DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS FOR
BACHELOR OF TECHNOLOGY (B. Tech)

COMPUTER SCIENCE & ENGINEERING
(Artificial Intelligence & Machine Learning)
(3rd to 8th Semester)

Graduation Batch: 2024-2028

SCHEME - B.TECH – 2024-25 ONWARDS

I SEM - CHEMISTRY CYCLE

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
			L	T	P	J	C		CIE	SEE	TM
1	24EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	0	0	0	3	3	60	40	100
2	24EN1102	OBJECT ORIENTED PROGRAMMING	2	1	2	0	4	3	60	40	100
3	24EN1103	COGNITIVE AND TECHNICAL SKILLS – I	0	0	4	0	2	1	100	-	100
4	24EN1104	ENGINEERING CHEMISTRY	2	0	2	0	3	3	60	40	100
5	24EN1105	INTRODUCTION TO MECHANICAL ENGINEERING	2	0	2	0	3	3	60	40	100
6	24EN1106	INTRODUCTION TO ELECTRICAL ENGINEERING	2	0	0	0	2	3	60	40	100
7	24EN1107	ENGINEERING MECHANICS	2	0	0	0	2	3	60	40	100
8	24EN1108	TECHNICAL ENGLISH	2	0	0	0	2	1	100	-	100
9	24EN1109	ENVIRONMENTAL SCIENCE	1	0	0	0	0	1	50	-	50
10	24EN1110	KANNADA KALI / MANASU	1	0	0	0	0	1	50	-	50
			17	1	10	0	21		660	240	900

L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. of Credits, CIE – Continuous Internal Evaluation,
SEE- Semester End Examinations, TM – Total Marks.

SCHEME - B.TECH – 2024-25 ONWARDS

I SEM - PHYSICS CYCLE

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
			L	T	P	J	C		CIE	SEE	TM
1	24EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	0	0	0	3	3	60	40	100
2	24EN1102	OBJECT ORIENTED PROGRAMMING	2	1	2	0	4	3	60	40	100
3	24EN1103	COGNITIVE AND TECHNICAL SKILLS – I	0	0	4	0	2	1	100	-	100
4	24EN1111	ENGINEERING PHYSICS	3	0	2	0	4	3	60	40	100
5	24EN1112	INTRODUCTION TO ELECTRONICS ENGINEERING	3	0	0	0	3	3	60	40	100
6	24EN1113	ENGINEERING GRAPHICS AND DESIGN THINKING	2	0	2	0	3	2	60	40	100
7	24EN1114	BIOLOGY FOR ENGINEERS	2	0	0	0	2	1	100	-	100
8	24EN1115	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	1	0	0	0	0	1	50	-	50
			16	1	10	0	21		550	200	750

L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. of Credits, CIE – Continuous Internal Evaluation,
SEE- Semester End Examinations, TM – Total Marks.

SCHEME - B.TECH – 2024-25 ONWARDS

II SEM - CHEMISTRY CYCLE

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
			L	T	P	J	C		CIE	SEE	TM
1	24EN1201	SINGLE AND MULTIVARIATE CALCULUS	3	0	0	0	3	3	60	40	100
2	24EN1202	C PROGRAMMING FOR PROBLEM SOLVING	2	1	2	0	4	3	60	40	100
3	24EN1203	COGNITIVE AND TECHNICAL SKILLS – II	0	0	4	0	2	1	100	-	100
4	24EN1104	ENGINEERING CHEMISTRY	2	0	2	0	3	3	60	40	100
5	24EN1105	INTRODUCTION TO MECHANICAL ENGINEERING	2	0	2	0	3	3	60	40	100
6	24EN1106	INTRODUCTION TO ELECTRICAL ENGINEERING	2	0	0	0	2	3	60	40	100
7	24EN1107	ENGINEERING MECHANICS	2	0	0	0	2	3	60	40	100
8	24EN1108	TECHNICAL ENGLISH	2	0	0	0	2	1	100	-	100
9	24EN1109	ENVIRONMENTAL SCIENCE	1	0	0	0	0	1	50	-	50
10	24EN1110	KANNADA KALI / MANASU	1	0	0	0	0	1	50	-	50
			17	1	10	0	21		660	240	900

L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. of Credits, CIE – Continuous Internal Evaluation,
SEE- Semester End Examinations, TM – Total Marks.

SCHEME - B.TECH – 2024-25 ONWARDS

II SEM - PHYSICS CYCLE

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
			L	T	P	J	C		CIE	SEE	TM
1	24EN1201	SINGLE AND MULTIVARIATE CALCULUS	3	0	0	0	3	3	60	40	100
2	24EN1202	C PROGRAMMING FOR PROBLEM SOLVING	2	1	2	0	4	3	60	40	100
3	24EN1203	COGNITIVE AND TECHNICAL SKILLS – II	0	0	4	0	2	1	100	-	100
4	24EN1111	ENGINEERING PHYSICS	3	0	2	0	4	3	60	40	100
5	24EN1112	INTRODUCTION TO ELECTRONICS ENGINEERING	3	0	0	0	3	3	60	40	100
6	24EN1113	ENGINEERING GRAPHICS AND DESIGN THINKING	2	0	2	0	3	2	60	40	100
7	24EN1114	BIOLOGY FOR ENGINEERS	2	0	0	0	2	1	100	-	100
8	24EN1115	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	1	0	0	0	0	1	50	-	50
			16	1	10	0	21		550	200	750

L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. of Credits, CIE – Continuous Internal Evaluation,
SEE- Semester End Examinations, TM – Total Marks.

III SEM – CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

SL. NO	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	BSC	24AM2301	Probability & Statistics	3	0	0	0	60	40	100	03
2	IPCC	24AM2302	Data Structures	3	0	2	0	60	40	100	04
3	IPCC	24AM2303	Computer Networks	3	0	2	0	60	40	100	04
4	PCC	24AM2304	Discrete Mathematics and Graph Theory	3	0	0	0	60	40	100	03
5	PCC	24AM2305	Computer Organization and Architecture	3	0	0	0	60	40	100	03
6	PCC	24AM2306	Embedded Systems Design	3	0	0	0	60	40	100	03
7	SEC	24AM2307	Skill Enhancement Course – I (Java Programming)	1	0	2	0	100	--	100	02
8	PCC	24AM2308	AI for Renewable Energy Systems	1	0	0	0	100	--	100	01
9	AEC	24AM2309	Cognitive and Technical Skills-III	--	--	--	--	--	--	--	Pass/Fail
			Total	20	0	06	0				**23**

IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, BSC-Basic Science, L – Lecture, T – Tutorial, P – Practical, J –Project, C – No. Of Credits, AEC-Ability Enhancement Course

PROBABILITY AND STATISTICS

[As per Choice Based Credit System (CBCS)scheme]

SEMESTER – III

Course Code	:	24AM2301	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Apply** statistical principles and probability concepts to solve complex problems in real-world scenarios involving uncertainty and randomness.
2. **Evaluate** and select appropriate probability distributions and statistical techniques toanalyze and interpret data accurately in various applications.
3. **Justify** the use of estimation methods and hypothesis testing techniques for drawing meaningful inferences about population parameters.
4. **Analyze** and interpret sample test results for different statistical relationships, such asmeans, variances, correlation coefficients, regression coefficients, goodness of fit, and independence, to make informed decisions.
5. **Identify** sample tests using appropriate statistical procedures to investigate the significance of observed data and communicate findings effectively.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in theclass.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students tocome up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I : Probability	**09 Hours**
Definitions of Probability, Addition Theorem, Conditional Probability, Multiplication Theorem, Bayes' Theorem of Probability	

UNIT – II: Random Variables and their Properties and Probability Distributions	**09 Hours**
Discrete Random Variable, Continuous Random Variable, Joint Probability Distributions Their Properties, Probability Distributions: Discrete Distributions: Binomial, Poisson Distributions and their Properties; Continuous Distributions: Exponential ,Normal, Distributions and their Properties.	
UNIT – III: Estimation and testing of hypothesis	**06 Hours**
Sample, Populations, Statistic, Parameter, Sampling Distribution, Standard Error, Un-Biasedness, Efficiency, Maximum Likelihood Estimator, Notion & Interval Estimation.	
UNIT – IV: Sample Tests-1	**07 Hours**
Large Sample Tests Based on Normal Distribution , Small Sample Tests : Testing Equality of Means, Testing Equality of Variances, Test of Correlation Coefficient	
UNIT – V: Sample Tests-2	**08 Hours**
Test for Regression Coefficient; Coefficient of Association, 2 – Test for Goodness of Fit, Test for Independence.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Apply** the principles of probability to solve complex problemsin various real-world scenarios.	L2 & L3
2	**Solve** and **compare** different probability distributions, including discrete and continuous random variables, in order to make informed decisions and predictions.	L2 & L3
3	**Apply** statistical estimation techniques, such as maximum likelihood estimation and interval estimation, to draw meaningful inferences about population parameters from sample data.	L3
4	**Examine** hypothesis testing methods, including large and small sample tests, to assess the significance of observed dataand draw valid conclusions.	L4
5	**Analyze** statistical relationships and perform sample tests to assess the Equality of means in different populations, Correlation coefficients between variables to determine the strength and direction of the relationship. Independence of variables using appropriate statistical tests to assess the absence of any relationship.	L4

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2		2				1					
CO2	3	2	2		2				1					
CO3	3	2	2						1					
CO4	3	2	2		2				1					
CO5	3	2	2		2				1					

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

TEXT BOOKS:

1. Probability & Statistics for Engineers and Scientists, Walpole, Myers, Myers, Ye. PearsonEducation.

REFERENCE BOOKS:

1. Probability, Statistics and Random Processes T. Veerarajan Tata McGraw – Hill
2. Probability & Statistics with Reliability, Queuing and Computer Applications, Kishor S. Trivedi,Prentice Hall of India ,1999

E-Resources:

1. https://nptel.ac.in/courses/106104233
2. https://nptel.ac.in/courses/117103067
3. https://nptel.ac.in/courses/103106120
4. https://www.coursera.org/learn/probability-intro#syllabus
5. https://nptel.ac.in/courses/111104073

Activity Based Learning (Suggested Activities in Class)

1. Tools like Python programming, R programming can be used which helps student to developa skill to analyze the problem and providing solution.
2. Regular Chapter wise assignments/ Activity/Case studies can help students to have criticalthinking, developing an expert mind set, problem-solving and teamwork.

Following are Assignments/ Activities Can be carried out using either R programming language orPython Programming or excel solver.

1. There are n people gathered in a room. What is the probability that at least 2 of them will havethe same birthday? (Use excel solver, R Programming, Python Programming)
   a. Use simulation to estimate this for various n., and Produce Simulation Graph.
   b. Find the smallest value of n for which the probability of a match is greater than 0.5.
   c. Explore how the number of trials in the simulation affects the variability of our estimates.
2. **Case Study 1: Customer Arrivals at a Coffee Shop**

a. A coffee shop wants to analyze the number of customer arrivals during its morning rush hour (7:00 AM to 9:00 AM). The shop has been recording the number of customer arrivals every 15 minutes for the past month.
b. Data: The data consists of the number of customer arrivals recorded at the coffee shop during each 15-minute interval for the past month.
c. Here is a sample of the data:

Time Interval	**stomer Arrivals**
00 AM - 7:15 AM	**6**
15 AM - 7:30 AM	**4**
30 AM - 7:45 AM	**9**
45 AM - 8:00 AM	**7**
00 AM - 8:15 AM	**5**
15 AM - 8:30 AM	**8**
30 AM - 8:45 AM	**10**
45 AM - 9:00 AM	**6**

analyze the customer arrivals and determine the probability distribution that best fits thedata. Specifically, explore both discrete and continuous probability distributions,

including the binomial, Poisson, exponential, and normal distributions.

3. **Case Study 2:** Comparing the Performance of Two Groups
   a. Suppose you are a data analyst working for a company that manufactures a new energy drink. The marketing team conducted a promotional campaign in two different cities (City A and City B) to determine the effectiveness of the campaign in increasing sales. The sales data for a random sample of customers in each city was collected over a week. Your task is to compare the average sales between the two cities and test whether thereis a significant difference in the variance of sales.
   b. **Data**: Let's assume the following sample data for the number of energy drinks sold in each city:

City A: [30, 28, 32, 29, 31, 33, 34, 28, 30, 32]
City B: [25, 24, 26, 23, 22, 27, 29, 30, 26, 24]

perform a two-sample t-test to test the equality of means and a test for equality of variances using Python's SciPy library.

4. **Case study 3:** testing independence between two categorical variables.
   a. Data: Sample of 100 employees, and each employee is classified as either Male or Female.They were asked to rate their job satisfaction on a scale of 1 to 5, where 1 represents low satisfaction and 5 represents high satisfaction. The data is as follows:

Employee	**Gender**	**Job Satisfaction**
1	Male	4
2	Female	3
3	Male	2
4	Female	5
...	...	...

100	Female	4

b. Test for independence between gender and job satisfaction, use the chi-squared test in R.

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DATA STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	24AM2302	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P-J	:	3–0–2-0			

Prerequisites:

Proficiency in a C programming language.

Course Objectives:

This Course will enable students to:

1. **Understand** the basic approaches for analyzing and designing data structures.
2. **Introduce** dynamic memory allocation and C language concepts required for building data structures.
3. **Develop** essential skills to construct data structures to store and retrieve data quickly and **efficiently**.
4. **Utilize** different data structures that support different sets of operations which are suitable for various applications.
5. **Explore & implement** how to insert, delete, search, and modify data in any data structure- Stack, Queues, Lists, Trees.
6. **Develop** applications using the available data structure as part of the course for mini project.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/Animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**
IINTRODUCTION: Introduction to Data Structure, Classification, C Structure and Union, C Pointers, Array Definition, Representation, Operations (Insertion, Deletion, Search and Traversal), Two/Multidimensional Arrays, Sparse matrix. TB1: 1.1, 2.2, 2.5 ; TB2: 1.1, 1.2,1.3.1-1.3.4; RB1: 5.1 – 5.12, 6.4	
UNIT – II	**08 Hours**
INTRODUCTION TO ADT: **Stack:** Definition, Array Representation of Stack, Operations on Stacks. **Applications of Stack:** Expression evaluation, Conversion of Infix to Postfix, Infix to Prefix Recursion, Tower of Hanoi **Queue:** Definition, Representation of Queues, Operations of Queues, Circular Queue. **Applications of Queue:** Job Scheduling, A Maze Problem TB1: 3.1,3.2, 3.3,3.4,3.5 ; TB2: 2.1, 2.2, 2.3, 3.2, 3.3	
UNIT – III	**08 Hours**
DYNAMIC DATA STRUCTURES: **Linked List:** Types, Representation of Linked Lists in Memory. Traversing, Searching, Insertion & Deletion from Linked List. Circular List, Doubly Linked List, Operations on Doubly Linked List (Insertion, Deletion, Traversal). **Applications:** Stack & Queue Implementation using Linked Lists. **Case Study**: Josephus problem. TB2: 4.2,4.3,4.5	
UNIT – IV	**08 Hours**
TREES: Basic Terminology, Binary Trees and their representation, Complete Binary Trees, Binary Search Trees, Threaded Binary Trees, Operations on Binary Trees (Insertion, Deletion, Search & Traversal). **Applications:** Expression Evaluation **Case Study:** Game Tree TB2: 5.5.3,5.5.4,5.6	
UNIT – V	**07 Hours**
Efficient Binary Search Trees: Optimal Binary Search Trees, AVL Trees, Red Black Trees, Splay Trees. **Case Study**: B Trees TB1: 10.1,10.2,10.3,10.4, 11.2	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	Apply the concepts of pointers, arrays, structures, and unions to address real-world problems and implement the concept in C programming language.	L3
2	Utilize stacks and queue data structures to solve problems such as infix to postfix, infix to prefix conversions, the Towers of Hanoi puzzle, job scheduling and maze navigation.	L3
3	Implement and manipulate singly linked lists, doubly linked lists, and circular linked lists, executing operations such as insertion, deletion, and traversal.	L3
4	Understand the concepts of binary trees, binary search trees, and threaded binary trees, and their associated operations.	L2
5	Understand advanced binary tree structures includes optimal binary search trees, AVL trees, Red-Black trees, and Splay trees.	L2

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	3	-	3	-	-	-	-	-	-	-	2	2
CO2	1	2	3	-	3	-	-	-	-	-	-	-	2	2
CO3	1	2	3	-	3	-	-	-	-	-	-	-	2	2
CO4	-	1	2	-	3	-	-	-	-	-	-	-	2	2
CO5	-	1	2	-	-	-	-	-	-	-	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS (TB):

1. Ellis Horowitz, Susan Anderson-Freed, and Sartaj Sahni, "Fundamentals of Data structures in C", 2nd Edition, Orient Longman, 2008.
2. A.M. Tannenbaum, Y Langsam, M J Augentien "Data Structures using C", 1st Edition, Pearson, 2019.

REFERENCE BOOKS:

1. Brian. W. Kernighan, Dennis. M. Ritchie, "The C Programming Language", 2nd Edition, Prentice-Hall, 1988.
2. Gilbert & Forouzan, "Data Structures: A Pseudo-code approach with C", 2nd Edition, Cengage Learning,2014.
3. Jean-Paul Tremblay & Paul G. Sorenson, "An Introduction to Data Structures with Applications", 2nd Edition, McGraw Hill, 2013.
4. R.L. Kruse, B.P. Learly, C.L. Tondo, "Data Structure and Program design in C", 5th Edition, PHI ,2009.

E-Resources:

1. https://nptel.ac.in/courses/106102064
2. https://www.coursera.org/learn/data-structures?specialization=data-structures-algorithms
3. https://www.udemy.com/topic/data-structures/free/
4. https://www.mygreatlearning.com/academy/learn-for-free/courses/data-structures
5. https://cse01-iiith.vlabs.ac.in/
6. https://kremlin.cc/k&r.pdf

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving using group discussion.
2. Role play E.g., Stack, Queue, etc.,
3. Demonstration of solution to a problem through programming.
4. Flip class activity E.g., arrays, pointers, dynamic memory allocation, etc.,

DATA STRUCTURES LABORATORY

Total Contact Hours: 26

Following are experiments to be carried out using either C programming language.

1. To Implement C programs to perform array operations.
2. To determine the validity of a 9x9 Sudoku board (application of 2-dimensional array).
3. To store, retrieve and update the elements in structures (structures and pointers to structures).
4. To implement stack using linked list.
5. To implement a queue data structure using a singly linked list.
6. To implement a singly linked list and its operations.
7. To implement a doubly linked list and its operations.
8. To create a circular queue using a circular linked list data structure

9. To implement binary tree traversal techniques.

OPEN-ENDED EXPERIMENTS

1. Design a web browser history tracker in C. Implement a stack data structure to keep track of visited URLs. Create functions to push new URLs onto the stack as users visit websites and pop URLs when users navigate backward in their browsing history.

2. Imagine you are responsible for designing a queue-based system to manage the queue of regular customers waiting to purchase cinema tickets at a popular movie theatre. Your system should ensure fair and efficient ticket sales for all customers. When a customer's arrive at the cinema, they join the queue. Each customer is represented by his name, age (for record-keeping), and number of tickets needed. When a customer reaches the front of the queue, they are served by the ticketing agent. Implement a ticket sale process where the agent provides the customer with the requested ticket(s). Initialize the total number of tickets and if the tickets are sold, then the ticketing agent should display a houseful message.

COMPUTER NETWORKS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER –III

Course Code	: 24AM2303	**Credits**:	04
Hours / Week	: 05 Hours	**Total Hours**:	39(T)+26(P) Hours
L–T–P-J	: 3–0–2-0		

Course Learning Objectives:

This Course will enable students to:

1. **Outline** the basic principles of computer networking and how computer network hardware and software operate.
2. **Evaluate** the operation and performance of practical data link protocols using the principles of framing, error detection and correction.
3. **Apply** the principles of network layer design to the analysis and evaluation of routing algorithms, congestion control techniques, internetworking and addressing.
4. **Investigate** the basic transport layer facilities and essentials of transport. protocol
5. **Illustrate** the working of various application layer protocols.

Teaching-Learning Process (General Instructions)

1. These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.
2. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
3. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
4. Show ***Video/Animation*** films to explain functioning of various concepts.
5. Encourage ***Collaborative*** (Group Learning) Learning in the class.
6. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
7. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
8. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

INTRODUCTION: Networks, network types, internet history, standards and administration (TB1-Ch1); Network models: Protocol layering, TCP/IP protocol suite, the OSI model (TB1-Ch2); Transmission media: Introduction, guided media, unguided media (TB1-Ch7); Switching: Introduction, circuit-switched networks, packet switching (TB1-Ch8).
UNIT – II **08 Hours**
Link layer addressing; (TB1-Ch10) Error detection and correction: Cyclic codes, checksum, forward error correction; (TB1-Ch10) Data link control: DLC services, data link layer protocols; (TB1-Ch11 & TB2-Ch3) Media access control: Random access, virtual LAN. (TB1-Ch12, Ch15)
UNIT – III **08 Hours**
Network layer design issues; (TB2-Ch5) Routing algorithms (Distance Vector Routing, Link State Routing and Hierarchical Routing).; (TB2-Ch5) Congestion control algorithms; (TB2-Ch5) Quality of service, and internetworking; (TB2-Ch5) The network layer in the internet: IPv4 addresses, IPv6; (TB2-Ch5, TB1-Ch19) Internet control protocols, OSPF (Open Shortest Path First), IP (Internet Protocol); (TB2-Ch5)
UNIT – IV **08 Hours**
The transport service, elements of transport protocols; (TB2-Ch6) Congestion control; (TB2-Ch6) The internet transport protocols: UDP (User Datagram Protocol), TCP (Transport Control Protocol); (TB2-Ch6) Performance problems in computer networks, and network performance measurement. (TB2-Ch6)
UNIT – V **07 Hours**
Introduction, client server programming, WWW (World Wide Web) and HTTP (Hyper Text Transfer Protocol); (TB1-Ch27) FTP (File Transfer Protocol); (TB1-Ch26) E-mail, telnet, (TB1-Ch26 & TB2-Ch7) DNS (Domain Naming System); (TB2-Ch7) SNMP (Simple Network Management Protocol) (TB1-Ch28)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Explain** the basic concepts of data communications including the key aspects of networking and their interrelationship, packet switching, circuit switching and cell switching as internal and external operations, physical structures, types, models, and internetworking.	L2

2	**Apply** the concept of Hamming distance, the significance of the minimum Hamming distance and its relationship to errors as well as the detection and correction of errors in block codes.	L3
3	**Solve** the problems related to various Routing Algorithms and also perform the Interpretation of routers, Internet Protocol IPv4, and IPv6.	L3
4	**Recognize** transport layer services and infer UDP and TCP protocols and **Distinguish** between UDP and TCP Protocols.	L4
5	**Infer** the significance, and purpose of protocols (FTP, SMTP), standards, and use in data communications and networking and **analyze** the most common DNS resource records that occur in a zone file.	L4

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	3	3		-	-	-	-	-	-	-	-	2	2
CO3	3	3	3	-	-	-	-	-	-	-	-	-	2	2
CO4	3	3	3	-	-	-	-	-	-	-	-	-	1	1
CO5	3	3	3	-	-	-	-	-	-	-	-	-	1	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Behrouz A. Forouzan—Data Communications and Networking with TCP/IP Protocol Suite‖ TataMcGraw- Hill, 6th Edition, 2022.

2. Andrew S. Tanenbaum, David Wetherall, —Computer Networks‖ Prentice-Hall, 6th Global Edition, 2021.

REFERENCE BOOKS:

1. Chwan-Hwa Wu, Irwin, —Introduction to Computer Networks and Cyber Security‖, CRC publications, 2014.
2. Douglas E. Comer, —Internetworking with TCP/IP —, Prentice-Hall, 5thEdition,2011.
3. Peterson, Davie, Elsevier, —ComputerNetworks,5thEdition,2011
4. Comer, —Computer Networks and Internets with Internet Applications,4thEdition,2004.

E-Resources:

1. http://computer.howstuffworks.com/computer-networking-channel.htm
2. https://www.geeksforgeeks.org/layers-osi-model/
3. https://www.wikilectures.eu/w/Computer_Network
4. https://technet.microsoft.com/en-us/network/default.aspx

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving using group discussion.
2. Flip class activity

LABORATORY EXPERIMENTS

1. Analyse the various line coding techniques used for data transmission of a digital signal over a transmission line
2. Design a program for error-detecting code using CRC-CCITT (16- bits).
3. Design a program to find the shortest path between vertices using Belman- ford algorithm
4. Given a graph derive the routing table using distance vector routing and link state routing algorithm
5. Try out some simple subnetting problems.
6. Using TCP/IP sockets, write a client–server program to make the client send the file name and to make the server send back the contents of the requested file if present. Implement the above program using message queues or FIFOs as IPC channels

7. Implement a webserver program to fetch a URL request and display the home page of the same in the browser
8. Implement a simple DNS server to resolve the IP address for the given domain name

DISCRETE MATHEMATICS AND GRAPH THEORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	:	24AM2304	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1**. Learn** the set theoretic concept and its application in theory of computation.

2. **Determine** the concepts of mathematical induction, recursive relations and their application.

3. **Illustrate** the association of functions, relations, partial ordered set and lattices with problems related to theoretical computer science and network models.

4. **Discuss** the basics of graph theory and its application in computer networks. Learn the concepts of counting techniques and its application.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. **Lecture method** means it includes not only traditional lecture method, but different type of teaching methods may be adopted to develop the course outcomes.
2. **Interactive Teaching:** Adopt the Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show **Video/animation** films to explain functioning of various concepts.
4. Encourage **Collaborative** (Group Learning) Learning in the class.
5. To make **Critical thinking**, ask at least three Higher order Thinking questions in the class.
6. Adopt **Problem Based Learning**, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the **different ways to solve** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every **concept can be applied to the real world** - and when that possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

SET THEORY: Sets and subsets, Operations on Sets: Basic set operations, algebraic properties of sets, The Addition Principle

RELATIONS AND ITS PROPERTIES: Relations and their properties, N-Ary Relations

and their applications, Representing relations. ***Textbook – 2: 1.1, 1.2 ; Textbook – 1: 7.1., 7.2, 7.3***
UNIT – II **06 Hours**
RELATIONS AND ORDER RELATIONS: Closure of relations, Equivalence Relations, Partial Orderings, Functions, The Growth of Functions. **Self-Study:** Transitive Closure and Warshall's Algorithm. ***Textbook – 1: 7.4., 7.5, 7.6, 3.2***
UNIT – III **08 Hours**
MATHEMATICAL INDUCTION AND RECURSION: Mathematical Induction, Recurrence Relations: Rabbits and the Fibonacci Numbers, The Tower of Hanoi, Code word Enumeration, Solving Linear Recurrence Relations **Self-Study:** Basic Connectives and Truth Tables ***Textbook-1: 4.1;6.1, 6.2;1.1***
UNIT – IV **09 Hours**
GRAPH THEORY: Graphs and Graph Models. Graph Terminology and Special Types of Graphs: Basic Terminology, Some Special Simple Graphs, Bipartite Graphs, Complete Bipartite Graphs. Representing Graphs and graph isomorphism: Adjacency lists, Adjacency Matrices, Incidence Matrices, Connectivity: Paths, Connectedness in Undirected and Directed Graphs, Vertex and Edge connectivity and their applications. ***Textbook-1: 8.1, 8.2, 8.3, 8.4***
UNIT – V **08 Hours**
GRAPHS AND ITS APPLICATIONS: Euler and Hamilton Paths and their applications, Planar Graphs and their Applications, Graph Coloring and its applications. ***Textbook-1: 8.5, 8.7, 8.8***

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Identify** the membership of the Set, Relations and make use of basic Algebraic properties.	L3
2	**Examine** the steps involved in Mathematical Induction and Linear recurrence-related problems.	L4
3	**Construct** different types of graphs based on the properties and the real-time applications of graph theoretical concepts.	L3
4	**Analyze** the methods for optimizing the solution for graph coloring problem, Eulerian and Hamilton circuits/planes.	L4

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	1	2					1	1	1		2	1	0
CO2	3	3	2					1	1	1		2	1	0
CO3	3	3	3					1	1	1		1	1	0
CO4	3	3	3					1	1	1		1	1	0

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Kenneth H. Rosen, "Discrete Mathematics and its applications", Tata McGraw Hill, 2003.
2. Bernard Kolman, Robert C. Busby, Sharon Ross, "Discrete Mathematical Structures", 3rdEdition, PHI 2001.

REFERENCE BOOKS:

1. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics", IV Edition, Pearson Education, Asia, 2002.
2. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with applications to computer Science", Tata McGraw Hill, 1987.
3. J K Sharma, "Discrete Mathematics", 3rd edition, 2013, Macmillan India Ltd.

E-Resources:

1. Discrete Mathematics with Algorithms by M. O. Albertson, J. P. Hutchinson – J 1988, Wiley.
2. Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides,Thomson Brooks/Cole, 2006.
3. http://ocw.mit.edu/courses/mathematics/
4. http://www.nptelvideos.in/2012/11/discrete-mathematical-structures.html
5. http://cglab.ca/~discmath/notes.html
6. https://www.cs.odu.edu/~toida/nerzic/content/web_course.html

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion.
2. Demonstration of solution to a problem using graph theory.

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COMPUTER ORGANIZATION AND ARCHITECTURE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 24AM2305	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P-J	: 3–0–0-0		

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the Architecture and programming of ARM microprocessor.
2. **Develop** program using Arm instruction set and appreciate the advanced features provided in the ARM
3. **Understand** the exception handling techniques.
4. **Study in** detail the concept of instruction level parallelism and concepts of pipelining.
5. **Understand** various cache memory mapping techniques and memory Organization.

Teaching-Learning Process

1. ***Lecture method*** along with traditional lecture method, different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *incorporating* brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Showing ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, asking Higher order Thinking questions in the class in the form of Quiz and writing programs with complex solutions.
6. Showing the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.

UNIT – I	**05 Hours**

An Overview of Computing Systems: History of Computers, The Computing Device,
The ARM7TDMI Programmers' Model:
Introduction, Data types, Processor Modes, Registers, Program Status Registers, The vector Table.
Assembler Rules and Directives: Structure of Assembly Language Modules, Registers, Directives and Macros. **Loads, Stores and Addressing:** LODS and STORES instructions, Operand Addressing , ENDIANNES ***Text Book-1: 1.1 to 1.3; 2.1 to 2.6 ; 4; 5.3, 5.4, 5.5***

UNIT – II	**05 Hours**

Constants and Literal Pools: The ARM Rotation Scheme, Loading Constants and address into Registers
Logic and Arithmetic: Flags and their Use, Compare instructions, Data Processing Instructions **Loops and Branches:** Branching, Looping, Conditional Execution, Straight-Line Coding

Subroutines and Stacks: Stack, Subroutines, Passing parameters to subroutines, The ARM APCS.
(Text Book-1: 6.1 to 6.4; 7.1 to 7.4; 8.2 to 8.6; 10.1 to 10.5

UNIT – III	**05 Hours**

Mixing C and Assembly Language: Inline Assembler Embedded Assembler, Calling Between C and Assembly.

Exception Handling: Interrupts, Error Conditions, Processor Exception Sequence, The Vector Table, Exception Handlers,
Exception Priorities, Procedures for Handling Exceptions. ***(Text Book-1: 11.1 to 11.8; 14.1 to 14.4***

UNIT – IV	**12 Hours**

Pipelining: Basic and Intermediate Concepts
Introduction, The Major Hurdle of Pipelining, How Pipelining Implemented, What makes Pipelining hard to Implement, Extending the MIPS Pipeline to Handle Multicycle Operations, The MIPS R4000 Pipeline, Crosscutting Issues. ***Text Book-2: C.1 to C.7***

UNIT – V	**12 Hours**

Memory Hierarchy:
Introduction, Cache Performance, Six basic cache Optimizations, Virtual Memory, Protection and examples of Virtual Memory, Fallacies and Pitfalls.
Text Book-2: B.1 to B.6

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Apply** knowledge of the internal architecture and organization of ARM microprocessors to utilize their components and functionalities.	L3
2	**Apply** the instruction set of ARM Microprocessor by writing Assembly language programs.	L3
3	**Analyze and compare** the various exception handling techniques.	L4

4	**Examine** the concept of instruction-level parallelism and **analyze** the principles of Pipelining techniques.	L4
5	**Compare** and C**ontrast** memory hierarchy and its impact on computer cost/performance.	L4

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3		2										2	
CO2	3		3		1								2	
CO3	3	3	1										2	
CO4	3	3	1										2	
CO5	3	3	1										2	

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. William Hohl, "ARM Assembly Language", 2nd Edition, CRC Press, 2009.
2. John L Hennessy, David A Patterson, "Computer Architecture, A Quantitative Approach", 5th Edition, Morgan Kaufmann publishers, 2012.

REFERENCE BOOKS:

1. David A Patterson, John L Hennessy, "Computer Organization and Design", 4th Edition, Morgan Kaufmann publishers, 2010.
2. Steve Furber, "ARM System-on-chip Architecture", 2nd Edition, Pearson Publications, 2000.
3. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", 5th Edition, Tata McGraw Hill, 2002.

E-Resources:

1. https://www.udemy.com/topic/arm-cortex-m/

2. https://www.edx.org/school/armeducation
3. https://onlinecourses.nptel.ac.in/noc22_cs93/preview

Activity Based Learning (Suggested Activities in Class)

1. Mini project implementation using Assembly Language Programming.
2. Demonstration of solution to a problem through programming.

EMBEDDED SYSTEMS DESIGN

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 24AM2306	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P-J	: 3–0–0-0		

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the fundamental concepts of embedded system design.
2. Gain **knowledge** of various hardware and software components used in embedded systems.
3. **Develop** skills to design and implement embedded systems for different applications.
4. Learn to **analyze** and optimize the performance of embedded systems.
5. **Enhance** problem-solving and critical thinking abilities in the context of embedded system design.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Interactive Lectures:*** Engage students through discussions, case studies, and real-life examples.
2. ***Hands-on Projects:*** Assign practical projects to students to enhance their understanding and application of concepts.
3. ***Group Discussions:*** Encourage collaborative learning and problem-solving through group discussions and brainstorming sessions.
4. ***Case Studies:*** Analyze real-world embedded system designs to understand their challenges and solutions.
5. ***Simulations and Virtual Labs:*** Use simulation tools and virtual labs to provide a virtual hands-on experience.
6. ***Guest Lectures:*** Invite industry experts to share their experiences and provide insights into real-world embedded system design practices.
7. ***Online Forums:*** Establish an online platform for students to discuss and share their ideas and questions related to the course.
8. ***Demonstrations:*** Conduct live demonstrations of embedded system prototypes to showcase practical implementations.
9. ***Assignments and Assessments:*** Assign regular assignments and assessments to evaluate students' understanding and progress.
10. ***Industry Visits:*** Organize visits to embedded system manufacturing companies to expose students to real-world applications.

UNIT – III	**08 Hours**

UNIT – I	**07 Hours**
INTRODUCTION TO EMBEDDED SYSTEMS **Introduction:** What is an Embedded System, Embedded Systems VS. General Computing Systems, History of Embedded Systems Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Wearable Devices—The Innovative Bonding of Lifestyle with Embedded Technologies ***(Text Book-3: Chapter 1)*** **Characteristics and Quality Attributes of Embedded Systems:** Characteristics of an Embedded System, Quality Attributes of Embedded Systems ***(Text Book-3: Chapter 3)*** **Embedded Systems—Application- and Domain-Specific:** Washing Machine—Application-Specific Embedded System, Automotive–Domain Specific Examples of Embedded System ***(Text Book-3: Chapter 4)***	
UNIT – II	**08 Hours**
EMBEDDED SYSTEM HARDWARE DESIGN-I **Embedded System Core:** General Purpose and Domain Specific Processors, Application Specific c Integrated Circuits (ASICs), Programmable Logic Devices (PLDs), Commercial off-the-shelf Components (COTS) ***(Text Book 3: Chapter 2.1)*** **Memory:** Overview on Various Types of memory sub systems used in Embedded systems and their selection ***(Text Book 3: Chapter 2.2)*** **Sensors and Actuators:** interfacing of LEDs, 7-segment LED Displays, Piezo Buzzer, Stepper Motor, Relays, Optocouplers, Matrix keyboard, Push button switches, Programmable Peripheral Interface Device (e.g. 8255 PPI), etc. with the I/O subsystem of the embedded system. ***(Text Book 3: Chapter 2.3)***	
EMBEDDED SYSTEM HARDWARE DESIGN-II **Communication Interface:** I2C, SPI, CAN, UART,1-wire, parallel bus, etc. RS-232C, RS-485, Parallel Port, USB, IEEE 1394, Infrared (IrDA), Bluetooth, Wi-Fi, ZigBee, GPRS, etc. ***(Text Book 3: Chapter 2.4)*** **Other System Components:** Reset Circuit, Brown-out protection circuit, Oscillator Unit, Real-Time Clock (RTC), Analog to Digital Converter (ADC), Timers and Watchdog Timer unit ***(Text Book 3: Chapter 2.6)*** **Arm Cortex Mx Processor Family Overview:** Features, Architecture, Memory System, Exception and Interrupts, Low Power Features ***(Text Book 1: Chapter 3)***	
UNIT – IV	**08 Hours**
EMBEDDED SYSTEM SOFTWARE DESIGN **Programming Concepts and Embedded Programming in C:** High -Level Language C programming, C program elements (compiler build stages, macros, functions, Bitwise Operations, Looping constructs, Pointers, and AAPCS) ***(Reference Book 2: Chapter 5.1 to 5.6)***	
UNIT – V	**08 Hours**
EMBEDDED SYSTEM SOFTWARE DESIGN **Embedded Firmware Design and Development:** Embedded Firmware Design Approaches ***(Text Book 3: Chapter 9.1)***	

REAL-TIME OPERATING SYSTEMS
Operating System Basics: The Kernel, Types of Operating Systems, Tasks, Process and Threads
(Text Book 3: Chapter 10.1, 10.2, 10.3)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Understanding** the fundamentals of embedded systems, including their characteristics, classifications, application domains, and quality attributes.	L2
2	**Describe** the roles of hardware components in embedded systems.	L2
3	**Illustrate** the working of embedded communication interfaces, system support components, and basic architecture of ARM Cortex Mx processors.	L2
4	**Apply** embedded C programming concepts to develop software modules using functions, pointers, bitwise operations, and looping constructs in accordance with AAPCS standards.	L3
5	**Analyze** embedded firmware design approaches and the role of real-time operating system components such as kernels, tasks, processes, and threads in embedded applications.	L4

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)								PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2											3	2
CO2	3	2			2								3	2
CO3		2	2		2								3	2
CO4	3	2	3	2	3								2	3
CO5	3	3	2	3	2	1							2	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Joseph Yiu," The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", 3rd Edition, Newnes, 2013
2. K.V. Shibu," Introduction to Embedded Systems", 2nd Edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. James K. Peckol, "Embedded Systems: A Contemporary Design Tool", Wiley, 2009.
2. Raj Kamal, "Embedded Systems- Architecture, Programming and Design", 3rd Edition, McGraw Hill Education, 2017.
3. Jonathan Valvano," Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers", 2nd Edition, CreateSpace Independent Pub, 2012.

E-Resources:

1. MOOC Course: "Introduction to Embedded Systems" by University of California, Irvine (Link: [www.coursera.org/embedded- systems])
2. Website: Embedded.com (Link: [www.embedded.com])
3. Online Tutorial: "Embedded Systems Tutorial" by Tutorials point (Link: [www.tutorialspoint.com/embedded_system])
4. ARM Procedure Call Standard (AAPCS) Standard documentation (Link: https://developer.arm.com/documentation/dui0041/c/ARM-Procedure-Call-Standard)

Activity Based Learning (Suggested Activities in Class)

1. **Project-based Learning:** Assign a semester-long project where students design and implement an embedded system for a specific application.
2. **Hackathons:** Organize hackathons where students work in teams to solve a given problem using embedded system design techniques.
3. **Guest Speaker Series:** Invite professionals from the industry to share their experiences and projects related to embedded system design.

Hands-on:

1. Introduction to Embedded System & STM32FXX Kit.
2. Explain the step-by-step procedure to create, build, and upload a program to the STM32FXX microcontroller using Keil uVision5.
3. Developing the GPIO Output driver to toggle the Onboard LED (Using Inbuilt Headers).
4. Developing the GPIO Input driver to turn ON the Onboard LED when you press the onboard button.
5. Developing the ADC Driver Code.

SKILL ENHANCEMENT COURSE-I
JAVA PROGRAMMING
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 24AM2307	**Credits**	: 02
Hours / Week	: 03 Hours	**Total Hours**	: 26 Hours
L–T–P–S	: 1–0–2–0		

Course Learning Objectives:

This course will enable students to:

1. Understand the basic principles of object-oriented programming and their application in Java.
2. Demonstrate proficiency in writing and executing simple Java programs using fundamental programming constructs.
3. Apply problem-solving skills to design and implement Java programs that solve real-world computational problems.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Real-World Examples:*** *Use* ***real-world examples*** *and scenarios to demonstrate the practical relevance of Java programming concepts which enhances their understanding of how Java is used in real-world applications*
2. ***Interactive Coding Sessions:*** *Conduct* ***Interactive coding sessions*** *where students can code alongside the teacher or participate in coding challenges. This promotes active participation and helps students develop their coding skills*
3. ***Project-Based Learning****: Assign projects or mini-projects that require students to apply Java programming concepts and develop complete applications. This approach fosters independent learning, problem solving skills and a deeper understanding of Java Programming Principles.*
4. ***Active Learning Strategies:*** *Incorporate* ***active learning strategies*** *such as group discussions, problem-solving activities, case studies, and hands-on coding exercises. This allows students to actively engage with the material and apply their knowledge in practical scenarios*
5. ***Collaborative Learning:*** *Encourage students to work in pairs or small groups on programming tasks.* ***Collaborative learning*** *promotes peer-to-peer learning, fosters teamwork, and allows for the exchange of ideas and knowledge.*
6. ***Guest Speakers and Industry Connections:*** *Invite* ***guest speakers, industry professionals, or alumni*** *who work with Java programming to share their*

experiences and insights. This provides students with real-world perspectives and helps them understand the practical applications of Java programming	
UNIT – I	**06 Hours**
An Overview of Java: Object-Oriented Programming, A First Simple Program, A Second Short Program, Two Control Statements, Using Blocks of Code, Lexical Issues, The Java Class Libraries, **Data Types, Variables, and Arrays**: Java Is a Strongly Typed Language, The Primitive Types, Integers, Floating-Point Types, Characters, Booleans, A Closer Look at Literals, Variables, Type Conversion and Casting, Automatic Type Promotion in Expressions, Arrays ***(Text book-1: Ch 2, Ch 3).***	
UNIT – II	**05 Hours**
Operators: Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The ? Operator, Operator Precedence, Using Parentheses, **Control Statements**: Java's Selection Statements, Iteration Statements, Jump Statements. ***(Text book 1: Ch 4, Ch 5).***	
UNIT – III	**05 Hours**
Introducing Classes: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection, The finalize( ) Method, A Stack Class, **A Closer Look at Methods and Classes**: Overloading	
Methods, Using Objects as Parameters, A Closer Look at Argument Passing, Returning Objects, Recursion, Introducing Access Control, Understanding static ***(Text book 1: Ch 6, Ch 7).***	
UNIT – IV	**05 Hours**
Inheritance: Inheritance Basics, Using super, Creating a Multilevel Hierarchy, When Constructors Are Executed, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class. Packages: **Packages**, Packages and member Access, Importing Packages, **Interfaces**, ***(Text book 1: Ch 8,Ch 9).***	
UNIT – V	**05 Hours**
Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java's Built-in Exceptions, Creating Your Own Exception Subclasses, Three Recently Added Exception Features, Using Exceptions. ***(Text book 1: Ch 10).***	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Demonstrate an understanding of object-oriented programming concepts in Java.	L2

2	Apply different operators and control statements in Java to solve programming problems.	L3
3	Design and implement classes, methods, and constructors in Java to create reusable and modular code.	L4
4	Utilize inheritance, packages, and interfaces in Java to develop complex object-oriented programs.	L4
5	Handle exceptions effectively in Java programs and develop robust error-handling mechanisms.	L5

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)								**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2				1				2			3	
CO2		3	2			2				2				3
CO3	2	2	3						2	2		2		2
CO4	2	2	3			1							2	
CO5		2		2	2	2								2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Herbert Schildt, Java The Complete Reference, 11th Edition, Tata McGraw Hill, 2019. (Chapters 2, 3, 4, 5, 6,7, 8, 9,10)

REFERENCE BOOKS:

1. H.M.Dietel and P.J.Dietel,Java, How to Program, 11th Edition, Pearson Education/PHI, 2017

2. E Balagurusamy, Programming with Java A primer, McGraw Hill Education,2019.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs47
2. https://www.geeksforgeeks.org/java/
3. https://www.codecademy.com/learn/learn-java

Activity Based Learning (Suggested Activities in Class)

1. **Code Walkthrough and Debugging**:
   a) Provide students with a pre-written Java program that contains bugs or logical errors. Divide the class into small groups or pairs.
   b) Instruct each group to identify and fix the errors in the code, encouraging them to use their knowledge of Java programming concepts.
   c) After a set time, have each group present their fixed code to the class and explain their debugging process.
2. **Mini Java Project:**
   a) Divide the class into small groups and assign each group a specific programming problem or scenario that requires a Java solution.
   b) Instruct each group to design and implement a Java program to solve the assigned problem, utilizing concepts learned in class.
   c) Provide guidance and support as needed while encouraging students to apply their creativity and problem-solving skills.

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AI FOR RENEWABLE ENERGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	24AM2308	**Credits**	:	01
Hours / Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P-J	:	1–0–0-0			

Course Objectives:

This Course will enable students to:

1. **Understand** the fundamentals of renewable energy systems and their challenges.
2. **Apply** ML/DL models for energy forecasting and optimization.
3. **Design** AI-driven control systems for smart energy management.
4. **Develop** predictive maintenance models for renewable infrastructure.
5. **Integrate** AI with IoT for real-time monitoring of renewable systems.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

9. ***Lecture method*** means it includes not only traditional lecture method, but different type of teaching methods may be adopted to develop the course outcomes.
10. ***Interactive Teaching***: Adopt the **Active learning** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
11. Show ***Video/animation*** films to explain functioning of various concepts.
12. Encourage ***Collaborative*** (Group Learning) Learning in the class.
13. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
14. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
15. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
16. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**03 Hours**

INTRODUCTION TO RENEWABLE ENERGY:

Overview of Renewable Energy Sources (Solar, Wind, Hydro, Biomass), Challenges in Renewable Energy Integration, Case Studies of Renewable Energy.

(Text Book-1 :)

UNIT – II	**03 Hours**

MACHINE LEARNING FOR ENERGY FORECASTING:

Time Series Forecasting Techniques (ARIMA), Supervised Learning for Energy Load Prediction, Feature Engineering with Weather & Environmental Data, Evaluation Metrics

(MAE, RMSE, R^2) ***(Text Book-2:)***
UNIT – III **02 Hours**
DEEP LEARNING IN RENEWABLE SYSTEMS: LSTM, GRU, and Hybrid Models for Energy Forecasting, CNN for Solar Panel Image Analysis, Predictive Maintenance with Sensor Data, Fault Detection and Classification in Solar/Wind Farms. ***(Text Book-3:)***
UNIT – IV **02 Hours**
Optimized Use of PV Arrays: Introduction to Optimization Algorithms, Efficiency of a MPPT Algorithm, Comparison of Different Algorithms ***(Ref boook-1:)***
UNIT – V **03 Hours**
Modelling of Energy Storage Systems and Real-Time Control: Description of Different Storage Systems, Battery Bank Systems, Battery Bank Model, Equivalent Circuit Battery Models. ***(Text Book-1 :)***

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Explain** the fundamentals of renewable energy systems such as solar, wind, hydro, biomass.	L2
2	**Apply** machine learning models to perform energy generation and load forecasting using historical and weather-related data.	L3
3	**Analyze** the outputs of machine learning/deep learning models for fault detection and predictive maintenance in renewable energy systems using sensor or image data.	L4
4	**Compare** commonly used optimization and MPPT algorithms to assess their impact on the efficiency of photovoltaic (PV) systems.	L4
5	**Develop** a simple AI-assisted renewable energy monitoring or energy storage model using simulated or real-time IoT data.	L4

Table: Mapping Levels of COs to POs / PSOs		
COs	**Program Outcomes (POs)**	**PSOs**

	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1					3		3			1	2	1
CO2	2	3		1	3		2		3			1	1	2
CO3	2	3		2	3		2		3			1	2	2
CO4	2	3	1		2		2		3			2	2	2
CO5	2	2	2		3		2		3	1	1	2	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS (TB):

3. Soteris Kalogirou – Artificial Intelligence in Energy and Renewable Energy Systems.
4. Alireza Khaligh – Energy Harvesting and Renewable Energies for Smart Devices.
5. Godfrey Boyle - Renewable Energy: Power for a Sustainable Future.

REFERENCE BOOKS:

5. Time Series Prediction: Forecasting the Future and Understanding the Past by Andreas S. Weigend, Addison-Wesley, 1994.
6. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 2016.
7. Artificial Intelligence Techniques in Power Systems by Ashish Rajurkar, Ashok Agarwal, IEEE Press / CRC Press, 2017.

E-RESOURCES:

7. NPTEL:
    a. Renewable Energy Systems (IIT Madras / IIT Kharagpur)
    b. Machine Learning for Engineering Applications

ACTIVITY BASED LEARNING:

1. Identification of problem statement by forming a team.
2. Real world problem solving using group discussion.

IV SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	BSC	24AM2401	Transform and Numerical Techniques	3	0	0	0	60	40	100	03
2	IPCC	24AM2402	Design and Analysis of Algorithms	3	0	2	0	60	40	100	04
3	IPCC	24AM2403	Database Management System	3	0	2	0	60	40	100	04
4	PCC	24AM2404	Theory of Computation and System Software	3	1	0	0	60	40	100	04
5	PCC	24AM2405	Artificial Intelligence	3	0	0	0	60	40	100	03
6	PCC	24AM2406	Full Stack Development	3	0	0	0	60	40	100	03
7	SEC	24AM2407	Skill Enhancement Course -II (Unix and Shell Programming)	1	0	2	0	100	--	100	02
8	AEC	24AM2408	Cognitive and Technical Skills-IV	--	--	--	--	--	--	--	Pass /Fail
			Total	19	1	06	0				**23**

IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, BSC-Basic Science, AEC-Ability Enhancement Course, L – Lecture, T – Tutorial, P – Practical, J– Project, C – No. Of Credits

TRANSFORMS AND NUMERIAL TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	: 24AM2401	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–J	: 3–0–0–0		

Course Learning Objectives:

This Course will enable students to:

1. **Apply** their knowledge of Laplace transforms and inverse Laplace transforms to proficiently solve linear ordinary differential equations with constant coefficients, facilitating the analysis and modelling of complex systems.
2. **Analyze** periodic functions using Fourier series, assessing the convergence properties and precision of the series expansion, thereby enhancing their ability to understand and manipulate periodic phenomena.
3. **Utilize** complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms to solve problems involving Fourier integrals, developing proficiency in applying these techniques to various mathematical scenarios.
4. **Employ** numerical methods, including Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods, to solve differential equations and effectively analyze dynamic systems, enabling them to model real-world phenomena and make accurate predictions**.**
5. **Apply** finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to effectively solve different types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations, enhancing their problem-solving skills in the context of differential equations and their applications.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.

5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding

UNIT – I: Laplace Transform and Inverse Laplace Transform	**09 Hours**

Laplace Transforms of Elementary functions (without proof), ***(Text Book-1: Chapter 6: 203 to 207).***

Laplace Transforms $e^{at}f(t), t^n f(t)$ and $\frac{f(t)}{t}$ of Periodic functions, Unit step function and impulse functions

(Text Book-1: Chapter 6:208-230).

Inverse Laplace Transforms- By the method of Partial Fractions, Logarithmic and Trigonometric functions, Convolution Theorem, Inverse Laplace transform using Convolution Theorem ***(Text Book-1: Chapter 6: 238)***. Solution to Differential Equations by Laplace Transform.

(Text Book-1: Chapter 238-242).

UNIT – II: Fourier Series	**09 Hours**

Periodic Functions, Trigonometric Series

(Text Book-1: Chapter 11: 495).

Fourier series Standard function, Functions of any Period 2L, Even and Odd functions, Half-range Expansions. ***(Text Book-1: Chapter 11: 483-492)***

Practical Harmonic analysis (calculate average power and RMS values of periodic waveforms)

UNIT – III: Fourier Transform	**06 Hours**

Calculation of Fourier integrals using complex exponential form ***(Text Book-1: Chapter 11: 510).***

Fourier transform of basic functions ***(Text Book-1: Chapter 11: 510-516).*** Fourier sine and cosine transforms. ***(Text Book-1: Chapter 11: 518-522).***

UNIT – IV: Numerical Methods for Solving Ordinary Differential Equations	**07 Hours**

Euler's Method-Basic principles of Euler's method for solving first-order ODEs ***(Text Book-1: Chapter 1:10-12).***

Runge-Kutta 4th order ***(Text Book-1: Chapter 21:904).***

Multistep Methods-Explanation of multistep methods (Adams-Bashforth, Adams–Moulton Methods) ***(Text Book-1: Chapter 21:911- 913).***

Second-Order ODE. Mass–Spring System (Euler Method, Runge–Kutta Methods) ***(Text Book-1: Chapter 21:916-918).***

UNIT – V: Numerical Methods for Partial Differential Equations	**08 Hours**

Classification of PDEs (elliptic, parabolic, hyperbolic), ***(Text Book-1: Chapter 21:922-923).*** Finite Difference Methods (Laplace and Poisson Equations), Derivation of finite difference approximations ***(Text Book-1: Chapter 21:923-927).*** Crank–Nicolson Method ***(Text Book-1: Chapter 21:938-941).*** Method for Hyperbolic PDEs ***(Text Book-1: Chapter 21:943-945).***

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Apply** Laplace transforms and inverse Laplace transforms to solve linear ordinary differential equations with constant coefficients, demonstrating proficiency in system analysis and modelling.	L3
2	**Analyze** periodic functions using Fourier series and evaluate the convergence properties and precision of the series expansion.	L2 & L3
3	**Solve** problems involving Fourier integrals by applying complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms.	L3
4	**Utilize** numerical methods such as Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods to solve differential equations and analyze dynamic systems	L2 & L3
5	**Apply** finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to solve various types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations.	L3

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	2	1					1					
CO2	3	2	2						1					

CO3	3	2	2	1					1					
CO4	3	2	2	1					1					
CO5	3	2	2	1					1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India.

REFERENCE BOOKS:

1. Higher Engineering Mathematics, B.S. Grewal, 2015, 43rd Edition, Khanna Publishers.
2. Higher Engineering Mathematics, John Bird, 2017, 6 th Edition, Elsevier Limited.

E-Resources:

1. https://nptel.ac.in/courses/111106139
2. https://nptel.ac.in/courses/111101164
3. https://nptel.ac.in/courses/111105038

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DESIGN AND ANALYSIS OF ALGORITHMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	24AM2402	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P–J	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Analyze** the non-recursive and recursive algorithms and to represent efficiency of these algorithms in terms of the standard Asymptotic notations.
2. **Acquire** the knowledge of Brute Force and Divide and Conquer techniques to design the algorithms and apply these methods in designing algorithms to solve a given problem.
3. **Master** the Decrease and Conquer, Transform and Conquer algorithm design techniques, and Time versus Space Trade-offs.
4. **Learn** Greedy method and dynamic programming methods and apply these methods in designing algorithms to solve a given problem.
5. **Understand** the importance of Backtracking and Branch and Bound algorithm design techniques to solve a given problem.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

INTRODUCTION:
What is an Algorithm? Fundamentals of Algorithmic Problem Solving.
(Text Book-1: Chapter 1: 1.1 to 1.2)
FUNDAMENTALS OF THE ALGORITHMS EFFICIENCY:
Analysis Framework, Asymptotic Notations and Standard notations and common functions ***(Text Book-2: Chapter 3: 3.1, 3.2)***,
Mathematical Analysis of Non-recursive and Recursive Algorithms,
(Text Book-1: Chapter 2: 2.1, 2.3, 2.4,)

UNIT – II	**08 Hours**

BRUTE FORCE:
Background, Selection Sort, Brute-Force String Matching. TSP
(Text Book-1: Chapter 3: 3.1, 3.2)
DIVIDE AND CONQUER:
General method, Recurrences: The substitution method, The recursion-tree method, The master method.
(Text Book-2: Chapter 4: 4.4, 4.5),
Merge sort, Quick sort, Binary Search, Multiplication of large integers,
Case study: Strassen's Matrix Multiplication.
(Text Book-1: Chapter 4: 4.1 to 4.3, 4.5)

UNIT – III	**06 Hours**

DECREASE & CONQUER:
General method, Insertion Sort, Graph algorithms: Depth First Search, Breadth First Search, Topological Sorting
TRANSFORM AND CONQUER:
Case study: Heaps and Heap sort.

TIME AND SPACE TRADEOFFS:
Input Enhancement in String Matching: Horspool's algorithm, Hashing: Open and Closed hashing.
(Text Book-1: Chapter 5: 5.1 to 5.3, Chapter 6: 6.3 to 6.4, Chapter 7: 7.2 to 7.3)

UNIT – IV	**9 Hours**

GREEDY TECHNIQUE:
General method of Greedy technique, Single-Source Shortest Paths: General method, The Bellman-Ford algorithm, Single-Source Shortest Paths in DAGs, Dijkstra's Algorithm
(Text Book-2: Chapter 24: 24.1 to 24.3).
Minimum Spanning Trees: Prim's Algorithm, Optimal Tree problem: Huffman Trees;
Case study: Kruskal's Algorithm. Fractional Problem
(Text Book-1: Chapter 9: 9.1, 9.2, 9.4).
DYNAMIC PROGRAMMING:
General method, The Floyd-Warshall Algorithm, Johnson's algorithm for sparse graphs ***(Text Book-2: Chapter 25: 25.1 to 25.3)***,
The Knapsack problem ***(Text Book-1: Chapter 8: 8.4).***

UNIT – V	**08 Hours**

LIMITATIONS OF ALGORITHMIC POWER
P, NP and NP-complete problems ***(Text Book-1: Chapter 11: 11.3***)

BACKTRACKING: General method, N-Queens problem, Subset-sum problem. ***(Text Book-1: Chapter 12: 12.1***) **BRANCH AND BOUND:** General method, Travelling Salesman problem, Approximation algorithms for TSP. **Case study:** Knapsack Problem. ***(Text Book-1: Chapter 12: 12.2, 12.3***)

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Exemplify** the algorithm design techniques and standard Asymptotic notations. Analyze non-recursive and recursive algorithms to obtain worst- case running times of algorithms using asymptotic analysis	L3
2	**Interpret** the brute-force, divide-and-conquer paradigms and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.	L3
3	**Demonstrate** the Decrease and Conquer, Transform and Conquer algorithm design techniques and analyze the performance of these algorithms.	L3
4	**Identify and interpret** the greedy technique, dynamic-programming paradigm as to when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms and analyze them	L3
5	**Illustrate** the Backtracking, Branch and Bound algorithm design paradigms and explain when an algorithmic design situation calls for it. Recite algorithms that employ these paradigms. **Summarize** the limitations of algorithmic power.	L3

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3											2	2
CO2	3	3	2										2	2
CO3	3	3											1	2
CO4	3	3	2										2	2
CO5	3	3											2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Anany Levitin, "Introduction to the Design & Analysis of Algorithms", 2nd Edition, Pearson Education, 2011.
2. Thomas H. Cormen, Charles E.Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI, 2014.

REFERENCE BOOKS:

1. Horowitz E., Sahni S., Rajasekaran S, "Computer Algorithms", Galgotia Publications, 2001.
2. R.C.T. Lee, S.S. Tseng, R.C. Chang & Y.T.Tsai, "Introduction to the Design and Analysis of Algorithms A Strategic Approach", Tata McGraw Hill, 2005.

E-Resources:

1. https://nptel.ac.in/courses/106/101/106101060/
2. http://cse01-iiith.vlabs.ac.in/
3. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
4. https://www.coursera.org/specializations/algorithms

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion. E.g., Fake coin identification, Cabbage puzzle, Konigsberg bridge puzzle etc.,
2. Demonstration of solution to a problem through programming.

LABORATORY EXPERIMENTS

Total Contact Hours: 26

Following are experiments to be carried out using either C programming language or Object-oriented programming language:

1. Apply divide and conquer method and Design a C program to implementation of Binary Search algorithm.
2. Sort a given set of n integer elements using Merge Sort method and compute its time complexity. Demonstrate this algorithm using Divide-and-Conquer method.
3. Sort a given set of n integer elements using Quick Sort method and compute its time complexity. Demonstrate this algorithm using Divide-and-Conquer method.
4. Incorporate the array data structure and demonstrate whether a given unweighted graph is connected or not using DFS method.
5. Implement the graph traversal technique using BFS method to print all the nodes reachable from a given starting node in an unweighted graph.
6. Compute the Transitive Closure for a given directed graph using Warshall's algorithm.
7. For a given weighted graph, construct an All-Pairs Shortest Paths problem using Floyd's algorithm and implement this algorithm to find the shortest distance and their shortest paths for every pair of vertices.
8. Implement 0/1 Knapsack problem using Dynamic Programming Memory Functions technique
9. Find Minimum Cost Spanning Tree for a given weighted graph using Prim's and Kruskal's algorithm.
10. From a given vertex in a weighted connected graph, determine the Single Source Shortest Paths using Dijkstra's algorithm.
11. Mini project proposal should be submitted and Implementation should be done based on the problem stated in the proposal

Open ended experiments

1. Implement Fractional Knapsack problem using Greedy Method.
2. Implement N-Queens problem using Backtracking technique.
3. implementation of Travelling Sales man problem using Dynamic programming

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DATABASE MANAGEMENT SYSTEM

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	: 24AM2403	**Credits**	: 04
Hours / Week	: 05 Hours	**Total Hours**	: 39(Th)+26(P) Hours
L–T–P–J	: 3–0–2–0		

Course Learning Objectives:

This course will enable students to:

1. **Acquire** the concept of databases, Entity-Relationship Model and relational model for creating and designing databases for the real-world scenario.
2. **Develop** queries to extract data from the databases using a structured query language.
3. **Differentiate** SQL and NoSQL.
4. **Demonstrate** the operations on MongoDB, Database connectivity with front end and **Optimize** the Database design using Normalization Concepts.
5. **Understand** the importance of Transaction Management, Concurrency control mechanism and recovery techniques.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**10 Hours**

INTRODUCTION TO DATABASE SYSTEMS :

Introduction, Characteristics of the Database Approach, Advantages of using DBMS Approach, Data Models, Schemas, Instances and Data Independence, Three Schema Architecture, various components of a DBMS.

(Text Book-1: Chapter 1: 1.1 to 1.4, 1.6, Chapter 2: 2.1,2.2, 2.4)

ENTITY-RELATIONSHIP MODEL:

Entity Types , Entity Sets , Attributes and Keys, Relationship types, Relationship Sets , Roles and Structural Constraints; Weak Entity Types; ER Diagrams

(Text Book-1: Chapter 7: 7.3, 7.4, 7.5, 7.7).

UNIT – II	**07 Hours**
RELATIONAL MODEL : Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update operations and Dealing with Constraint Violations. ***(Text Book-1: Chapter 3: 3.1 to 3.3).*** **SQL –THE RELATIONAL DATABASE STANDARD:** SQL Data Definition and Data types, Specifying constraints in SQL, Basic Queries in SQL-Data Definition Language in SQL, Data Manipulation Language in SQL; ***(Text Book-1: Chapter 4: 4.1 to 4.4).***	
UNIT – III	**08 Hours**
SQL –THE RELATIONAL DATABASE STANDARD: Additional Features of SQL; Views (Virtual Tables) in SQL; Database Programming Issues and Techniques ; ***(Text Book-1: Chapter 4: 4.5; Chapter 5: 5.1 to 5.4).*** **SQL AND NOSQL DATA MANAGEMENT:** Triggers, Database connectivity using Python, SQL vs NoSQL, Introduction to MongoDB, ***(Text Book-1: Chapter 5: 5.2,5.3***)***(Text Book-2 Chapter 1: 1.1 to 1.5***)	
UNIT – IV	**07 Hours**
NOSQL DATA MANAGEMENT: Data Types, Data Modelling, CRUD Operations. ***(Text Book-2 Chapter 1: 1.1 to 1.5***) **DATABASE DESIGN:** Design Guidelines, Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form; ***(Text Book-1: Chapter 14: 14.1 to 14.5)***	
UNIT – V	**07 Hours**
TRANSACTION MANAGEMENT The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Concurrency Control Mechanisms; Error recovery methods. ***(Text Book-1: Chapter 20: 20.1 to 20.5, Chapter 21: 21.1 to 21.3, Chapter 22: 22.1 to 22.4***)	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Use** the basic concepts of database management system in the design and creating database blueprint using E-R model and relational model.	L3
2	**Formulate** SQL and NoSQL queries for building structure and unstructured databases	L3
3	**Demonstrate** database connectivity using vendor specific drivers	L3

4	**Apply** normalization techniques to design relational database management system	L3
5	**Adapt** Transaction Management, concurrency control and recovery management techniques in database management system.	L3

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2	-	-	-	-	-	2	2	-	-	2	3
CO2	3	2	1	-	3	-	-	-	2	2	-	-	2	3
CO3	2	2	2	-	3	-	-	-	2	2	-	-	2	3
CO4	3	1	2	-	1	-	-	-	2	2	-	-	2	3
CO5	2	1	-	-	-	-	-	-	2	2	-	-	2	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Elmasri and Navathe, ”Fundamentals of Database Systems“, Seventh Edition, Pearson Education, 2021.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", First Edition, Pearson Education, Inc. 2012.

REFERENCE BOOKS:

1. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Third Edition, McGraw-Hill, 2003.
2. Silberschatz, Korth and Sudharshan: “Database System Concepts”, Seventh Edition, Mc-GrawHill, 2019.

3. C.J. Date, A. Kannan, S. Swamynatham: "An Introduction to Database Systems", Eight Edition, Pearson Education, 2012.

E-Resources:

1. http://nptel.ac.in/courses/106106093/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/lecture-notes/
3. http://agce.sets.edu.in/cse/ebook/DBMS%20BY%20RAGHU%20RAMAKRISHNAN.pdf
4. http://iips.icci.edu.iq/images/exam/databases-ramaz.pdf
5. https://db-class.org/
6. https://www.w3schools.com/mongodb/

Activity Based Learning (Suggested Activities in Class)

1. Database designing and data extraction using group discussion.
2. Collaborative Activity is minor project development with a team of 4 students.

LABORATORY EXPERIMENTS

Total Contact Hours: 26 Following are experiments to be carried out using either oracle or mysql, Mongo Db .

1. Design any database with at least 3 entities and establish proper relationships between them. Draw suitable ER/EER diagrams for the system. Apply DCL and DDL commands.
2. Design and implement a database and apply at least 10 Different DML Queries for the following task.
    a. For a given input string display only those records which match the given pattern or a phrase in the search string. Make use of wild characters and like operators for the same. Make use of Boolean and arithmetic operators wherever necessary
3. Write SQL statements to join table and retrieve the combined information from tables.
4. Execute the Aggregate functions count, sum, avg, min, max on a suitable database. Make use of built in functions according to the need of the database chosen .
5. Retrieve the data from the database based on time and date functions like now(), date(), day(), time() etc., Use of group by and having clauses.
6. Write and execute database trigger. Consider row level and statement level triggers.
7. Write and execute program to perform operations on MongoDb Database.
8. Write and execute program to perform CRUD operations.

Open Ended Experiments

1. Consider the Table "employees", write a SQL query to remove all the duplicate emails of employees keeping the unique email with the lowest employee id,return employee id and unique emails .

table: employees

Employee id	Employee_name	Email id
101	Liam Alton	li.al@abc.com
102	Josh Day	jo.da@abc.com
103	Sean Mann	se.ma@abc.com
104	Evan Blake	ev.bl@abc.com
105	Toby Scott	jo.da@abc.com

2. A salesperson is a person whose job is to sell products or services. Consider the table "Sales" [given below]. Write a SQL query to find the top 10 salesperson that have made highest sale. Return their names and total sale amount.

Table: sales

TRANSACTION_ID|SALESMAN_ID|SALE_AMOUNT|

501	18	5200.00
502	50	5566.00
503	38	8400.00
599	24	16745.00
600	12	14900.00

Table: salesman

SALESMAN_ID	SALESMAN_NAME
11	Jonathan Goodwin
12	Adam Hughes
13	Mark Davenport
59	Cleveland Hart
60	Marion Gregory

THEORY OF COMPUTATION and SYSTEM SOFTWARE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	: 24AM2404	**Credits**:	04
Hours / Week	: 04 Hours	**Total Hours**:	52 Hours
L–T–P–S	: 3–1–0–0		

Course Learning Objectives:

This course will enable students to:

1. Understand the concept of finite automata.
2. Explore Regular Grammar, Context-Free Language & Grammars and Pushdown Automata
3. Explain the working principles of Turing Machines as computational models and undecidability.
4. Explain the functions of assemblers, loaders, and the compilation process including compiler structure and phases.
5. Design and construct parsers using LL(1) and LR parsing techniques, perform grammar transformations, and handle syntax errors effectively.
6. Generate intermediate code using syntax-directed translation, create three-address code representations, and apply fundamental code optimization techniques. RetryPR

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Real-World Examples:*** *Incorporate real-world examples and case studies that demonstrate the relevance and application of automata theory in areas such as natural language processing, compilers, and pattern recognition*.
2. ***Problem-Solving Sessions:*** *Organize problem-solving sessions where students can work through challenging problems together*.
3. ***Reflective Learning****: Encourage students to reflect on their problem-solving approaches and discuss the reasoning behind their solutions****.***

UNIT – I	**11 Hours**

Part 1: Introduction to Finite Automata. The Central Concepts of Automata Theory, Deterministic Finite Automata, Non deterministic Finite Automata, An application, Finite Automata with Epsilon Transitions.

Part II: Regular Expressions Concept, Relation with Finite Automata, Applications of Regular Expressions, Properties of Regular Languages.

UNIT – II	**10 Hours**

Regular Language Context Free Grammars and Languages: Context Free Grammars, Parse Tree, Applications of Context Free Grammar, Ambiguity in Grammars and Languages, Properties of Context Free Languages, The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages.	
UNIT – III	**10 Hours**
Definition of Pushdown Automata, Deterministic Pushdown Automata, The Languages of a PDA, , Introduction to Turing Machines: The Turing Machines, Undecidability A language that is not Recursively Enumerable, An Undecidable Problem That is RE, Post Correspondence Problem	
UNIT – IV	**8 Hours**
Introduction to System Software, ASSEMBLERS Introduction to System Software, ASSEMBLERS: Basic assembler functions: A simple assembler, Machine dependent assembler features, Machine independent assembler features: Literals, Symbol-defining statements, Expressions, Program blocks, Basic loader functions: Design of an Absolute Loader, A Simple Bootstrap Loader, Introduction: Language Processors, Structure of compiler, Phases of Compiler.	
UNIT – V	**13 Hours**
COMPILERS Part I: LEXICAL AND SYNTAX ANALYSIS: Role of lexical Analyzer, Specification of Tokens, Lexical Analyzer generator Lex. SYNTAX ANALYSIS I: Role of Parser, Syntax error handling, Error recovery strategies, Writing a grammar: Eliminating ambiguity, Left recursion, Left factoring. Part II: Top down parsing: Recursive Descent Parsing, First and follow, LL (1), –Bottom up parsing: Shift Reduce Parsing, Introduction to LR parsing Simple LR: Why LR Parsers, Items and LR0 Automaton, The LR Parsing Algorithm. SYNTAX-DIRECTED TRANSLATION: Syntax-Directed Definitions: Inherited and Synthesized Attributes, Evaluation orders for SDDs: Dependency graphs, Ordering the evaluation of Attributes,Three address code: Quadruples, Triples, indirect triples, Basic Blocks, Optimization of Basic Blocks, The Code Generation Algorithm, Peephole optimization	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Analyze and formulate finite Automata, Regular Expressions for Text Processing	L3
2	Demonstrate Understanding of Context-Free Grammars and Pushdown Automata	L3
3	Apply Turing Machines to explore Undecidability and Computational Limits	L4
4	Construct lexical analyzers and parsers (LL(1), LR) with grammar transformation capabilities.	L4
5	Implement syntax-directed translation, generate intermediate code, and perform basic code optimization.	L3

Mapping Levels of COs to POs / PSOs														
COs				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Developmen	Conduct Investigatio	Modern Tool Usage	The Engineer	Environmen t and	Ethics	Individual & Team Work	Communica tion	Project managemen	Life-long Learning	Cognitive Outcome	Skill & Design
CO1	3	3	1		2	2						1	2	1
CO2	3	3	2		2						1	1	3	2
CO3	3	3	2	2	3					2	1	3	3	3
CO4	3	2	1		3						1	2	2	2
CO5	3	2	3	3	3						2	3	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Esparza, Javier, and Michael Blondin. *Automata theory: An algorithmic approach*. MIT Press, 2023.
2. Pettorossi, Alberto. *Automata Theory and Formal Languages: Fundamental Notions, Theorems, and Techniques*. Springer Nature, 2022.
3. "System Software: An Introduction to Systems Programming" by Leland L. Beck and D.Manjula was the 3rd edition, published in 2020.
4. "Compilers: Principles, Techniques, and Tools" by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman (commonly known as the "Dragon Book") 2nd Edition 2020.

REFERENCE BOOKS:

1. K.L.P. Misra and N. Chandrashekaran. Theory of Computer Science- Automata, Languages and Computation, 3rd Edn. PHI, New Delhi, 2007
2. Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson education,2013
3. J.E. Hopcroft , R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edn. Pearson Education ,2013
4. Computation, 3rd Edn. PHI, New Delhi, 2007
5. Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson education,2013
6. V. Raghavan, Principles of Compiler Design||, Tata McGraw Hill Education Publishers, 2010.

7. Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004. 3. D.M.Dhamdhere, Systems Programming and operating systems, Second Revised edition, Tata McGraw Hill.

TEXTBOOKS:

E-Resources:

- https://archive.nptel.ac.in/courses/111/103/111103016/
- https://www.youtube.com/watch?v=58N2N7zJGrQ&list=PLBlnK6fEyqRgp46KUv4ZY69yXmpwKOIev
- https://www.geeksforgeeks.org/theory-of-computation-automata-tutorials/
- Compiler Design - Course (nptel.ac.in)

Activity Based Learning (Suggested Activities in Class)

Hands on activity, Quiz, Seminar

ARTIFICIAL INTELLIGENCE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	: 24AM2405	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To provide a strong foundation of fundamental concepts in artificial intelligence.
2. To provide a basic exposition to different types of searching in Artificial intelligence.
3. To provide different knowledge representation, reasoning, and learning techniques.
4. To distinguish the different types of Experts Systems.
5. To design the Expert System based on the concepts of knowledge representation, searching and Reasoning on various applications using modernised AI tools.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Introduction: Artificial Intelligence, AI Problems, AI Techniques: supervised learning, unsupervised learning, and reinforcement learning, Different Types of Agents: Simple reflex agents, Model-based reflex agents, Goal-based agents and Utility-based agents; Environment, Problem Space and Search, Defining the Problem as a State Space Search, Problem Characteristics.

Textbook 2: Chapter 1,2

UNIT – II	**08 Hours**

Basic Search Techniques: Solving problems by searching; issues in the design of search programs; uniform search strategies: Breadth first search, Depth first search, Depth limited search, Bidirectional search, Best First search. Textbook 3: Chapter 3, 4; Textbook 2: Chapter 2, 3
UNIT – III **08 Hours**
Special Search Techniques: Heuristic Search, greedy best first search, A* search, AO*Algorithm, Hill climbing search, Simulated Annealing search, Adversarial search, Minimax search, Alpha, beta pruning, Genetic Algorithm. Knowledge Representation: Procedural Vs Declarative Knowledge, Approaches to Knowledge Representation, Forward Vs Backward Reasoning. Textbook 1: Chapter 5; Textbook 2: Chapter 3, 6
UNIT – IV **07 Hours**
Symbolic Logic: Propositional Logic, First Order Predicate Logic: Representing Instance and isa Relationships. Reasoning: Introduction to Monotonic Reasoning and Non-Monotonic Reasoning. Statistical Reasoning: Bayes Theorem, Certainty Factors, Bayesian Networks, Dempster-Shafer Theory. Textbook 2: Chapter 7,8
UNIT – V **08 Hours**
Experts Systems: Overview of an Expert System, Structure of an Expert Systems, Different Types of Expert Systems: Rule Based, Model Based, Case Based and Hybrid Expert Systems, Knowledge Building System Tools, Expert System Shells and Fuzzy Expert systems. Textbook 1: Chapter 8,9; Textbook 2: Chapter 20,22

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Summarize** the basic concepts of Artificial Intelligence, AI principles, AI Task domains and applications.	L2
2	**Apply** the different types of searching and knowledge representations techniques to solve the AI problems.	L3
3	**Make use of** the different types of reasoning such as Monotonic Reasoning, Non-Monotonic Reasoning and Statistical Reasoning techniques for making analysis and predictions.	L4

4	**Differentiate** the various types of Experts Systems such as Rule Based, Model Based, Case Based, Hybrid and Fuzzy Expert Systems.	L4
5	**Design** the Expert System based on the concepts of knowledge representation, searching and Reasoning on various applications using modernised AI tools.	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
COs	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	2				2	1			1	1			2	2
CO2	3	2			2	1			1	1			2	2
CO3	3	2			2	1			1	1			2	2
CO4	3	2			2	1			1	1			2	2
CO5	3	3	2		2	1			1	1			2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Artificial Intelligence, George F Luger, Sixth Edition, Pearson Education Publications, 2014.
2. Artificial Intelligence, Elaine Rich and Knight, McGraw-Hill Publications, 2010.

REFERENCE BOOKS:

1. Artificial Intelligence: A modern Approach, Russell and Norvig, Printice Hall, 2010.

2. Introduction To Artificial Intelligence & Expert Systems, Patterson, PHI.
3. Multi Agent systems- a modern approach to Distributed Artificial intelligence, Weiss. G, MIT Press.
4. Artificial Intelligence: A modern Approach, Russell and Norvig, Printice Hall.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://onlinecourses.nptel.ac.in/noc23_ge40/preview

Activity Based Learning (Suggested Activities in Class)

1. Flipped Class Activity on Searching techniques.
2. Problem Solving and Discussion.
3. Role Play
4. Mini Project

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FULL STACK DEVELOPMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	: 24AM2406	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To demonstrate the ability to design basic web pages using HTML and CSS
2. To utilize advanced CSS methods to design the web page, background and components.
3. To experiment with Bootstrap, Javascript and DOM for to create dynamic webpages.
4. To build web pages with the ReactJS and NodeJS as front end and back end.
5. To Model a complete web-page with mangoDB CRUD operations.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Introduction to HTML: HTML syntax, HTML elements, HTML document structure, CSS selectors, properties, and values, Build your first web page, Semantics of HTML, Block and inline elements, Hyperlinks, Lists, Tables, Forms, Create a basic multi page website, Cascading effect, Advanced selectors, CSS resets, Positioning

UNIT – II	**08 Hours**

Introduction to CSS: CSS syntax ,Cascading effect, Specificity, Combining and layering selectors, Backgrounds and gradients, CSS resets, The box model, Positioning with floats, Creating a grid structure, Precise Positioning, Basic website clone.

UNIT – III	08 Hours
Bootstrap and JavaScript Basics: Introduction to Bootstrap, Bootstrap Basics ,Bootstrap Grids, Bootstrap Themes, Bootstrap CSS, Bootstrap JS, Fundamentals Of JavaScript, Fundamentals of jQuery, Fundamentals of Ajax Development, Document Object Model, DOM Manipulation, DOM Events, JavaScript Libraries (jQuery and Underscore), Simple HTML CSS JavaScript Project with AJAX.	
UNIT – IV	**08 Hours**
ReactJS and NodeJS Development: Introduction and Foundation, Node Projects, Working with shrink-wrap to lock the node modules versions, Working with asynchronous programming, Building a HTTP Server with Node.JS using HTTP APIs, React Components, React State and Props, React Event Handling, Routing in React React flux, Styling React.	
UNIT – V	**08 Hours**
MongoDB Development: Introduction to NoSQL databases, MongoDB A Database the Modern Web, CRUD Operations in MongoDB, Indexing and Aggregation, Replication and Sharding, Developing Java and Node JS Application with MongoDB. LAMP/WAMP/XAMP	

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		3				-						
CO2	3	3	3		3				-						
CO3	2	2	2		3	2			-		3	2	2	2	2
CO4	3	3	3		3	2			-		3	2	2	2	2
CO5	3	1	3		3	2			-		3	2	2	2	2

Text Books:

1. Riaz Ahmed-Full Stack Web Development For Beginners,2021
2. Chris Northwood - The Full Stack Developer: Your Essential Guide to the Everyday Skills
3. Edwin Ross Torres -Full Stack Web Development,2020

Reference Books:

1. Ahmed Bouchefra,- Full Stack Development with Angular and GraphQL, 2022
2. David Choi -Full-Stack React, TypeScript, and Node,2020.
3. Valerio De Sanctis-ASP.NET Core 5 and Angular,2021

E-Resources:

1.Manu Sharma, Full Stack Development with MongoDB, bpb publishers
2. Apress Modern Full-Stack Development by Zammetti

SKILL ENHANCEMENT COURSE-II
UNIX AND SHELL PROGRAMMING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	: 24AM2407	**Credits**	: 02
Hours / Week	: 03	**Total Hours**	: 39 Hours
L–T–P–S	: 1–0–2–0		

Course Learning Objectives:

This Course will enable students to:

1. Understand the basic UNIX process structure and the UNIX file system.
2. Understand the roles of unix developers / systems programmers
3. Good knowledge of simple UNIX filters.
4. Familiar with pipes and redirection, imagine the UNIX environment.
5. Practice various commands related to Signals, filter parameters and options,
6. Differentiate shell scripting and commands practice with various options.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT I	**4 Hour**

Introduction to operating system and Unix: computer system organization, Computer system architecture, The Structure of the
UNIX Operating System, Linux Kernel, Applications, Understanding Linux. Unix vs. Linux, Downloading and Installing Oracle Virtual Box, Linux Distributions. System login. Directories Found On Linux Systems. Manipulating Files And Directories**:** cp – Copy files and directories, mv – Move/rename files and directories, mkdir – Create directories, rm – Remove files and directories, ln – Create hard and symbolic links.

(Text Book-3: chapter1; Text Book-1: Chapter 4)

UNIT II	**6 Hour**

Permissions, file attributes, ownership**:** Exploring system with ls command, Owners, Group Members, And Everybody Else; Reading, Writing, And Executing; File attributes and chmod – Change File Mode, Changing Identities, su and sudo commands; chown, passwd. Process and signals. Environment and bashrc. Text editors: vi and nano ***(Text Book-1: Chapter 3,7,11)***

UNIT III	5 Hour
grep, awk and ipcs: awk, awk and regular expression, pipe line and specifying patterns, actions, grep command and its options for string handling. Writing your first script: Script File Format, Executable Permissions, Script File Location ***(Text Book-2: Chapter 21; Text Book-1: Chapter 19)***	
UNIT - IV	**6 Hour**
Starting with Linux Shells: Using Shell Variables , Special Variables , Using Shell Arrays, — Shell Basic Operators ,Shell Decision Making, Unix — Shell Loop Types, Shell Input/Output Redirections, — Shell Functions. ***(Text Book-2: Chapter***	
UNIT - V	**5 Hour**
Some advanced commands: File System Check (fsck and xfs_repair), System Backup (dd Command), Network File System (NFS), SSH command and its options, Download files with URLs (wget), curl and ping commands, File transfer commands (ftp, scp etc.).	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Elucidate** basics organization of system and operating system.	L2
2	**Demonstrate** the manipulation of file system, directories and file attributes using commands.	L3
3	**Interpret** the inter process communication.	L4
4	**Implement** shell scripts for running a program or creating a program environment.	L4
5	**Use** advance commands to manage filesystem and access remote connection	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Project management and finance	Life-long learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3							2					

CO2	3	3	2						2	2				
CO3	3	3							2	2				
CO4	3	3	2						2	2				
CO5	3	3							2	2				

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Suggested Experiments :

1. Use the date and who commands in sequence (in one line) such that the output of date will display on the screen and the output of who will be redirected to a file called myfile2.
2. List the top 10 files where the filename begins with a,e,i,o,u and Find and list all the binary files in your environment
3. Write a shell script that accepts one or more file name as arguments and converts all of them to uppercase, provided they exist in the current directory
4. Write a shell script that computes the gross salary of a employee according to the following rules:
   i) If basic salary is < 1500 then HRA =10% of the basic and DA =90% of the basic.
   ii) If basic salary is >=1500 then HRA =Rs500 and DA=98% of the basic The basic salary is entered interactively through the key board.

TEXT BOOKS:

1. Sarwar, Syed Mansoor, and Robert M. Koretsky. UNIX: the textbook. Chapman and Hall/CRC, 2016.
2. Rosen, Kenneth H., Douglas A. Host, Rachel Klee, and Richard R. Rosinski. *UNIX: the complete reference*. McGraw-Hill, Inc., 2006.
3. Operating System Concepts Essentials, Binder Ready Version - By Abraham Silberschatz, Peter B. Galvin, Greg Gagne - 2014

REFERENCE BOOKS:

1. Ebrahim, Mokhtar, and Andrew Mallett. Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming. Packt Publishing Ltd, 2018.

E-Resources:

1. https://docs.kernel.org/
2. https://linux.die.net/
3. https://bjpcjp.github.io/pdfs/devops/linux-commands-handbook.pdf
4. https://www.unixtutorial.org/basic-unix-commands

Activity Based Learning (Suggested Activities in Class)

1. Mini projects using Linux.
2. Exploration of Linux distros

****

V SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	IPCC	24AM3501	Machine Learning	3	0	2	0	60	40	100	04
2	IPCC	24AM3502	Operating Systems	3	0	2	0	60	40	100	04
3	PCC	24AM3503	Natural Language Models	3	1	0	0	60	40	100	04
4	PCC	24AM3504	Image Processing and Computer Vision	3	0	0	0	60	40	100	03
5	HSMC	24AM3505	Innovation and Entrepreneurship	2	0	0	0	60	40	100	02
6	SEC	24AM3506	Skill Enhancement Course –III (Cloud Computing)	1	0	2	0	100	--	100	02
7	PEC	24AM35X X	Professional Elective Course -I	3	0	0	0	60	40	100	03
8	AEC	24AM3507	Cognitive and Technical Skills-V	-	-	-	-	--	--	--	Pass/Fail
			Total	18	1	6	0				**22**

HSMC-
Humanities and Social Sciences including Management Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, AEC-Ability Enhancement Course, L – Lecture, T – Tutorial, P – Practical, J-Project, C – No. Of Credits

Professional Elective -1 (PEC-1) Offering										
Sl. No	**Course Type**	**Course Name**	**Teaching Hours / Week**				**Examination**			
			Lecture	**Tutorial**	**Practica**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	**C**
			L	**T**	**P**	**J**				
1	PEC	Optimization Techniques	3	0	0	0	60	40	100	**03**
2	PEC	Fundamentals of Robotics	3	0	0	0	60	40	100	**03**
3	PEC	Fundamentals of IoT	3	0	0	0	60	40	100	**03**
4	PEC	Data Science & Analytics	3	0	0	0	60	40	100	**03**

MACHINE LEARNING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code : 24AM3501		**Credits**	: 04
Hours / Week	: 05 Hours	**Total Hours**	: 39(T)+26(P) Hours
L–T–P–S	: 3–0–2–0		

Course Learning Objectives:

This course will enable students to:

1. **Summarize** the basic concepts and different types of Machine Learning including Supervised learning, Unsupervised and Reinforcement learning Techniques.
2. **Explore** and analyze the mathematics behind Machine Learning algorithms to gain a solid understanding of probability density functions, basics of sampling theorem and estimation of the maximum likelihood.
3. **Make Use of** the Supervised Machine Learning techniques for solving appropriate real-world applications.
4. **Make Use of** the Unsupervised Machine Learning techniques , Feature Engineering and Dimensionality Reduction techniques for solving appropriate real-world applications.
5. **Evaluate** the performance of Machine Learning algorithms using appropriate metrics such as accuracy, precision, recall, FI Score and Make Use of the different Optimization and Regularization Techniques for improving the model performance.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**6 Hours**

INTRODUCTION TO MACHINE LEARNING

Well-posed learning problems, Designing a Learning system. Introduction to AI, Machine learning, and Deep learning with applications. Types Of Learning: Supervised, Unsupervised, And Reinforcement Learning. Perspective and Issues in Machine Learning.

Classical Paradigm of Solving Learning Problems, The Learning Problems--Classes and Types of Learning, Fundamental of Statistical Learning And Its Framework. Introduction to Feature Representation and Extraction.

Text-2-Chapter 1

UNIT – II	**9 Hours**

MATHEMATICS FOR MACHINE LEARNING

Introduction To Statistics And Probability: Probability concepts - Axioms of probability, Notion of random variables, PMF, PDFs, CDFs. Two Random Variables, Pairs of Discrete Random Variables, Joint Probability, Conditional Probability, Bayes Theorem, Different Distributions, Univariate And Multivariate Gaussian Distribution, PDF, MLE, Motivation, Estimating Hypothesis Accuracy, Basics of the Sampling Theorem, General Approach For Deriving Confidence Intervals, Difference in the Error of Two Hypotheses, Comparing Learning Algorithms.

Text-2-Chapter 2

UNIT – III	**8 Hours**

SUPERVISED LEARNING

Introduction to Supervised Learning: Introduction to Classification, Naive Bayes Classification Binary and Multi-Class Classification, Decision Trees and Random Forest, Regression (Methods Of Function Estimation) -- Linear Regression And Nonlinear Regression, Logistic Regression, Introduction to Kernel Based Methods of Machine Learning: K-Nearest Neighborhood, Kernel Functions, SVM, Introduction to Ensemble-Based Learning.

Text-2-Chapter 2

UNIT – IV	**8 Hours**

UNSUPERVISED LEARNING

Introduction To Unsupervised Learning, Clustering (Hard and Soft Clustering) Hierarchal Clustering: K-Means, Fuzzy C-Means (FCM) Algorithm, Gaussian Mixture Models (GMM), Expectation Maximization Algorithm, Feature Engineering In Machine Learning, Dimensionality Reduction, Linear Discriminant Analysis And Principal Component Analysis.

Text-2-Chapter 3

UNIT – V	**8 Hours**

MODEL SELECTION

Machine Learning Model Validation - Confusion Matrix, Accuracy, Precision, F Score, Cost Function, Machine Learning Optimization Algorithms: Gradient Descent, Stochastic GD. Regularization: Normalization and Standardization, Overfitting, Underfitting, Optimal Fit, Bias, Variance, Cross-Validation.

Text-2-Chapter 5

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	**Describe** the basic concepts and different types of Machine Learning techniques including Supervised learning, Unsupervised learning and Reinforcement learning techniques and design Well Posed Learning system for solving the problem.	L2
2	Explore and **Analyze** the mathematics behind Machine Learning algorithms to gain a solid understanding of probability density functions, the basics of sampling theorem and estimating the maximum likelihood.	L4
3	**Apply** the learned concepts of machine learning to interpret the Supervised learning algorithms including regression and classification problems.	L3

4	**Apply** Unsupervised Machine Learning Algorithms such as Hard and Soft clustering and Feature Engineering and Dimensionality Reduction techniques for solving appropriate real-world applications.	L3
5	**Evaluate** the performance of Machine Learning algorithms using appropriate metrics such as accuracy, precision, recall, FI Score and Make Use of the different Optimization and Regularization Techniques for improving the model performance.	L5

Mapping Levels of COs to POs / PSOs

Cos	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	2	1	-	-	-	-	-	-	-	1	-	2	2
CO2	2	2	1	-	-	-	-	-	-	-	1	-	2	2
CO3	3	2	1	1	1	2	1	-	2	1	1	-	2	2
CO4	3	2	1	1	1	2	1	-	2	1	1	-	2	2
CO5	3	2	1	1	1	2	1	-	2	1	1	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXTBOOKS:

1. Thomas M. Mitchell, Machine Learning, McGraw- Hill, Inc. New York, ISBN-13: 978-1259096952, 2017.
2. Andreas Muller, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'reilly, 2016.

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press; second edition, 2009.
2. U Dinesh Kumar Manaranjan Pradhan, Machine Learning Using Python, Wiley India Pvt. Ltd, 2019.
3. Mark Fenner, Machine Learning with Python for Everyone, Addison-Wesley Professional, 2019.

E-Resources:

1. https://machinelearningmastery.com
2. https://www.knuggets.com/
3. https://www.geeksforgeeks.org/machine-learning-projects/

MOOC's Courses:

1. "Introduction to Machine Learning", NPTEL

2. "Machine Learning for Engineering and Science applications", NPTEL

Activity-Based Learning (Suggested Activities in Class)

1. Workshops/Seminar (ML Projects Based on Python)
2. Quiz

LIST OF LABORATORY/PRACTICAL EXPERIMENTS ACTIVITIES TO BE CONDUCTED
1. Write a Program to Implement the Water-Jug problem using Python. 2. Apply Linear Regression on a given dataset and comment on their efficiency and performance. 3. •Implement linear regression using sklearn library. 4. •Split the obtained dataset into training and testing: 80-20, 70-30 ratio. 5. •Evaluate the model using metrics: Accuracy, Mean Square Error. 6. Apply logistic regression to the given dataset and evaluate the model using a confusion matrix. Download the dataset from the repository and import it as input. Build a Logistic Regression Model and train the dataset. 7. Apply Naïve Bayes Classifier to the given dataset and evaluate the model using a confusion matrix Precision, Recall, F score, and AUC-ROC curve. 8. Use K Nearest Neighbor technique on a given dataset and analyze the performance by changing the value of K. 9. •Implement the KNN algorithm. 10. •Apply KNN model on the dataset and perform testing on unseen dataset. 11. •Change the value of K in KNN and analysis the performance of the model. 12. Build a machine learning model using the Decision Tree algorithm to predict whether a breast tumor is benign or malignant based on various characteristics of the tumor, improving diagnostic accuracy in medical applications. 13. Apply a Random Forest Classifier for classifying breast cancer tumors as benign or malignant based on features like radius and texture. 14. Use Support Vector Machine to perform the classification and regression on given dataset. 15. •Import the dataset and perform the classification using SVM. 16. •Evaluate the model's performance on testing dataset and validation dataset 17. •Use Sklearn's Grid Search CV method for fine tuning of hyper-parameters. 18. Apply K-Means Clustering on the collected dataset. 19. •Implement K-Means clustering using sklearn. 20. •Check for the best k-value. 21. Implement Principal Component Analysis (PCA) for dimensionality reduction and data visualization, demonstrating both from-scratch implementation and sklearn comparison on iris and digits datasets. 22. Implement both simple Perceptron and Multi-Layer Perceptron (MLP) neural networks, demonstrating binary classification with custom implementation and multi-class classification using TensorFlow/Keras. 23. Implement Byte Pair Encoding (BPE) for text processing, a tokenization technique that reduces vocabulary size by iteratively merging the most frequent character pairs in a corpus while retaining important sub word components.

OPERATING SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	:	24AM3502	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39(T)+26(P) Hours
L–T–P–S	:	3–0–2–0			

Course Learning Objectives:

This course will enable students to:

1. To understand the basic concepts, types, and functions of operating systems.
2. To understand the Processes and Threads.
3. To analyze the process Scheduling algorithms.
4. To understand the concept of Deadlocks and process synchronization.
5. To analyze various Memory management techniques.
6. To understand the various file management approaches.
7. To analyze the disk scheduling algorithms.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I: OS Overview and System Structure	**05 Hours**

Introduction to operating systems and System structures, Computer System organization; Computer System architecture; Operating System structure; Operating System operations;

Different types of operating system: Batch Processing, multi-programmed, time-sharing, real-time, distributed, parallel.

Operating System Services: User and operating System interface; System calls; Types of system calls; operating system structure; Virtual machines.

UNIT – II: Process Management	**09 Hours**

Process Management: Process concept; Process scheduling; Operations on processes.

Threads : Overview; Multithreading models; Threading issues, User and Kernel threads.

Process Scheduling Algorithms: Basic concepts; Scheduling Criteria; Scheduling Algorithms (FCFS, SJF, SRTF, RR, Priority).

UNIT – III: Process Coordination	**09 Hours**

Process Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors.

Deadlocks: Deadlocks; System model; Deadlock characterization; Methods for handling

deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.
UNIT – IV: Memory Management **08 Hours**
Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. **Virtual Memory Management:** Background; Demand paging; Performance; Page replacement algorithms (FCFS, LRU, Optimal); Allocation of frames; Thrashing.
UNIT – V File & Disk Management **08 Hours**
File Systems: File concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping). Disk Management: Disk structure, Disk scheduling (FCFS, SSTF, SCAN, C-SCAN).

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Explain** the basic concept of OS, structures, and different types of OS	L2
2	**Apply** the knowledge of process, threads, and scheduling techniques to manage the system resources.	L3
3	**Make use of** Synchronization and Deadlock Handling techniques to solve the real-world problems.	L3
4	**Analyze** the memory management techniques like paging, segmentation, and page fault handling techniques.	L4
5	**Analyze and distinguish** the file and disk management approaches to manage resources in operating system.	L4

Mapping Levels of COs to POs / PSOs

COs				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3													
CO2	3	3		2					2	2			2	
CO3	3	3	3	3					2	2			2	

CO4	3	3	3	3					2	2			2	3
CO5	3	3		2									2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Kossiakoff, Alexander, Steven M. Biemer, Samuel J. Seymour, and David A. Flanigan. *Systems engineering principles and practice*. John Wiley & Sons, 2020.
2. Jaeger, Trent. *Operating system security*. Springer Nature, 2022.

REFERENCE BOOKS:

1. Greg Gagne, Abraham Silberschatz, Peter B. Galvin, Operating System Concepts Essentials, 2nd Edition 8th edition, ISBN: 978-1-118-80492-6, Wiley-India, 2013.
2. Operating Systems-Internals and Design Principles, William Stallings, 9th Edition, Pearson Education, ISBN-13: 978013751674, 2021.
3. Andrew S. Tanenbaum, Modern Operating System, 5th Edition. Pearson, 2022.
4. Dhamdhere, D. M. Operating Systems: A Concept Based Approach, 3rd Edition (Indian), ISBN: 9781259005589, McGraw Hill Education, 2017.
5. Fox, Richard. *Linux with operating system concepts*. Chapman and Hall/CRC, 2021.
6. Chakraborty, Pranabananda. *Operating Systems: Evolutionary Concepts and Modern Design Principles*. CRC Press, 2023.

E-Resources:

-NIL-

Activity Based Learning (Suggested Activities in Class)

1. Quiz.
2. Group Discussion.

LABORATORY EXPERIMENTS

Following are experiments to be carried out using either C programming language

1. Write a program for the implementation of various CPU scheduling algorithms (FCFS, SJF, Priority).
2. Write a program for the implementation of various page replacement algorithms (FIFO, Optimal, LRU).
3. Write a program for the implementation of Producer-Consumer problem.
4. Write a program for the implementation of Readers Writers problem.
5. Write a program for the implementation of Banker's algorithm.
6. Write a program to simulate the concept of semaphores.
7. Write a program to simulate the concept of inter process communication.
8. Write a program for the implementation of various memory allocation algorithms (First fit, Best fit, and Worst fit).
9. Write a program for the implementation of various Disk scheduling algorithms (FCFS, SCAN, SSTF, C-SCAN).

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NATURAL LANGUAGE MODELS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	: 24AM3503	**Credits**:	04
Hours / Week	: 04 Hours	**Total Hours**:	52 Hours
L–T–P–S	: 3–1–0–0		

Course Learning Objectives:

This course will enable students to:

1. To understand the algorithms available for the processing of linguistic information and computational properties of natural languages
2. To conceive basic knowledge on various morphological, syntactic and semantic NLP task
3. To understand machine learning techniques used in NLP,
4. To write programs in Python to carry out natural language processing

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**
Past, present, and future of NLP; Classical problems on text processing; Necessary Math concepts for NLP; Regular expressions in NLP. Parts of Speech and Morphology, Phrase Structure, Semantics and Pragmatics, Corpus-Based Work: Getting Set Up, Looking at Text, Marked-up Data Text processing: lemmatization, stop word, tokenization, stemming, Spelling errors corrections–Minimum edit distance, Bayesian method	

UNIT – II	**08 Hours**
Words & Sentences, N-grams: Simple unsmoothed n-grams; smoothing, backoff, spelling correction using N-grams, Metrics to evaluate N-grams. Parts of Speech tagging: Word classes, POST using Brill's Tagger and HMMs; Information Extraction: Introduction to Named Entity Recognition and Relation Extraction WordNet and WordNet-based similarity measures, Concept Mining using Latent Semantic Analysis	

UNIT – III	**08 Hours**
Sequence to sequence & Language Modelling, Word embedding: skip-gram model, CBOW, GloVe, Language Modelling: Basic ideas, smoothing techniques, Language modeling with RNN and LSTM	

UNIT – IV	**08 Hours**

Case studies on Generative AIs in NLP: History of generative AI, ChatGPT technical overview, Generative pre-trained Transformer – 1, Generative pre-trained Transformer – 2, and Generative pre-trained Transformer – 3.
UNIT – V **07 Hours**
Advanced Topics and Hands-on Practices Python libraries supporting NLP; Hands-on Data collection - from social network platforms, pdfs, word files, JSON, HTML Parsing text using regular expression; scraping data from web; Text processing: convert to lowercase, remove punctuation, remove stop words, standardizing text, tokenising, stemming, lemmatising. Applications: Spam detection, consumer complaint classification, Semantic Analyser, Dialogue processing (Chatbots), Text summarization, Text Categorization.

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Demonstrate an understanding of fundamental NLP concepts, including text processing techniques and classical problems in NLP.	L2
2	Analyze and evaluate different NLP methods and algorithms for tasks such as part-of-speech tagging and named entity recognition.	L4
3	Apply NLP techniques to real-world problems, such as spam detection and text summarization, using Python libraries.	L4
4	Compare and contrast advanced NLP models, such as language models using recurrent neural networks (RNNs) and generative pre-trained transformers (GPTs).	L5
5	Synthesize their knowledge of NLP concepts and evaluate the techniques to design and develop their own NLP applications, such as chatbots or text categorization systems.	L5

Mapping Levels of COs to POs / PSOs

COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2										2	1
CO2	3	3	2						2	2			2	1
CO3	3	2	1		2				2	2			2	1
CO4	3	2	2		2				2	2			2	1
CO5	3	2	2		2				2	2			2	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, "Harshit Surana, Practical Natural Language Processing: A Comprehensive Guide to Building Real-World Nlp Systems" - "O'Reilly Media, Inc.", 17 Jun 2020.
2. Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more - Denis Rothman, Packt Publishing Ltd, 2021
3. Daniel Jurafsky and James H. Martin. 2009. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. Prentice-Hall.
4. Tiwary, U. S., & Siddiqui, T. (2008). Natural language processing and information retrieval. Oxford University Press, Inc.

REFERENCE BOOKS:

1. Hands-on Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems - Aurélien Géron,Edition 2, O'Reilly Media, 2017.
2. Deep Learning for Natural Language Processing - Palash Goyal, Sumit Pandey, Karan Jain, Apress Berkeley, CA- 2018

E-Resources:

1. https://github.com/topics/nlp-models
2. https://devopedia.org/site-map/browse-articles/natural%20language%20processing
3. https://wisdomml.in/hidden-markov-model-hmm-in-nlp-python/
4. https://spotintelligence.com/2023/06/16/activation-function/
5. https://radimrehurek.com/gensim/models/word2vec.html

Activity Based Learning (Suggested Activities in Class)

1. Better Understanding the concept of Sampling and Semantic Role Labeling Quantization of Speech and using group discussion.

2. Collaborative Activity is minor project development with a team of 4 students.

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IMAGE PROCESSING AND COMPUTER VISION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	: 24AM3504	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students:

1. To understand the algorithms available for the processing of linguistic information and computational properties of natural languages.
2. To conceive basic knowledge on various morphological, syntactic, and semantic NLP tasks.
3. To understand and analyze the fundamental concepts of Computer Vision
4. To understand and analyze the fundamental concepts of Computer Vision.
5. To learn to use deep learning tools and framework for solving real-life problems related to images and signals.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainmentof the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the student's understanding.

UNIT – I	**08 Hours**

INTRODUCTION:

Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Image File Formats, Color Models, In spatial domain: Basic gray level transformations, Histogram processing, using arithmetic/Logic operations, smoothening spatial filters, Sharpening spatial filters. In Frequency domain: Introduction to the Fourier transform and frequency domain concepts, Frequency-domain filters: Low pass filter, High pass filter, Band pass filter, Sharpening frequency domain filters.
(Text1: Chapters 1, 2, 3)

UNIT – II	**08 Hours**

IMAGE SEGMENTATION:
Introduction, Detection of isolated points, line detection, Edge detection, Edge linking, Region-based segmentation- Region growing, split and merge technique, local processing, regional processing, Hough transform, Segmentation using Threshold.
COLOR IMAGE PROCESSING:
Color fundamentals, Color models, Color transformation, Smoothing and Sharpening, Color segmentation.
(Text1: Chapters 6, 10)

UNIT – III	**08 Hours**

MORPHOLOGICAL IMAGE PROCESSING:
Erosion, dilation, opening, closing, Basic Morphological Algorithms: hole filling, connected components, thinning, skeleton.
FEATURE EXTRACTION:
Textural Features, Shape Features, Color Features. Image Compression: Introduction, coding Redundancy, Inter-pixel redundancy, image compression model, Lossy and Lossless compression, Huffman Coding.
(Text1: Chapters 9, 8, 5)

UNIT – IV	**08 Hours**

Introduction to Computer Vision, Camera Models and Calibration: Camera Projection Models – Orthographic, Affine, Perspective, Projective Geometry, Camera Internal and External Parameters, Lens Distortion Models, Local Feature Detectors and Descriptors: Hessian corner detector, Harris Corner Detector, LOG detector, DOG detector.
(Text3: Chapters 1, 4, 5, 8)(Text4: Chapter 4)

UNIT – V	**07 Hours**

Stereo vision, Epipolar Geometry, Rectification and Issues related to Stereo, SIFT, PCA-SIFT, SURF, HOG, and Image segmentation.
(Text3: Chapters 11, 15) (Text4: Chapters 5, 8, 12)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Comprehend different image representations such as grayscale, RGB and HSV	L2
2	Apply Image Enhancement Techniques including histogram equalization, contrast stretching and sharpening filters	L3
3	Implement spatial domain operations like convolution smoothing filters and edge detection	L4
4	Apply image segmentation techniques like thresholding, region growing and edge-based segmentation	L3
5	Evaluate real-world applications including medical imaging, satellite imagery, face recognition and video processing	L5

Mapping Levels of COs to POs / PSOs

Cos				Program Outcomes (POs)								PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	2											2	2
CO2	3	2	2		2								2	1
CO3	2	2		2									2	2
CO4	3	2		2	2								2	1
CO5	3	2	2		2				2				2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2nd Edition, 2022.
2. Manas Kamal Bhuyan, "Computer vision and Image Processing Fundamentals and Applications", © 2020 by Taylor & Francis Group.

REFERENCE BOOKS:

1. Tekalp A.M., Digital Video Processing, Prentice Hall (1995).
2. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
3. Gonzalez, R.C., and Woods, R.E., Digital Image Processing. 4th edition. Pearson Education (2017).
4. Jain A.K., Fundamentals of Digital Image Processing, Prentice Hall (2015).
5. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2015.

E-Resources:

1. Image Processing/Open CV| Udemy
2. Introduction to Computer Vision and Image Processing | Coursera

Activity-Based Learning (Suggested Activities in Class)

1. The Applications of Computer vision using group discussion.
2. Collaborative Activity is minor project development with a team of 4 students.

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INNOVATION AND ENTREPRENEURSHIP

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	: 24AM3505	**Credits**	: 02
Hours / Week	: 02 Hours	**Total Hours**	: 26 Hours
L–T–P–S	: 2–0–0–0		

Course Learning Objectives:

This course will enable students:

1. Identify and analyze the factors that contribute to the process of successfully launching an entrepreneurial venture and managing a new business.
2. Learn the entrepreneurial process from idea generation to implementation.
3. Acquaint with special problems of starting new ventures, finding products and services, which can support new enterprises, and raising capital.
4. Discuss how to start own business and also to work in or with small business or are involved with entrepreneurship.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainmentof the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the student's understanding.

UNIT – I	**08 Hours**

Overview Of Entrepreneurship: The Entrepreneurial Perspective:

Nature and Development of Entrepreneurship. Defining Manager, Entrepreneur, Entrepreneurship and Entrepreneurship. Key Elements of Entrepreneurship. Personality Characteristics of Successful Entrepreneurs. Common Myths about Entrepreneurs. Ethics and Social Responsibility of Entrepreneurs. Types of Start-Up Firms. Process of New Ventu2re7 Creation. Role of Entrepreneurship in Economic Development. Emerging Trends and Issues in Entrepreneurship.
Case Study: Successful Entrepreneurs Narayana Murthy Infosys

UNIT – II	08 Hours

THE ENTREPRENEURIAL AND ENTREPRENEURIAL MIND:
The Entrepreneurial Process: Identify and Evaluate the Opportunity, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise. Managerial Versus Entrepreneurial Decision Making: Strategic Orientation, Commitment to Opportunity, Commitment of Resources, Control of Resources, Management Structure, Entrepreneurial Venturing inside a Corporation, Causes for Interest in Entrepreneurship, Climate for Entrepreneurship, Entrepreneurial Leadership Characteristics.
Case study: How to develop effective Business Plan

UNIT – III	08 Hours

CREATIVITY AND BUSINESS IDEA:
Identify and Recognizing Opportunities: Observing Trends and Solving Problems. Creativity: Concept,Components and Types of Creativity, Stages of Creative Process. Sources of New Venture Ideas.Techniques for Generating Ideas. Stages of Analyzing and Selecting the Best Ideas. Protecting the Idea:Intellectual Property Rights and its Components. Linking Creativity, Innovation and Entrepreneurship. Case study: Application of Design Thinking in New business ideas generation in particular sector (Health care, Water Saving, Energy saving)

UNIT – IV	08 Hours

Preparing The Proper Ethical And Legal Foundation:
Initial Ethical and Legal Issues Facing a New Firm, Establishing a Strong Ethical Culture, Choosing an attorney (Lawyer), Drafting a founder's agreement, Avoiding legal disputes, Choosing a form of business organization, Obtaining business licenses and permits, Choosing a Form of Business Ownership (Sole, Proprietorship, Partnership, Corporation & Limited Liability Company)
Case study: Startup Law A to Z IP
https://techcrunch.com/2019/02/25/startup-law-a-to-z-intellectual-property/

UNIT – V	07 Hours

Managing Early Growth And Challenges
Recruiting and Selecting Key Employees. Lenders and Investors. Funding Requirements: Sources of Personal Financing. Venture Capital. Commercial Banks. Sources of Debt Financing. Key Marketing Issues for New Ventures. Why marketing is critical for Entrepreneurs. Entrepreneurs face unique Marketing Challenges. Guerrilla Marketing. Business Growth: Nature of Business Growth, Planning for Growth, Reasons for Growth. Managing Growth: Knowing and Managing the Stages of Growth, Challenges of Growing a Firm. Strategies for Firms Growth: Internal and External Growth Strategies. Implications of Growth for the Firm and Entrepreneur.
Entrepreneurial Skills and Strategies to Overcome Pressures On: Financial Resources (Financial Control, Managing Inventory and Maintaining Good Records). Human Resources, Management of Employees, Time Management.
Case study: 9 ways to get startups funded
https://www.quicksprout.com/how-to-get-your-startup-funded/

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Demonstrate knowledge of the key elements of the entrepreneurial process	L2
2	Employ strategies to generate new ideas for startups	L2
3	Outline how to protect IP legally	L2
4	Examine different ways of generating funding	L2
5	Explain organizing managing people, finance and customers	L2

Mapping Levels of COs to POs / PSOs

Cos				Program Outcomes (POs)								PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	2							2		2		2	2
CO2	3	2	2		2				2		2		2	1
CO3	2	2		2					2		2		2	2
CO4	3	2		2	2				2		2		2	1
CO5	3	2	2		2				2		2		2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Dana, Léo-Paul, ed. *World encyclopedia of entrepreneurship*. Edward Elgar Publishing, 2021.
2. Barringer, Bruce R., and R. Duane Ireland Bruce Barringer. *Entrepreneurship: Successfully launching new ventures*. Pearson Education India, 2013.

REFERENCE BOOKS:

1. Soltanifar, Mariusz, Mathew Hughes, and Lutz Göcke. *Digital entrepreneurship: Impact on business and society*. Springer Nature, 2021.
2. Aulet, Bill. *Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Expanded & Updated*.

John Wiley & Sons, 2024.
3. Havinal, Veerabhadrappa. Management and entrepreneurship. New Age International, 2009.
4. Janakiram, B. *Management & Entrepreneurship*. Excel Books India, 2010.

E-Resources:

1. https://archive.nptel.ac.in/courses/110/106/110106141/
2. https://www.coursera.org/mastertrack/innovation-management-entrepreneurship-hec

Activity-Based Learning (Suggested Activities in Class)

1. Organizational improvement in startup's using group discussion.

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CLOUD COMPUTING
(skill Enhancement Course - III)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	:	24AM3506	**Credits**	:	02
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	1–0–2–0			

Course Learning Objectives:

This course will enable students to:

1. **Understand** various basic concepts related to cloud computing technologies.
2. **Contrast** various programming models used in cloud computing.
3. **Choose** appropriate cloud model for a given application.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainmentof the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and role-playing.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the student's understanding.

UNIT – I	**08 Hours**

INTRODUCTION TO CLOUD COMPUTING

Introduction, Cloud Computing at a Glance, The Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Reference Model, Characteristics and Benefits, Challenges Ahead, Historical Developments, Distributed Systems, Virtualization, Web 2.0, Service- Oriented Computing, Utility- Oriented Computing

UNIT – II	**08 Hours**

TYPES OF CLOUDS

Types of Clouds, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economicsof the Cloud, Open Challenges.

Cloud Definition, Cloud Interoperability and Standards Scalability and Fault ToleranceSecurity, Trust, and Privacy Organizational Aspects.

UNIT – III	**08 Hours**

CLOUD SERVICES AND PLATFORMS

Building Cloud Computing Environments, Application Development, Infrastructure and System Development.
Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com, Manjrasoft Aneka.
Cloud Computing Architecture-Introduction, Cloud Reference Model- Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service.

Text Book 1: Chapter 1, Chapter 4

UNIT – IV	**08 Hours**

AWS CLOUD APPLICATION PLATFORM

Introduction to AWS ecosystem-Introduction to AWS Elastic Beanstalk-Benefits of using AWS for application development- Supported platforms on Elastic Beanstalk (Java, Python, Node.js, etc.)-Installing AWS CLI & EB CLI-Configuring AWS credentials locally-Creating Elastic Beanstalk environment-Deployment options: CLI, Console, GitHub-Lifecycle of an application in Beanstalk-Modify app configuration-Update code and redeploy changes-Explore environment dashboard-Auto-scaling and load balancing-Monitoring tools: CloudWatch metrics, logs-Health monitoring in Elastic Beanstalk-Connecting Elastic Beanstalk with RDS (Relational Database Service)-Using S3 for static asset storage-IAM roles and security basics

Text Book 1

UNIT – V	**07 Hours**

CLOUD PLATFORMS IN INDUSTRY

Concurrent Computing: Thread Programming, Introducing Parallelism for Single MachineComputation.

Cloud Platforms in Industry, Amazon Web Services, Compute Services, Storage Services, Communication Services, Additional Services, Google AppEngine, Architecture and Core Concepts, Application Life-Cycle, Cost Model, Observations, Microsoft Azure, Azure CoreConcepts, SQL Azure, Windows Azure Platform Appliance.

Text Book 1: Chapter 9

LABORATORY EXPERIMENTS

1. Introduction to Cloud and Virtualization
Objective: Understand cloud computing and install a virtualization environment.

Tools: VirtualBox or VMware

Tasks:

Install VirtualBox

Create and manage a virtual machine (e.g., Ubuntu)

Understand virtualization vs cloud

2. Setting Up a Private Cloud using Eucalyptus/OpenStack (Simulation)
Objective: Simulate a private cloud environment.

Tools: Ubuntu + Eucalyptus (or DevStack for OpenStack)

Tasks:

Install Eucalyptus/DevStack

Launch a VM instance inside the private cloud

Access the dashboard

3. Creating a Virtual Machine in AWS / Azure / GCP
Objective: Deploy a VM in a public cloud.

Tools: AWS EC2 / Azure VM / GCP Compute Engine

Tasks:

Launch an EC2 instance

Connect via SSH

Install a web server (e.g., Apache or Nginx)

4. Deploying a Web Application on AWS Elastic Beanstalk
Objective: Understand PaaS by deploying a web app.

Tools: AWS Elastic Beanstalk, Python/Node.js app

Tasks:

Initialize EB environment

Deploy app using CLI or Console

Monitor deployment logs

5. Using AWS S3 for Object Storage
Objective: Store and retrieve data from cloud storage.

Tools: AWS S3

Tasks:

Create an S3 bucket

Upload and download files

Set permissions and enable static website hosting

6. Load Balancing and Auto Scaling
Objective: Explore scalability in cloud environments.

Tools: AWS Elastic Load Balancer + Auto Scaling Groups

Tasks:

Create multiple EC2 instances

Attach to Load Balancer

Setup auto-scaling rules

7. Monitoring and Logging with CloudWatch
Objective: Monitor performance and logs of cloud resources.

Tools: AWS CloudWatch

Tasks:

Set up basic alarms (CPU usage, memory)

View application logs

Create a dashboard

8. Working with Cloud Databases (RDS / Firebase)
Objective: Use cloud-based relational or NoSQL databases.

Tools: AWS RDS or Firebase

Tasks:

Launch an RDS instance (MySQL/PostgreSQL)

Connect from a web app

Perform CRUD operations

9. Identity and Access Management (IAM)
Objective: Manage user roles and permissions in cloud.

Tools: AWS IAM

Tasks:

Create users and groups

Assign policies (S3 access, EC2 control)

Test access restrictions

10. Final Mini Project – Host a Full-Stack Application on Cloud
Objective: Integrate all concepts in a real-world mini project.

Tasks:

Backend (Node.js/Python) + Frontend (HTML/CSS/JS)

Deployed on EC2 or Beanstalk

Use S3 for static content and RDS for database

Optional Tools & Simulators
CloudSim – For simulating cloud environments in research

Cisco Packet Tracer – For network simulation in cloud labs

Google Cloud Shell – In-browser terminal for experiments

Course Outcomes:

At the end of the course the student will be able to:

1. **Analyze** the principles and components of cloud computing, demonstrating a comprehensive understanding of its architecture and operation.
2. **Compare and contrast** cloud architecture, computing platforms, and technologies.
3. **Analyze** cloud computing architecture principles to design scalable and resilient systems, utilizing various platforms and technologies.
4. **Examine** the framework, cloud deployment mode, and services in Aneka to gain a comprehensive understanding of its functionalities.
5. **Apply** web services and search engines in the industry by utilizing cloud platforms such as Amazon Web Services and Google AppEngine to leverage compute, storage, and communication services.

Cos	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineeringknowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer andsociety	Environment and sustainability	Ethics	teamwork	Communication	Life-long learning	Project managementand finance	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	-	-	-	-	-	-	-	-	-	1		1
CO2	3		-	2	2	-	-	-	-	-	-	1		1
CO3	2	3	2		2	-	-	-	2	-	-	2		1
CO4	3	3	2	-	-	-	-	-	-	-	-	1		1
CO5	2	2	3	-	3	-	-	-	3	-	-	2		1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. 1. Cloud Computing: From Beginning to End", Ray J. Rafaels Rajkumar Buyya, James Broberg, and Andrzej Goscinski, Packt,2022.
2. Cloud Computing: Principles and Paradigms" by Rajkumar Buyya, James Broberg, and Andrzej Goscinski, Wiley in 2020.

REFERENCE BOOKS:

1. Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Pearson Education,2020.
2. Cloud Computing A Practical Approach, Anthony T Velte et.al, MC Graw Hill publications, 2014.
3. Cloud Computing Principles and Paradigms, Rajkumar Buyya et.al, WileyPublications, 2015.

Activity Based Learning (Suggestion Activities in Class)

- Presentation
- Collaborative Activity is minor project development with a group of 4 students.

Optimization Techniques

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	:	24AM3508	**Credits**	:	3
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. Introduces various optimization techniques i.e classical, linear programming, simplex algorithm, and constrained and unconstrained optimization techniques.
2. Apply different optimization techniques for solving and optimizing engineering problems in real-world situations.
3. Illustrate population-based optimization techniques.
4. To provide a clear understanding of heuristic optimization techniques and multi-objective optimization techniques.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**07 Hours**

MODULE 1: Introduction and Classical Optimization Techniques:

Statement of an Optimization problem, design vector, design constraints, constraint surface, objective function, Classification of Optimization problems Single variable Optimization, multi variable Optimization without constraints, multivariable Optimization with equality constraints, Solution by the method of Lagrange multipliers, multivariable Optimization with inequality constraints, Kuhn–Tucker conditions.

UNIT – II	**07 Hours**

MODULE 2: Linear Programming:

Standard form of a linear programming problem, Solution of a system of linear simultaneous equations, pivotal reduction of a general system of equations, simplex algorithm.

UNIT – III	**08 Hours**

MODULE 3: Transportation Problem & Unconstrained Optimization

Transportation Problem & Unconstrained Optimization: Finding initial basic feasible solution by

north-west corner rule, least cost method, Vogel's approximation method, testing for optimality of balanced transportation problems

Constrained Nonlinear Programming: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method, Basic approaches of Interior and Exterior penalty function methods.

UNIT – IV	**09 Hours**

MODULE 4: Genetic Algorithms & Particle Swarm Optimization

Genetic algorithms: Genetic Algorithm versus Conventional Optimization Techniques, Genetic representations and selection mechanisms, Genetic operators, different types of crossover and mutation operators.

Particle Swarm Optimization: anatomy of a particle, equations based on velocity and positions, PSO topologies, control parameters, Fly Optimization Technique.

UNIT – V	**09 Hours**

MODULE 5: Colony Optimization and Evolutionary Computing

Ant Colony Optimization: Biological ant colony system, Pheromone updating, local-global, Pheromone evaporation.

Artificial Bee Colony Algorithms: Task partitioning in honey bees, Balancing foragers and receivers, Artificial bee colony (ABC) algorithms, binary ABC algorithms.

Multi-Objective Optimization: Application to multi-modal function optimization. Introduction to multi-objective optimization, Concept of Pareto optimality.

Evolutionary Computing: Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search.

Course Outcomes:

At the end of the course, the student will be able to:

1) Make use of the classical optimization techniques, linear programming, and simplex algorithm to real-world problems and applications.
2) Analyse unconstrained optimization, constrained non-linear programming, and dynamic programming techniques.
3) Distinguish the different types of optimization techniques.
4) Apply heuristic optimization techniques and multi-objective optimization techniques to complex problems.
5) Evaluate the concepts of population-based optimization techniques.

COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering knowledge	Problem analysis	Design	Conduct investigations of	tool usage	The engineer and	Environment and sustainability	Ethics	team work	Communication	Life-long learning	Project management and	Solve complex engineering problems in	Apply technical skills and research skills to provide the
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	1	1
CO	3	2	-	-	-	-	-	-	-	-	-	-	1	1

2														
CO 3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO 4	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO 5	3	2	-	-	1	-	-	-	2	2	-	-	2	2

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

TEXT BOOKS:

1. Operations Research: An Introduction, H.A.Taha, ISBN-10 :9352865278, Pearson Pvt. Ltd, 2019.
2. Bio-Inspired Artificial Intelligence - Theories, Methods, and Technologies By Dario Floreano and Claudio Mattiussi, ISBN: 9780262547734, MIT Press, 2023.
3. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation, Springer International Publishing, Switzerland, 2015.
4. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, ISBN: 978-0-471-87339-6, 2001.

REFERENCE BOOKS:

1. Engineering optimization: Theory and practice", S. S.Rao, New Age International (P) Limited, John Wiley & Son, ISBN 978-0-470-18352-6, 2019.
2. Optimization Methods in Operations Research and Systems Analysis, K.V. Mittal and C. Mohan, New Age International (P) Limited ISBN-10: 9388818334, 2020.

Activity-Based Learning (Suggested Activities in Class)

1. Student seminars (on topics of the syllabus and related aspects (individual activity)
2. Study projects (by very small groups of students on selected local real-time problems pertaining to the syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)).

FUNDAMENTALS OF ROBOTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	: 24AM3509	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. Differentiate between automation and robotics.
2. Classify robots and describe its anatomy.
3. Specify various types of industrial sensors.
4. Classify various grippers.
5. Discuss about motion analysis of robot.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

INTRODUCTION TO ROBOTICS

Introduction: Automation and robotic, an over view of robotics, classification by coordinate system and control systems; Components of the industrial robotics: Degrees of freedom, end effectors: Mechanical gripper, magnetic, vacuum cup and other types of grippers, general consideration on gripper selection and design.

UNIT – II	**08 Hours**

MOTION ANALYSIS AND KINEMATICS

Motion analysis: Basic rotation matrices, composite rotation matrices, Euler angles, equivalent angle and axis, homogeneous transformation, problems; Manipulator kinematics: D-H notations, joint coordinates and world coordinates, forward and inverse kinematics, problems.

UNIT – III	**08 Hours**

KINEMATICS AND DYNAMICS

Differential kinematics: Differential kinematics of planar and spherical manipulators, Jacobians problems. Robot dynamics: Lagrange, Euler formulations, Newton-Euler formulations, problems on planar two link manipulators

UNIT – IV	**08 Hours**

TRAJECTORY PLANNING AND ACTUATORS
Trajectory planning: Joint space scheme, cubic polynomial fit, avoidance of obstacles, types of motion: Slew motion, joint interpolated motion, straight line motion, problems, Robot actuators and feedback components; Actuators: pneumatic and hydraulic actuators.
UNIT – V **07 Hours**
ELECTRIC ACTUATORS AND ROBOTIC APPLICATIONS
Electric actuators: DC servo motors, stepper motors, feedback components: position sensors, potentiometers, resolvers and encoders, velocity sensors, tactile sensor; Robot application in manufacturing: Material handling, assembly and inspection.

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Recall the characteristic features of robots and usage of different grippers for industrial applications.	L2
2	Comprehend direct and inverse kinematics of robot structure.	L3
3	Demonstrate differential Kinematics of planar and spherical manipulators.	L4
4	Analyze classification of robot actuators and trajectory planning.	L4
5	Assess material handling and applications in manufacturing.	L5

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)								**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2	-	1	-	-	-	2	2	-	2	2	2
CO2	3	3	2	-	1	-	-	-	2	2	-	2	2	2
CO3	3	2	1	-	1	-	-	-	2	2	-	2	1	1

CO4	3	1	-	-	1	-	-	-	2	2	-	2	2	2
CO5	2	1	3	-	1	-	-	-	2	2	-	2	1	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Yan, Lili, and Gene M. Grossman. Robots and AI: A new economic era. Taylor & Francis, 2023.
2. Niku, Saeed B. Introduction to robotics: analysis, control, applications. John Wiley & Sons, 2020.

REFERENCE BOOKS:

1. Groover M. P, "Industrial Robotics", TataMcGraw-Hill, 1 st Edition, 2013
2. Richard D. Klafter, "Robotic Engineering", Prentice Hall, 1st Edition, 2013.
3. Fu K S, "Robotics", McGraw-Hill, 1st Edition, 2013.

E-Resources:

1. https://www.doc.ic.ac.uk/~ajd/Robotics/RoboticsResources/lecture1.pdf
2. http://opencourses.emu.edu.tr/course/view.php?id=32
3. https://www.researchgate.net/publication/277712686_Introduction_to_Robotics_class_notes_UG_level

Activity Based Learning (Suggested Activities in Class)

1. Group discussion.
2. Projects on Computer graphics & User interface design.
3. Quiz
4. Assignment

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FUNDAMENTALS OF IOT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	: 24AM3510	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To study fundamental concepts of IoT
2. To understand roles of sensors in IoT
3. To Learn different protocols used for IoT design
4. To be familiar with data handling and analytics tools in IoT
5. Appreciate the role of big data, cloud computing and data analytics in a typical IoT system.
6. Understand the role of IoT in various domains of Industry.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

FUNDAMENTALS OF IOT:

Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.

UNIT – II	**08 Hours**

SENSORS NETWORKS:

Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RFID Principles and components

WIRELESS SENSOR NETWORKS:

History and Context, the node, Connecting nodes, Networking Nodes, WSN and IoT.

UNIT – III	**08 Hours**

FUNDAMENTALS OF PYTHON PROGRAMMING & RASPBERRY PI:

Introduction to python programming, working with functions, classes, REST full Web services, Client Libraries, Introduction & programming Raspberry Pi3, Integrating input-output devices with Raspberry Pi3.

UNIT – IV	08 Hours
IOT PLATFORM, CLOUD COMPUTING PLATFORMS FOR IOT DEVELOPMENT: IOT platform Architecture (IBM Internet of things & Watson Platform); API Endpoints for platform Services; Devices Creation & Data Transmission; Introduction to NODE-RED and Application deployment. **CYBER PHYSICAL SYSTEMS:** Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis	
UNIT – V	**07 Hours**
APPLICATIONS OF IOT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Explain** the Basic concepts, terminologies and architecture of IoT systems.	L1
2	**Apply** different Sensors and Actuators in IoT Application.	L1
3	**Develop** sketch for the IoT application using Raspberry Pi & Python Programming.	L2
4	**Work** with the help of IOT Architecture and NODE-RED, implement real time projects usings the tools and **understand** the concepts of Cyber physical systems.	L6
5	**Illustrate** the working of real world IoT applications **Understand** APIs to connect IoT related technologies.	L1

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome

CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO3	3	1	-	1	-	1	-	-	-	-	-	-	-	1
CO4	3	2	2	1	2	-	-	-	-	-	-	-	1	1
CO5	3	1	2	1	2	-	-	-	-	-	-	-	1	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. IoT and Edge Computing for Architects, Second Edition, By Perry Lea Chief Architect at Hewlett-Packard, Co-founder of Rumble ,|2020|632 Pages
2. INTERNET OF THINGS A HANDS-ON APPROACH, Arshdeep Bahga, Vijay Madisetti, 1st Edition VPT, 2022
3. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media,2016.
4. Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.
5. Adrian McEwen, Hakim Cassimally, "Designing the Inernet of Things", Wiley Publications, 2013

REFERENCE BOOKS:

1. Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.
3. Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", 1st Edition, Packt Publishing Ltd, 2018
4. Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren, "IoT: Building Arduino-Based Projects", 1st Edition, Packt Publishing Ltd, 2016.

E-Resources:

1. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
2. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
3. https://nptel.ac.in/courses/106105166

Activity Based Learning (Suggested Activities in Class)

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)

2. Student seminars (on topics of the syllabus and related aspects (individual activity)
3. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))
4. Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity))

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DATA SCIENCE & ANALYTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	:	24AM3511	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. **Understand** the fundamental concepts of data science and different types of Data Distribution.
2. **Utilize** the given data and perform hypothesis testing, Parametric and Non-Parametric Tests.
3. **Make use** of the different visualization techniques to find out the distribution of data set.
4. **Analyze** the Univariate and Bivariate Data using different graphical techniques.
5. **Apply the** classification techniques on the given data.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**09 Hours**

Introduction to Data Science and its applications, Data Science Life Cycle, Data Architecture and its components, Statistics vs Data Mining vs Data Analytics vs Data Science; Understanding data: Introduction, Types of Data, Types of Data Distribution: Normal distribution, Poisson Distribution, Binomial Distribution, Uniform distribution, The Central Limit Theorem, Basics of R Programming.
Textbook 2: Chapter 2, Textbook 1: Chapter 2

UNIT – II	**08 Hours**

Introduction to Hypothesis Testing, Steps involved in Hypothesis Testing, One and Two-Sided Tests, Type I and Type II Errors, One and Two Sample Estimation Problems, Confidence Interval, Introduction to Parametric Test: T-Test, F-Test, Z-Test, ANOVA. Introduction to non-parametric test: Wilcoxon Mann-Whitney U-Test, Kruskal Wallis H-Test, Chi-square Test.
Textbook 1:Chapter 3

UNIT – III	07Hours
Univariate and Bivariate Data Analysis: Univariate Data Analysis –Description and summary of data set, measure of central tendency Interquartile Range, Concepts on Symmetry of Data, Skewness and Kurtosis, Introduction to Bivariate Distributions, Association between two Nominal Variables, Contingency Tables, Chi-Square calculations, Scatter Plot and its causal interpretations, Relationship between two ordinal variables – Spearman Rank correlation, Kendall's Tau Coefficients. Textbook 4: Chapter 6 and 7 ; Textbook 6: Chapter 3	
UNIT – IV	**08 Hours**
Graphical Representation: Introduction to graphical representation of data, dot plot, stem and leaf plot, bar chart, stacked bar chart, multiple bar chart, percentage bar chart, histogram, symmetric histogram, Pie chart and its legends, Box Plot, Contour plot, Star plot, qq plot, Scree Plot, Dendrogram (cluster analysis), Interpretation of dendrogram, Heat map, Tree map, Geographic Data with Basemap. Textbook 4: Chapter 2 and 3,Textbook 1:Chapter 1	
UNIT – V	**07 Hours**
Classification Techniques: Introduction to classification techniques, Conditional probability, odds ratio, Moving on to logistic regression from linear regression, Estimation using the Maximum Likelihood Method, Making sense of logistic regression parameters, Wald test, Likelihood Ratio Test statistic, Decision Tree (Information Gain and Gini Index) and Pruning a Tree, Ensemble Methods – Bagging and Boosting. Textbook 6: Chapter 6	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Summarize** the fundamental concepts of data science and Make Use of R Programming to identify the types of Data Distribution for the given data.	L2
2	**Utilize** the given data and perform hypothesis testing - Parametric and Non-Parametric Tests to understand the characteristics of the population.	L3
3	**Make Use of** the Univariate and Bivariate Data Analysis techniques for interpreting the given data.	L3
4	**Utilize** the different visualization techniques to interpret the trends, outliers, and patterns of data.	L4

5	**Develop** the classification techniques such as Logistic Regression and Ensemble Methods on the given data to perform categorization and **evaluate** the performance using different parameters.	L5

Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	1	-	-	2	-	-	-	1	-	-	-	2	2
CO2	3	2	-	-	2	-	-	-	1	-	-	-	2	2
CO3	3	2	-	-	2	-	-	-	1	-	-	-	2	2
CO4	3	2	-	-	2	-	-	-	1	-	-	-	2	2
CO5	3	2	-	-	2	-	-	-	1	-	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Practical Statistics for Data Scientists,Second edition, Peter Bruce, Andrew Bruce, and Peter Gedeck, O'Reilly,2020.
2. Doing Data Science, Cathy O'Neil, Rachel Schutt, Straight Talk from The Frontline. O'Reilly, 2013.
3. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, Hand book of Data Visualization, ISBN - 9783540330363Springer Publication, 2008.
4. Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Christian Heumann · Michael Schomaker, Springer 2017.
5. SC Gupta and VK Kapoor, "Fundamentals of mathematical statistics", Sultan Chand & Sons Publication, New Delhi, 2014.
6. Learning Predictive Analytics with Python– Ashish Kumar, PACKT Publishing, 2016.

REFERENCE BOOKS:

1. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly, 1st edition, 2015.

2. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications Co., 1st edition, 2016.

E-Resources:

1. https://nptel.ac.in/courses/106106179
2. https://nptel.ac.in/courses/111104146

Activity Based Learning (Suggested Activities in Class)

1. Flipped class Activity on data visualization and data analysis techniques.
2. Problem Solving and Discussion.

VI SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	IPCC	24AM3601	Deep Learning	3	0	2	0	60	40	100	04
2	IPCC	24AM3602	Gen AI and Prompt Engineering	3	0	2	0	60	40	100	04
3	PCC	24AM3603	Designing MLOps for Enterprises	3	0	0	0	60	40	100	03
4	PEC	24AM36XX	Professional Elective Course – II	3	0	0	0	60	40	100	03
5	PEC	24AM36XX	Professional Elective Course – III	3	0	0	0	60	40	100	03
6	OEC	24OEXXXX	Open Elective – I	3	0	0	0	60	40	100	03
7	PROJ	24AM3604	Minor Project	0	0	0	4	--	100	100	02
8	AEC	24AM3605	Cognitive and Technical Skills-VI	-	-	-	-	--	--	--	P/F
			Total	18	0	4	4				**22**

IPCC-Integrated Professional Core Course, AEC-Ability Enhancement Course,PCC-Professional Core Courses, PEC-Professional Elective Courses, OEC-Open Elective Courses, PROJ-Project Work, L – Lecture, T – Tutorial, P – Practical, J– Project, C – No. Of Credits

Professional Elective Courses –II (PEC-II) Offering										
Sl. No	**Course Type**	**Course Name**	**Lecture**	**Tutoria**	**Practic**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	C
			L	**T**	**P**	**J**				
1	PEC	Explainable AI	3	0	0	0	60	40	100	**03**
2	PEC	Reinforcement Learning	3	0	0	0	60	40	100	**03**
3	PEC	Cryptography & Network Security	3	0	0	0	60	40	100	**03**
4	PEC	Predictive Analytics	3	0	0	0	60	40	100	**03**

Professional Elective Courses –III (PEC-III) Offering										
Sl. No	**Course Type**	**Course Name**	**Lectur**	**Tutori**	**Practi**	**Projec**	**CIE Marks**	**SEE Marks**	**Total Marks**	C
			L	**T**	**P**	**J**				
1	PEC	Quantum Machine Learning	3	0	0	0	60	40	100	**03**
2	PEC	Robot Operating System (ROS)	3	0	0	0	60	40	100	**03**
3	PEC	Advanced Computer Architecture	3	0	0	0	60	40	100	**03**
4	PEC	Financial Technology (FinTech)	3	0	0	0	60	40	100	**03**

Open Elective-1 (OE-1) Offering										
Sl. No	**Course Type**	**Course Name**	**Lecture**	**Tutorial**	**Practica**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	
			L	**T**	**P**	**J**				
1	OEC	Industrial Robotics	3	0	0	0	60	40	100	**03**
2	OEC	Machine Learning for Health Care	3	0	0	0	60	40	100	**03**

DEEP LEARNING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	: 24AM3601	**Credits**:	04
Hours / Week	: 05 Hours	**Total Hours**:	39 (T) +26(p)
L–T–P–S	: 3–0–2–0		

Course Learning Objectives:

This course will enable students to:

1. To understand the basic building blocks and general principles that allow oneto design Deep learning algorithms
2. To become familiar with specific, widely used Deep learning networks
3. To introduce building blocks of Convolution neural network architecture
4. To learn to use deep learning tools and frameworks for solving real-life problems

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

MODULE 1: INTRODUCTION TO DEEP LEARNING **08 Hours**

Introduction to Perceptron, Learning rules, Single layer perceptron and its applications, Multilayer Feed forward Neural Network, neural networks training, activation functions, loss functions, Model Selection.
(Text 2: Chapters 2&3)

MODULE 2: COMPUTATION IN DEEP LEARNING **07 Hours**

Forward and Backward Propagation, Computational Graphs Layers, shallow neural network, deep neural network, Optimization for Training Deep Models, Gradient Descent and its types, Regularization techniques, Automatic Differentiation. (Text 1: Chapter 4)

MODULE 3: CONVOLUTIONAL NEURAL NETWORKS **08 Hours**

Convolutional Neural Networks (CNNs) - Biological inspiration, Mapping of Human Visual System and CNN. Convolution operation, Convolutional Layers, Padding and Stride, Subsampling - Pooling, Fully Connected CNN Layer, Transfer Learning, Overview of Alex Net, VGG, Google Net, Res Net, YOLO, Graph Neural Networks.
(Text1: Chapter 7)

MODULE 4: SEQUENCES TO MODEL **08 Hours**

Basics of RNN, Types of RNN, RNN's For Sequence Modeling- Language Modeling, Back Propagation Through Time, LSTM Network, Bidirectional LSTMs, Applications of LSTM.
(Text 1: Chapter 9, 10)

MODULE 5: UNSUPERVISED DEEP LEARNING **08 Hours**

Unsupervised Pretrained Networks (UPNs)- Autoencoders, Deep Belief Networks (DBNs), Generative Adversarial Networks (GANs), Restrictive Boltzmann Machines, Transformers.
Deep Learning Applications in Healthcare and other areas (Case study)
Text 1: chapter 20

Lab Programs:

1. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets. Vary the activation functions used and compare the results.
2. **Design** and build a comprehensive project leveraging various deep learning architectures to solve real-world problems effectively
3. Analyze the performance of CNN on the image dataset.

a. Load the dataset as input.

b. Change the hyper-parameter (Varying with different convolutional and pooling layer) of classification model and analyze its performance.

Evaluate and compare the model performance by using metrics – classification accuracy and Binary Cross Entropy Loss.

4. Design and implement a CNN model (with 2+ layers of convolutions) to classify multi category image datasets. Use the concept of padding and Batch Normalization while designing the CNN model. Record the accuracy corresponding to the number of epochs. Use the Fashion MNIST/MNIST/CIFAR10 datasets.
5. Design and implement a CNN model (with 4+ layers of convolutions) to classify multi category image datasets. Use the concept of regularization and dropout while designing the CNN model. Use the Fashion MNIST/MNIST/CIFAR10 datasets datasets. Record the Training accuracy and Test accuracy corresponding to the following architectures:

i. Base Model
ii. Model with L1 Regularization
ii. Model with L2 Regularization
v. Model with Dropout

6. Model with both L2 (or L1) and Dropout
7. Implement the standard VGG-16, Resnet architecture model to classify multi category image dataset and check the accuracy.
8. Implement the standard Densenet architecture model to classify multi category image dataset and check the accuracy.
9. Implement and Compare RNN and LSTM for sentiment analysis on movie reviews/other dataset and tabulate the results.

9. Implement and Compare LSTM and Bidirectional LSTM for sentiment analysis on movie reviews/other dataset and tabulate the results.

10. Implement Generative Adversarial Networks to generate realistic Images. Use MNIST, Fashion MNIST or any human face datasets.

11. Implement Auto encoders for image denoising on MNIST, Fashion MNIST or any suitable dataset.

Open Ended Experiments:

1) "Smart Diagnosis" – Disease Prediction Using Medical Imaging.
2) "Smart Yield" – Predicting Crop Yield with Satellite and Environmental Data.
3) "Stock Sense" – Predicting Stock Market Trends Using Deep Learning.

Course Outcomes:

At the end of the course the student will be able to:

1. **Apply** deep learning models such as Artificial Neural Networks (ANN) and Convolutional Neural Networks (CNN) for classification tasks on various datasets.
2. **Evaluate and compare** the performance of deep learning architectures using different hyperparameters and regularization techniques on image data.
3. **Implement** Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) networks for learning, predicting, and classifying real-world problems within the deep learning domain.
4. **Apply** Autoencoders and Generative Adversarial Networks (GANs) for tasks such as image denoising and data augmentation.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Build an Image classifier model for applying the concept of single layer and multilayer NN and analyze activation and loss function with that model.	L2
2	Apply the mathematical concept of deep learning for the manipulation and preprocessing of data.	L3
3	Evaluate deep learning models applying optimization techniques to solve real-world problems and analyse the efficiency of the models.	L5
4	Build an image classifier model, applying CNN and evaluating associated hyperparameters.	L4, L5
5	Construct deep learning-based models for healthcare applications and compare effectivity of advanced networks.	L5

Mapping Levels of COs to POs / PSOs					
COs				**Program Outcomes (POs)**	**PSOs**

	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	3	-	2	-	-	-	2	-	2	-	1	1
CO2	3	3	3	3	2	-	-	-	2	-	2	-	2	2
CO3	3	3	3	3	2	-	-	-	2	-	2	-	2	2
CO4	3	3	3	3	2	-	-	-	2	-	2	-	3	3
CO5	3	3	3	3	2	-	-	-	2	-	2	-	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, “Dive into Deep Learning”, Amazon Science, 2020
2. Josh Patterson and Adan Gibson, “Deep Learning a Practitioners Approach”, July 2018.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, The MIT Press, 2016

REFERENCE BOOKS:

1. Tom Mitchell, Machine Learning, McGraw-Hill, 1997
2. François Chollet, “Deep Learning Python”, Manning Publications, 2018
3. Neural Networks: A Comprehensive Foundation,” S. Haykin, 2ndEd, Prentice Hall of India, 2003.

Activity-Based Learning (Suggested Activities in Class)

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2. Student seminars (on topics of the syllabus and related aspects (individual activity)
3. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))
4. Study projects (by very small groups of students on selected local real-time problems about the syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity))

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GEN AI AND PROMPT ENGINEERING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

Subject Code	:	24AM3602	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39 (T)+26 (P)
L–T–P–S	:	3–0–2–0			

Course Learning Objectives:

This course will enable students to:

1. **Understand foundational concepts** of Generative AI, including transformer architectures, attention mechanisms, embeddings, and the distinction between language models and foundational models.
2. **Master prompt engineering and model evaluation** including zero-shot and few-shot learning, defensive prompting strategies, evaluation metrics, and model selection criteria.
3. **Implement advanced customization techniques** including parameter-efficient finetuning (PEFT), RLHF, and Retrieval-Augmented Generation (RAG) systems based on specific use case requirements.
4. **Design and deploy AI agent systems** with planning, memory, and tool-use capabilities, utilizing frameworks like LangChain for autonomous decision-making and multi-agent orchestration.
5. **Apply AI engineering principles** for practical implementation, monitoring, and deployment of generative AI solutions in production environments.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**06 Hours**

Introduction to Generative AI: Introduction to Generative AI, Definition and scope of Generative AI, Hierarchy of Generative AI, Overview of generative models and their applications, Importance of Generative AI in various domains, Ethical considerations and challenges.

UNIT – II	**09 Hours**

Understanding Foundational Models: Introduction to Embeddings, Basic Encoder/decoder architectures, Simple Attention Mechanisms, Transformer Architecture, Multi-Head Attention Mechanisms, GPT architecture and its significance, Dataset Engineering Fundamentals, Hands-on Implementation.	
UNIT – III	**07 Hours**
Prompt Engineering and Evaluating Foundational Models: Introduction to Prompt Engineering, In-Context Learning: Zero-Shot and Few-Shot, Prompt Engineering Best Practices, Defensive Prompt Engineering, Language Modeling Metrics, Challenges of Evaluating Foundational Models, Evaluation Criteria, Model Selection, Designing an Evaluation Pipeline	
UNIT – IV	**09 Hours**
Finetuning and RAG: Overview of Finetuning, Memory Bottlenecks and Computational Considerations, Full Finetuning vs Parameter Efficient Finetuning (PEFT), Reinforcement Learning with Human Feedback (RLHF) Fundamentals, Introduction to Retrieval Augmented Generation (RAG), Finetuning vs RAG, Retrieval Algorithms and Vector Databases, RAG Pipeline optimization and Chunking Strategies, Hybrid approaches (Combining fine-tuning with RAG), Model Merging Techniques and Multitask considerations	
UNIT – V	**09 Hours**
AI Agents and Practical Implementation: Introduction to AI agents and autonomous systems, Core components of intelligent agents (Planning, Memory, Tool Use, Goal-directed behavior), Types of AI agents (Reflex agents, Goal-based agents, Utility-based agents, Learning agents), Agent orchestration and multi-agent systems, Introduction to frameworks (LangChain, AutoGen, CrewAI, LangGraph), Retrieval-Augmented Generation (RAG) agents, Chain of thought reasoning and multi-step decision making, Agent deployment strategies and monitoring, AI Engineering Architecture and Monitoring, Case studies and hands-on implementation, Responsible AI Development	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Explain foundational concepts of Generative AI including transformer architectures and embeddings.	L2
2	Apply prompt engineering techniques and evaluate model performance using appropriate metrics.	L3
3	Implement finetuning and RAG techniques to customize foundational models for specific tasks.	L3
4	Design AI agent systems with planning and memory capabilities using modern frameworks.	L4
5	Create and deploy generative AI solutions with proper monitoring and engineering practices.	L6

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Cos	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	1	2	2	1		1	1	2		3	2	2
CO2	2	3	2	3	3	1		2	1	2	1	3	1	3
CO3	2	2	3	2	3	2	1	2	2	1	1	2	2	3
CO4	2	3	3	2	3	2	1	2	3	2	2	2	2	3
CO5	3	2	3	1	3	3	2	3	2	3	3	3	2	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Books:

1. Foster, David. *Generative deep learning*. O'Reilly Media, Inc., 2022.
2. Dhamani, Numa. *Introduction to Generative AI*. Simon and Schuster, 2024.
3. Chip Huyen. *AI Engineering: Building Applications with Foundation Models*. O'Reilly Media, Inc., 2024.

Reference Books:

1. Mastering AI Agents: A comprehensive guide for evaluating AI agents: *Pratik Bhavsar*
2. Babcock, Joseph, and Raghav Bali. *Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models*. Packt Publishing Ltd, 2021
3. Alto, Valentina. *Modern Generative AI with ChatGPT and OpenAI Models: Leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4*. Packt Publishing Ltd, 2023. de Albuquerque, Victor Hugo C., Pethuru Raj, and Satya Prakash Yadav, eds. *Toward Artificial General Intelligence: Deep Learning, Neural Networks, Generative AI*. Walter de Gruyter GmbH & Co KG, 2023.

E-Resources:

1. https://jalammar.github.io/illustrated-transformer/
2. https://www.3blue1brown.com/lessons/gpt

3. https://poloclub.github.io/transformer-explainer/
4. https://www.datacamp.com/blog/what-is-prompt-engineering-the-future-of-ai-communication
5. https://www.promptengineering4u.com/learning/techniques/template-based-prompting#h.2n56pv37pv0c

Activity Based Learning (Suggested Activities in Class)

1. Hands-on prompt engineering with real LLMs.
2. Model evaluation sessions using different metrics.
3. AI agent development project using modern frameworks.
4. Mini Project

LIST OF LABORATORY/PRACTICAL EXPERIMENTS ACTIVITIES TO BE CONDUCTED
24. Implement Word Embeddings using the Skip-gram model and explore semantic similarity. 25. Build a Simple Autoencoder for image reconstruction and dimensionality reduction. 26. Implement a Tiny GAN for generating handwritten digits using adversarial training. 27. Design and implement a Variational Autoencoder (VAE) for probabilistic image generation. 28. Develop a Character-Level RNN for text generation using the Shakespeare dataset. 29. Implement a Baby Transformer model from scratch for sequence prediction tasks. 30. Perform GPT-2 Prompting and analyze text generation under different decoding strategies. 31. Build a Semantic Search engine using sentence embeddings and FAISS. 32. Fine-tune a pre-trained DistilBERT model for sentiment classification on the IMDB dataset. 33. Generate images from text prompts using Stable Diffusion and analyze quality–speed tradeoffs. 34. Implement a Mini Retrieval-Augmented Generation (RAG) system integrating retrieval and generation. 35. Develop a Multi-Modal Search system using CLIP embeddings for text–image alignment and retrieval.

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DESIGNING MLOPS FOR ENTERPRISES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	: 24AM3603	**Credits**:	03
Hours / Week	: 3 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To impart knowledge on production-level challenges of ML models
2. To provide comprehension of various activities involved in the development, deployment, and monitoring of ML models
3. To familiarize the principles of MLOps and different platforms

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**07 Hours**
Introduction to DevOps: SDLC, Virtualization: Containers, Container Orchestration Systems, Cloud platforms, CI/CD: Continuous Integration – Configuration Management, Deployment and Delivery phases, Continuous monitoring, Continuous Testing	
UNIT – II	**08 Hours**
Basic Concepts: Evolution of MLOps, Data-centric AI, ML Development Lifecycle, MLOps Approach, Features of MLOps, ML Data Lifecycle in Production, MLOps maturity levels, ML artifacts, MLOps workflows.	
UNIT – III	**08 Hours**
Machine Learning Pipelines and automation: CI/CD for Machine Learning, ML model serving, Data pipelines, Data drift, ML pipelines: Data ingestion, Feature engineering, Hyperparameter optimization, testing and packaging.	
UNIT – IV	**08 Hours**
Model in MLOps : Model management: Model deployment and monitoring, feedback, orchestration pipelines for ML workflows, ML security, Real-time Streaming ML models, Deployment on edge devices, Automated ML.	
UNIT -V	**08 Hours**

Case Studies on MLOps best practices: **Netflix:** Enhancing Content Recommendations with MLOps, **Uber:** Demand Forecasting with MLOps, **Airbnb**: Search Ranking Models, **Intuit**: Fraud Detection and Prevention, **NASA:** Satellite Image Analysis.

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Explain and assess the effectiveness and scalability of an end-to-end machine learning system in a real-world scenario.	L2
2	Recall various metrics used to evaluate machine learning model performance	L2
3	Design and integrate comprehensive automated systems that encompass ML pipelines, CI/CD, data processing, model serving, and drift detection.	L3, L4
4	Analyze the challenges and benefits of implementing MLOps in an organization.	L4
5	Evaluate the applicability and effectiveness of MLOps best practices from case studies in your own or another organization.	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	2	2	2	-	2	-	-	2	1	-	2	2	2
CO2	2	2	2	2	-	2	-	-	2	1	-	2	2	2
CO3	2	2	2	2	-	2	-	-	2	1	-	2	2	2
CO4	2	2	2	2	-	2	-	-	2	1	-	2	2	2
CO5	2	1	-	2	-	-	-	2	-	1	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Alla, Sridhar, and Suman Kalyan Adari. *Beginning MLOps with MLFlow*. Apress, 2021.
2. Rao, Dattaraj. *Keras to Kubernetes: The Journey of a Machine Learning Model to Production*. John Wiley & Sons, 2019.
3. Sculley, David, et al. "Machine learning: The high interest credit card of technical debt." (2014).
4. Jez Humble, David Farley. Continuous Delivery.,2011

REFERENCE BOOKS:

1. Treveil, Mark, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, and Lynn Heidmann. *Introducing MLOps*. O'Reilly Media, 2020.
2. Burkov, Andriy. *Machine Learning Engineering.* True Positive Inc. , 2020.
3. Ameisen, Emmanuel. *Building Machine Learning Powered Applications.* O'Reilly Media, 2020..

Activity Based Learning (Suggested Activities in Class)

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2. Student seminars (on topics of the syllabus and related aspects (individual activity)
3. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))
4. Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity))

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MINOR PROJECT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3604	**Credits**	:	02
Hours / Week	:	02	**Total Hours**	:	26 Hours
L–T–P–S	:	0–0–0–4			

Course Learning Objectives:

This course will enable students to:

1. **To identify** key research questions within a field to carry out research in a team.
2. **To identify** and summarize the literature review of the relevant field.
3. **To demonstrate** relevant referencing and inculcate new skills in various aspects of academic writing.
4. **To demonstrate** the knowledge and understanding of writing the publication/report.
5. **To showcase** the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information.
6. **To detail description** of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature.
7. **To analyze** and synthesize the new research findings.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method means it includes not only the traditional lecture method but a different type of teaching method that may be adopted to develop the course outcomes.
2. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show Video/animation films to explain the functioning of various concepts.
4. Encourage Collaborative (Group Learning) Learning in the class.
5. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the student's understanding.

COURSE CONTENT:

The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.

All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.

The following criteria will be checked by the department chairman to approve for the research proposal:

a. Department staff as course guide
   1. Ability to provide research direction to the student in the chosen field of interest
   2. Ability to design an appropriate research strategy and methodology to carry out the research by student
   3. Ability to provide and evaluate the strong literature review document for the chosen research topic
   4. Ability to train students on research paper / technical writing skills
   5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team
   1. To be dedicated and committed to work on a new research topic by learning new technical skills
   2. To have fair knowledge on what is product development or research topic
   3. To have constant interaction with allocated guide by providing weekly updates
   4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

There will be CIA evaluation as well as the Semester end evaluation of the work done. Itwill be done by a committee of senior researchers of the Department.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Identify and Select an Appropriate Research Problem	L1
2	Explain and Summarize Relevant Literature	L2
3	Compare and Critically Analyze Relevant Research Papers	L3
4	Construct a Research Model and Perform Evaluation	L4
5	Create and Draft Publications or Demonstrations	L5

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1	1	1	1	1	2	2	3	2	2	1
CO2	2	2	3	2	2	1	1	1	2	2	3	2	1	2
CO3	3	3	3	2	3	2	2	1	2	2	2	2	2	2
CO4	2	3	2	3	2	1	2	2	2	2	2	3	2	2
CO5	1	1	2	1	2	1	1	1	3	3	2	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

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EXPLAINABLE AI

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3606	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. To understand the basic building block of Explainable AI and interpretable machine learning
2. To understand the inner workings of AI and consequent outcomes.
3. To bring transparency to AI systems by translating, simplifying, and visualizing its decisions.
4. To discover unknown correlations with causal relationships in data.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and role playing.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning/Seminars) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.

UNIT – I : Introduction to Interpretability and Explainability	**07 Hours**
Black-Box problem, Goals, Porphyrian Tree , Expert Systems , Case-Based Reasoning, Bayesian Networks , Types of Explanations, Trade-offs, Taxonomy, Flowchart for Interpretable and Explainable Techniques (TextBook 1: 1.1 to 1.9)	
UNIT – II: Pre-model Interpretability and Explainability	**08 Hours**
Data Science Process and EDA, Exploratory Data Analysis, Feature Engineering-Feature Engineering and Explainability , Feature Engineering Taxonomy and Tools. (TextBook 1: 2.1 to 2.3)	
UNIT – III: Model Visualization Techniques and Traditional Interpretable Algorithms	**08 Hours**
Model Validation, Evaluation, and Hyperparameters, Model Selection and Visualization, Classification Model Visualization, Regression Model Visualization, Clustering Model Visualization, Interpretable Machine Learning Properties, Traditional Interpretable Algorithms-Linear Regression. (TextBook- 3.1 to 3.6, 3.7.2)	
UNIT – IV: Model Interpretability: Advances in Interpretable Machine Learning	**08 Hours**
Interpretable vs. Explainable Algorithms, Ensemble-Based-Boosted Rulesets, Explainable	

Boosting Machines (EBM), RuleFit, Skope-Rules, Iterative Random Forests (iRF), Decision Tree Based-Optimal Classification Trees, Optimal Decision Trees, Scoring System (TextBook 1: 4.1-4.4,4.6)
UNIT – V: Explainable Deep Learning **08 Hours**
Applications, Tools and Libraries, Intrinsic, Perturbation- LIME, Occlusion, RISE, Prediction Difference Analysis, Meaningful Perturbation, Gradient/Backpropagation Activation Maximization, Class Model Visualization, Saliency Maps, DeepLIFT, DeepSHAP, Deconvolution, Guided Backpropagation, Integrated Gradients, Layer-Wise Relevance Propagation, Excitation Backpropagation, CAM Textbook 1: 6.1 to 6.4 , 6.5.1 to 6.5.11

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Apply concepts of interpretability and explainability in AI employing various explanation techniques and taxonomies.	L3
2	Apply techniques like LIME, and SHAP to generate explanations from black-box machine learning models and utilize Feature Engineering for Explainability	L3
3	Implement explainable deep learning algorithms and solve real-world problems	L3
4	Analyze challenges and limitations associated with Explainable AI methods, such as trade-offs between model complexity and interpretability	L2, L4
5	Identify and evaluate novel methods, address open challenges in transparent and interpretable machine learning	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome

CO1	3	2	1		2							2	1
CO2	2	3	2		2							2	1
CO3	2	2	2		2							2	2
CO4	2	3	3		3							2	2
CO5	3	2	3									3	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Books:

1. Mayuri Mehta, Vasile Palade , Indranath Chatterjee, "Explainable AI: Foundations, Methodologies and Applications", Springer, 2023.
2. John Liu, James Whitaker, James Whitaker, Uday Kamath, "Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning", Springer, 2021.

Reference Books:

1. Christoph Molnar , "Interpretable Machine Learning: A Guide for Making Black Box Models Explainable", Second Edition Leonida Gianfagna, Antonio Di Cecco, "Explainable AI with Python" , 2021

E-Resources:

1. https://www.udemy.com/course/xai-explain-ml-models/

Activity-Based Learning (Suggested Activities in Class)

Nil

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REINFORCEMENT LEARNING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3607	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. Use Reinforcement Learning Methods for the agents to learn an optimal, or nearly optimal, policy that maximizes the "reward function" or other user-provided reinforcement signal .
2. Apply such Reinforcement Learning mechanisms to various learning problems.
3. Learn about several algorithms that can learn near optimal policies based on trial and error interaction with the environment---learning from the agent's own experience

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I :	**08 Hours**

Introduction: Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, History of Reinforcement Learning, Probability concepts - Axioms of probability, Notion of random variables, PMF, PDFs, CDFs. Two Random Variables, Pairs of Discrete Random Variables, The Joint cdf of X and Y, The Joint pdf of two continuous random variables, Independence of two Random variables, Stochastic process and agent environment Textbook 1: Ch 1.1 to 1.4; Textbook 2: 2.2,3.1,3.2,4.1 to 4.2, 5.1 to 5.5 RBT: L1, L2

UNIT – II:	**08 Hours**

Finite Markov Decision Processes: The Agent-Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation Textbook 1: Ch 3.1 to 3.9 RBT: L1, L2, L3

UNIT – III:	**07 Hours**

Dynamic Programming : Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming Textbook 1: Ch 4.1 to 4.8 RBT: L1, L2, L3	
UNIT – IV:	**08 Hours**
Monte Carlo Methods : Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, O-policy Prediction via Importance Sampling, Incremental Implementation, O-Policy Monte Carlo Control, Importance Sampling on Truncated Returns Textbook 1: Ch 5.1 to 5.8 RBT: L1, L2, L3	
UNIT – V	**08 Hours**
Deep Reinforcement Learning : Methods for learning from demonstrations, model-based and model-free deep RL methods, Case study-Methods for learning from offline datasets and more advanced techniques for learning multiple tasks such as goal-conditioned RL, meta-RL, and unsupervised skill discovery.	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Comprehend the foundational concepts of Reinforcement Learning and probability.	L2
2	Apply the principles of Finite Markov Decision Processes (MDPs)	L3
3	Analyze dynamic programming methods for policy optimization	L4
4	Evaluate the effectiveness of Monte Carlo methods in reinforcement learning	L5
5	Recall and implement Temporal Difference (TD) learning algorithms	L2, L3

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2											2	1
CO2	3	2	2	1							2		1	1
CO3	3	2			2								2	2
CO4	3				2								1	2
CO5	3	2	2		2						2		2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Zai, Alexander, and Brandon Brown. *Deep reinforcement learning in action*. Manning Publications, 2020.
2. Dong, Hao, Hao Dong, Zihan Ding, Shanghang Zhang, and Chang. *Deep Reinforcement Learning*. Singapore: Springer Singapore, 2020.

REFERENCE BOOKS:

1. Murphy, Kevin P. *Machine learning: a probabilistic perspective*. MIT press, 2012.
2. Vamvoudakis, Kyriakos G., Yan Wan, Frank L. Lewis, and Derya Cansever, eds. *Handbook of reinforcement learning and control*. Springer International Publishing, 2021.
3. Szepesvári, Csaba. *Algorithms for reinforcement learning*. Springer nature, 2022.
4. Weber, Cornelius, Mark Elshaw, and N. Michael Mayer, eds. *Reinforcement Learning*. BoD–Books on Demand, 2008.
5. Bertsekas, Dimitri. *Reinforcement learning and optimal control*. Vol. 1. Athena Scientific, 2019.

E-Resources:

1. https://machinelearningmastery.com
2. https://www.knuggets.com/
3. https://www.geeksforgeeks.org/machine-learning-projects/
4. Sutton, Richard S., and Andrew G. Barto. "Reinforcement learning." Journal of Cognitive Neuroscience 11, no. 1 (1999): 126-134.

Activity Based Learning (Suggested Activities in Class)

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2. Student seminars (on topics of the syllabus and related aspects (individual activity)
3. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))

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CRYPTOGRAPHY AND NETWORK SECURITY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3608	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

1. Summarize the importance of legal compliance, ethical considerations, and professional standards in implementing security measures across various domains.
2. To learn and apply various classical and modern encryption techniques, including substitution and transposition methods, and understand their historical significance and limitations.
3. To understand by applying the mathematical principles underpinning symmetric and asymmetric cryptographic algorithms, including algebraic structures, modular arithmetic, and finite fields.
4. To implement and evaluate symmetric key ciphers like DES and AES, and asymmetric key algorithms like RSA, Diffie-Hellman, and elliptic curve cryptography.
5. To Analyse and implement techniques for ensuring message authentication and integrity, including MACs, hash functions, and digital signatures.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** clips to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**10 Hours**

INTRODUCTION:

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography).- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.

UNIT – II	**10 Hours**

SYMMETRIC CRYPTOGRAPHY:

MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures - Modular arithmetic-Euclid‘s algorithm- Congruence and matrices - Groups, Rings, Fields- Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES –

Differential and linear cryptanalysis - Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard - RC4 – Key distribution.	
UNIT – III	**06Hours**
PUBLIC KEY CRYPTOGRAPHY **MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY:** Primes – Primality Testing – Factorization – Euler‘s totient function, Fermat‘s and Euler‘s Theorem - Chinese Remainder Theorem.	
UNIT – IV	**06Hours**
ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange - ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.	
UNIT – V	**07 Hours**
MESSAGE AUTHENTICATION AND INTEGRITY: Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols	

Course Outcome	Description	Bloom’s Taxonomy Level
At the end of the course, the student will be able to:		
1	Articulate and **apply** legal regulations, ethical principles, and professional standards in the development and management of secure systems.	L3
2	**Demonstrate** proficiency in implementing and analysing classical encryption techniques and appreciate the transition to modern cryptographic methods.	L2
3	**Solve** problems involving mathematical concepts such as Euclid's algorithm, groups, rings, fields, and finite fields, and apply these concepts to cryptographic algorithms.	L3
4	**Design, implement, and evaluate** the security of symmetric and asymmetric cryptographic systems, and understand key distribution and management.	L5
5	**Analyse** the various Authentication schemes to simulate different applications.	L4

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	-	3	2	-	-	3	-	-	-	2	3	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	2	-	-	1
CO3	3	3	-	-	2	-	-	-	-	-	2	-	1	-
CO4	3	3	3	2	3	-	-	-	-	-	2	-	2	1
CO5	3	3	3	2	3	-	-	-	-	-	2	-	2	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOK:

1 Introduction to Modern Cryptography by Jonathan Katz and Yehuda Lindell, 3rd Edition 2021.
2 William Stallings, Cryptography and Network Security: Principles and Practice, PHI 8th Edition, 2019.

REFERENCES:

1. Network Security Essentials: Applications and Standards" by William Stallings, 7th Edition 2020.
2. C K Shyamala, N Harini and Dr. T R Padmanabhan: Cryptography and Network Security, Wiley India Pvt.Ltd, 2015.
2. BehrouzA. Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Prentice Hall, ISBN 0-13-046019-2, 2002.

Activity Based Learning (Suggested Activities in Class)

4. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
5. Student seminars (on topics of the syllabus and related aspects (individual activity)
6. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))

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PREDICTIVE ANALYTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	: 24AM3609	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. Summarize the basic concepts of predictive analytics.
2. Utilize the Linear Regression techniques to obtain the summary of the models and interpret the results.
3. Apply the different types of Regression techniques such as Multiple Linear regression, SVM regression, ANN regression on the data to perform analysis and predictions.
4. Illustrate the different Time Series Analysis and Forecasting techniques with the example to obtain Time Series Patterns from the data.
5. Develop the models for of Predictive Analytics Applications.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.

   Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**07 Hours**

Introduction to Analytics - Predictive Analytics Process-Benefits of Predictive Models-Applications of Predictive Analytics. Predictive Analytics vs. Business Intelligence; Predictive Analytics vs. Statistics; Predictive Analytics vs. Data Mining; Challenges and scope of Predictive Analytics.

Textbook 1: Chapter 1, 2

UNIT – II	09 Hours
Linear Regression: Linear Regression with Python: Definition and overview of linear regression analysis, Linear regression using simulated data, Fitting a linear regression model and checking its efficacy, Finding the optimum value of variable coefficients, Making sense of result parameters, p-values, F-statistics, Residual Standard Error, R-squared, adjusted-R-Squared, AIC or BIC Implementing linear regression with Python, Linear regression using the stats model library, Model validation, Summary of models, Statistical inferences for the logistic regression model, Linear Discriminant Analysis (LDA), and Quadratic Discriminant Analysis (QDA).	
UNIT – III	**08 Hours**
Different Types of Regression: Multiple Linear Regression, Multi-collinearity: Variance Inflation Factor, Regularization methods: Lasso, Ridge and Elastic nets, Polynomial Regression, Regression tree algorithm, implementing a regression tree using Python, SVM regression, ANN for Regression, Poisson Regression.	
UNIT – IV	**07 Hours**
Time Series Analysis and Forecasting: Time Series Patterns: Trend Pattern, Seasonal Pattern, Cyclic Forecast Accuracy, Moving Averages, Weighted Moving Averages, Exponential Smoothing, Linear Trend Regression, Holt's Linear Exponential Smoothing, Holt's Winter seasonal method, Arima Models.	
UNIT – V	**08 Hours**
Errors in forecasting: Mean Average Deviation (MAD), Mean Absolute Percentage Error, Mean Percentage Error, Root Mean Square, Root Percent Mean Square. **Case Studies of Predictive Analytics Applications** - Weather forecasting, Stock market prediction, Diabetes Disease Prediction, Recommendation systems, Online Marketing and Retail.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Summarize** the basic concepts challenges and scope of predictive analytics.	L2
2	**Make use of** the Linear Regression techniques to obtain the summary of the models and to Analyze the results on various parameters such as p-values, F-statistics, Residual Standard Error.	L3
3	**Apply** the different types of Regression techniques such as Multiple Linear regression, SVM regression, ANN regression on the data to perform analysis and predictions.	L3
4	**Utilize** the different Time Series Analysis and Forecasting techniques to obtain Time Series Patterns from the data.	L3

5	**Evaluate** the performance of the predictive models using appropriate metrics such as Mean Average Deviation (MAD), Mean Absolute Percentage Error, Mean Percentage Error, Root Mean Square, Root Percent Mean Square. And **develop** the models for Predictive Analytics Applications.	L5

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	-	-	-	2	-	-	-	1	1	-	-	-	-
CO2	3	2	-	-	2	-	-	-	1	1	-	-	2	2
CO3	3	2	-	-	2	-	-	-	1	1	-	-	2	2
CO4	3	2	-	-	2	-	-	-	1	1	-	-	2	2
CO5	3	2	-	-	2	-	-	-	1	1	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Ashish Kumar, Learning Predictive Analytics with Python, First Edition, PACKT Publishing, 2016.
2. Nooruddin Abbas Ali, Predictive Analytics for the Modern Enterprise, Publisher(s): O'Reilly Media, Inc. , ISBN: 9781098136864, 2024.
3. Manohar Swamynathan, Mastering Machine Learning with Python in Six Steps, Apress. 2019.

REFERENCE BOOKS:

1. Joseph Babcock, Mastering Predictive Analytics with Python, PACKT Publishing, 9781785882715, 2016.
2. Anasse Bari, Predictive Analytics for dummies , 2nd Edition, Wiley, 2017.

E-Resources:

1. https://onlinecourses.swayam2.ac.in/imb22_mg43.
2. https://onlinecourses.nptel.ac.in/noc23_ma46/preview
3. https://www.mooc-list.com/course/introduction-predictive-modeling-coursera.

Activity Based Learning (Suggested Activities in Class)

1. Practical based Learning.
2. Mini Project

QUANTUM MACHINE LEARNING

PEC-III

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3610			**Credits**:	03
Hours / Week	:	3 Hours			**Total Hours**:	39 Hours
L–T–P–S	:	3–0–0–0				

Course Learning Objectives:

The purpose of learning this course is to:

1. Gain knowledge about quantum computing, quantum mechanics and analyze the quantum circuits
2. Learn about the fundamentals of Machine Learning
3. Utilize Qiskit for supervised learning
4. Learn unsupervised learning with Qiskit
5. Utilize the quantum neural networks with Pennylane

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

7. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
8. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
9. Show ***Video/animation*** clips to explain the functioning of various concepts.
10. Encourage ***Collaborative*** (Group Learning) Learning in the class.
11. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
12. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Introduction to Quantum Computing:
Introduction to Superposition, Classical superposition, Quantum superposition, Explain with example of Qubit, Mathematical Representation on Qubits, Bloch Sphere, Quantum Gates: Entanglement, Multi-Qubits states-CNOT gate. Quantum Bits, Dirac Notation, Single and Multiple Qubit Gates, No Cloning Theorem, Quantum Interference.

UNIT – II	**08 Hours**

Classical vs. Quantum Machine Learning, Examples of Typical Machine Learning Problems, The Three Ingredients of a Learning Problem, Risk minimization in Supervised Learning, Training in Unsupervised Learning, Linear Models, Neural Networks, Graphical and Kernel methods, Quantum Linear Regression

UNIT – III	**08 Hours**

Introduction to Quantum Machine Learning, Four approaches to QML, Parameterized quantum circuits (PQC), Quantum Information Encoding, Training parameterized quantum circuits, Supervised learning, Quantum variational classification, Quantum Euclidean Distance Calculation, Quantum kernel estimation, Quantum feature map and kernels, Quantum Support Vector classification (QSVM).

UNIT – IV	**08 Hours**
Introduction to Unsupervised learning, Principal Component Analysis, Clustering-Classifiers used in QML, Problem solving session, QML programming concepts in Qiskit, Analysis of Qiskit, Analysis of exercises created by Qiskit, Quantum K-Means Clustering, Quantum Principal Component Analysis	
UNIT -V	**08 Hours**
Introduction to Quantum Neural Networks, Quantum Convolutional Neural Networks (QCNN), Hybrid QNN, Problem solving session on a real dataset, Classical Generative Adversarial Networks (GAN), Quantum Generative Adversarial Networks (QGAN), QGAN in Qiskit, Problem Solving session: Pennylane and AWS Quantum Braket introduction **Use cases in QML.** • Hybrid Quantum-Classical Neural Networks • Classification using Hybrid Quantum-Classification Neural Network • Quantum Neural Network for Classification on Near-Term Processors Tools: Qiskit-based programming	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Identify the need of quantum computing and quantum gates	L2
2	Compare Classical vs. Quantum Machine Learning	L2
3	Develop the Quantum Machine Learning programs	L3, L4
4	Incorporate the Unsupervised learning with Qiskit	L4
5	Demonstrate the QNN, QCNN, QGAN using Qiskit and Pennylane.	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
Cos	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome

CO 1	1	3												
CO 2	2	3	1											
CO 3	2	3		3										
CO 4	2	3		3										
CO 5	1	3		3										

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. **Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press.**
2. **Peter Wittek, Quantum Machine Learning: What Quantum Computing Means to Data Mining, Academic Press.**
3. **Maria Schuld & Francesco Petruccione, Supervised Learning with Quantum Computers, Springer.**
4. Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press
5. Ciaran Hughes, Joshua Isaacson, Anastatsia Perry, Ranbel F. Sun, Jessica Turner, “Quantum Computing for the Quantum Curious”, Springer, 2021
6. Maria Schuld and Francesco Petruccione, “Machine Learning with Quantum Computers”, Second Edition, Springer, 2021
7. Maria Schuld and Francesco Petruccione, “Supervised Learning with Quantum Computers”, Springer, 2018
8. Peter Wittek, “Quantum Machine Learning – What Quantum Computing Means to Data Mining”, Elsevier
9. Michael A. Nielsen and Issac L. Chuang," Quantum Computation and Information, Cambridge, 2002
10. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press, 2008
11. N. David Mermin, "Quantum Computer Science", Cambridge, 2007
12. https://qiskit.org/
13. https://qiskit.org/documentation/machine-learning/
14. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
15. Quantum Computer Science. N. David Mermin:, Cambridge University Press
16.

REFERENCE BOOKS:

1. **Jack D. Hidary, Quantum Computing: An Applied Approach, Springer.**
2. **Seth Lloyd, Programming the Universe, Knopf. Nathan Killoran et al.,**
3. **PennyLane Documentation & Tutorials.**

4. **IBM Qiskit Textbook (Online Resource).**

Tools / Software

- **IBM Qiskit (Python SDK for Quantum Circuits)**
- **PennyLane (for hybrid quantum-classical models)**
- **TensorFlow Quantum**
- **Cirq by Google**

Activity Based Learning (Suggested Activities in Class)

5. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
6. Student seminars (on topics of the syllabus and related aspects (individual activity)
7. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))
8. Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity))

LAB EXPERIMENTS:

1. Introduction to Qiskit with some execises
2. Develop circuit composer in Qiskit lab
3. Demonstrate Quantum gates using Qiskit
4. Python basics and Project preparation phase 1 (Analysis of problem statement related to quantum computing)
5. Implement single and multiple qubit gates using python
6. Project preparation phase 2 (Design of the project based on problem statement using Qiskit or Pennylane)
7. Implementation of QML algorithms
8. Implementation of Quantum classifiers
9. Implementation of QSVM and Project preparation phase 3 (Implementation of quantum problem statement in Qiskit or Pennylane)
10. Implementation of Quantum K Nearest Neighbour
11. Implementation of different QML models
12. Project presentation phase 4 demo (use case developed) and thesis preparation
13. Implementation of Quantum Neural Networks
14. Implementation of QCNN in healthcare applications
15. Project report submission (Thesis of use case developed)

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Projects:

- Hybrid Quantum Neural Networks for Remote Sensing Imagery Classification
- Analysis and Implementation of Quantum Encoding Techniques
- Quantum Convolutional Neural Network for Classical Data Classification
- Prediction of Solar Irradiation using Quantum Support Vector Machine Learning

Algorithm

- To Solve any Combinatorial Optimisation Problem (Like Knapsack) Using a Quantum Annealing Approach
- Comparative Study of Data Preparation Methods in Quantum Clustering Algorithms
- To Calculate the Ground State Energy of a Simple Molecule (H2, LiH, or H2O) Using VQE
- Variational Quantum Classifier
- Implementing Grover's Algorithm and Proving Optimality of Grover's Search (Bounded Error and Zero Error)
- To Implement Grover's Search Algorithm Where 1101 Is the Marked State
- Quantum Computing for Finance
- To Solve Crop-Yield Problem using QAOA and VQE, and Run the Same on Real Quantum Computer
- Analysis of Solving Combinatorial Optimisation Problems on Quantum and Quantum-like Annealers
- Quantum Convolutional Neural Network for Classical Data Classification
- Research on Quantum Computing usage to Expedite the Drug Discovery Process (Life Sciences)
- To Implement Shor's Code in Qiskit with Noise Models
- To Understand and Implement Quantum Counting
- Enterprise Intelligence - Managed Services with Quantum Computing
- On-ground Implementation of Quantum Key Distribution in Indian Navy
- Implementing MC Simulations using Quantum Algorithm (Financial domain)
- To Design and Build an Educational Game Using Fundamentals of Quantum Computing
- Solving Travelling Salesman Problem Using QAOA
- Implementing Clinical Data Classification by Quantum Machine Learning (QML)
- To Understand and Implement Quantum
- Carry-Save Arithmetic
- To Implement Shor's Algorithm to Factor 49
- To Understand and Implement Grover Search-Based Algorithm for the List Coloring Problem
- Optimisation Problem Where We Try to Find the Best Solution to Coal Overburden Problem with Depth and Coal Quantity Mined
- Implementing HHL Algorithm and Proving BQP-completeness of Matrix Inversion
- Quantum Convolutional Neural Network-based Medical Image Classification
- Quantum Convolutional Neural Network
- Quantum Computing for Finance
- Differential Detection of Internal Fault of an Electrical Network: A Comparison with Classical vs Quantum Approach
- Major Area: Implementing any One Quantum Algorithm and Understanding Classical vs Quantum Hardness of Problems
- Quantum Computing and Information Security
- Feature Selection in Machine Learning Using Quantum Computing

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ROBOT OPERATING SYSTEM (ROS)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	: 24AM3611	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To be able to outline the architecture and file system of ROS.
2. To make use of Libraries such as turtlesim and Gazebo for ROS programming and simulation.
3. To be able to Examine the behaviour of robot programming to debug.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Getting Started with ROS,The ROS Equation,Robot Programming Before and After ROS,Robots and Sensors Supporting ROS,Popular ROS Computing Platforms,ROS Architecture and Concepts,The ROS File System,ROS Demo: Hello World Example

Chapter 4 (**ros for absolute begginers**)

UNIT – II	**08 Hours**

ROS Demo: turtlesim,Programming Using ROS:Creating a ROS Workspace and Package,Using ROS Client Libraries.Programming Embedded Boards Using ROS,

Chapter 5(ROS for absolute beginners)

Topics: Publishing,subscribing to topics,defining and using Message, Services: defining, implementing and using services, Actions: defining, implementing and using actions.

Chapter 3,4 & 5(a practical introduction to ROS)

UNIT – III	**08 Hours**

Debugging Robot Behavior: Log Messages: /rosout and rqt_console, Nodes, Topics, and Connections: rqt_graph and rosnode, Sensor Fusion: rviz, Plotting Data: rqt_plot, Data Logging and Analysis: rosbag and rqt_bag. Programming Robots with ROS **Chapter 21**
UNIT – IV **08 Hours**
Wobbling Robot Arms Using Joint Control, Introducing Baxter,Baxter's arms, Baxter Simulator in Gazebo, Baxter's arms and forward kinematics, Controlling Your Robots with External Devices. **Chapter 6(ROS Robotics By Example)**
UNIT – V **07 Hours**
Some recommended projects using ROS: Radar and ROS Powered Indoor Home Mapping and Positioning Robot Artificial Intelligence-Based Chatbot for Appliance Control Virtual Telepresence Robot Using Raspberry Pi Arduino based Smartphone Controlled Robot Car

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Explain** the core concepts and architecture of ROS, including its file system, computing platforms, and programming environment.	L2
2	**Utilize** ROS client libraries, and program embedded boards using ROS for basic robotic applications.	L3
3	**Demonstrate** the ability to publish and subscribe to topics, define and use messages, and implement services and actions in ROS to facilitate communication between different components of a robotic system.	L3
4	**Analyze** and debug robot behavior using tools such as /rosout, rqt_console, rqt_graph, rviz, rqt_plot, and rosbag to effectively diagnose and resolve issues in robotic systems.	L4
5	**Design and Evaluate** ROS-based projects, such as indoor home mapping robot, an AI-based chatbot for appliance control, a virtual telepresence robot, and a smartphone-controlled robot car, showcasing advanced project management and implementation skills	L5

Mapping Levels of COs to POs / PSOs														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2										1	1
CO2	3	3	2		3								2	1
CO3	3	3	2		2					1			2	1
CO4	3	3	2		2				2	2			2	2
CO5	3	3	2		2				2	2			2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. ROS Robotics by Example: Learning to Control Wheeled, Limbed, and Flying Robots Using ROS Kinetic Kame, Carol Fairchild, Thomas L. Harman, 2nd edition, Packt Publishing, 2017
2. Programming Robots with ROS: A Practical Introduction to the Robot Operating System (Greyscale Indian Edition) Paperback – 1 January 2016 by Morgan Quigley (Author), Brian Gerkey (Author), William D. Smart (Author)
3. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy Paperback – Import, 25 May 2018 by Lentin Joseph

REFERENCE BOOKS:

1. A very informal journey through ROS 2 patterns, anti-patterns, frameworks and best practices- 2023-Bassa Marco Matteo
2. Mastering ROS for Robotics Programming - Third Edition Paperback – Import, 15 October 2021
3. Programming Robots with ROS: A Practical Introduction to the Robot Operating System, Morgan Quigley, Brian Gerkey, William D. Smart, "O'Reilly Media, Inc.", 2015.

E-Resources:

1. Open-CV: http://wiki.ros.org/vision_opencv
2. PCL: http://wiki.ros.org/pcl_ros
3. Open-NI: http://wiki.ros.org/openni_launch

4. Open-Rave: http://openrave.org/
5. Orocos: http://www.orocos.org/
6. Webots: https://www.cyberbotics.com/overview
7. V-REP: http://www.coppeliarobotics.com/

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ADVANCED COMPUTER ARCHITECTURE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3612	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. Analyze computer architecture performance using quantitative evaluation methodologies and understand instruction set design principles.
2. Master advanced processor microarchitecture concepts including pipelining, superscalar execution, and parallelism exploitation techniques.
3. Design and optimize memory hierarchies for high-performance computing with understanding of cache coherence and consistency models.
4. Evaluate parallel computing architectures including multicore processors and GPU systems relevant to AI workloads.
5. Apply architectural principles to understand AI accelerators and emerging computing paradigms for machine learning applications.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** *covering both fundamental architecture principles and modern AI-specific optimizations.*
2. ***Interactive Teaching:*** *Comparative analysis of different architectures, discussion of design trade-offs, case studies of real systems.*
3. ***Demonstrations:*** *Performance analysis tools, architectural simulators, GPU programming basics.*
4. ***Collaborative learning:*** *Group discussions on architecture papers, benchmark analysis.*
5. ***Critical thinking:*** *Design decisions under constraints, architecture selection for different workloads.*
6. ***Real-world application:*** *Analysis of contemporary processors, understanding AI system requirements, performance profiling.*

UNIT – I	**06 Hours**

Fundamentals and Performance Analysis: Quantitative principles of computer design. Performance metrics: execution time, throughput, speedup, CPI. Amdahl's Law and its implications. Benchmarking: SPEC, MLPerf overview. Instruction Set Architecture (ISA) principles: RISC vs CISC. Introduction to RISC-V architecture. Power dissipation: dynamic power, power wall. Performance-per-watt considerations.

UNIT – II	**07 Hours**

Processor Architecture and Parallelism: Instruction pipelining: 5-stage pipeline, pipeline hazards (data and control). Superscalar processors: instruction-level parallelism (ILP), multiple issue, dynamic scheduling. Out-of-order execution overview. Dynamic branch prediction techniques. Thread-level parallelism (TLP): simultaneous multithreading (SMT). Data-level parallelism (DLP): SIMD concepts, vector processing.

UNIT – III	**07 Hours**

Memory Hierarchy Design: Memory hierarchy principles: locality, cache organization. Cache design parameters: block size, associativity, capacity, LRU replacement. Write-back policy. Multi-level cache hierarchies. Cache performance analysis: miss rate, AMAT. Virtual memory and TLB overview. Memory technologies: DRAM, HBM. Main memory organization and memory controllers. Cache coherence concepts. Memory consistency models overview. Bandwidth considerations for AI workloads.
UNIT – IV **09 Hours**
Parallel Architectures: Multicore processor architecture: shared vs private caches. Interconnection networks: mesh topologies. GPU architecture fundamentals: motivation, SIMT execution model. NVIDIA GPU architecture overview: SMs, warps, thread hierarchy. GPU memory hierarchy: global, shared, register memory. CUDA programming basics: kernels, thread blocks, grids. GPU vs CPU: workload characteristics. Multi-GPU systems. Heterogeneous computing: CPU+GPU cooperation. Scalability considerations
UNIT – V **07 Hours**
AI Accelerators and Emerging Architectures: Domain-Specific Architectures (DSAs): motivation and principles. AI workload characteristics: matrix operations, memory bandwidth demands. Tensor Processing Unit (TPU) overview. Mixed-precision computing: FP16, INT8. Google TPU architecture overview. Edge AI accelerators: concepts and constraints. Model quantization and pruning: hardware implications. Processing-in-memory (PIM) concepts. Emerging trends: chiplets, 3D stacking. Neuromorphic computing overview. Case studies: Contemporary AI systems (NVIDIA H100, AMD MI300). Performance metrics for AI systems: throughput, latency, efficiency**.**

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Evaluate computer architectures using performance metrics and explain ISA design principles.	L5
2	Analyze advanced processor techniques including pipelining, superscalar execution, and parallelism exploitation.	L4
3	Design memory hierarchies with cache optimization and understanding of coherence requirements.	L5
4	Compare parallel computing architectures including multicore and GPU systems for different workload types.	L4
5	Assess AI accelerator architectures and emerging computing paradigms for machine learning deployment.	L5

Mapping Levels of COs to POs / PSOs														
COs				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	1	2	2		1			1		3	3	2
CO2	3	3	2	2	2					1		3	3	2
CO3	3	3	3	2	2					1		3	3	3
CO4	3	3	2	3	3		1		2	1		3	3	3
CO5	3	3	3	3	3	2	2	1	2	2	1	3	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Hennessy, John L., and David A. Patterson. Computer Architecture: A Quantitative Approach. 6th Edition. Morgan Kaufmann, 2017.
2. Patterson, David A., and John L. Hennessy. Computer Organization and Design: The Hardware/Software Interface. RISC-V Edition. Morgan Kaufmann, 2017.
3. Kirk, David B., and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-on Approach. 4th Edition. Morgan Kaufmann, 2022.

REFERENCE BOOKS:

1. Solihin, Yan. Fundamentals of Parallel Multicore Architecture. Chapman and Hall/CRC, 2015.
2. Sze, Vivienne, Yu-Hsin Chen, Tien-Ju Yang, and Joel S. Emer. Efficient Processing of Deep Neural Networks. Synthesis Lectures on Computer Architecture, Morgan & Claypool, 2020.
3. Stallings, William. Computer Organization and Architecture: Designing for Performance. 10th Edition. Pearson, 2015.
4. Patterson, David, and Andrew Waterman. The RISC-V Reader: An Open Architecture Atlas. Strawberry Canyon, 2017.

E-Resources:

1. https://www.gem5.org/ (gem5 Architectural Simulator)
2. https://nptel.ac.in/courses/106105163 (NPTEL: Advanced Computer Architecture)
3. https://mlperf.org/ (MLPerf AI Benchmarks)
4. https://docs.nvidia.com/cuda/ (CUDA Programming Guide)
5. https://www.spec.org/ (SPEC Benchmarks)
6. https://riscv.org/ (RISC-V ISA Documentation)

Activity Based Learning (Suggested Activities in Class)

1. Performance analysis: Benchmark comparison using SPEC or simple programs.
2. Cache simulation: Design and evaluate cache configurations.
3. Pipeline analysis: Trace instruction execution through a pipeline.
4. GPU programming exercise: Simple CUDA kernel implementation.
5. Architecture comparison: Compare different processors for AI workloads.
6. Case study presentation: Analysis of contemporary processor architectures.

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FINANCIAL TECHNOLOGY (FINTECH)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24AM3613	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. Recall the fundamentals of machine learning in finance for risk assessment and investment optimization.
2. Identify the key concepts and future trends in payment technologies, emphasizing security and efficiency.
3. Apply knowledge of blockchain and cryptocurrency to explain their roles and applications in financial systems.
4. Relate the methods of raising capital through credit tech, coin offerings, and crowdfunding.
5. Utilize innovations in investment technology driven by artificial intelligence to enhance portfolio management and risk analysis.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	07 Hours
Fundamentals of AI&ML in Finance Introduction to Fundamentals of Machine Learning in Finance - Support Vector Machines – Tree based Classifiers – PCA & concepts of Dimension Reduction – Clustering Algorithms - Sequence Modeling - Neural Architecture for Sequential Data	
UNIT – II	**08 Hours**
Payment Technologies Fintech Innovations - Digital Wallets – Payment like consumer-to-business (C2B), consumer-to-consumer (C2C), and business-to-business (B2B) - Social-Network-Based Payment Innovations - Credit Card network and Transactions - PayTech in India - M-Pesa: Business Model	
UNIT – III	**08 Hours**
Blockchain and Cryptocurrency in Finance Introduction to Blockchain and Cryptocurrency - Network and Data Processing – Blockchain Consensus - Crypto Mining - Buying and Selling Cryptocurrencies - Crypto Risk Factors	
UNIT – IV	**08 Hours**
Capital Understanding and Raising Credit Analysis and Scoring - Data Analysis – Concept of Crowdfunding - Equity Based Models - ICO: Pricing, compliance, and returns - Smart Banking – Concept and Implementation	
UNIT – V	**08 Hours**
Innovations in Investment Technology Building an Efficient Portfolio - Diversified Investments - Exchange Traded Funds - Stock Selection: Fundamental Analysis - AI/ML in investment management	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Comprehend machine learning fundamentals in finance for effective risk assessment and investment optimization	L1, L2
2	Analyze the future landscape of payment technologies to enhance security and efficiency in financial transactions	L3
3	Evaluate blockchain and cryptocurrency mechanisms to comprehend their applications within financial systems.	L4
4	Examine various methods of raising capital, including credit tech, coin offerings, and crowdfunding.	L4
5	Develop innovative investment technologies powered by artificial intelligence for quantitative analysis.	L5

Mapping Levels of COs to POs / PSOs

COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2					2			2		2	2
CO2	3	2	2	1	2			2			1			
CO3	3	2		1				2						2
CO4	3	2	2		2			2			1			
CO5	3	1			2			2					2	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Liermann, Volker, and Claus Stegmann, eds. The impact of digital transformation and FinTech on the finance professional. Palgrave Macmillan, 2019.
2. Boukherouaa, E., et al. "Powering the Digital Economy: Opportunities and Risks of Artificial Intelligence in Finance. Departmental Papers." (2021).
3. Chishti, Susanne. The AI book: the artificial intelligence handbook for investors, entrepreneurs and fintech visionaries. John Wiley & Sons, 2020.

REFERENCE BOOKS:

1. Bazarbash, Majid. Fintech in financial inclusion: machine learning applications in assessing credit risk. International Monetary Fund, 2019.
2. Ng, Jeffrey, and Subhash Shah. Hands-On Artificial Intelligence for Banking: A practical guide to building intelligent financial applications using machine learning techniques. Packt Publishing Ltd, 2020.
3. Dixon, Matthew F., Igor Halperin, and Paul Bilokon. Machine learning in finance. Vol. 1170. Berlin/Heidelberg, Germany: Springer International Publishing, 2020.
4. Choi, Paul Moon Sub, and Seth H. Huang, eds. Fintech with artificial intelligence, big data, and Blockchain. Springer, 2021.

E-Resources:

1. https://www.coursera.org/learn/fundamentals-machine-learning-in-finance?specialization=machine-learning-reinforcement-finance
2. https://www.coursera.org/specializations/financialtechnology#courses

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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INDUSTRIAL ROBOTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24OE0016	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. Understand the configuration space with specific reference to roboticmotion
2. Understand different types of kinematics used in industrial robotics.
3. To understand motion planning in industrial robotics.
4. Understand Computational Motion Planning and Mobility
5. Understand the concept of grasping and manipulation.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I :	**08 Hours**

Introduction Configuration Space: Foundations of Robot Motion-Degrees of Freedom of a Rigid Body-Degrees of Freedom of a Robot-Configuration Space Representation Configuration and Velocity Constraints-Task Space and Workspace.

Rigid-Body Motions: Introduction to Rigid-Body Motions-Rotation Matrices-Angular Velocities-Homogeneous Transformation Matrices.

UNIT – II:	**08 Hours**

Forward Kinematics: Forward Kinematics Example- Velocity Kinematics and Statics: Introduction to Velocity Kinematics and Statics-Space Jacobian-Body Jacobian, Inverse Kinematics: Inverse Kinematics of Open Chains.

UNIT – III:	**08 Hours**

Kinematics of Closed Chains: Dynamics of Open Chains- Lagrangian Formulation of Dynamics-Understanding the Mass Matrix, Newton-Euler Inverse Dynamics, Trajectory Generation: Point-to-Point Trajectories-Polynomial Via Point Trajectories-
Time-Optimal Time Scaling.

UNIT – IV:	07 Hours
Motion Planning: Overview of Motion Planning, Robot Control, Control System Overview-Error Response-Linear Error Dynamics-First-Order Error Dynamics- Second-Order Error Dynamics-Motion Control with Velocity Inputs - Motion Control with Torque or Force Inputs.	
UNIT – V:	**08 Hours**
Grasping and Manipulation: First-Order Analysis of a Single Contact Contact Types: Rolling, Sliding, and Breaking-Multiple Contacts, Force Closure-Duality of Force and Motion Freedoms, Omnidirectional Wheeled Mobile Robots- Controllability of Wheeled Mobile Robots	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Recall foundational concepts of robot motion and configuration space.	L1, L2
2	Interpret rigid-body motions and transformation matrices.	L2
3	Apply forward kinematics to solve problems related to robot motion.	L3
4	Analyze the dynamics of open chains using Lagrangian and Newton-Euler formulations.	L4
5	Evaluate motion planning and control systems for robots, including error dynamics and motion control inputs.	L5

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Cos	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome

CO1	3	3	2	-	1	-	-	-	2	2	-	2	2	2
CO2	3	3	2	-	1	-	-	-	2	2	-	2	2	2
CO3	3	2	1	-	1	-	-	-	2	2	-	2	1	1
CO4	3	1	-	-	1	-	-	-	2	2	-	2	2	2
CO5	2	1	3	-	1	-	-	-	2	2	-	2	1	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Yan, Lili, and Gene M. Grossman. Robots and AI: A new economic era. Taylor & Francis, 2023.
2. Niku, Saeed B. Introduction to robotics: analysis, control, applications. John Wiley & Sons, 2020.

REFERENCE BOOKS:

1. Groover M. P, "Industrial Robotics", TataMcGraw-Hill, 1 st Edition, 2013
2. Richard D. Klafter, "Robotic Engineering", Prentice Hall, 1st Edition, 2013.
3. Fu K S, "Robotics", McGraw-Hill, 1st Edition, 2013.
4. Spong, M. W., Hutchinson, S., & Vidyasagar, M. (2020). Robot Modeling andControl, 2nd Edition. Wiley, ISBN: 978-1-119-52404-5.
5. Peter cork, Robotics, 2017, Vision and Control (2nd ed.), springer tracts inadvanced Robotics.
6. Simon J.D. Prince,Computer Vision: Models, Learning, and Inference, Cambridge University press
7. Ghosal, A. (2015). Robotics: Fundamental concepts and analysis. Oxford: Oxford University Press. ISBN: 978-0-195-67391-3.

E-Resources:

1. https://www.doc.ic.ac.uk/~ajd/Robotics/RoboticsResources/lecture1.pdf
2. http://opencourses.emu.edu.tr/course/view.php?id=32
3. https://www.researchgate.net/publication/277712686_Introduction_to_Robotics_class_notes_UG_level

Activity Based Learning (Suggested Activities in Class)

1. Group discussion.
2. Projects on Computer graphics & User interface design.
3. Quiz
4. Assignment

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MACHINE LEARNING FOR HEALTHCARE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	:	24OE0017	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. **Summarize** the different types of medical data and its Medical Standards, Challenges.
2. **Apply** the different techniques to handle the missing and imbalanced problems and perform data analytics on the clinical and image data.
3. **Apply** Modelling techniques, Reinforcement Learning and Natural Language Processing for healthcare data.
4. **Utilize** the suitable Machine Learning and Deep Learning algorithms for various types of healthcare applications**.**
5. **Develop** a project using the appropriate case study in the healthcare.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Knowing Healthcare Industry: Introduction to healthcare informatics, Introduction to Machine Learning and Deep Learning in Healthcare, Medical Standards and Coding Types, Health Level Seven (HL7;) Global Healthcare Challenges and Trends; Past-Present-Future of AI&ML in Healthcare, Electronic Medical Records (EMR), Electronic Health Records (EHR) - Dataflow of EHR, Difference between EHR and EMR.

UNIT – II	**08 Hours**

Advanced Analytics in Health Care: Overview of Clinical Data, Data Types; Data handling

techniques – Imputation technique for handling missing data; Synthetic Minority Oversampling Technique for handling imbalanced data, Different types of Data Analytics techniques, Risk Stratification; Survival Modelling; Disease progression Modelling.
UNIT – III **08 Hours**
Medical Image Diagnostics and its Preprocessing: Biomedical Imaging Modalities - Computed Tomography, Magnetic Resonance Imaging, Positron Emission Tomography; Biomedical Signal: Electrocardiogram (ECG), Electroencephalogram (EEG), Segmentation – Thresholding and Region based Segmentation, Image Registration; ML applications in medical Ology space (cardiology, oncology).
UNIT – IV **08 Hours**
AI/ML and NLP for healthcare: Automating clinical workflow, Regulation of AI/ML, Challenges in deploying ML model, NLP for Healthcare, Re-inforcement learning in healthcare applications, Wearable devices and Medical Bots.
UNIT – V **07 Hours**
Applications of Machine learning models (Linear regression, SVM, Random Forest) and Deep learning models (CNN, RNN….) for the Healthcare area (Case study)

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Explain the different types of Medical data and its Medical Standards, Challenges.	L2
2	Utilize the preprocessing and post-processing techniques to handle the image and clinical data.	L3
3	Apply the Image Processing and Machine Learning Techniques for Computer Aided Diagnosis using Biomedical Image Modalities and Biomedical Signals.	L3
4	Make use of the Modelling techniques, Reinforcement Learning and Natural Language Processing to process the healthcare data.	L3
5	Apply Machine Learning and Deep Learning Techniques to solve real world problems in healthcare domain.	L3

Mapping Levels of COs to POs / PSOs														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	1							2	2			1	1
CO2	3	2			1				2	2			2	2
CO3	3	2			1				2	2			2	2
CO4	2	1			1				2	2			2	2
CO5	3	3			1				2	2			2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Arjun Panesar, Machine Learning and AI for Healthcare, ISBN-13: 978-1484237984, Apress, 2019.
2. SumeetDua, U. RajendraAcharya, PrernaDua , Machine Learning in Healthcare Informatics, Springer Nature 2014.
3. Sergio Consoli, Diego ReforgiatoRecupero, Milan Petkovic, Data Science for Healthcare Methodologies and Applications, 2019.
4. Machine Learning for Healthcare Analytics Projects: Build smart AI applications using neural network methodologies across the healthcare vertical market, ISBN-13 : 9781789536591, Packt Publisher, 2018.

REFERENCE BOOKS:

1. Thomas M. Deserno, Fundamentals of Bio-Medical Image processing, Biological and Medical Physics, Biomedical Engineering, Springer, ISBN 978-3-642-15816-2, 2011.

E-Resources:

1. https://stellar.mit.edu/S/course/HST/sp19/HST.956/
2. https://www.coursera.org/learn/fundamental-machine-learning-healthcare.
3. https://www.coursera.org/learn/introduction-clinical-data

Activity Based Learning (Suggested Activities in Class)

1. Group discussion on different Health Care Problems.
2. Collaborative Activity is minor project development with a team of 4 students.

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VII SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	PROJ	24AM4701	Capstone Project Phase-I	0	0	0	8	100	--	100	04
2	PEC	24AM47XX	Professional Elective Course – IV	3	0	0	0	60	40	100	03
3	PEC	24AM47XX	Professional Elective Course – V/ MOOC	3	0	0	0	60	40	100	03
4	OEC	24OEXXXX	Open Elective – II	3	0	0	0	60	40	100	03
			Total	9	0	0	8				**13**

IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, OEC-Open Elective Courses, PROJ-Project Work, L – Lecture, T – Tutorial, P – Practical, J–Project, C – No. Of Credits

Professional Elective Courses –IV (PEC-IV) Offering												
SL	Course Type	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
				Lecture	Tutorial	Practica	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	J					
1	PEC	AI Ethics		3	0	0	0	03	60	40	100	**03**
2	PEC	Industry 5.0		3	0	0	0	03	60	40	100	**03**
3	PEC	GPU Architecture		3	0	0	0	03	60	40	100	**03**
4	PEC	Big Data Analytics		3	0	0	0	03	60	40	100	**03**

Professional Elective Courses - V (PEC-V) Offering												
SL	Course Type	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
				Lecture	Tutorial	Practica	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	J					
1	PEC	Human Computer Interface		3	0	0	0	03	60	40	100	**03**
2	PEC	Robotics and Automation Application		3	0	0	0	03	60	40	100	**03**
3	PEC	Blockchain Technology		3	0	0	0	03	60	40	100	**03**
4	PEC	UG Research Project		0	0	0	6	03	100	--	100	**03**

Open Elective Course (OEC-II) Offering												
SL	**Course Type**	**Course Name**	**Teaching Department**	**Teaching Hours / Week**				**Examination**				**Credits**
				Lecture	**Tutorial**	**Practica**	**Project**	**Duration in Hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
				L	**T**	**P**	**J**					
1	OEC	Responsible AI & Ethics		3	0	0	0	03	60	40	100	**03**

CAPSTONE PROJECT PHASE - I

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24AM4701	**Credits**	:	04
Hours / Week	:	04	**Total Hours**	:	42 Hours
L–T–P–J	:	0–0–0–8			

Course Learning Objectives:

This course will enable students to:

1. **To identify** key research questions within a field to carry out research in a team.
2. **To identify** and summarize the literature review of the relevant field.
3. **To demonstrate** relevant referencing and inculcate new skills in various aspects of academic writing.
4. **To demonstrate** the knowledge and understanding of writing the publication/report.
5. **To showcase** the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information.
6. **To detail description** of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature.
7. **To analyze** and synthesize the new research findings.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

7. Lecture method means it includes not only the traditional lecture method but a different type of teaching method that may be adopted to develop the course outcomes.
8. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
9. Show Video/animation films to explain the functioning of various concepts.
10. Encourage Collaborative (Group Learning) Learning in the class.
11. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
12. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the student's understanding.

COURSE CONTENT:

1. The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further.
2. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.
3. The problem statement should be big enough to be carried out in two phases over the two semesters i.e., VII and VIII semesters in the VI year.
4. All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.
5. The following criteria will be checked by the department chairman to approve for theresearch proposal:

a. Department staff as course guide
   1. Ability to provide research direction to the student in the chosen field of interest
   2. Ability to design an appropriate research strategy and methodology to carry out the research by student
   3. Ability to provide and evaluate the strong literature review document for the chosen research topic
   4. Ability to train students on research paper / technical writing skills
   5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team
   1. To be dedicated and committed to work on a new research topic by learning new technical skills
   2. To have fair knowledge on what is product development or research topic
   3. To have constant interaction with allocated guide by providing weekly updates
   4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

1. Phase-1 comprises of Literature Survey, Problem identification, Objectives and Methodology.
2. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department based on the rubrics
3. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert

COURSE CONTENT:

1. The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further.
2. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.
3. The problem statement should be big enough to be carried out in two phases over the two semesters i.e., VII and VIII semesters in the VI year.
4. All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.
5. The following criteria will be checked by the department chairman to approve for theresearch proposal:

b. Department staff as course guide

1. Ability to provide research direction to the student in the chosen field of interest
2. Ability to design an appropriate research strategy and methodology to carry out the research by student
3. Ability to provide and evaluate the strong literature review document for the chosen research topic
4. Ability to train students on research paper / technical writing skills
5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team

1. To be dedicated and committed to work on a new research topic by learning new technical skills
2. To have fair knowledge on what is product development or research topic
3. To have constant interaction with allocated guide by providing weekly updates
4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

1. Phase-1 comprises of Literature Survey, Problem identification, Objectives and Methodology.
2. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department based on the rubrics
3. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Identify and Select an Appropriate Research Problem	L1
2	Explain and Summarize Relevant Literature	L2

3	Compare and Critically Analyze Relevant Research Papers	L3
4	Construct a Research Model and Perform Evaluation	L4
5	Create and Draft Publications or Demonstrations	L5

Mapping Levels of COs to POs / PSOs														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	2	1	1	1	1	1	2	2	3	2	2	1
CO2	2	2	3	2	2	1	1	1	2	2	3	2	1	2
CO3	3	3	3	2	3	2	2	1	2	2	2	2	2	2
CO4	2	3	2	3	2	1	2	2	2	2	2	3	2	2
CO5	1	1	2	1	2	1	1	1	3	3	2	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

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AI ETHICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	: 24AM4702	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. **Understand** the impact of analytics and AI/ML on individuals and society.
2. **Identify** the problems associated with Big Data using the appropriate technique.
3. **Apply** AI/ML techniques on identifying fairness and bias issues.
4. **Use** Tools and methods to quantify bias.
5. **Develop** the project using the case study.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Data, Individuals, and Society: The power and impact that analytics and AI/ML have on individuals and society, especially concerning issues such as fairness and bias, ethics, legality, data collection and public use.

UNIT – II	**08 Hours**

Big Data: Components of big data, basic statistical techniques to data scenarios, and understand the issues faced when learning from big data, ranging from data biases, overfitting, causation vs correlation, etc.

UNIT – III	**09 Hours**

Privacy and Fairness in AI/ML: Use of AI/ML techniques to data scenarios, with a focus on identifying fairness and bias issues found in the design of decision-making systems. Technical approaches to current AI/ML applications such as facial recognition, natural language processing, and predictive algorithms, all while being mindful of its social and legal context.

UNIT – IV	07 Hours
Various methods to quantify bias and examine ways to use algorithmic fairness to mitigate this bias, taking into consideration ethical and legal issues associated with it. Knowledge of analytics and AI/ML to transform a current biased data-set into a more objective solution.	
UNIT – V	**07 Hours**
Case Studies : 1. Robustness and beneficial AI 2. Benefits and dangers of super-intelligence 3. Rationality in Advanced Artificial Agents 4. Artificial Morality	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	**Analyze** the societal and individual impacts of AI/ML technologies, focusing on ethical, legal, and fairness concerns, and the significance of unbiased data collection and public data use.	L4
2	**Apply** basic statistical methods to big data, identifying and addressing issues like data biases, overfitting, and distinguishing between causation and correlation.	L3
3	**Compare** AI/ML systems for fairness and bias in decision-making processes, in applications like facial recognition and natural language processing.	L2
4	**Utilize** tools and methods to quantify and mitigate bias in datasets, understanding ethical and legal issues, and transforming biased datasets into more objective solutions.	L3
5	**Analyze** case studies on AI robustness, risks of super-intelligence, rationality in artificial agents, and artificial morality, articulating their implications for future technologies and society.	L4

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	1	-	-	-	-	-	-	-	2	2	1	-	2	2
CO2	3	2	-	-	1	-	-	-	2	2	1	-	2	2
CO3	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO4	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO5	3	2	-	-	1	-	-	-	2	2	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. O'neil, Cathy. Weapons of math destruction: How big data increases inequality and threatens democracy. Broadway Books, 2016.
2. Kearns, Michael, and Aaron Roth. The ethical algorithm: The science of socially aware algorithm design. Oxford University Press, 2019.

REFERENCE BOOKS:

1. S. J. Russell, D. Dewey, and M. Tegmark, 'Research priorities for robust and beneficial artificial intelligence', AI Magazine, 2015.
2. Bostrom, N. (2014), Superintelligence: Paths, Dangers, Strategies, Oxford University Press, Chapters 2-6.
3. Bostrom, N. (2012). The Superintelligent Will: Motivation and Instrumental Rationality in Advanced Artificial Agents. Minds & Machines 22: 71-85.
4. Allen, C., Smit, I.,Wallach,W. (2005) 'Artificial morality: Top-down, bottom-up, and hybrid approaches', Ethics and Information Technology ; 7, 149-155
5. Lake, B. M., Ullman, T. D., Tenenbaum, J. B., Gershman, S. J. (2017) 'Building machines that learn and think like people', Behavioral and Brain Sciences, e253.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ee56/
2. https://nptel.ac.in/courses/106106046

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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INDUSTRY 5.0

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	: 24AM4703	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students:

1. **To acquaint with the digital transformation of Industry 5.0**
2. **To recognize the power of industry to achieve societal goals beyond jobs and growth**
3. **To understand the design of personalized electronics products**
4. **To focus on methods of interaction between humans and machines in virtual reality**
5. **To develop the concept of augmented reality in electronics manufacturing beyond automation and optimization**

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**07 Hours**

INTRODUCTION TO INDUSTRY 5.0

Evolution from Industry 1.0 to 5.0, Introduction to Industry 5.0, Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Healthcare and Human computer interactions, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis.

UNIT – II	**08 Hours**

DIGITAL TRANSFORMATION TO INDUSTRY 5.0

Digital Transformation, Introduction to Digital Transformation, Digital business transformation, Causes of disruption and transformation, Digital transformation myths and realities, Digital transformation across various industries, Retail industry, Urban Development, e-Governance and the public sector, Insurance industry, Healthcare, Food, Manufacturing, Disaster Control, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.

UNIT – III	**08 Hours**
SMART WORLD Introduction: Sensing & actuation, Communication, Electronics in Smart city, 5G Technology, Communication protocols, Integration of Sensors in Robots and Artificial Intelligence, Human-Machine Interaction, Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries.	
UNIT – IV	**08 Hours**
CYBER SECURITY IN INDUSTRY 5.0 Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Intellectual Property Rights (IPR).	
UNIT – V	**08 Hours**
AR/VR IN INDUSTRY 5.0 Unity, Basics of Unity, Understanding different panels in Unity, Moving, rotating & scaling Gameobjects in Unity, Game Panel in Unity, Physics in Unity, Increasing the light intensity, Adding colors to Gameobject, Adding textures to Gameobject, Parent and child Gameobjects in Unity. Case Studies- Development of AR/VR Models in Unity.	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth	L2
2	Analyze enhanced new production models in electronics	L3
3	Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization	L4
4	Design suitable sensors for smart world real time applications with virtual reality experience	L4
5	Evaluate the performance of various cyber physical systems	L5

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	1								2	2			2	2
CO2	3	2			1				2	2			2	2
CO3	3	2			1				2	2			2	2
CO4	3	2			1				2	2			2	2
CO5	3	3	2		1				2	2			2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial internet of things and industry 4.0. CRC Press, 2021.
2. Elangovan, Uthayan. Industry 5.0: The future of the industrial economy. CRC Press, 2021.
3. Saini, Aarti, and Vikas Garg, eds. Transformation for Sustainable Business and Management Practices: Exploring the Spectrum of Industry 5.0. Emerald Publishing Limited, 2023.

REFERENCE BOOKS:

1. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA, 2017.
2. Oliver Grunow, ”SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies”, Studylab Publications, 2016..
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
4. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
5. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016

E-Resources:

1. https://www.udemy.com/course/digital-transformation-from-industry-40-to-industry-50/

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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GPU ARCHITECTURE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	: 24AM4704	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	39 Hours
L–T–P–S	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

1. To understand the basics of GPU architectures
2. To write programs for massively parallel processors
3. To understand the issues in mapping algorithms for GPUs
4. To introduce different GPU programming models

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Evolution of GPU architectures – Understanding Parallelism with GPU –Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

(Text Book-1: Chapter 1: 1.1 to 1.4, 1.6, Chapter 2: 2.1,2.2, 2.4)

UNIT – II	**08 Hours**

CUDA PROGRAMMING Using CUDA – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

(Text Book-1: Chapter 3: 3.1 to 3.3).

UNIT – III	**08 Hours**

PROGRAMMING ISSUES Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors. ***(Text Book-1: Chapter 5: 5.2,5.3***)***(Text Book-2 Chapter 1: 1.1 to 1.5***)

UNIT – IV	**08 Hours**
OPENCL BASICS OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples. ***(Text Book-1: Chapter 14: 14.1 to 14.5)..***	
UNIT – V	**07 Hours**
ALGORITHMS ON GPU Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster. ***(Text Book-1: Chapter 20: 20.1 to 20.5, Chapter 21: 21.1 to 21.3, Chapter 22: 22.1 to 22.4***)	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Outline the historical evolution of GPU architectures, the fundamental concepts of parallelism, and typical GPU components, including threads, blocks, grids, warps, and scheduling.	L2
2	Apply CUDA programming principles to develop solutions that utilize single and multi-GPU setups, focusing on problem decomposition, memory considerations, and efficient thread usage.	L3
3	Analyze common problems in CUDA programming, including error handling, parallel programming issues, and synchronization challenges.	L4
4	Utilize OpenCL to create basic examples and demonstrate how it can be used for heterogeneous computing tasks, enhancing their ability to work across different hardware platforms	L3
5	Evaluate the effectiveness of these algorithms in programming heterogeneous clusters, ensuring efficient and scalable solutions for complex computational problems	L5

Mapping Levels of COs to POs / PSOs														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2		1							2	2	
CO2	3	3	2		1							2	2	1
CO3	3	2	1		1				2	2		2		2
CO4	3	2	1		1				2	2		2	2	1
CO5	3	2	1		1				2	2		2	3	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Robey, Robert, and Yuliana Zamora. *Parallel and high performance computing*. Simon and Schuster, 2021.
2. Deakin, Tom, and Timothy G. Mattson. *Programming Your GPU with OpenMP: Performance Portability for GPUs*. MIT Press, 2023.
3. Shane Cook, CUDA Programming: —A Developer's Guide to Parallel Computing with GPUs(Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012

REFERENCE BOOKS:

1. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, —Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
2. Learn CUDA Programming - Jaegeun Han, Bharatkumar Sharma Packt Publishing, 27-Sept-2019 - 508 pages.
3. Parallel Computing for Data Science (Chapman & Hall/CRC The R Series) 1st Edition

E-Resources:

1. https://developer.nvidia.com/cuda-toolkit
2. https://developer.nvidia.com/opencl
3. https://leonardoaraujosantos.gitbook.io/opencl/chapter1
4. https://github.com/topics/opencl
5. https://github.com/mikeroyal/OpenCL-Guide

Activity Based Learning (Suggested Activities in Class)

1. Group discussion on how to optimize the machine learning algorithms or a whole neural network using CUDA.
2. Collaborative Activity is minor project development with a team of 4 students.

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BIG DATA ANALYTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code : 24AM4705	**Credits** : 03
Hours / Weel : 03 Hours	**Hours** 39 Hours
L–T–P–S : 3–0–0–0	

Course Learning Objectives:

This course will enable students to:

1. **Explain** the fundamental concepts of big data and analytics.
2. **Make Use of** the Hadoop Distributed File System components and Hadoop Daemons for storing large data sets of structured or unstructured data across various nodes.
3. **Develop** a MapReduce paradigm for the analysis of Big Data of different applications.
4. **Execute** the commands using Pig Hadoop ecosystem tools.
5. **To analyze and interpret** the data by executing the queries using Hive Hadoop Ecosystem tools.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I :	**07 Hours**

INTRODUCTION TO BIGDATA: Understanding Big Data, Types of Data: Structured, Unstructured and Semi-structured, Different sources of Data Generation, Different V's: Volume, Variety, Velocity, Veracity, Value.

Phases of Big Data Analytics, Types of Data Analytics, Apache Hadoop, Need for the Hadoop, Apache Hadoop Architecture, How Does Hadoop Work? Advantages of Hadoop, Apache Hadoop Ecosystem.

Textbook 1 Chapter 1

UNIT – II:	**09 Hours**

Hadoop Distributed File System: Hadoop Distributed File System, Features of HDFS, HDFS Architecture, Commands and description of HDFS, Hadoop File system, Replication factor, Name Node, Job Tracker, Task tracker, Data Node, FS Image, Edit-logs, Check-pointing Concept, HDFS federation, Architectural description for Hadoop Cluster, Hadoop – File Blocks and Replication

Factor.
Textbook 1 Chapter 3

UNIT – III:	08 Hours

Processing Unit:

MapReduce, Internal architecture, Record Reader, Mapper Phase, Reducer Phase, Sort and Shuffle Phase, Data Flow, Counters, Combiner Function, Partition Function, Joins, Map Side Join, Reduce Side Join, writing a simple MapReduce program to Count Number of words, YARN, YARN Architecture, YARN Components, Resource Manager.
Textbook 1 Chapter 6

UNIT – IV:	08 Hours

Apache Pig

Apache Pig, Pig on Hadoop, Pig Latin, Local Mode and MapReduce Mode, Pig's Data Model, Scalar, Complex, Load, Dump, Store, Foreach, Filter, Join, group, Order by, Distinct, Limit, Sample, Parallel, User Defined Function, Program for Word Count Job, Comparison Apache Pig and MapReduce.
Textbook 1 Chapter 11

UNIT – V:	08 Hours

Apache Hive

Apache Hive, Features of Apache Hive, History of Apache Hive, Hive Data Types & Files Formats, Creating Managed Table, External Table, Partitioned Tables, loading data into Managed Table, Inserting Data into Tables from Queries, Dynamic Partitions inserts, Exporting data, SELECT from clauses, WHERE Clauses, GROUP BY Clauses, JOIN Statements, DISTRIBUTE BY, CLUSTER BY, bucketing, View, Hive Metastore.
Textbook 1 Chapter 12

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Summarize the concept of big data and its phases, architecture, features and compare it with traditional RDBMS.	L2
2	Make Use of the Hadoop Distributed File System components and Hadoop Daemons for storing large data sets of structured or unstructured data across various nodes.	L3
3	Illustrate and develop a MapReduce paradigm for the analysis of Big Data of various applications.	L4

4	Make use of the Pig Hadoop Ecosystem tool for performing data processing operations.	L4
5	Apply Hive Hadoop Ecosystem tool for performing data processing operations and to store the data in Hive Meta store .	L5

Mapping Levels of COs to POs / PSOs

Cos				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	2	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	2	-	2	-	-	-	-	-	-	-	1	1
CO5	3	2	2	-	2	-	-	-	-	-	-	-	1	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Books:

1. Hands-on introduction to Big Data Analytics: Funmi obembe, Ofer Engel , 1st Edition, SAGE Publication, 2024, Isbn: 9781529600087.
2. Hadoop: The Definitive Guide, By: Tom White, O'REILLY, 4th Edition,2015.
3. Programming Pig, By: Alan Gates, Published by O'Reilly Media, Inc., 2016.
4. Programming Hive, By: Edward Capriolo, Dean Wampler & Jason Rutherglen, Published by O'REILLY, 2012.

Reference Books:

1. Dirk deRoos, Paul C. Zikopoulos, Bruce Brown, Rafael Coss, and Roman B. Melnyk , "Hadoop for Dummies", A Wiley brand, 2014.
2. Programming Hive, By: Edward Capriolo, Dean Wampler & Jason Rutherglen, Published by O'REILLY, 2012.

E-Resources:

1. https://www.ibm.com/ae-en/analytics/hadoop/big-data-analytics
2. https://www.tableau.com/learn/articles/big-data-analytics

Activity Based Learning (Suggested Activities in Class)

1. Quiz.
2. Collaborative Activity is minor project development with a team of 4 students.

HUMAN COMPUTER INTERACTION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24AM4706	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. **Describe** effective and usable graphical computer interfaces.
2. **Describe and apply** core theories, models, and methodologies from the field of HCI.
3. **Choose** an appropriate approach for interface designing.
4. **Make use of** the components to build new and navigation schemes in windows.
5. **Build** the model in the field of HCI.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Introduction: Introduction: Importance of user Interface – definition, the importance of 8 good designs. Benefits of good design. A brief history of Screen design. The graphical user interface – the popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface
popularity, characteristics- Principles of user interface.

UNIT – II	**08 Hours**

Design Process: Human interaction with computers, the importance of 8 human characteristics human consideration, Human interaction speeds, and understanding of business junctions. III Screen Designing:
Design goals – Score.

UNIT – III	**09 Hours**

Screen Designing: Design goals – Screen planning and purpose, 8 organizing screen elements, ordering of screen data and content – screen navigation and flow – visually pleasing composition – the amount of information – focus and emphasis – presentation of information simply and meaningfully – information
retrieval on the web – statistical graphics – Technological consideration in interface design.

UNIT – IV	**07 Hours**
Windows: New and Navigation schemes selection of window, 8 selection of devices based and screen- based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.	
UNIT – V	**07 Hours**
Software Tools Specification methods, interface – Building Tools. 8 Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers.	
Course Outcomes: At the end of the course the student will be able to: 1. **Summarize** effective and usable graphical computer interfaces**.** 2. **Design** effective HCI for individuals and persons with disabilities**.** 3. **Choose** an appropriate approach for interface designing and **assess the importance of user feedback.** 4. **Make use of** the components to build new and navigation schemes in windows. 5. **Demonstrate** the HCI implications for designing multimedia/eCommerce/e-learning websites.	

Table: Mapping Levels of COs to POs / PSOs

COs	**Program Outcomes (POs)**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Life-long learning	Project management and finance	Apply the principal concepts of AI Engineering	Apply the knowledge gained pertaining to data storage, data analytics and AI concepts	develop, and test principles of AI concepts on Intelligent Systems
CO 1	1	-		-	-	-	-	-	-	2	2	-	-	1	1
CO	3	2	2	-	1	-	-	-	2	2	-	-	2	2	2

2															
CO 3	3	2	-	-	1	-	-	-	2	2	-	-	2	2	2
CO 4	3	2	-		-	1	-	-	-	2	2	-	-	2	2
CO 5	3	3	2	-	1	-	-	-	2	2	-	-	2	2	2

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

TEXT BOOKS:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale Human Computer Interaction, 3rd Edition rentice Hall, 2004.
2. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, Research Methods in Human Computer I nteraction, Wiley, 2010.
3. Samit Bhattacharya. (2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw Hill Education (1st ed).
4. Bruce R Maxim & Roger S Pressman (2019). Software Engineering: A Practitioner's Approach. (8th ed). McGraw Hill Education.

REFERENCE BOOKS:

1. Ben Shneiderman and Catherine Plaisant Designing the User Interface: Strategies for Effective Human-Computer

E-Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106177/
2. https://onlinecourses.nptel.ac.in/noc22_cs125/

Activity Based Learning (Suggested Activities in Class)

1. Quiz.
2. Collaborative Activity is minor project development with a team of 4 students.

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ROBOTICS AND AUTOMATION APPLICATION
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24AM4707	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:
This course will enable students:

1. **Understand** the fundamental principles and components of robotics and automation systems.
2. **Analyze** the role of robotics and automation in various industries and their impact on productivity and efficiency.
3. **Design** robotic systems and automation solutions to solve real-world problems and optimize processes.
4. **Evaluate** ethical, social, and economic implications associated with the widespread adoption of robotics and automation.
5. **Apply** programming languages and software tools to develop, simulate, and control robotic and automation systems.

Teaching-Learning Process (General Instructions)
These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**07 Hours**

INTRODUCTION TO AUTOMATION: Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation. Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

UNIT – II	**08 Hours**

AUTOMATED FLOW LINES: Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. ASSEMBLY LINE BALANCING: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.
UNIT – III **08 Hours**
INTRODUCTION TO INDUSTRIAL ROBOTICS: Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers. ROBOT ACTUATORS AND FEEDBACK COMPONENTS: Actuators, Pneumatic, Hydraulic actuators, Electric &Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.
UNIT – IV **08 Hours**
MANIPULATOR KINEMATICS: Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics. MANIPULATOR DYNAMICS: Differential transformations, Jacobians, Lagrange - Euler and Newton - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion,joint integrated motion - straight line motion.
UNIT – V **08 Hours**
ROBOT PROGRAMMING: Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages. ROBOT APPLICATION IN MANUFACTURING: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Recall the key components and technologies in robotics and automation.	L2
2	Illustrate the principles of robotics and automation, detailing key components and technologies.	L3
3	Utilize programming languages and simulation tools to develop and test control algorithms for robotic and automation systems.	L4
4	Assess the impact of robotics and automation on various sectors, such through case studies.	L4

5	Evaluate ethical considerations in the use of robotics and automation.	L5

Mapping Levels of COs to POs / PSOs														
				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	1							2	2			1	1
CO2	3	2	2		1				2	2			2	1
CO3	3	2			1				2	2			1	1
CO4	3	2			1				2	2			2	2
CO5	3	3	2		1			2	2	2			1	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Niku, Saeed B. *Introduction to robotics: analysis, control, applications*. John Wiley & Sons, 2020.
2. Mullakara, Nandan, and Arun Kumar Asokan. *Robotic process automation projects: build real-world RPA solutions using UiPath and automation anywhere*. Packt Publishing Ltd, 2020.
3. Bhattacharyya, Siddhartha, Jyoti Sekhar Banerjee, and Debashis De, eds. *Confluence of Artificial Intelligence and Robotic Process Automation*. Vol. 335. Springer Nature, 2023.

REFERENCE BOOKS:

1. Robotics and control - R K Mittal and I J nagrath, TataMcGraw Hill 2004.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering - integrated approach by Richard d Klafter-London: Prentice-HaJJ-1989.

E-Resources:

1. http://www.leamerstv.com/Free-Engineering-Video-lectures-ltv071-Page 1.htm
2. http://www.cadcamfunda.com/cam _computer_ aided_manufacturing

3. http://wings.buffalo.edu/eng/mae/courses/460-564/Course-Notes/cnc-classnotes.pdf
4. http://nptel.iitm.ac.in/courses.php?branch=Mechanical
5. http://academicearth.org/courses/introduction-to-roboticsVideo
6. http://nptel.iitm.ac.in/video.php?courseid= 1052
7. http://www.npteJ.iitm.ac.in/and iitb.ac.in,

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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BLOCKCHAIN TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24AM4708	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

6. Learn the underlying principles and techniques associated with block chain Technologies.
7. Understand and describe how blockchain works
8. Familiarize with Ethereum, smart contracts and related technologies, and solidity language.
9. Understand the application of Blockchain in various domains.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

7. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
8. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
9. Show ***Video/animation*** films to explain the functioning of various concepts.
10. Encourage ***Collaborative*** (Group Learning) Learning in the class.
11. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
12. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**

Introduction to Blockchain:

Distributed systems, P2P network Architecture of Blockchain, Generic elements of a blockchain: How blockchain works, Benefits, features, and limitations of blockchain How blockchain accumulates blocks, types of blockchain, Distributed ledger, Consensus mechanisms-Proof of work, Proof of Stake, Proof of Authority, CAP theorem, Decentralization, Disintermediation, Ecosystem - Storage, Communication and Computation

UNIT – II	**08 Hours**

Cryptography and Smart Contracts:

Symmetric cryptography (DES, AES), Asymmetric cryptography, Public and Private keys, Algorithms - RSA, Hash functions, SHA, SHA-256

Smart contracts - Benefits of Smart contracts, Solidity Programming-Types, Literals, Enums, write basic program using Solidity, Compile, verify and deploy.

UNIT – III	**08 Hours**

Ethereum Blockchain: The Ethereum network, Ethereum Virtual Machine Execution Environment, Opcodes and their meaning, Structure of a Block, Genesis Block, Merkle tree, Geth, Transactions, Transaction receipts, Nonce, Gas - gasPrice, gasLimit, Ether, Mining, Wallets, Ethereum network (main net, test net), Metamask
UNIT – IV **08 Hours**
Ethereum Development: Infura, Web3.0 for Blockchain, Web3J -Java frontend, Creating Blockchain network and peering, Truffle - build contract, migrate and deploy, Ganache CLI
UNIT – V **07 Hours**
Hyperledger: Projects under Hyperledger, Hyperledger reference architecture, Hyperledger design principles, Hyperledger Fabric, Hyperledger Sawtooth, Case study: Blockchain in IoT

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Recall basic blockchain and cryptography concepts.	L2
2	Comprehend mining and Merkle tree concepts in blockchain.	L2
3	Utilize Solidity for real-world smart contract development.	L3
4	Evaluate Ethereum tools like Geth and Truffle for blockchain applications.	L5
5	Apply blockchain in IoT and healthcare via Hyperledger.	L3

Mapping Levels of COs to POs / PSOs

				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
COs	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2			2				2				2	2
CO2	3		1		2								1	1
CO3	2	2	1		2				2				1	2
CO4	3		2		2								2	2
CO5	2	2	1		2				2				2	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

4. Lantz, Lorne, and Daniel Cawrey. Mastering blockchain. O'Reilly Media, 2020.
5. Comuzzi, Marco, Paul Grefen, and Giovanni Meroni. Blockchain for Business: IT Principles into Practice. Routledge, 2023.

REFERENCE BOOKS:

5. Bashir, Imran. Mastering blockchain. Packt Publishing Ltd, 2017.
6. Raj, Pethuru, Kavita Saini, and Chellammal Surianarayanan, eds. Blockchain technology and applications. CRC Press, 2020.
7. Dave, Chintan. Security Challenges with Blockchain: Navigate Blockchain Security Challenges, Unveil Vulnerabilities, and Gain Practical Strategies for Secure Application Development (English Edition). Orange Education Pvt Ltd, 2024.
8. Julie, E. Golden, J. Jesu Vedha Nayahi, and Noor Zaman Jhanjhi, eds. Blockchain Technology: Fundamentals, Applications, and Case Studies. CRC Press, 2020.

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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UG RESEARCH PROJECT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24AM4709	**Credits**	:	03
Hours / Week	:	03	**Total Hours**	:	39 Hours
L–T–P–S	:	0–0–0–6			

Course Learning Objectives:

This course will enable students to:

1. **To identify** key research questions within a field to carry out research in a team.
2. **To identify** and summarize the literature review of the relevant field.
3. **To demonstrate** relevant referencing and inculcate new skills in various aspects of academic writing.
4. **To demonstrate** the knowledge and understanding of writing the publication/report.
5. **To showcase** the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information.
6. **To detail description** of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature.
7. **To analyze** and synthesize the new research findings.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method means it includes not only the traditional lecture method but a different type of teaching method that may be adopted to develop the course outcomes.
2. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show Video/animation films to explain the functioning of various concepts.
4. Encourage Collaborative (Group Learning) Learning in the class.
5. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the student's understanding.

COURSE CONTENT:

The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.

All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.

The following criteria will be checked by the department chairman to approve for the research proposal:

a. Department staff as course guide
   1. Ability to provide research direction to the student in the chosen field of interest
   2. Ability to design an appropriate research strategy and methodology to carry out the research by student
   3. Ability to provide and evaluate the strong literature review document for the chosen research topic
   4. Ability to train students on research paper / technical writing skills
   5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team
   1. To be dedicated and committed to work on a new research topic by learning new technical skills
   2. To have fair knowledge on what is product development or research topic
   3. To have constant interaction with allocated guide by providing weekly updates
   4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

There will be CIA evaluation as well as the Semester end evaluation of the work done. Itwill be done by a committee of senior researchers of the Department.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Identify and Select an Appropriate Research Problem	L1
2	Explain and Summarize Relevant Literature	L2
3	Compare and Critically Analyze Relevant Research Papers	L3
4	Construct a Research Model and Perform Evaluation	L4
5	Create and Draft Publications or Demonstrations	L5

Mapping Levels of COs to POs / PSOs														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	2	1	1	1	1	1	2	2	3	2	2	1
CO2	2	2	3	2	2	1	1	1	2	2	3	2	1	2
CO3	3	3	3	2	3	2	2	1	2	2	2	2	2	2
CO4	2	3	2	3	2	1	2	2	2	2	2	3	2	2
CO5	1	1	2	1	2	1	1	1	3	3	2	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

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RESPONSIBLE AI & ETHICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	:	24OE0018	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. **Understand** the impact of analytics and AI/ML on individuals and society.
2. **Identify** the problems associated with Big Data using the appropriate technique.
3. **Apply** AI/ML techniques on identifying fairness and bias issues.
4. **Use** Tools and methods to quantify bias.
5. **Develop** the project using the case study.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.

UNIT – I	**08 Hours**
Data, Individuals, and Society: The power and impact that analytics and AI/ML have on individuals and society, especially concerning issues such as fairness and bias, ethics, legality, data collection and public use.	

UNIT – II	**08 Hours**
Big Data: Components of big data, basic statistical techniques to data scenarios, and understand the issues faced when learning from big data, ranging from data biases, overfitting, causation vs correlation, etc.	

UNIT – III	**09 Hours**
Privacy and Fairness in AI/ML: Use of AI/ML techniques to data scenarios, with a focus on identifying fairness and bias issues found in the design of decision-making systems. Technical approaches to current AI/ML applications such as facial recognition, natural language processing, and predictive algorithms, all while being mindful of its social and legal context.	

UNIT – IV	**07 Hours**
Tools and methods to quantify bias and examine ways to use algorithmic fairness to mitigate this bias, taking into consideration ethical and legal issues associated with it. Knowledge of analytics and AI/ML to transform a current biased data-set into a more objective solution.	
UNIT – V	**07 Hours**
Case Studies : 1. Robustness and beneficial AI 2. Benefits and dangers of super-intelligence 3. Rationality in Advanced Artificial Agents 4. Artificial Morality	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	**Analyze** the societal and individual impacts of AI/ML technologies, focusing on ethical, legal, and fairness concerns, and the significance of unbiased data collection and public data use.	L4
2	**Apply** basic statistical methods to big data, identifying and addressing issues like data biases, overfitting, and distinguishing between causation and correlation.	L3
3	**Compare** AI/ML systems for fairness and bias in decision-making processes, in applications like facial recognition and natural language processing.	L2
4	**Utilize** tools and methods to quantify and mitigate bias in datasets, understanding ethical and legal issues, and transforming biased datasets into more objective solutions.	L3
5	**Analyze** case studies on AI robustness, risks of super-intelligence, rationality in artificial agents, and artificial morality, articulating their implications for future technologies and society.	L4

Mapping Levels of COs to POs / PSOs														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO 1	1	-	-	-	-	-	-	-	2	2	1	-	2	2
CO 2	3	2	-	-	1	-	-	-	2	2	1	-	2	2
CO 3	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO 4	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO 5	3	2	-	-	1	-	-	-	2	2	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. O'neil, Cathy. Weapons of math destruction: How big data increases inequality and threatens democracy. Broadway Books, 2016.
2. Kearns, Michael, and Aaron Roth. The ethical algorithm: The science of socially aware algorithm design. Oxford University Press, 2019.

REFERENCE BOOKS:

1. S. J. Russell, D. Dewey, and M. Tegmark, 'Research priorities for robust and beneficial artificial intelligence', AI Magazine, 2015.
2. Bostrom, N. (2014), Superintelligence: Paths, Dangers, Strategies, Oxford University Press, Chapters 2-6.
3. Bostrom, N. (2012). The Superintelligent Will: Motivation and Instrumental Rationality in Advanced Artificial Agents. Minds & Machines 22: 71-85.
4. Allen, C., Smit, I.,Wallach,W. (2005) 'Artificial morality: Top-down, bottom-up, and hybrid approaches', Ethics and Information Technology ; 7, 149-155
5. Lake, B. M., Ullman, T. D., Tenenbaum, J. B., Gershman, S. J. (2017) 'Building machines that learn and think like people', Behavioral and Brain Sciences, e253.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ee56/
2. https://nptel.ac.in/courses/106106046

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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VIII SEM- ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	PROJ	24AM4801	Capstone Project Phase-II	0	0	0	24	100	--	100	12
2	INT	24AM4802	Internship	0	0	0	6	100	--	100	03
			Total	0	0	0	30				**15**

PROJ-Project Work, INT-Internship, L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. Of Credits

CAPSTONE PROJECT PHASE – II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

Subject Code	:	24AM4801	**Credits**	:	12
Hours / Week	:	12	**Total Hours**	:	156 Hours
L–T–P–J	:	0–0–0–24			

Course Learning Objectives:

This course will enable students to:

1. **To identify** key research questions within a field to carry out research in a team.
2. **To identify** and summarize the literature review of the relevant field.
3. **To demonstrate** relevant referencing and inculcate new skills in various aspects of academic writing.
4. **To demonstrate** the knowledge and understanding of writing the publication/report.
5. **To showcase** the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information.
6. **To detail description** of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature.
7. **To analyze** and synthesize the new research findings.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method means it includes not only the traditional lecture method but a different type of teaching method that may be adopted to develop the course outcomes.
2. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show Video/animation films to explain the functioning of various concepts.
4. Encourage Collaborative (Group Learning) Learning in the class.
5. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the student's understanding.

COURSE CONTENT:

1. The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further.
2. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.
3. The problem statement should be big enough to be carried out in two phases over the two semesters i.e., VII and VIII semesters in the VI year.
4. All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.
5. The following criteria will be checked by the department chairman to approve for theresearch proposal:

a. Department staff as course guide
   1. Ability to provide research direction to the student in the chosen field of interest
   2. Ability to design an appropriate research strategy and methodology to carry out the research by student
   3. Ability to provide and evaluate the strong literature review document for the chosen research topic
   4. Ability to train students on research paper / technical writing skills
   5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team
   1. To be dedicated and committed to work on a new research topic by learning new technical skills
   2. To have fair knowledge on what is product development or research topic
   3. To have constant interaction with allocated guide by providing weekly updates
   4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

1. The problem statement selected in Capstone Project Phase - I (VII semester) will be carried in the VIII semester.
2. Phase 2 comprises of the detailed design, implementation, and testing results during the internal and external review.
3. Each Project team needs to submit the technical paper or patent or participate in hackathons and project exhibitions as well as apply for various state and national funding agencies within the stipulated time frame by the university
4. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department.
5. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		

1	Identify and Select an Appropriate Research Problem	L1
2	Explain and Summarize Relevant Literature	L2
3	Compare and Critically Analyze Relevant Research Papers	L3
4	Construct a Research Model and Perform Evaluation	L4
5	Create and Draft Publications or Demonstrations	L5

Mapping Levels of COs to POs / PSOs

Cos				Program Outcomes (POs)									PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	2	1	1	1	1	1	2	2	3	2	2	1
CO2	2	2	3	2	2	1	1	1	2	2	3	2	1	2
CO3	3	3	3	2	3	2	2	1	2	2	2	2	2	2
CO4	2	3	2	3	2	1	2	2	2	2	2	3	2	2
CO5	1	1	2	1	2	1	1	1	3	3	2	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

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RESEARCH INTERNSHIP/ INDUSTRY INTERNSHIP/IN-HOUSE INTERNSHIP

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

Subject Code	:	24AM4802	**Credits**	:	03
Hours / Week	:	-	**Total Hours**	:	78 Hours
L–T–P–S	:	0–0–0–6			

Course Learning Objectives:

This course will enable students to:

1. To expose students to the industrial environment
2. To create competent professionals for the industry.
3. To provide possible opportunities to learn, understand and sharpen the real time technical/managerial skills required at the job
4. To work on a problem assigned by a mentor at industry, prepare action plan and complete within time limit
5. To learn, create/prepare report for Project/research as used in industry with productive and efficient way
6. To strengthen industry-institute linkage and increase employability of the students

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method means it includes not only the traditional lecture method but a different type of teaching method that may be adopted to develop the course outcomes.
2. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show Video/animation films to explain the functioning of various concepts.
4. Encourage Collaborative (Group Learning) Learning in the class.
5. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the student's understanding.

COURSE CONTENT:

1. The course includes a 16 weeks of on-job training on current industry-relevant problem through supervised self-learning approach.
2. The internship is an individual activity.
3. The student should obtain approval from the chairman/supervisor to pursue.
4. A student shall submit a brief proposal about the work to be carried out in the internship, to a coordinator within 3 weeks, after starting the internship.
5. A comprehensive report is required to be prepared and submit to the department at the end of the semester.
6. A certificate shall be attached with this report duly signed by the competent authority of the industry for the successful completion of the internship.
7. An attendance report shall also be attached with this report.
8. The CIA evaluation will be done by faculty mentor or Industry Supervisor.
9. There is no SEE Exam for this course.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Comprehend the modern tools used in the field of AIML and engineering for product development.	L2
2	Demonstrate ethical conduct and professional accountability while working in a team for the benefit of society	L3
3	Analyze the resources requirement and planning to facilitate the project success	L4
4	Assess and adapt technical skills on industry environment	L5
5	Apply the modern industry practice for internship	L3

Mapping Levels of COs to POs / PSOs													
Cos				Program Outcomes (POs)								PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	2	1	1	1	1	1	2	2	3	2	2	1
CO2	2	2	3	2	2	1	1	1	2	2	3	2	1	2
CO3	3	3	3	2	3	2	2	1	2	2	2	2	2	2
CO4	2	3	2	3	2	1	2	2	2	2	2	3	2	2
CO5	1	1	2	1	2	1	1	1	3	3	2	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

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