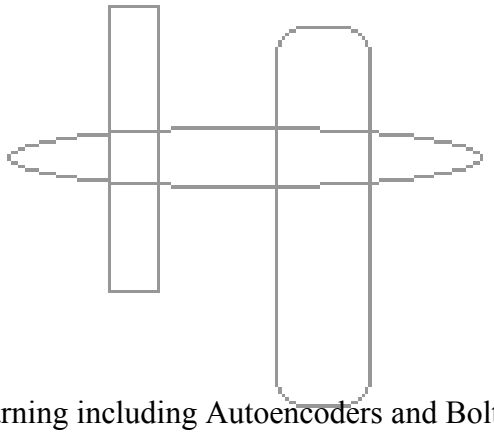
CO-PO Map:

	Program Outcomes (PO)												PSO			
CO/PO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	
CO1	3	3	3	2	3	1		1	1	1		2		3	3	
CO2	3	3	3	2	3	2		1	1	1		2		3	3	
CO3	2	3	3	3	3	2		1	1	1		2		3	3	
CO4	3	3	3	3	3	2		1	1	1		2		3	3	
CO5	3	3	3	3	3	2		1	1	1		2		3	3	
CO6	3	3	3	3	3	2		1	1	1		2		3	3	
Average	**3**	**3**	**3**	**2.66**	**3**	**1.83**		**1**	**1**	**1**		**2**		**3.0**	**3.0**	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CO Attainment levels:

Co1 - Level 3
Co2 - Level 3
Co3 - Level 4
Co4 - Level 5
Co5 - Level 5
Co6 - Level 2



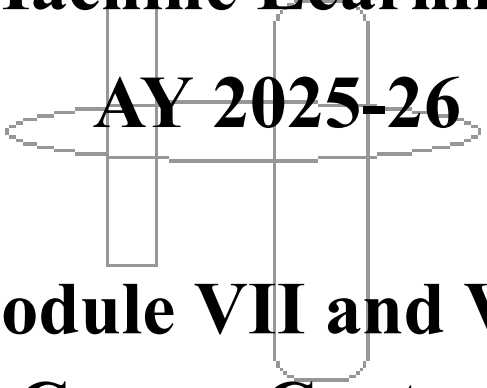
Future Course Mapping:

Advanced course on Deep learning including Autoencoders and Boltzmann machines, Reinforcement Learning etc

Job Mapping:

Deep learning engineer, Data Scientist and Algorithm Architect with industries in domains Healthcare, Industrials & Energy, Automobiles, Finance & Insurance, Human Resources, Agriculture, Cybersecurity, Ad & Marketing, Media and Entertainment, Government, Defence, Data Analytics

B. Tech. Final Year
Computer Science & Engineering
(Artificial Intelligence
&
Machine Learning)
AY 2025-26



Module VII and VIII
Course Content

FF No. : 654

Coursera Specialization Courses
Credits: 2

Sr. No.	Course code	Specialization Name	Link
1	MD4228	IBM Full Stack Software Developer	https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer
2	MD4230	IBM Back-End Developer	https://www.coursera.org/professional-certificates/ibm-backend-development
3	MD4248	IBM DevOps and Software Engineering	https://www.coursera.org/professional-certificates/devops-and-software-engineering
4	MD4262	Salesforce Sales Development Representative	https://www.coursera.org/professional-certificates/salesforce-sales-operations
5	MD4238	Microsoft Cybersecurity Analyst	https://www.coursera.org/programs/faculty-development-program-d5iiv/professional-certificates/microsoft-cybersecurity-analyst?source=search
6	MD4243	IBM Data Engineering	https://www.coursera.org/professional-certificates/ibm-data-engineer
7	MD4245	IBM Data Science	https://www.coursera.org/professional-certificates/ibm-data-science
8	MD4247	IBM Data Warehouse Engineer	https://www.coursera.org/professional-certificates/data-warehouse-engineering
9	MD4257	IBM Mainframe Developer	https://www.coursera.org/professional-certificates/ibm-mainframe-developer
10	MD4269	Google UX Design	https://www.coursera.org/professional-certificates/google-ux-design

FF No. : 654

ML4003: Generative AI

Credits: 2

Teaching Scheme Theory: 2 Hours/Week

Course Prerequisites:
Statistical Mathematics, Artificial Intelligence

LinkedIn Course: For this course, each student will have to complete following six modular courses mentioned in six units. **Other guidelines related to examination and assessment will be given by course coordinator.**

Unit-I: Processing Text with Python Essential Training
In the world of big data, more and more information is consumed and analyzed in text form. Websites, social media, emails, and chats have become the key sources for data and insights. If you work with data, then understanding how to deal with unstructured text data is essential. In this course, instructor Kumaran Ponnambalam helps you build your text mining skill set, covering key techniques for extracting, cleansing, and processing text in Python. Kumaran reviews key text processing concepts like tokenization and stemming. He also looks at techniques for converting text into analytics-ready form, including n-grams and TF-IDF. Along the way, he provides examples of these techniques using Python and the NLTK library.

Unit-II: Hands-On Natural Language Processing
Dexterity at deriving insight from text data is a competitive edge for businesses and individual contributors. This course with instructor Wuraola Oyewusi is designed to help developers make sense of text data and increase their relevance. This is a hands-on course teaching practical application of major natural language processing tasks. Learn how to replicate the knowledge gained into the data that you work with. This course includes a background of each task's process flow, use cases, and a coding demo. Some of the topics covered are named entity recognition, text summarization, topic modeling, and sentiment analysis.

Unit-III: Advanced NLP with Python for Machine Learning

An incredible amount of unstructured text data is generated every day by social media, web pages, and a variety of other sources. But without the ability to tame and harness that data, you'll be unable to glean any value from it. In this course, learn how to translate messy text data into powerful insights using Python. Instructor Derek Jedamski begins with a quick review of foundational NLP concepts, including how to clean text data and build a model on top of vectorized text. He then jumps into more complex topics such as word2vec, doc2vec, and recurrent neural networks. To wrap up the course, he lends these concepts a real-world context by applying them to a machine learning problem.

Unit-IV Deep Learning Foundations: Natural Language Processing with Tensor Flow

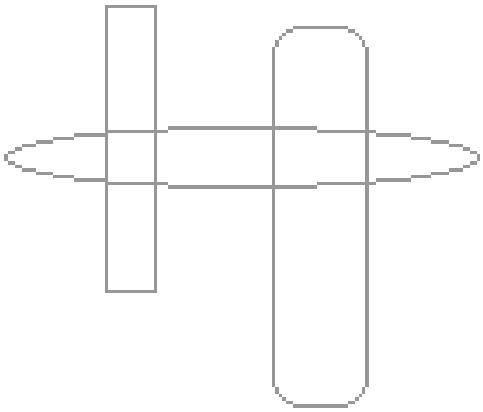
There is a growing demand to harness the power of natural language processing (NLP) and deep learning models to be able to make sense of textual data and reduce the emotional intervention of humans in order to make better decisions. In this course, instructor Harshit Tyagi provides a complete guide to understanding NLP using recurrent neural networks (RNNs). Harshit begins by introducing you to word encodings and using TensorFlow for tokenization. He describes the important concept of word embeddings and shows you how to use TensorFlow to classify movie reviews and project vectors. Harshit discusses RNNs and long short-term memory (LSTM), then shows you how to improve the movie review classifier from earlier in the course. He concludes with a discussion of how you can train RNNs to predict the next word in a sentence, which in turn allows you to generate some original text.

Unit-V Recurrent Neural Networks

Get started with recurrent neural network (RNN) concepts in a simplified way and build simple applications with RNNs and Keras. RNN is a fast-growing domain within the AI world. Popular groundbreaking applications like language translation, speech synthesis, question answering, and text generation use RNNs as their base technology. Studying this technology, however, has several challenges. Most learning resources are math heavy and are difficult to navigate without good math skills. IT professionals from varying backgrounds need a simplified resource to learn the concepts and build models quickly. In this course, Kumaran Ponnambalam provides a simplified path to studying the basics of recurrent neural networks, allowing you to become productive quickly. Kumaran starts with a simplified introduction of RNN before walking through the process of building a model. He then covers the popular building blocks of RNN with GRUs, LSTMs, word embeddings, and transformers.

Unit VI Generative AI: Working with Large Language Models

Transformers have quickly become the go-to architecture for natural language processing (NLP). As a result, knowing how to use them is now a business-critical skill in your AI toolbox. In this course, instructor Jonathan Fernandes walks you through many of the key large language models developed since GPT-3. He presents a high-level overview of GLaM, Megatron-Turing NLG, Gopher, Chinchilla, PaLM, OPT, and BLOOM, relaying some of the most important insights from each model.Get a high-level overview of large language models, where and how they are used in production, and why they are so important to NLP. Additionally, discover the basics of transfer learning and transformer training to optimize your AI models as you go. By the end of this course, you'll be up to speed with what's happened since OpenAI first released GPT-3 as well as the key contributions of each of these large language models.



FF No.: 654

ML4004: Natural Language Processing (Swayam)

Credits: 2

Teaching Scheme Theory: 2 Hours/Week

Course Prerequisites: Theory of Computer Science, Compiler Design

Course Objectives:

1. To understand morphology for given natural language
2. To learn how to design lexical analyzer for given natural language
3. To learn how to design Syntactic Analyzer for given natural language
4. To learn how to design type dependency parser using pragmatic approach for given natural language
5. To understand the scientific process for machine transliteration, machine translation and information retrieval for given natural language using statistical approach

Course Relevance: Although Natural Language Processing (NLP) has been with us for quite some time, it has only recently gained industry-wide attention, thanks to Deep Learning. Today, NLP is a core competence area in Data Science and IT, with applications spanning across sectors that rely on harnessing language data's potential. Essentially, NLP applications are designed to extract relevant and meaningful information from natural human language data and impart machines with the ability to interact with humans.

SECTION 1: TOPICS/CONTENTS

Unit-I Introduction **[5 Hours]**

What is natural language processing? Applications of NLP, Origins of NLP, Challenges of NLP, Language and Knowledge, Language and Grammar, Processing Indian Languages. Grammar-based

language models, lexical functional Grammar(LFG), Government and Binding (GB), Lexical functional Grammar Model, Generative grammars, Statistical Language Model.

Unit-II Regular Expressions and Automata **[5 Hours]**

Formal Language Theory: Basic Notions, Basic Regular Expression Patterns, Disjunction, Grouping and Precedence, Advanced Operators, Substitution, Finite State Automata, NFSA. Words and Transducers, Morphology, Inflectional Morphology, Derivational Morphology, Finite State Morphological Parsing, Construction of Finite State Lexicon, Finite State Transducers, FST for Morphological Parsing.

Unit-III Theory of parsing / Syntactic Analysis **[4 Hours]**

Context Free Grammar, parsing, Top-down Parsing, Bottom-up parsing, Probabilistic parsing, Indian Languages parsing Semantic Analysis: Meaning Representation, Lexical Semantic, Ambiguity, Word Sense Disambiguation, Discourse processing, Natural Language Generation.

SECTION2: TOPICS/CONTENTS

Unit-IV Computer Linguistics **[5 Hours]**

Machine Transliteration using Statistical Language modeling: N-gram model, Machine Transliteration: Rule-based, Phonology and Stress Analysis based and Statistical based, Support vector machine, Memory Entropy Model, Hidden Markov Model, Conditional Random Fields, Evaluation Metrics

Unit-V Machine Translation **[5 Hours]**

Introduction, Problems in MT, Characteristics of Indian Languages, Machine Translation Approaches, Direct Machine Translation, Rule-Based MT, Corpus Based Machine Translation, Semantic/Knowledge based MT Systems, Translation involving Indian Languages, Statistical-Based using MT Tools - GIZA++, SRTLM and Moses, Evaluation Metrics

.

Unit-VI Information Retrieval **[4 Hours]**

Designing features for IR Systems, IR Models, Classical IR Models, Non Classical IR Models. Evaluation of IR Systems, NLP in IR, Relation Mapping, and Knowledge based Approaches, Conceptual Graphs in IR, Cross Language Information Retrieval, Evaluation Metrics.

List of Course Project Areas:

1. Biomedical Text Mining.
2. Computer Vision and also NLP.
3. Deep Linguistic Processing.
4. Controlled Natural Language.
5. Language Resources and also Architectures for NLP.
6. Sentiment Analysis and also Opinion Mining.
7. Recognizing Similar Texts
8. Inappropriate Comments Scanner
9. Language Identifier
10. Image-Caption Generator

List of Design based Home Assignments:

Design:

1. Use a simple method to classify positive or negative sentiment in tweets
2. Use a more advanced model for sentiment analysis
3. Use vector space models to discover relationships between words and use principal component analysis (PCA) to reduce the dimensionality of the vector space and visualize those relationships
4. Write a simple English-to-French translation algorithm using pre-computed word embeddings and locality sensitive hashing to relate words via approximate k-nearest neighbors search
5. Create a simple auto-correct algorithm using minimum edit distance and dynamic programming
6. Write a better auto-complete algorithm using an N-gram model (similar models are used for translation, determining the author of a text, and speech recognition)
7. Write your own Word2Vec model that uses a neural network to compute word embeddings using a continuous bag-of-words model
6. Train a neural network with GLoVe word embeddings to perform sentiment analysis of tweets
8. Train a recurrent neural network to perform NER using LSTMs with linear layers

Translate complete English sentences into French using an encoder/decoder attention model

9. Build a transformer model to summarize text
1. Build a chatbot using a reformer model.

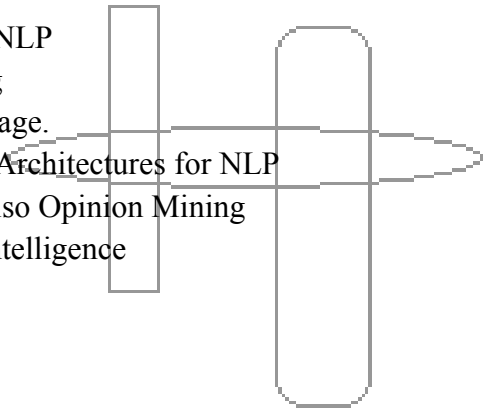
Case Study:

1. Clinical Documentation
2. Speech Recognition
3. Computer-Assisted Coding (CAC)

4. Data Mining Research
5. Automated Registry Reporting
6. Clinical Decision Support
7. Clinical Trial Matching
8. Prior Authorization

Blog:

1. Machine Translation: Rule-Based
2. Machine Translation: Statistical-Based
3. MT Tools - GIZA++, SRTLM and Moses
4. GIZA++, SRTLM and Moses
5. Natural Language Resources for Beginners
6. Natural Language Resources for Practitioners
7. Biomedical Text Mining
8. Computer Vision and also NLP
9. Deep Linguistic Processing
10. Controlled Natural Language.
11. Language Resources and Architectures for NLP
12. Sentiment Analysis and also Opinion Mining
13. NLP includes Artificial Intelligence



Survey:

1. Language Models
2. Top-down Parsing
3. Bottom-up parsing
4. Probabilistic parsing
5. Indian Languages parsing

Text Books:

1.Tanveer Siddiqui and U S Tiwary, "Natural Language Processing and Information Retrieval" Fourth Impression, Oxford, ISBN-13:978-019-569232-7.

2. Daniel Jurafsky and James H Martin., "Speech and Language Processing", 2nd edition, Pearson, Second Impression-2014,ISBN: 978-93-325-1841-43.

3. Christopher D.Manning and Hinrich Schutze,, "Foundations of Statistical Natural Language Processing" , MIT Press, 1999.

Reference Books:

1. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), "The Handbook of Computational Linguistics and Natural Language Processing".
2. Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein, and Edward Loper, O'Reilly Publication
3. Natural Language Processing with Python CookBook, Krishna Bhavsar, Naresh Kumar, Pratap Dangeti, Packt Publication.
4. Ralph Grishman, " Computational Linguistics: An Introduction (Studies in Natural Language Processing)", Cambridge University Press, ASIN : B01MQYCTOB.

MOOCs Links and additional reading material:

- www.nptelvideos.in
- www.nfnlp.com
- https://www.mooc-list.com/tags/nlp
- https://www.my-mooc.com/en/mooc/natural-language-processing-nlp/
- https://huggingface.co/learn/nlp-course/
- https://www.coursera.org/learn/attention-models-in-nlp

Course Outcomes:

The student will be able to:

1. Interpret morphology for given natural language (2)
2. Construct shallow depth lexical analyzer and syntactic analyzer for given natural language(3)
3. Develop shallow depth type dependency parser for given natural language(3)
4. Develop shallow depth machine transliteration, machine translation, information retrieval for given natural language using either linguistic or statistical approach (3)
5. Correlate shallow depth machine transliteration, machine translation, information for given natural language (4)
6. Evaluate machine transliteration, machine translation and information retrieval results using standard evaluation metrics (5)

CO-PO Mapping:

	Program Outcomes (PO)											PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2											2	
CO2	3	2	3	2									3	3
CO3	3	2	3	2										3
CO4	3	2	3	3	3				1					3
CO5	3	3	3	3	3	2			1		3			2
CO6	3	2	3	3	3	2						2		2
Average	**3**	**2.16**	**3**	**2.6**	**3**	**2**			**1**		**3**	**2**	**2.5**	**2.6**

CO Attainment levels:

Weights for attainment levels: L1 - Easy-0.75 L2 - Comfortatble-0.7 L3 – Medium – 0.65
L4 – Somewhat difficult – 0.6 L5 – Difficult – 0.55

CO1 – L2, CO2 – L3, CO3 – L3, CO4 – L3, CO5 – L4 and CO6 – L5

Future Course Mapping:

Computational Linguistics, ANN, RNN, Deep Learning

Job Mapping:

Application Developers, System programmer.

Syllabus Template

ML4005: Deep Learning for Computer Vision (swayam)

Credits:.2

Teaching Scheme Theory: 2 Hours/Week

Course Prerequisites: Knowledge of Linear Algebra & Different types of Signals, Image Processing

Course Relevance: Computer vision is an interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to understand and automate tasks that the human visual system can do.

Course Objectives:

1. Learn fundamentals of and techniques used in image processing and computer vision
2. To acquaint with Image filtering and shape representation.
3. Understand Segment the image to identify the region of interest.
4. Identify various algorithms for Motion Estimation & Pattern recognition
5. To learn pattern recognition.
6. Develop an algorithm to recognize the specified objects in the given image.

Theory

Syllabus

Section-I:

Image Formation Models : (6 hrs)

Introduction, Elements of image processing system, Scenes and Images, Vector Algebra, color vision color model: RGB, HVS, YUV, CMYK, YCbCr and some basic relationships between pixels, Fundamentals of Image Formation, Human Vision System, Computer Vision System

Image Processing and Feature Extraction: (8 hrs.)

Thresholding, Spatial domain techniques, Image Negative, Contrast stretching, gray level slicing, bit plane slicing, histogram and histogram equalization, local enhancement technique, image subtraction

and image average, Image Smoothening: low-pass spatial filters, median filtering, Image Sharpening: high-pass spatial filter, derivative filters

Shape Representation and Segmentation : (6 hrs.)

Classification of image segmentation techniques: Edge-based Segmentation, Region based techniques, Types of Edge detector Feature Extraction- Boundary representation(Chain code), Boundary detection based techniques, Edges – Canny, Convolutional Neural Network

Section-II:

Motion Estimation & Pattern recognition: (6 hrs.)

Regularization theory ,Epipolar Geometry, Optical computation , Stereo Vision: Distortion, Rectification, , Motion estimation , Structure from motion. Pattern recognition models: hidden Markov modes

Feature detection and description: (6 hrs.)
Feature matching and model fitting, Dimension reduction and sparse representation, Shape correspondence and shape matching, Principal component analysis, Singular Value Decomposition Shape priors for recognition

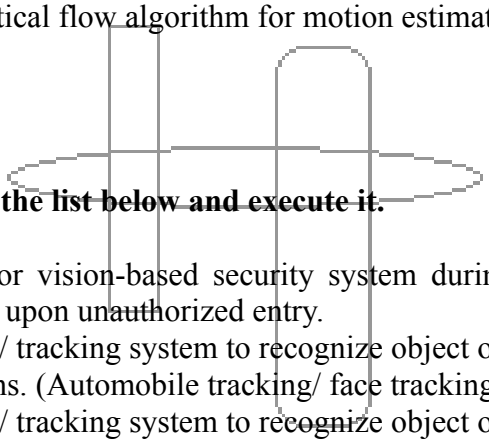
Object Recognition: (8 hrs.)
Need, Automated object recognition system, pattern and pattern class, relationship between image processing and object recognition, approaches to object recognition. Global Methods; Active Contours; Split and Merge; Mean Shift and Mode Finding, Change Detection. Principal component analysis, Singular Value Decomposition Shape priors for recognition, Face Recognition

List of Tutorials:

1. Introduction to OpenCV and Setting up Python Programming Environment for Computer Vision 2. Essentials of Linear Algebra Part-I (Matrix Theory) for Computer Vision
3. Essentials of Linear Algebra Part-II (Vector Spaces) for Computer Vision
4. Comparison of various edge detection techniques
5. Configuration of Raspberry Pi-4B for Computer Vision
6. Mathematics of Support Vector Machine
7. Mathematics of K-Means Classification.
8. Barcode detection Methods
9. Face Detection Methods

List of Practical's: (Any Six)

1. Image Manipulations and Geometrical Transformations
2. Implementation of Image Filtering Techniques
3. Implementation of Image Enhancements Techniques
4. Detection of Lines, Edges and Corners
5. Object Detection Model
6. Face Recognition Model
7. Image and Video Editing
8. Develop an algorithm for segmentation of an input image
9. Develop an algorithm for recognition of an object from input image.
10. Develop an algorithm for motion estimation from given video sequence.
11. Design an algorithm for SVM classifier
12. Design an algorithm for adaboost classifier
13. Line detection using Hough transforms
10. To design and develop optical flow algorithm for motion estimation



List of projects:

Select any one project from the list below and execute it.

1. Develop an application for vision-based security system during day/night time. The system should trigger an audio- visual alarm upon unauthorized entry.
2. Develop motion estimation/ tracking system to recognize object of interest related to one
3. of the following applications. (Automobile tracking/ face tracking/ human tracking)
4. Develop motion estimation/ tracking system to recognize object of interest related to one
5. of the following applications. (Space vehicle tracking/ solar energy tracking/ crowd pattern
6. tracking)
7. Human Detection using HOG or SIFT.
8. Line detection in video
9. Motion Estimation in video
10. Face Recognition
11. Digital Object Insertion
12. Video Stabilization
13. Barcode Detection
14. Detection of Dents on a Car
15. Detection of Stray Animals on the Road

List of Course Seminar Topics:

1. Bioinspired Stereo Vision Calibration for Dynamic Vision Sensors
2. Low-Power Computer Vision: Status, Challenges, and Opportunities
3. Subpixel Computer Vision Detection based on Wavelet Transform
4. Automatic Counting and Individual Size and Mass Estimation of Olive-Fruits Through
5. Computer Vision Techniques 6. 5. Person Recognition in Personal Photo Collection
6. Measuring Gait Variables Using Computer Vision to Access Mobility and Fall Risk in
8. Wearable Vision Assistance System based on Binocular Sensors for Visually Impaired
9. Edge Detection Algorithm for Musca-Domestica Inspired Vision System
10. Automated Vision Based High Intraocular Pressure Detection using Frontal Eye Images
11. Detection of Possible Illicit Messages using Natural Language Processing and Computer
12. Vision on Twitter and LinkedIn Websites

List of Course Group Discussion Topics:

1. Human Visual System vs Computer Vision System
2. Spatial Domain Filtering and Frequency Domain Filtering
3. Features from Accelerated Segment Test Features from Accelerated Segment Test and
4. Oriented Fast and Rotated Brief
5. Local Binary Pattern and Local Directional Pattern
6. K-Nearest Neighbors and K-Means
7. Monocular Vision and Stereo Vision
8. Image Enhancement and Image Restoration
9. Raspberry Pi-4B and Jetson Nano
10. Essential Matrix and Fundamental Matrix
11. Camera Calibration.

List of Home Assignments: Design:

1. Depth Calculation based on Monocular Vision
2. Depth Calculation based on Stereo Vision
3. Automatic Attendance monitoring system
4. Detection of Traffic Signals
5. Pose Estimation

Case Study:

1. Detection of Roadside Infrastructure (Lampposts, Pavement Blocks, Seating Arrangements,
2. Roadside Line Markers, Manholes, Barricades, etc.
3. Vehicle License Plate Recognition at Security Checkpoints
4. Detection of Dents on a Car
5. Detection of Type of Roads (Tar, Cement, and Mud)

6. Hand-Gesture Recognition

Blog Computer Vision for:
1. Mobility of Visually Impaired People
2. Avoiding Accidents
3. Obstacle Detection and Avoidance
4. Patient Monitoring
5. Fall detection
6. Surveys
7. Computer Vision for Differently Abled People
8. Computer Vision for Kids Care
9. Computer Vision Electric Vehicles
10. Computer Vision for Women Safety
11. Computer Vision for Teaching-Learning Process at Academic Institutes

Text Books: (As per IEEE format)

1. Gonzalez, Woods, "Digital Image Processing", Prentice Hall India, 2nd edition.
2. Pratt W.K., "Image Processing", John Wiley, 2001
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Publication.
4. Forsyth and Ponce, "Computer Vision-A Modern Approach", 2nd Edition, Pearson Education.
5. R. O. Duda, P. E.Hart, and D.G.Stork,", Pattern Classification", 2nd edition, Springer, 2007.
6. Theodoridis and Koutrombas," Pattern Recognition", 4th edition, Academic Press, 2009.

Reference Books:

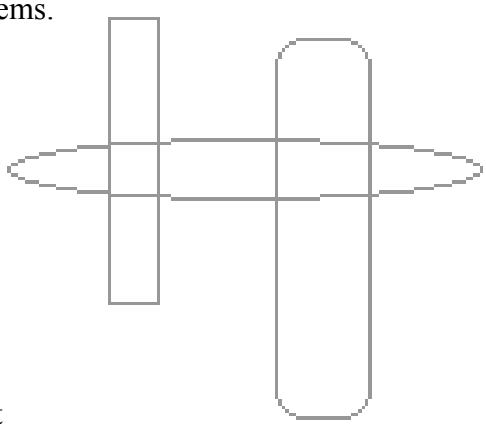
1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Thomson Learning.
2. Robert Haralick and Linda Shapiro, "Computer and Robot Vision", Vol I, II, Addison- Wesley, 1993.
3. Ludmila I.Kuncheva, "Combining pattern classifiers", John Wiley and sons Publication.
4. EthemAlpaydin," Introduction to Machine Learning", The MIT press.

Moocs Links and additional reading material:
1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/
2. https://www.coursera.org/lecture/introduction-tensorflow/an-introduction-to-computer-vision rGn1n
3. https://www.coursera.org/lecture/convolutional-neural-networks/edge-detection-example
4. https://www.coursera.org/learn/computer-vision-basics
5. https://www.coursera.org/projects/computer-vision-object-detection

6. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/

Course Outcomes:
The student will be able –
1) To formulate computational problems in abstract and mathematically precise manner
2) To design efficient algorithms for computational problems using appropriate algorithmic paradigm 3) To analyze asymptotic complexity of the algorithm for a complex computational problem using suitable mathematical techniques.
4) To establish NP-completeness of some decision problems, grasp the significance of the notion of NP-completeness and its relationship with intractability of the decision problems.
5) To understand significance of randomness, approximability in computation and design randomized algorithms for simple computational problems and design efficient approximation algorithms for standard NP-optimization problems.
6) To incorporate appropriate data structures, algorithmic paradigms to craft innovative scientific solutions for complex computing problems.

CO PO Map:



Future Courses Mapping:
1. Pattern Recognition
2. Deep Learning

Job Mapping:
1. Computer Vision Specialist
2. Data Engineer
3. Machine Learning Engineer
4. Data Scientist
5. Engineer-Autonomous Vehicle
6. Research Engineer

FF No.: 654

ML4006 & ML4007: Major Project

Credits:.9.....

Teaching Scheme Theory: …26... Hours/Week

Course Prerequisites: Project Based Learning

Aim

This course addresses the issues associated with the successful management of a project. The course emphasizes project life cycle phases requirement engineering, system analysis and system design. A further aim is for students to heighten personal awareness of the importance of developing strategies for themselves and working with peers to create desired outcomes. Project Work can lead to:

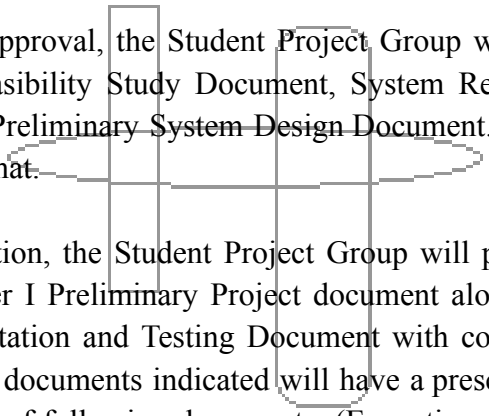
- Transform existing Ideas into conceptual models.
- Transform conceptual models into determinable models.
- Use determinable models to obtain system specifications.
- Select optimum specifications and create physical models.
- Apply the results from physical models to create real target systems.

Project Group and Topic Selection and Synopsis:

The project work needs to be undertaken by a group of maximum FOUR and minimum of THREE students. The Project work will be jointly performed by the project team members. The student needs to identify a technological problem in the area of Computer Engineering or Information Technology of their choice and address the problem by formulating a solution for the identified problem. The Project Group will prepare a synopsis of the project work which will be approved by the concerned faculty member. The project should not be a reengineering or reverse engineering project. In some cases, reverse engineering projects will be permissible based on the research component involved in it. The project work aims at solving a real world technical problem. Hence ample literature survey is required to be done by the students. Application-oriented projects will not be acceptable. Low-level custom User Interface development and its allied mapping with a particular technology will not be accepted.

Overview of the Course:

1. The Student Project Group is expected to make a survey of situation for identifying the requirements of selected Technological Problem. The Student Project Group will be monitored by Internal Guides and External Guides (if any).
2. The project requires the students to conceive, design, implement and operate a mechanism (the design problem). The mechanism may be entirely of the student's own design, or it may incorporate off-the-shelf parts. If the mechanism incorporates off-the-shelf parts, the students must perform appropriate analysis to show that the parts are suitable for their intended purpose in the mechanism.
3. The project must be based on a Fresh Idea or Implementation of a Theoretical Problem – meaning that there is not a known Solution to the design problem Or Create a Better Solution.
4. The project must have an experimental component. Students must conceive, design, implement and operate an appropriate experiment as part of the project. The experiment might be to collect data about some aspect of the design (i.e., to verify that the design will work as expected). Alternatively, the experiment could be to verify that the final mechanism performs as expected.
5. Upon receiving the approval, the Student Project Group will prepare a preliminary project report consisting, Feasibility Study Document, System Requirement Specification, System Analysis Document, Preliminary System Design Document. All the documents indicated will have a prescribed format.



6. Upon project completion, the Student Project Group will prepare a detailed Project Report consisting of Semester I Preliminary Project document along with Detailed System Design Document, Implementation and Testing Document with conclusion and future scope of the Project Work. All the documents indicated will have a prescribed format. The Project Report ideally should consist of following documents: (Exceptions may be there based on the nature of the project, especially if some of the following documents are not applicable to a particular project as determined by the project guide, coordinator and head of department).

Sr.	Project Item
1	Project Cover Front Page
2	Project Completion Certificate [Institute]
3	Project Completion Letter [In case of Sponsored Projects]
4	Acknowledgments
5	Table of Contents
6	List of Figures
7	List of Tables
8	Project Synopsis [Problem Background, Existing System Details, Proposed Solution]
9	Feasibility Study Report
10	Project Plan
11	System Requirement Specification
12	System Analysis Document: UML Use Case Diagrams
13	System Analysis Document: UML Sequence Diagrams
14	System Analysis Document: UML State Diagrams
15	System Design Document with Module Specifications
16	System Implementation
17	System Testing and Experimental Findings
18	Conclusion
19	References

7. The Project Work will be assessed jointly by a panel of examiners consisting faculty and industry experts. The Project Groups will deliver the presentation and demonstration of the Project Work which will be assessed by the panel.
8. The Student Project Group needs to actively participate in the presentation. The panel of examiners will evaluate the candidate's performance based on presentation skills, questions based on the Project Work and overall development effort taken by the candidates.

Note:
The student needs to design and develop solution for the identified technological problem in the area of Computer Engineering or Information Technology of their choice. The Project Implementation needs to be completed using best possible use of available technologies as applicable to deal with the complexity of the project. The Project Group will prepare a detailed report of the project work which

will be approved by the concerned faculty member. The Project Report need to be submitted both in Hard form and Soft form in CD. The Soft Copy of the Project Report must accompany other project deliverables as well.

Assessment: MSE and ESE
1. Mid Semester Assessment – 50 Marks to be converted to 30 Marks.
2. End Semester Assessment – 100 Marks to be converted to 70 Marks.

Mid-Semester Assessment

Sr. No.	Parameter	Marks
1	Problem Statement	10
2	Literature Review	10
3	Group formation and identification of individual responsibility	10
4	Objective of Project activity	10
5	Knowledge of domain, latest technology and modern tools used /to be used	10
	TOTAL	**50**

End Semester Assessment

Sr. No.	Parameter	Marks
1	Realization of project as per problem statement	10
2	Design, Testing / Experimentation, Analysis / Validation	30
3	Documentation and Report Writing	20
4	Quality of Work	15
5	Performance in Question & Answers Session	15
6	Regular interaction with guide	10
	TOTAL	**100**

Course Outcomes:
Upon completion of the course, graduates will be able to -

CO1: Identify the real life problem from societal need point of view

CO2: Prepare the requirement engineering, feasibility analysis documents

CO3: Form the teams and share responsibilities according to individual skill strengths

CO4: Create design documents to build software solutions

CO5: Develop software solutions based on standard engineering specifications

CO6: Perform the verification and validation up to the mark

CO PO Map

	Program Outcomes (PO)											PSO		
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3		2					3					
CO2	2	3	3	2	2				3	3	2	3		3
CO3	2	-	-	-	-				3		2	3		
CO4	2	3	3	2	2	3	3.0	2.0	3	3	2	3	3	3
CO5	2	3	3	2	2				3	3	2	3	3	3
CO6	2	2	2	3	2				3	2	2	3	2	3
Average	**2.0**	**2.8**	**2.75**	**2.83**	**2.0**	**3.0**	**3.0**	**2.0**	**3.0**	**2.75**	**2.0**	**3.0**	**1.75**	**3.0**

CO attainment levels

CO1 -4 CO2 –2 CO3-4 CO4-5 CO5 -1 CO6-3