DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

SCHEME FOR
BACHELOR OF TECHNOLOGY (B. Tech)

COMPUTER SCIENCE & ENGINEERING
(Artificial Intelligence & Machine Learning)
(1st to 8th Semester)

Graduation Year: 2022-2026

(With effect from 2022-23)

DAYANANDA SAGAR UNIVERSITY Harohalli 562 112

Dayananda Sagar University APPROVED COPY

Dayananda Sagar University
School of Engineering
Devarakaggalahalli, Harohalli, Kanakapura Road, Ramanagara Dt., Bengaluru- 562112
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence & Machine Learning)

Total Credits

Sl. No	Semester	Credits
1	1st semester	21
2	2nd semester	21
3	3rd semester	20
4	4th semester	22
5	5th semester	25
6	6th semester	24
7	7th semester	14
8	8th semester	14
Total		**161**

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence & Machine Learning)

I SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	22EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	CR	3	-	-	-	3	*	***
2	101-105 & 1 121-123	22EN1102	C PROGRAMMING FOR PROBLEM SOLVING	CR	2	-	2	-	3	*	***
3	101-105 & 121-123	22EN1103	ENGINEERING CHEMISTRY	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	22EN1104	ELEMENTS OF MECHANICAL ENGINEERING	CR	2	-	2	-	3	*	***
5	101-105 & 121-123	22EN1105	INTRODUCTION TO ELECTRICAL ENGINEERING	CR	3	-	-	-	3	*	***
6	101-105 & 121-123	22EN1106	BIOLOGY FOR ENGINEERS	CR	3	-	-	-	3	*	***
7	101-105 & 121-123	22EN1107	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	CR	1	-	-	-	1	*	***
8	101-105 & 121-123	22EN1108	KANNADA KALI / MANASU	CR	1	-	-	-	1	*	***
			Total		18	-	06	-	21		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence & Machine Learning)

I-SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	22EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	CR	3	-	-	-	3	*	***
2	101-105 & 121-123	22EN1102	C PROGRAMMING FOR PROBLEM SOLVING	CR	2	-	2	-	3	*	***
3	101-105 & 121-123	22EN1109	ENGINEERING PHYSICS	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	22EN1110	ENGINEERING MECHANICS	CR	3	-	-	-	3	*	***
5	101-105 & 121-123	22EN1111	INTRODUCTION TO ELECTRONICS	CR	3	-	-	-	3	*	***
6	101-105 & 121-123	22EN1112	ENGINEERING GRAPHICS AND DESIGN THINKING	CR	2	-	2	-	3	*	***
7	101-105 & 121-123	22EN1113	ENVIRONMENTAL SCIENCE	CR	1	-	-	-	1	*	***
8	101-105 & 121-123	22EN1114	TECHNICAL ENGLISH	CR	1	-	-	-	1	*	***
			Total		18	-	06	-	21		

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II SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	22EN1201	SINGLE AND MULTIVARIATE CALCULUS	CR	3	-	-	-	3	*	***
2	101-105 & 1 121-123	22EN1202	PYTHON PROGRAMMING FOR PROBLEM SOLVING	CR	2	-	2	-	3	*	***
3	101-105 & 121-123	22EN1103	ENGINEERING CHEMISTRY	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	22EN1104	ELEMENTS OF MECHANICAL ENGINEERING	CR	2	-	2	-	3	*	***
5	101-105 & 121-123	22EN1105	INTRODUCTION TO ELECTRICAL ENGINEERING	CR	3	-	-	-	3	*	***
6	101-105 & 121-123	22EN1106	BIOLOGY FOR ENGINEERS	CR	3	-	-	-	3	*	***
7	101-105 & 121-123	22EN1107	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	CR	1	-	-	-	1	*	***
8	101-105 & 121-123	22EN1108	KANNADA KALI / MANASU	CR	1	-	-	-	1	*	***
			Total		18	-	06	-	**21**		

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II-SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	22EN1201	SINGLE AND MULTIVARIATE CALCULUS	CR	3	-	-	-	3	*	***
2	101-105 & 121-123	22EN1202	PYTHON PROGRAMMING FOR PROBLEM SOLVING	CR	2	-	2	-	3	*	***
3	101-105 & 121-123	22EN1109	ENGINEERING PHYSICS	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	22EN1110	ENGINEERING MECHANICS	CR	3	-	-	-	3	*	***
5	101-105 & 121-123	22EN1111	INTRODUCTION TO ELECTRONICS	CR	3	-	-	-	3	*	***
6	101-105 & 121-123	22EN1112	ENGINEERING GRAPHICS AND DESIGN THINKING	CR	2	-	2	-	3	*	***
7	101-105 & 121-123	22EN1113	ENVIRONMENTAL SCIENCE	CR	1	-	-	-	1	*	***
8	101-105 & 121-123	22EN1114	TECHNICAL ENGLISH	CR	1	-	-	-	1	*	***
			Total		18	-	06	-	**21**		

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence & Machine Learning)

III SEM – CSE(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

III SEMESTER													
SL	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	IPCC / PCC	22AM2301	Transform and Numerical Techniques	MAT	3	0	0	0	03	60	40	100	03
2	IPCC / PCC	22AM2302	Data Structures	CSE	3	0	2	0	03	60	40	100	04
3	IPCC / PCC	22AM2303	Digital Logic Design	ECE	3	0	2	0	03	60	40	100	04
4	IPCC / PCC	22AM2304	Discrete Mathematics and Graph Theory	CSE	3	0	0	0	03	60	40	100	03
5	OEC	22AM2305	Artificial Intelligence	AI&ML	3	0	0	0	03	60	40	100	03
6	PEC	22LS23XX	Liberal Studies	Not Specific	1	0	0	0	01	100	--	100	01
7	SEC	22AM2306	Skill Enhancement – I	AI&ML	1	0	2	0	01	100	--	100	02
			Total		17	0	6	0					**20**

BSC-Basic Science Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

LIBERAL STUDIES LIST - B.TECH PROGRAMME – 2022-23 Batch

Sl. No.	Course Code	Course Title	Offering dept
1	22LS0001	INTRODUCTION TO DRAMA	Any department
2	22LS0002	INTRODUCTION TO DANCE	
3	22LS0003	INTRODUCTION TO MUSIC	
4	22LS0004	INTRODUCTION TO PHOTOGRAPHY	
5	22LS0005	INTRODUCTION TO JAPANESE LANGUAGE	
6	22LS0006	LAW FOR ENGINEERS	
7	22LS0007	INTRODUCTION TO PAINTING	
8	22LS0008	COMMUNICATION THROUGH SANSKRIT	
9	22LS0009	VEDIC MATHEMATICS	
10	22LS0010	FUNDAMENTALS OF CRITICAL THINKING	
11	22LS0011	INTRODUCTION TO FILM STUDIES	
12	22LS0012	PRACTICING YOGA & MEDITATION	
13	22LS0013	CYBER CRIMES, POLICIES & LAWS	
14	22LS0014	INTRODUCTION TO GERMAN LANGUAGE	

IV SEM – CSE(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

IV SEMESTER													
SL	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	J					
1	BSC	22AM2401	Probability & Statistics	MAT	3	0	0	0	03	60	40	100	03
2	IPCC	22AM2402	Design and Analysis of Algorithms	CSE	3	0	2	0	03	60	40	100	04
3	PCC	22AM2403	Database Management System	CSE	3	0	2	0	03	60	40	100	04
4	PCC	22AM2404	Embedded Systems Design	ECE	3	0	2	0	03	60	40	100	04
5	IPCC	22AM2405	Computer Organization and Architecture	CSE	3	0	0	0	03	60	40	100	03
6	AEC	22AM2406	Special Topic	AI&ML	0	0	0	4	02	100	--	100	02
7	SEC	22AM2407	Skill Enhancement Course -II	AI&ML	1	0	2	0	01	100	--	100	02
			Total		16	0	8	4					22

BSC-Basic Science Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

V SEM – CSE(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	Credits
				L	T	P	J				
1	IPCC / PCC	22AM3501	Machine Learning	3	0	2	0	60	40	100	4
2	IPCC / PCC	22AM3502	Operating Systems	3	0	2	0	60	40	100	4
3	IPCC / PCC	22AM3503	Theory of Computation	3	1	0	0	60	40	100	4
4	IPCC / PCC	22AM3504	Computer Networks	3	0	2	0	60	40	100	4
5	SEC	22AM3505	Skill Enhancement Course – III	1	0	2	0	100	--	100	2
6	PEC	22AM35XX	Professional Elective Course -I	3	0	0	0	60	40	100	3
7	PROJ	22AM3506	Minor Project	0	0	0	4	100	--	100	2
8	AEC	22AM3507	Cognitive and Technical Skills - I	0	0	4	0	100	--	100	2
			Total	16	1	12	4				25

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

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VI SEM – CSE(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	Credits
				L	T	P	J				
1	HSMC	22AM3601	Innovation and Entrepreneurship	2	0	0	0	60	40	100	02
2	IPCC / PCC	22AM3602	Deep Learning	3	0	0	0	60	40	100	03
3	IPCC / PCC	22AM3603	Compiler Design and System Software	3	0	2	0	60	40	100	04
4	IPCC / PCC	22AM3604	Image Processing and Computer Vision	3	0	2	0	60	40	100	04
5	PEC	22AM36XX	Professional Elective Course – II	3	0	0	0	60	40	100	03
6	PEC	22AM36XX	Professional Elective Course – III	3	0	0	0	60	40	100	03
7	OEC	22OEXXXX	Open Elective – I	3	0	0	0	60	40	100	03
8	AEC	22AM3605	Cognitive and Technical Skills - II	0	0	4	0	100	--	100	02
			Total	20	0	8	0				24

HSMC- Humanities and Social Sciences including Management Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, AEC-Ability Enhancement Course, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, OEC-Open Elective Courses, PROJ-Project Work, INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

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VII SEM – CSE(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	Credits
				L	T	P	J				
1	IPCC / PCC	22AM4701	Designing MLOps for Enterprises	1	0	2	0	60	40	100	02
2	PROJ	22AM4702	Capstone Project Phase-I	0	0	0	6	100	--	100	03
3	PEC	22AM47XX	Professional Elective Course – IV	3	0	0	0	60	40	100	03
4	PEC	22AM47XX	Professional Elective Course – V/ MOOC course	3	0	0	0	60	40	100	03
5	OEC	22OEXXXX	Open Elective – II	3	0	0	0	60	40	100	03
			Total	12	0	0	6				14

CID* - NPTEL COURSE ID

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, OEC-Open Elective Courses, PROJ-Project Work,INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

VIII SEM –CSE(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	Credits
				L	T	P	J				
1	PROJ	22AM4801	Capstone Project Phase-II	0	0	0	22	100	--	100	**11**
2	INT	22AM4802	Research Internship/ Industry Internship	0	0	0	6	100	--	100	**03**
			Total	0	0	0	28				**14**

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, OEC-Open Elective Courses, PROJ-Project Work,INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22EN1101**					
TITLE OF THE COURSE	**LINEAR ALGEBRA & DIFFERENTIAL EQUATIONS**					
SCHEME OF INSTRUCTION	Lecture Hours (L)	Tutorial Hours (T)	Practical Hours (P)	Project Hours (J)	Total Hours	Credits
	3	-	-	-	39	3

COURSE OBJECTIVES:

- Understanding basic concepts of linear algebra to illustrate its power and utility through applications to science and Engineering.
- Apply the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering.
- The course is discussed with algebraic as well as geometric perspectives.
- Solve problems in cryptography, computer graphics and wavelet transforms.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Apply the abstract concepts of matrices and system of linear equations using decomposition methods	L3
CO2	Implement the basic notion of vector spaces and subspaces	L3
CO3	Apply the concept of vector spaces using linear transforms which is used in computer graphics and inner product spaces	L3
CO4	Applications of linear transforms in computer graphics and imaging	L3
CO5	Applications of orthogonality in various domains	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Linear algebra: Introduction - The Geometry of Linear Equations - Row reduction and echelon forms- Rank of a matrix - Gaussian Elimination - Solution sets of linear equations – LU decomposition - Inverse of a matrix by Gauss-Jordan method.	
MODULE 2	**8Hrs**
Vector spaces and subspaces: Linear spaces – Subspaces - Linear independence – Span - Bases and Dimensions -Finite dimensional vector spaces, Fundamental subspaces associated with a matrix.	
MODULE 3	**9Hrs**
Linear transformations and orthogonality: Linear transformations – Basic properties - Invertible linear transformation - Matrices of linear transformations - Vector space of linear transformations – Inner Product, Orthogonal Vectors - Projections onto Lines - Projections and Least Squares - The Gram- Schmidt Orthogonalization process, QR Factorization.	

MODULE 4	7Hrs
Eigenvalues and eigenvectors: Introduction to Eigenvalues and Eigenvectors - Diagonalization of a Matrix- Diagonalization of symmetric matrices - Quadratic forms.	
MODULE 5	**7Hrs**
Differential equations: Linear second order ordinary differential equation with constant coefficients – Solutions of homogenous and non-homogenous equations - Method of undetermined coefficients – method of variation of parameters – Solutions of Cauchy-Euler and Cauchy-Legendre differential equations.	

TEXT BOOKS:

1. D C Lay, S R Lay and JJ McDonald, Linear Algebra and its Applications, Pearson India, Fifth edition.
2. Linear Algebra and its Applications by Gilbert Strang, 4 th Edition, Thomson Brooks/Cole, Second Indian Reprint 2007.
3. Introductory Linear Algebra- An applied first course, Bernard Kolman and David, R. Hill, 9th Edition, Pearson Education, 2011.
4. Thomas' Calculus, George B.Thomas, D.Weir and J. Hass, 2014, 13th edition, Pearson.

REFERENCES:

1. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).
2. Higher Engineering Mathematics by B S Grewal, 42 nd Edition, Khanna Publishers.
3. Elementary Linear Algebra, Stephen Andrilli and David Hecker, 5th Edition, Academic Press (2016).
4. Contemporary linear algebra, Howard Anton, Robert C Busby, Wiley 2003.
5. Practical Linear Algebra, Farin and Hansford, CRC Press (2013).

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1103**					
TITLE OF THE COURSE	**ENGINEERING CHEMISTRY**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	3	-	2	-	39(L)+26(P) = 65	4

COURSE OBJECTIVES:

- To provide chemical concepts most relevant to engineering students and demonstrate them in an applied context.
- To expose to the principles required to understand important contemporary topics like alternate energy sources, corrosion control, polymer technology, phase equilibria nanomaterials and green chemistry and catalysis.
- To emphasize on applications of these concepts to real world problems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Appreciate the basic principles of electrochemistry, use of different types of electrodes in analysis and evaluate cell potential for different cell reactions.	L2
CO2	Know construction, working and applications of various energy storage devices such as batteries, fuel cells and supercapacitors.	L2
CO3	Understand basic principles of corrosion and apply suitable techniques for corrosion control. Also know the technological importance and processes involved in metal finishing.	L3
CO4	Know the synthesis, structure –property relationship and applications of commercially important polymers and polymer composites. Understand properties and applications of nanomaterials. Also learn the principles of green chemistry for a sustainable and eco-friendly world	L3
CO5	Differentiate various instrumental techniques involved in determining chemical reactions	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Chemical energy source: Introduction to energy; Fuels - definition, classification, importance of hydrocarbons as fuels; Calorific value-definition, Gross and Net calorific values (SI units). Determination of calorific value of a solid / liquid fuel using Bomb calorimeter. Numerical problems on GCV&NCV. Petroleum cracking-fluidized catalytic cracking. Reformation of petrol. octane number, cetane number, anti-knocking agents, power alcohol, Biodiesel & Biogas. **Solar energy:** Thermal energy: Photovoltaic cells- Introduction, definition, importance, working of PV cell. Solar grade silicon physical and chemical properties relevant to photo-voltaics, doping of silicon by diffusion technique.	

MODULE 2	8Hrs
Energy science and technology: Single electrode potential - Definition, origin, sign conventions. Standard electrode potential- Definition-Nernst equation expression and its Applications. EMF of a cell- Definition, notation and conventions. Reference electrodes– Calomel electrode, Ag/AgCl electrode. Measurement of standard electrode potential. Numerical problems on EMF. Ion-selective electrode- glass electrode **Battery technology:** Basic concepts including characteristics of anode, cathode, electrolyte and separator. Battery characteristics. Classification of batteries–primary, secondary and reserve batteries. State of the art Batteries-Construction working and applications of Zn-air, Lead acid battery, Nickel-Metal hydride and Lithium ion batteries. Introduction to fuel cells, types of fuel cells. Construction, working and application of Methanol-Oxygen fuel cell.	
MODULE 3	**8Hrs**
Corrosion science: Definition, Chemical corrosion and Electro-chemical theory of corrosion, Types of corrosion, Differential metal corrosion, Differential aeration corrosion (pitting and water line corrosion), Stress corrosion. Corrosion control, Metal coatings-Galvanization, Tinning and its disadvantages. Cathodic protection of Corrosion: Sacrificial anode method and current impression method. **Surface Modification Techniques:** Definition, Technological importance of metal finishing. Significance of polarization, decomposition potential and over-voltage in electroplating processes, Electroless Plating. Distinction between electroplating and Electroless plating, advantages of electroless plating. Electroless plating of copper.	
MODULE 4	**8Hrs**
High Polymers: Introduction to polymers, Glass transition temperature, structure and property relationship. Synthesis, properties and applications of Teflon. PMMA. Elastomers - Deficiencies of natural rubber and advantages of synthetic rubber. Synthesis and application of silicone rubber, Conducting polymers-Definition, mechanism of conduction in polyacetylene. Structure and applications of conducting polyaniline. **Nanotechnology:** Introduction, properties, synthesis by sol-gel. Fullerenes, Carbon nanotubes, dendrimers and nano-composites.	
MODULE 5	**7Hrs**
Water Technology: Impurities in water. Hardness of Water: Types of Hardness and determination of total hardness of water by using disodium salt of ethylenediaminetetraacetic acid method, Potable water treatment by Electro dialysis and Reverse Osmosis. Water analysis- Biochemical oxygen demand and Chemical oxygen demand. Determination of COD. Numerical problems on COD. Sewage treatment. **Instrumental Methods of Analysis:** Instrumental methods of analysis, Principles of spectroscopy-Beer's Lamberts law, Difference between spectrometer and spectrophotometer, Potentiometry, Conductometry (Strong acid against strong base, weak acid against strong base, mixture of strong acid and a weak acid against strong base).	

List of Laboratory/Practical Experiments activities to be conduct	26Hrs
Volumetric Analysis and Preparations 1. Evaluation of quality of water in terms of total hardness by Complexometric titration. 2. Determination of Chemical Oxygen Demand (COD) of the given industrial waste water sample. 3. Determination of Alkalinity of the given water sample 4. Preparation of MgO nanoparticles by solution combustion method (Demonstration experiment) and spectrometric analysis. 5. Electroless plating of copper (Demo experiment) 6. Preparation of Polyaniline (Demo experiment)	

Instrumental methods of Analysis

1. Potentiometric titration–Estimation of FAS using standard $K_2Cr_2O_7$ solution.
2. Conductometric estimation of hydrochloric acid using standard sodium hydroxide solution
3. Determination of viscosity coefficient, surface tension, density of a given liquid
4. Colorimetric estimation of copper in a given solution
5. Determination of Pka of given weak acid.
6. Determination of calorific value of coal/oil using Bomb calorimeter (Group experiment)

TEXT BOOKS:

1. Dr. S. Vairam, Engineering Chemistry, Wiley-India Publishers, 2017
2. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015

REFERENCES:

1. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015
2. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015
3. Dayanada Sagar University laboratory manual
4. J. Bassett, R.C. Denny, G.H. Jeffery, Vogel's, Text book of quantitative inorganic analysis, 4th edition

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1104**					
TITLE OF THE COURSE	**ELEMENTS OF MECHANICAL ENGINEERING**					
SCHEME OF INSTRUCTION	L	T	P	J	TotalHours	Credits
	2	-	2	-	26(L)+26(P) = 52	3

COURSE OBJECTIVES:

The course will enable the students to

- Acquire a basic understanding of renewable energy resources and basic concepts of hydraulic turbines.
- Acquire knowledge of various engineering materials and metal joining techniques.
- Acquire essential knowledge of modern manufacturing tools and techniques.
- Acquire knowledge on basics of refrigeration and air-conditioning.
- Explain about the cooling of electronic devices.
- Acquire knowledge of basic concepts of mechatronics and robotics.
- Explain about the electric and hybrid vehicles.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Describe basic concepts of renewable energy resources and power generation	L2
CO2	Distinguish various engineering materials and metal joining techniques	L2
CO3	Demonstrate different modern manufacturing tools and techniques	L3
CO4	Make use of basic concepts of refrigeration and air-conditioning concepts	L3
CO5	Illustrate essential knowledge of basic concepts of mechatronics and robotics	L2
CO 6	Comprehend the important concepts of electric and hybrid vehicles	L2

COURSE CONTENT:	
MODULE 1 Energy Sources and Power Generation	**10 Hrs**
Review of energy sources: Construction and working of Hydel power plant, Thermal power plant, Nuclear power plant, Solar power plant, Tidal power plant, Wind power plant. Principle and Operation of Hydraulic turbines, Pelton Wheel, Francis Turbine and Kaplan Turbine. Working of Centrifugal Pump & reciprocating pump. **Thermodynamics:** System, boundary, surroundings, types of systems, Zeroth law, First and second laws of thermodynamics, Efficiency, COP, Carnot theorem	
MODULE 2 Engineering Materials and Metal Joining Processes	**10 Hrs**
Metals-Ferrous: Tool steels and stainless steels. Non-ferrous /metals: aluminum alloys. **Ceramics-** Glass, optical fiber glass, cermets. **Composites-** Fiber reinforced composites, Metal matrix Composites.	

Smart materials- Piezoelectric materials, shape memory alloys, semiconductors, and super-insulators. **Metal Joining Processes:** Fitting, Sheet metal, Soldering, brazing and Welding: Definitions. Classification and methods of soldering, brazing, and welding. Brief description of arc welding, Oxy-acetylene welding, Introduction to TIG welding and MIG welding.	
MODULE 3 Modern Manufacturing Tools and Techniques	**12 Hrs**
CNC: Introduction, components of CNC, advantages and applications of CNC, CNC Machining centres and Turning Centers Concepts of Smart Manufacturing and Industrial IoT. **Additive Manufacturing:** Introduction to reverse Engineering, Traditional manufacturing vs Additive Manufacturing, Computer aided design (CAD) and Computer aided manufacturing (CAM) and Additive Manufacturing (AM), Different AM processes, Rapid Prototyping, Rapid Tooling, **3D printing:** Introduction, Classification of 3D printing process, Applications to various fields.	
MODULE 4 Thermal Systems and Management	**10 Hrs**
Heat in Electronic Devices: Modes of Heat Transfer, heat generation in electronics, temperature measurement, heat sink, Cooling of electronic devises: Active, Passive, and Hybrid Cooling. **Refrigeration:** Principle of refrigeration, Refrigeration effect, Ton of Refrigeration, COP, Refrigerants and their desirable properties. Principles and Operation of Vapor Compression and Vapor absorption refrigeration. Applications of Refrigerator. **Air-Conditioning:** Classification and Applications of Air Conditioners. Concept and operation of Centralized air conditioning system.	
MODULE 5 Advanced Technologies	**10 Hrs**
Mechatronics: Introduction, Concept of open-loop and closed-loop systems, Examples of Mechatronic systems and their working principle. **Robotics:** Introduction, Robot anatomy, Joints & links, common Robot configurations. Applications of Robotics in Material Handling, Processing, Assembly, and Inspection. **Electric and Hybrid Vehicles:** Introduction, Components of Electric and Hybrid Vehicles, Drives and Transmission. Advantages and disadvantages of EVs and Hybrid vehicles.	

List of Laboratory/Practical Experiments activities to be conduct
Demonstration on Principle and Operation of any one Turbo-machine
Demonstration on pumps
Visit any one Conventional or Renewable Energy Power Plant and prepare a comprehensive report.
One exercises each involving Fitting and Sheet metal.
One exercises each involving welding and Soldering.
Study oxy-acetylene gas flame structure and its application to gas welding
Demonstration on Principle and Operation of CNC machine.
Demonstration on Principle and Operation of 3D printing process.
Demonstration of anyone Heat transfer application device and prepare a comprehensive report.
Demonstration of anyone air conditioning system.
Demonstration of the machine consists of Gear Trains.
Demonstration of various elements of mechatronic system.
Demonstration of any one model of Robot

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P.K.Nag, Tata McGraw Hill 2nd Ed., 2002
2. Non-Conventional Energy Sources, G.D Rai, Khanna Publishers, 2003
3. Elements of Workshop Technology (Vol. 1 and 2), Hazra Choudhry and Nirzar Roy, Media Promoters and Publishers Pvt. Ltd., 2010

4. Thermal Management in Electronic Equipment, HCL Technologies, 2010
5. Robotics, Appu Kuttan KK K. International Pvt Ltd, volume 1

REFERENCES:

1. An Introduction to Mechanical Engineering, Jonathan Wickert and Kemper Lewis, Third Edition, 2012
2. Turbo Machines, M. S. Govindegowda and A. M. Nagaraj, M. M. Publications 7Th Ed, 2012
3. Manufacturing Technology- Foundry, Forming and Welding, P.N.Rao Tata McGraw Hill 3rd Ed., 2003.
4. Thermal Management of Microelectronic Equipment, L. T. Yeh and R. C. Chu, ASME Press, New York, 2002
5. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Pearson Education (US).

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1105**					
TITLE OF THE COURSE	**INTRODUCTION TO ELECTRICAL ENGINEERING**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

COURSE OBJECTIVES:

This course enables students:

- To impart basic knowledge of electrical quantities such as current, voltage, powerand energy
- To distinguish between passive and active electrical components
- To explain the general structure of electrical power system
- To define basic laws of electric circuit and to solve related problems
- To understand basics of earthing, protective devices and wiring
- To introduce concepts, analogies and laws of magnetic circuits
- To learn the working principle, construction and characteristics of various DC machines
- To study the construction, principle of operation and types of transformers
- To understand the working principles of measuring equipment.

COURSE OUTCOMS:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Explain the basic knowledge about the Electric and Magnetic circuits.	L2
CO2	Analyze the working of various Electrical Machines.	L3
CO3	Applying basic laws and determine various circuit parameters in AC and DCCircuits.	L3
CO4	Explain the construction, basic principle of operation, applications and determineperformance parameters of various measuring instruments.	L2
CO5	Outline the knowledge of Green Energy, Electrical Safety Rules & standards course.	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
ELECTRICAL CIRCUIT CONCEPTS: Voltage and current sources: independent, dependent, ideal and practical; V-I relationships of resistor, ohm's law, inductor, and capacitor; types of electrical circuits, voltage and current divider rule, Kirchhoff's laws, Peak, average and rms values of ac quantities; apparent, active and reactive powers; phasor analysis, Power factor, impedance and admittance, power and energy in electrical elements, introduction to3 phase systems.	

MODULE 2	8Hrs
MAGNETIC CIRCUIT CONCEPTS: Basics of magnetic circuits, laws of magnetism, magnetic field, magnetic lines of force, permeability, Electromagnetic Fields: Relation between field theory and circuit theory; numerical on capacitance calculations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Self and Mutual inductance of simple configurations.	
MODULE 3	**8Hrs**
DC MACHINES AND TRANSFORMERS: DC Machines: Basic principles of electromagnetic energy conversion, Construction, operation, characteristics, performance, of dc generators and motors, testing of dc machines, applications, Transformers: Construction, working principle, equivalent circuit, voltage regulation, efficiency, Auto-transformers.	
MODULE 4	**8Hrs**
SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. General working principles and construction of indicating instruments. Electro-magnetic Instruments for the measurement of current, voltage, power and energy. Instruments for the measurementof power factor, frequency, Potentiometers. CRO, Calibration of instruments; importance, procedures and standards.	
MODULE 5	**7Hrs**
POWER STATION PRACTICES, ECONOMICS, AND GREEN ENERGY CONCEPTS: Energy generation-Conventional generation of electrical energy using thermal, hydro, nuclear and, non-conventional sources of energy; overview on green energy technology, load forecasting, electricity tariffs, power factor improvement, power plant economics, Overview on electrical safety standards in industries	

TEXT BOOKS:

1. D.P.Kothari and I.J. Nagrath, "Basic Electrical Engineering", 4th Edition, Tata McGrawHill, 2010
2. B.L Thereja and A.K Thereja, "A text book of Electrical Technology (Vol III)(Transmission, distribution, and Utilization)", 23rd Edition, S Chand and Company

REFERENCES:

1. Clayton Paul, Syed A Nasar and Louis Unnewehr, 'Introduction to ElectricalEngineering', 2nd Edition, McGraw-Hill, 1992
2. P.S. Dhogal, 'Basic Electrical Engineering – Vol. I& II', 42nd Reprint, McGraw-Hill, 2012.
3. K Sawhney, A course in Electrical and Electronic Measurements andInstrumentation Dhanpat Rai & Co. (P) Limited January 2015
4. NPTEL - https://nptel.ac.in/courses/108/108/108108076/

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SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22EN1102**					
TITLE OF THE COURSE	**C PROGRAMMING FOR PROBLEM SOLVING**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	2	**-**	**2**	**-**	**26(L)+26(P) = 52**	**3**

COURSE OBJECTIVES :

- To develop student competence in writing clear, correct, and maintainable programs that implement known algorithms.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Express algorithms learned implicitly in school explicitly in algorithmic form and calculate the number of basic operations (exact or upper bound).	L3
CO2	Trace the execution of short programs/code fragments involving fundamental programming constructs.	L4
CO3	Write a short program/code fragment for a given task using fundamental programming constructs.	L3
CO4	Debug a short program/code fragment with fundamental programming constructs manually, and debug more complex code using a modern IDE and associated tools.	L4
CO5	Design a large program, conduct a personal code review, and contribute to a small-team code review focused on common coding errors and maintainability using a provided checklist.	L3

COURSE CONTENT:	
MODULE 1	**7 Hrs**
Basics and overview of C: Introduction to Problem Solving using Algorithms and Flowchart: Key features of Algorithms: Sequence, Decision, Repetition with examples. Background, structure of C program, keywords, Identifiers, Data Types, Variables, Constants, Input / Output statements, Operators (Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associativity, Expression Evaluation, Type conversions. Conditional Branching Statements-if and switch statements, iterative statements (loops)-while, for, do-while statements, Loop examples, Nested loops, break, continue, go to statement.	
MODULE 2	**5 Hrs**
Arrays: Introduction, declaration & initialization of array, reading and writing array elements, Operations on array: Traversal, searching, sorting. Declaration and Initialization of two-dimensional arrays. Matrix Operations (addition, subtraction, multiplication, transpose) using two-dimensional array.	

Strings: definition, declaration, initialization, and representation. String handling functions and character handling functions.	
MODULE 3	**6 Hrs**
Pointers: Definition and declaration and initialization of pointers. Accessing values using pointers. Accessing array elements using pointers. **Functions:** Definition and declaration. Built-in functions and User-defined functions. Categories of functions with example. Pointers as function arguments, array as function argument, Call-by-value and call-by-reference. Recursion.	
MODULE 4	**4 Hrs**
Structures: Purpose and usage of structures. Declaration of structures. Assignment with structures. Structure variables and arrays. Nested structures. Student and employee database implementation using structures. **Unions**: Declaration and initialization of a union. Difference between structures and unions. Example programs.	
MODULE 5	**4 Hrs**
Memory allocation in C programs: Dynamic memory allocation, memory allocation process, allocating a block of memory, releasing the used space, altering the size of allocated memory. **Files**: Defining, opening and closing of files. Input and output operations.	

List of Laboratory/Practical Experiments activities to be conducted

1. Design a C program to Swapping of two numbers. (Simple Expressions).

2. Design a C program to find the simple interest as per the below conditions
(Simple expressions, Integer division issues (data loss), Explicit typecasting, when p, t, r are integers and si is float.

3. Design a C program to find the largest of 3 numbers.
a) Using if and no else. (Conditionals)
b) Using nested if. (conditionals and Boolean expressions)
c) Using Ladder if else if
d) Using Ternary operator.

4. Design a program that takes three coefficients (a, b, and c) of a Quadratic equation (ax2+bx+c=0) as input and compute all possible roots.

5.Design a C program to read the vehicle type (Use c or C for car, b or B for bus, t or T for Tempo for vehicle type) and Duration of customer vehicle parked in parking slot. Parking fare is calculated as per the rates given below: print the total parking charges.

Vehicle	First Rate	Second Rate
Car	Rs 20/hr for first 2hr	Rs 30/hr for next
Bus	Rs 40/hr for first 2hr	Rs 50/hr for next
Tempo	Rs 30 /hr for first 2hr	Rs 40/hr for next

6. a Write a program to calculate the factorial of a given number.
b Write a program using four functions to check if the given number is a palindrome.

7.a Sum of natural numbers (sum(n) = n + sum(n-1);).
b. Write a program to calculate Power of a number ($b^n = b * b^{n-1}$).

8. a. Write a program to calculate nth fibonacci number given first two numbers in the series.

Inputs	N	Output
0,1	3	2
1,5	4	11
2,4	7	42
8,1	5	19
3,5	6	34

b. Write a program to calculate GCD of two numbers.

9. Write a program to emulate a calculator with the following operations: Addition, Subtraction, Multiplication, Division – using functions, switch and break.)

10. Write a program using four functions to compute the sine of a value using Taylor's series approximation - pass by value.

11. Write a program to find the sum of n different using four functions and arrays.
Use the following function prototype:
void input(int n, int a[n]);
int add(int n, int a[n]);
void output(int n, int a[n],int sum) and main().

12. Write a program to add two matrices using separate function for input, add matrices, display matrix and main function.

13. String handling:
a) Write a function to reverse the string in reverse and display it. (Strings))
b) Write a function to concatenate the two strings without using strcat.(Strings)
c) Write a function to find the length of the string.

14. Write a program using Bubble sort technique to sort an array of integer elements (Sorting technique, Const array arguments.)

15. Write a program to search an array of elements of data type requested by the user for a given item using binary search algorithm. (Searching technique, Const array arguments).

16. Write a program with functions to add and multiply two complex numbers. Define a structure Complex to represent a complex number. The main function should call other functions for the purposes of input, computations and display. (Structs as arguments).

17. Define a structure, student, to store the following data about a student: rollno (integer), name (string) and marks(integer) . Your program must contain the following functions: (Array of Structures).

- A function to read the students data.
- A function to display records of each student.
- A function to sort the records of student Rank Wise
- A function print all students details
- A function to search student details by Rollno
- A function to print the names of the students having the highest test score

TEXT BOOKS:

1. Brian W. Kernigham and Dennis M. Ritchie, (2012) “The C Programming Language”, 2nd Edition, PHI.
2. ReemaThareja, "Programming in C". Oxford University Press, Second Edition, 2016

REFERENCES :

1. R. S Bichkar, “Programming with C and Data Structure”, University Press, 2014
2. Behrouz A. Forouzan, Richard F. Gilberg, “Computer Science - A Structured Approach Using C”,Cengage Learning, 2007
3. Brian W. Kernigham and Dennis M. Ritchie, “The C Programming Language”, 2nd Edition, PHI, 2012
4. Vikas Gupta, “Computer Concepts and C Programming”, Dreamtech Press 2013.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1106**					
TITLE OF THE COURSE	**BIOLOGY FOR ENGINEERS**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	3	-	-	**-**	**39**	**3**

COURSE OBJECTIVES:

- To introduce students to basics modern biological concepts with an emphasis on how bio-processes are analogous to engineering field, as a multidisciplinary field.
- To make students understand basic engineering principles imminently run physiological processes particularly about engineering designs and solutions are arrived citing body functional examples.
- To motivate students of engineering that many bio-solutions could be foundational to design, develop better processes, products and useful to achieve quality of life.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Student appreciates and explains the biological mechanisms of living organisms from the perspective of engineers and find solutions to solve bio-engineering problems with appropriate tools.	L2
CO2	Explain optimal designs in engineering that are bio-mechanical in nature and build and use by observing and understanding bio-physiological processes involved in sensing, locomotion, and knowledge application of range of bio-chemicals.	L3
CO3	Demonstrate that bio-chemical, bio-sensory, bio-processes could be path-finders to optimise similarities for functional aspects of electronic, computer, mechanical, electrical machines	L3

COURSE CONTENT:	
MODULE 1	**8 Hrs**
Biomimetics: Biology for Engineers, Body Fluid: Blood- Mechanics of heart, Blood pressure, Life molecules: Water, Carbohydrates, Proteins, Lipids and Nucleic acids, Biomimetics: Bio-processes - engineering analogies	
MODULE 2	**8 Hrs**
Bioenergy: Unit of life: Human and Plant cell, Metabolism: Enzymes as Bio-catalysts and physiological entities, Development- Bioenergy from Sun-Photosynthesis	
MODULE 3	**8 Hrs**
Biomechanics (Human Body Movement Mechanics): Normal Human Movement: Force-Vector of Body; Movement Angles; Muscle contraction -Relaxation; Posture – Static & Dynamic; Ideal and abnormal posture, Practical: Stepping-Lifting-Sit-Stand.	

MODULE 4	8 Hrs
Bioelectronics: Brain & Computer: Senso-neural networks, IoT as applied to biology, Bionic Eye: Mechanism of Vision, Electronic Nose: Bio-olfactory mechanisms (Science of smell), Impulses: Cardiac and Nerve, Biological Clock, Circadian rhythm	
MODULE 5	**7 Hrs**
Biopharma: Metabolic syndromes, Cancer and its diagnostics, Lab on a chip, Bio-Sensors, Drug Discovery	

REFERENCES:

- Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M,L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson. "Biology: A global approach", , Global Edition, 10/E, 2014
- David Nelson, Michael Cox. "Lehninger Principles of Biochemistry". W H Freeman & Company, Seventh Edition, 2017.
- Janine M Benvus. "Biomimicry: Innovation inspired by Nature". William Morrow Paperbacks, 2002.
- Lecture Notes, PPT slides by course instructor.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1107**					
TITLE OF THE COURSE	**CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	1	**-**	**-**	**-**	**13**	**1**

COURSE OBJECTIVES:

This course enables students:

- To provide basic information about Indian constitution.
- To identify individual role and ethical responsibility towards society.

COURSE OUTCOMS:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Understand state and central policies, fundamental duties.	L2
CO2	Understand Electoral Process, special provisions.	L2
CO3	Understand powers and functions of Municipalities, Panchayats and Cooperative Societies.	L2
CO4	Understand Engineering ethics and responsibilities of Engineers	L2

COURSE CONTENT:	
MODULE 1:	**7Hrs**
Introduction to the Constitution of India, the making of the constitution and salient features of the constitution. Preamble to the Indian constitution fundamental rights & its limitations. Directive principles of state policy & relevance of directive principles state. Policy fundamental Duties.	
MODULE 2	**6Hrs**
Union Executives – President, Prime Minister, Parliament, Supreme Court of India. State Executives – Governor Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st amendments. Special provision for SC & ST, special provision for Women, children & backward classes, Emergency provisions. Powers and functions of municipalities, panchyats and co – operative Societies.	

TEXT BOOKS:

1. Brij Kishore Sharma,"Introduction to the Constitution of India", PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Durga Das Basu: "Introduction to the Constitution on India", (Students Edn.) PrenticeHall, 19th / 20th Edn., 2001.

REFERENCES:

1. M.V. Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.

SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1109**					
TITLE OF THE COURSE	**KANNADA KALI**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	1	**-**	**-**	**-**	**13**	**1**

COURSE OBJECTIVES:

This course enables students:

- To introduce Kannada language & culture to Non – Kannada speakers.
- To train them to communicate in colloquial Kannada with connivance.

COURSE OUTCOMS:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	The learners can communicate in Kannada & acquaint themselves with Kannada culture.	L2

COURSE CONTENT:	
MODULE 1:	**7Hrs**
Introduction to Karnataka & Kannada Culture, Evolution of Kannada. Introduction to Kannada Alphabets. Introduction to Kannada Numbers.	
MODULE 2	**6Hrs**
Kannada words, sentences & phrase making for colloquial communication.	

REFERENCES:

1. Kannada Kali –Dr. Lingadevaru Halemane
2. Kannada Paatagalu– Editor: Dr. Chandrashekara Kambara.
3. SLN Sharma & K Shankaranarayana "Basic Grammar", Navakarnataka Publications.
4. Spoken Kannada. Publication: Kannada Sahitya Parishat Bengaluru.

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SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22EN1201**					
TITLE OF THE COURSE	**SINGLE AND MULTI VARIABLE CALCULUS**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	3	-	-	-	39	3

COURSE OBJECTIVES:

- To analyze and solve constrained and unconstrained optimization problems.
- To understand the meaning of the definite integral both as a limit of Riemann sums and as the net accumulation of a rate of change.
- To find volumes of solids by calculating appropriate double integrals in rectangular and polar coordinates.
- To relate rectangular coordinates in 3-space to spherical and cylindrical coordinates.
- To evaluate triple integrals and use them to find volumes in rectangular, cylindrical and spherical coordinates.
- To evaluate line integrals of curves and vector fields and interpret such quantities as work done by a force.
- To use Green's theorem to evaluate line integrals along simple closed contours on the plane.
- To apply Stoke's theorem to compute line integrals along the boundary of a surface.
- To apply Divergence theorem to evaluate surface integral.
- To have a good foundation of Sequences of Bounded, Monotonic and Convergence.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Understand basic calculus concept such as limit, continuity and derivatives	L2
CO2	Compute partial derivatives and use it to give polynomial approximation of functions in several variables	L3
CO3	Apply calculus concepts to solve real-world problems such as optimization and related rates problems	L3
CO4	Evaluate integrals of functions or vector-related quantities over curves, surfaces, and domains in two- and three-dimensional space	L5
CO5	Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, or Divergence Theorem to evaluate integrals	L3
CO6	Distinguish between the concepts of sequence and series, and determine limits of sequences and convergence and approximate sums of series	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
Differential Calculus: Functions of two or more variables: Definition, Region in a plane, Level curves, Level surfaces, Limits, Continuity, Partial derivatives, Differentiability, Gradients, Directional derivatives, Normals to level curves and tangents, Extreme values and saddle points, Lagrange multipliers. **Self-Learning Component** : Single variable calculus	
MODULE 2	**9Hrs**
Integral calculus: Double integral and iterated integrals - Cartesian and polar coordinates, Volume of solids of revolution, Triple integral, Change of variables, Multiple integrals in cylindrical and spherical coordinates.	
MODULE 3	**9Hrs**
Vector Calculus: Line Integrals, Vector Fields, Work, Circulation and flux, Path independence, Potential functions, and Conservative fields, Green's theorem in the plane, Surface area and surface integrals, Surface area of solid of revolution, Parametrized surfaces, Stokes' theorem, The Divergence theorem.	
MODULE 4	**6Hrs**
Sequence and Series I: Sequences of real numbers and their convergence criteria, Infinite series, Sequence of partial sums, Tests for convergence/divergence - n^{th} term test, Boundedness and monotonicity, Integral, Condensation, Comparison, Ratio and root tests	
MODULE 5	**6Hrs**
Sequence And Series II: Alternating series, Absolute and conditional convergence, Rearrangement theorem, Power series, Taylor and Maclaurin series (one and two variables)	

TEXT BOOKS:

1. Thomas' Calculus, George B. Thomas, D. Weir and J. Hass, 2014, 13th edition, Pearson.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India.

REFERENCES:

1. Higher Engineering Mathematics, B.S. Grewal, 2015, 43rd Edition, Khanna Publishers.
2. Higher Engineering Mathematics, John Bird, 2017, 6 th Edition, Elsevier Limited.
3. Calculus: Early Transcendentals, James Stewart, 2017, 8 th edition, Cengage Learning.
4. Engineering Mathematics, K.A. Stroud and Dexter J. Booth, 2013, 7 th Edition, Palgrave Macmillan.
5. Basic Multi Variable Calculus, Marsden, Tromba and Weinstein, W.H. Freeman, Third Edition

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1109**					
TITLE OF THE COURSE	**ENGINEERING PHYSICS**					
SCHEME OF Instruction	L	T	P	J	Total Hours	Credits
	3	-	2	-	39(L)+26(P)=65	4

COURSE OBJECTIVES:

- To introduce the basic concepts of Quantum mechanics which are essential in understanding and solving problems in engineering,
- To understand Band structure of solids, Semiconductors and electrical conductivity of SC's, and their applications.
- To explain semiconductor devices like LED, Photodiode and Solar cell and Semiconductor BJT.
- To review different types of Engineering materials –Electronic, electrical, mechanical and Magnetic materials and Dielectric material Properties and their applications in Science and Engineering.
- Classify the magnetic materials based on susceptibility and their temperature dependence
- To understand different crystal systems and determine structure by miller-indices
- To explain Thin-film Phenomena, Thin-film fabrication Process and their applications in engineering.
- To learn how to fabricate Nano materials by using Top-down and Bottom–up approach& To review Nano science and technology and its practical applications in biology, engineering and medicine.

COURSE OUTCOMEs:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Describe the concepts of Quantum mechanics and applications of Schrodinger time independent wave equation in one dimension	L1
CO2	Illustrate Semiconductors, Semiconductor devices like Photo diode, LED, Solar cell and BJT and its applications	L3
CO3	Distinguish the different engineering materials such as Electronic, electrical and mechanical materials properties and their applications in engineering	L2
CO4	Apply the concept of magnetism to magnetic data storage devices.	L3
CO5	Classify Lattice parameters of different crystalline solids by using X-ray diffraction methods and its applications in science and engineering.	L2

CO6	Interpret Basic concepts of thin films and thin film deposition processes and their applications leads to Sensors and engineering devices	L3
CO7	Categorize Nano materials, Properties, and fabrication of Nano materials by using Top-down and Bottom –up approach's - Applications for Science and technology	L2

COURSE CONTENT:

MODULE 1	**8Hrs**

Quantum Mechanics: Foundations of quantum theory, wave function and its properties, de-Broglie hypothesis, Heisenberg uncertainty principle, one dimensional time independent Schrodinger wave equation, eigen values and eigen functions, applications: one dimensional motion of an electron in a potential-well.

LASER PHYSICS: Introduction to lasers, conditions for laser action, requisite of a laser system principle, construction and working of Nd-YAG and semiconductor laser, application of lasers in defense (LASER range finder), engineering (data storage) and applications of LASERS in medicine.

MODULE 2	**8Hrs**

Semiconductor Physics: Band structure, Fermi level in intrinsic and extrinsic semiconductors, Density of energy states in conduction and valence bands of a semiconductor (Mention the expression), Expression for concentration of electrons in conduction band (Derivation), Hole concentration in valance band (Mention the expression), Intrinsic carrier concentration, Conductivity of semiconductors, Hall effect, Numericals.

Semiconducting devices for optoelectronics applications: - Principle and working of LED, photodiode, Solar cell, BJT.

MODULE 3	**8Hrs**

Dielectrics: Introduction – Dielectric polarization **–** Dielectric Polarizability, Susceptibility and Dielectric constant - Types of polarizations: Electronic, Ionic and Orientation polarizations (qualitative) – Lorentz Internal field (Expression only) – Claussius - Mossoti equation (derivation) – Applications of Dielectrics – Numericals.

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability - Classification of magnetic materials: Dia, para, Ferro, antiferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials - Engineering applications.

MODULE 4	**8Hrs**

Crystallography: Lattice, unit cell, lattice parameters, crystal systems, Bravais lattices, Packing fraction for SCC, BCC and FCC crystal systems. Introduction to Miller Indices. Determination of Crystal structure by Miller Indices. Expression for Inter-planar distance. X-ray diffraction, Bragg's law and Determination of Crystal structure by Powder method. Numericals.

Mechanical Engineering Materials – mechanical properties: stress- strain curve for different materials. Introduction to Tensile strength, Compressive strength, Ductility, Toughness, Brittleness, Impact strength, Fatigue, Creep. Testing of engineering materials: Hardness Tests: Brinell and Vickers hardness test.

MODULE 5	**7Hrs**

Thin films technology: Introduction to thin-films-Advantages of thin-films over bulk materials. Thin film deposition processes- Physical vapour deposition (Thermal evaporation technique, and sputtering technique) process, Applications of Thin films.

Nano Science &technology: Introduction to Nano materials, Classification of nano materials, Size dependent properties of materials, Top-down and Bottom-up approach- Ball-milling and Photolithography, Process. Fundamental Principles of Biophysics & Applications of Nano technology in Biology and Engineering.

List of Laboratory/Practical Experiments activities to be conduct

1. I-V characteristics of a Zener Diode
I–V Characteristics of a Zener diode in forward and reverse bias condition (Module 2)
2. Planck's constant
Measurement of Planck's constant using LED (Module 2)
3.**Transistor characteristics**
Input and output characteristics of a NPN transistor in C-E configuration (Module2)
4. Dielectric constant
Determination of dielectric constant of a dielectric material (Module 2)
5. Torsional Pendulum
Determination of moment of inertia of a circular disc using torsional pendulum
6. Diffraction grating
Determination of wavelength of a laser light using diffraction grating (Module 4)
7. LCR series and parallel resonance
Study the frequency response of a series and parallel LCR circuit (Module 3)
8. Band gap energy
Determination of energy gap of an intrinsic semiconductor (Module 2)

TEXT BOOKS:

1. S. M. Sze, Semiconductor devices, Physics and Technology, Wiley. Publishing
2. Engineering Physics (2019), DSU Pearson, New Delhi.

REFERENCES:

1. M. Young (1977), Optics & Lasers An Engineering Physics approach, Springer
2. K.L. Chopra, Thin film Phenomena, McGraw Hill, New York.
3. S. O. Pillai (2018), Solid State Physics, revised edition, New Age International Publishers, New Delhi
4. M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy (2018), A textbook of Engineering Physics, S Chand, New Delhi.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**222EN1110**					
TITLE OF THE COURSE	**ENGINEERING MECHANICS**					
SCHEME OF Instruction	L	T	P	J	TotalHours	Credits
	3	-	-	-	39	3

COURSE OBJECTIVES:

The course will enable the students to

- Explain different types of forces, equilibrium conditions and related theorems
- Illustrate Couples and equivalent force couple system and related problems
- Explain concepts of friction and their relevance in Engineering problems
- Describe centroid, center of gravity, moment of inertia and mass moment of inertia and their relevance in Engineering problems
- Describe Trusses and its classification
- Determine axial forces in members of Planar determinate Truss
- Illustrate various concepts in dynamics and related problems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Understand free body diagrams and principle of statics	L2
CO2	Analyze structures using concept of equilibrium conditions considering effect of frictional forces	L4
CO3	Describe the centroid and moment of inertia of composite geometrical sections	L2
CO4	Calculate axial forces in members of determinate truss	L3
CO5	Demonstrate plane kinematics and kinetics of particles/rigid bodies	L3

COURSE CONTENT:	
MODULE 1	**9 Hrs**
Introduction to Engineering Mechanics: Introduction to Engineering Mechanics, Force Systems Basic concepts, Particle Equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Resultant- Moment of Forces and its Application; Couples and Resultant of force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium.	
MODULE 2	**7 Hrs**
Friction : Introduction, Types of friction, Limiting friction, Cone of Friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, Ladder friction, related problems.	
MODULE 3	**8 Hrs**
Centroid, Centre and gravity and Moment of inertia: Introduction, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia Definition, Moment of inertia of plane sections from first principles, Theorems of moment of	

inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder and Prism.	
MODULE 4	**7 Hrs**
Analysis of Truss: Introduction, Classification of trusses, Equilibrium in two and three dimension; Method of Sections; Method of Joints; To determine if a member is in tension or compression; Simple Trusses; Zero force members.	
MODULE 5	**8 Hrs**
Dynamics: Introduction, Rectilinear motion; Plane curvilinear motion (rectangular path, and polar coordinates); Projectile motion, Basic terms, general principles in dynamics; Types of motion, motion and simple problems; D Alembert's principle and its applications in plane motion and connected bodies.	

TEXT BOOKS:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall publications.
2. A Nelson (2009), Engineering Mechanics: Statics and dynamics, Tata McGraw Hill publications.

REFERENCES:

1. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill publications.
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications.
5. H.J. Sawant, S.P Nitsure(2018), Elements of Civil Engineering and Engineering Mechanics, Technical Publications.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1111**					
TITLE OF THE COURSE	**INTRODUCTION TO ELECTRONICS**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

COURSE OBJECTIVES:

This course enables students:

- To introduce the concepts of fundamentals of semiconductor devices with the basic knowledge of the flow of current in semiconductor devices such as diodes and transistors
- To Explain the characteristics of various semiconductor devices and the concept of Integrated circuits
- To understand the principles of electronic circuits for operations of energy conversions from AC to DC, noise removal and building the required power supply
- To understand how a particular electronic device can increase the power of a signal and also to be acquainted with gain calculations
- To implement the Boolean functions and to realize basic logic gate operations and logic functions
- To understand the basics of communication system, to modify the characteristics of carrier signals according to the information signals
- To study the fundamentals of electromagnetic waves
- To identify and understand the different blocks present in transmitter and receiver.
- To describe various parameters of Op-Amp, its characteristics and specifications.
- To understand the various applications of Op-Amp.

COURSE OUTCOMS:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Explain the fundamentals of semiconductor devices, analog and digital circuits	L2
CO2	Design and analyze the behavior of analog and digital circuits.	L3
CO3	Outline the overview of communication systems and oscillators.Solve various kinds of numerical problems.	L3
CO4	Develop the analog and digital circuits using simulation tool	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Semiconductor Diodes: Semiconductor materials- intrinsic and extrinsic types, Ideal Diode. Terminal characteristics of diodes: p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, p-n junction in breakdown region, Zener diode, Series voltage regulator, Rectifier Circuits: Half wave and full wave, Reservoir and smoothing circuits.	

MODULE 2	8Hrs
Transistors: Introduction, Transistor construction, operation and characteristics; Configuration types: Common base and common emitter configuration, Active region operation of transistor, Transistor amplifying action, Biasing the BJT: fixed bias, emitter feedback bias, collector feedback bias and voltage divider bias, Transistor as a switch: cut-off and saturation modes. Field Effect Transistors: Construction and characteristics of n-channel JFET, Types of power amplifiers: Class A operation, Class B operation, Class AB operation.	
MODULE 3	**8Hrs**
Operation Amplifier: Ideal Op-amp, Differential amplifier: differential and common mode operation common mode rejection ratio (CMRR), Practical op-amp circuits: inverting amplifier, non-inverting amplifier, comparator, summing amplifier, integrator, differentiator. The concept of positive feedback, Oscillator circuits using op amps: RC phase shift oscillator, wein bridge oscillator.	
MODULE 4	**8Hrs**
Communication system: The radio frequency spectrum, electromagnetic waves, A simple CW transmitter and receiver, modulation, demodulation, AM transmitter, FM transmitter, Tuned radio frequency receiver, Superheterodyne receiver. RF amplifiers, AM demodulators.	
MODULE 5	**7Hrs**
Digital circuits: Logic functions, Switch and lamp logic, logic gates, combinational, Logic, bistables/flipflops, application of Flip flops, Integrated circuit logic devices:introduction to Microprocessor and microcontrollers (Architecture), Related Problems.	

TEXT BOOKS:

1. Electronic Devices and Circuit Theory: Robert L Boylestad and Louis Nashelsky, Pearson Education, Eleventh Edition, 2013.
2. Electronic Circuits: Fundamentals and applications, Michael Tooley, Elsevier, Third edition, 2006.

REFERENCES:

1. David A Bell, Electronic Devices and Circuits, PHI, 5th edition, 2007.
2. Millman & Halkias, Electronics Devices and Circuits, McGraw Hill, second edition, 2010
3. Modern Digital and Analog Communication Systems by B.P.Lathi. Oxford University Press, Fourth edition, 2010
4. NPTEL- https://nptel.ac.in/courses/122/106/122106025/
   Virtual Labs- http://vlabs.iitkgp.ac.in/be/

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1112**					
TITLE OF THE COURSE	**ENGINEERING GRAPHICS & DESIGN THINKING**					
SCHEME OF Instruction	L	T	P	J	Total Hours	Credits
	2	**-**	**2**	**-**	**26(L)+26(L)**	**3**

COURSE OBJECTIVES:

- To create awareness and emphasize the need for Engineering Graphics & design thinking
- To learn using professional CAD software for construction of geometry
- To understand the concepts of orthographic and isometric projections
- To construct orthographic projection of points, lines, planes and solids
- To construct development of surfaces of solids
- To construct isometric projections of planes and solids
- To create simple engineering 3D components
- To work in a team for creating conceptual design of products
- To learn application of design methods and tools on real world problem

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Explain usage of instruments, dimensioning & tolerances, conventions and standards related to working drawings	L1
CO2	Construct points, lines, planes and solids using orthographic projections principles	L3
CO3	Construct & understand development of lateral surfaces of solids	L3
CO4	Construct geometries of planes and solids using isometric projection principles	L3
CO5	Apply the design thinking principles and recognize the significance of innovation	L3
CO6	Design various part models related to engineering field using AutoCAD modelling software	L3

COURSE CONTENT:	
MODULE 1	**4 Hrs**
Introduction to engineering graphics: Fundamentals, Drawing standard - BIS, dimensioning, Lines, lettering, scaling, symbols, dimensioning & tolerances, conventions, Introduction to orthographic projection. Types of projections & their principles **- (For CIA only)** **Introduction to computer aided drafting software**- Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, coloring, mirror, rotate, trim, extend, break, chamfer, fillet and curves **- (For CIA only)**	

MODULE 2	12 Hrs
Projection of points and lines- Orthographic projections of points in all the quadrants, Orthographic projections of lines- inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. **Orthographic projections of planes** viz triangle, square, rectangle, pentagon, hexagon and circular laminae.	
MODULE 3	**16 Hrs**
Projection of solids & development of surfaces: Projection of simple solids like prisms, pyramids, cylinder & cone when the axis is inclined to one or both of the principal planes by change of position method, Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.	
MODULE 4	**12 Hrs**
Isometric projections: Isometric scale, Isometric projection of hexahedron (cube), regular prisms, pyramids, cylinders, cones and spheres, Isometric projection of combination of two solids Conversion of Isometric Views to Orthographic Views & Conversion of orthographic views to isometric projections.	
MODULE 5	**8 Hrs**
Introduction to design thinking for innovations: A brief history of Design, Engineering Design process, Product development cycle, creation of models and their presentation in standard 3D view. Theory, Practice & Examples in Design thinking, Storytelling, Creativity and Idea Generation, Concept Development, Testing and Prototyping. **(For CIA only)**	

List of Laboratory activities to be conducted
• Manual & Computer Sketching problems for all the modules in sketch book and also take print out of the problems. • Problems to be solved in first quadrant system. • Minor Project for Design thinking in a group of students with VIVA- (Examples on Solid Modeling - Using 3D Modelling Software & Physical Model Prototype). Module1 & 5 – Only For CIA

TEXT BOOKS:

1. "A Textbook of Computer Aided Engineering Drawing", Gopalakrishna, K. R. and Sudheer Gopala Krishna (2017), Subash Publishers, Bangalore, India.
2. "Engineering Design- A Project Based Introduction", C. L. Dym and Patrick Little, John Wiley & Sons (2022)

REFERENCES:

1. "Engineering Drawing", Bhatt N.D., 3rd Edition, Charotar Publishing House, Gujarat, India,(2019)
2. "Engineering Drawing with Introduction to AutoCAD" Dhananjay .A .J, Tata McGraw-Hill Publishing Company Ltd, (2018)
3. "Engineering Design Methods: Strategies for Product Design", N. Cross, John Wiley, 2021.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22ENN1114**					
TITLE OF THE COURSE	**ENVIRONMENTAL SCIENCE**					
SCHEME OF Instruction	L	T	P	J	Total Hours	Credits
	1	**-**	**-**	**-**	**13**	**1**

COURSE OBJECTIVES:

- To understand the concepts of environment, pollution, energy resources
- To learn water as a resource, rain water harvesting as a method of conversation of water
- To explain solid waste and its management
- To learn environmental Protection Act laws, environmental Impact Analysis and air monitoring

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Critically elucidate the basic concepts that govern environmental quality, ambient air quality standards	L2
CO2	Compare different Energy resource and their environmental implications	L2
CO3	Identify different types of pollution, waste stream	L2
CO4	Identify different natural and manmade disasters and prevention	L2
CO5	Apply the process of environmental impact assessment and implications of Indian Environment Laws	L2

COURSE CONTENT:	
MODULE 1	**3 Hrs**
Definition of environment; Scope and importance of environmental studies; Basic concepts: Xenobiotic, natural & anthropogenic; why are we concerned? Eco-kinetic & Bio-kinetic Properties of a xenobiotic, Dose-Response Relationships; 3 T's, Chronic and acute effects.	
MODULE 2	**4 Hrs**
Pollution: Criteria Air pollutants – Ozone, Particulate Matter, Carbon Monoxide, Nitrogen, Oxides, Sulphur Dioxide, Lead; Acid Rain Cycle. Water as a resource; Lentic and Lotic Water Systems; Rain Water Harvesting; Water Pollution; Noise pollution-sources and effects of noise; Municipal Solid Waste: Hazardous Waste: Electronic Waste: Biomedical Waste; Solid Waste Management: Landfills, composting Process.	
MODULE 3	**2 Hrs**
Energy Types of energy: Conventional sources of energy, fossil fuel, Coal, Solar, wind; Non-conventional Sources of Energy, Biofuels - biomass, biogas.	

MODULE 4	2 Hrs
Disasters & Management; Definition, Natural (Earthquakes, landslides, floods), Man-made disasters (biological, chemical, nuclear, radiological explosions) – definition, causes and management and/or mitigation strategies; Bhopal & Chernobyl Disasters.	
MODULE 5	**2 Hrs**
Environmental Impact Assessment (EIA); Air pollution monitoring and Ambient Air Quality Standards (AAQS); Environment Protection Act, 1986.	

TEXT BOOKS:

1. Benny Joseph (2005). "Environmental Studies", Tata McGraw – Hill Publishing Company Limited, New Delhi.
2. R. J. Ranjit Daniels and Jagadish Krishnaswamy (2014). "Environmental Studies" (2014), Wiley India Pvt Limited, New Delhi.

REFERENCE BOOKS:

1. P. Aarne Vesilind, Susan M.Morgan, Thomson (2008). "Introduction to Environmental Engineering" (2008), Thomson learning, Second Edition, Boston.
2. R. Rajagopalan (2005). "Environmental Studies – From Crisis to Cure" Oxford University Press, New Delhi.

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SEMESTER	**I/II**					
YEAR	**I**					
COURSE CODE	**22EN1114**					
TITLE OF THE COURSE	**TECHNICAL ENGLISH**					
SCHEME OF Instruction	L	T	P	J	Total Hours	Credits
		-	**2**	**-**	**26**	**1**

COURSE OBJECTIVES:

- To enhance their communicative skills
- To equip students with oral and appropriate written communication skills
- To inculcate students with employability and job search skills
- To achieve proficiency in English
- To create interest among the students about any topic
- To learn the use of body language and improve verbal message
- To acquire skills for placement
- To help them frame their ideas and thoughts in a proper manner.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Make a complete Group Project: Poster Making, Power Point Presentation, Abstract Writing, Project Paper, Facing Viva	L2
CO2	Skit Performance on any social awareness theme in group.	L2
CO3	Learning how to create a Cover Letter, Job Application and Resume.	L3

COURSE CONTENT:	
MODULE 1	**4 Hrs**
Group Project: How to create a Poster & do Power Point Presentation. Learn to write an Abstract & Project Paper. Applying the basic etiquettes while facing Viva.	
MODULE 2	**12 Hrs**
Skit Performance: How to write a script. Use of powerful vocabulary, focus on pronunciation and maintaining the body language.	
MODULE 3	**16 Hrs**
Cover Letter, Job Application and Resume: Learn to create a resume. How to fill a Job Application form & create a proper Cover letter.	

REFERENCES:

- Chauhan, Gajendra S., L. Thimmesha and Smita, Kashiramka (2019) Technical Communication, Cengage Learning, New Delhi.
- Other Resources: Language Lab

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SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22EN1202**					
TITLE OF THE COURSE	**PYTHON PROGRAMMING FOR PROBLEM SOLVING**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	2	**-**	**2**	**-**	**26(L)+26(P)**	**3**

COURSE BJECTIVES:

- To understand basic concepts of computational thinking.
- To introduce python programming for problem solving.
- To introduce different debugging and unit testing tools.
- To solve real world problems using python data structures.
- Learn to handle files and exception handling in python.
- To explore Python's object-oriented features.
- To build Web services and Networked programs in python.
- To train students to design an application as part of the course mini- project using computationalthinking with python.

COURSEOUTCOMES:

CO No.	Outcomes	Bloom's TaxonomyLevel
CO1	Understand basic concepts of computational thinking.	L2
CO2	Outline basic python programming for problem solving.	L2
CO3	Apply computational thinking to solve real world programs using Python	L3
CO4	Build python programs using core data structures like list, dictionaries and tuples	L3
CO5	Implement object oriented concepts using python	L3
CO6	Design applications related to web services and network Programming.	L3

COURSE CONTENT:	
MODULE 1	**5Hrs**
INTRODUCTION: Values, expressions and statements, Conditional execution,Functions, Iterations	
MODULE 2	**6Hrs**
PYTHON DATA STRUCTURES: Python Data Structures: Strings, Arrays, Lists, Tuples, Sets and Dictionaries	
MODULE 3	**5Hrs**
PYTHON OBJECTS: Classes and Objects: Creating classes, Using Objects, Accessing attributes, Classes as Types,Introduction to Multiple Instances, Inheritance.	

MODULE 4	5Hrs
EXCEPTION HANDLING: Try-Except, Exception syntax, examples, Types of exception with except multiple exceptions with except, Try-Finally, Raise exceptions with arguments, Python built-in exceptions,User-defined exceptions, Assertions	
MODULE 5	**5Hrs**
PYTHON FILES & LIBRARIES: Files: File types, modes, File functions, File attributes, File positions, Looping over file. Basics of NumPy and Pandas	

List of Laboratory/Practical Experiments activities to be conduct

1. Python program to evaluate Values, expressions, and statements, Conditional execution, and
   Functions Iterations
   a. prompt the user to enter an integer and reverse it. And print the sum of the reversed integer.
   b. Write a python program to find whether a number (num1) is a factor of 255. c. Write a python program to find whether a number (num1) is a factor of 255. d. Write a program to find the sum of the following series:
      i. 1 + 1/3 + 1/5 + 1/7 + ... up to 'N' terms.
      ii. 1 + x/1! + x3/2! + x5/3! + x7/4 + ... x2n-1/n!
2. Python program to evaluate Python Collections
   a. Write a Python Program to demonstrate the inbuilt functions of Strings, List, and sets.
   b. Write a Python program for counting a specific letter 'o' in a given string; the number of
      times vowel 'o' appears.
   c. Write a Python Program to find the frequency of each word in given strings/strings d. Store the following for 'n' countries, using a dictionary:
      i. Name of a country, country's capital, per capita income of the country.
      ii. Write a program to display details of the country with the highest and second lowest per capita income.
3. Write a python program to create two classes "Python" and "Java" having data members "Version"
   and "name" and a member function "display()". With the help of the object, print the appropriate
   messages.
4. Create a class "Employee" with __init__ method to initialize data members: Name, Designation, Ph.
   No., and a member function display (). Create an instance for the class and display the details of the employee

5. Write an interactive calculator! User input is assumed to be a formula that consist of a number, an operator (at least + and -), and another number, separated by white space (e.g. 1 + 1). Split user input using str.split(), and check whether the resulting list is valid:
    a. If the input does not consist of 3 elements, raise a FormulaError, which is a custom
    Exception.
    b. Try to convert the first and third input to a float (like so: float_value = float (str_value)).
    Catch any Value Error that occurs, and instead raise a
    Formula Error c. If the second input is not '+' or '-', again
    raise a Formula Error

d. If the input is valid, perform the calculation and print out the result. The user is then prompted to provide new input, and so on, until the user enters quit.6. Write a Python program to count the number of lines in a text file and read the file line by line and store it into a list as well as find the longest word in the file.

7. Write a Python program to create a list of student details: usn, name dob and email {using dictionary}
and write a list to a file.
8. Generate one-hot encodings for an array in numpy.
9. Write a Pandas program to import excel data into a Pandas dataframe and find a list of employees where hire_date is between two specific month and year.

TEXT BOOKS:

1. "Python for Everybody-Exploring Data Using Python 3", Dr. Charles R. Severance,

REFERENCES:

1. "Computer Science Using Python: A Computational Problem- Solving Focus", Charles Dierbach, Introduction John Wiley, 2012.
2. "Introduction to Computation and Programming Using Python", John V Guttag,Prentice Hall of
India, 2015.
3. "How to think like a Computer Scientist, Learning with Python", Allen Downey, JeffreyElkner and
Chris Meyers, Green Tea Press, 2014.
4. "Learning to Program with Python", Richard L. Halterman, 2011.

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III SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

III SEMESTER													
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Department**	**Teaching Hours / Week**				**Examination**				
					Lecture	**Tutorial**	**Practical**	**Project**	**Duration in Hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
					L	**T**	**P**	**J**					
1	IPCC / PCC	22AM2301	Transform and Numerical Techniques	MAT	3	0	0	0	03	60	40	100	03
2	IPCC / PCC	22AM2302	Data Structures	CSE	3	0	2	0	03	60	40	100	04
3	IPCC / PCC	22AM2303	Digital Logic Design	ECE	3	0	2	0	03	60	40	100	04
4	IPCC / PCC	22AM2304	Discrete Mathematics and Graph Theory	CSE	3	0	0	0	03	60	40	100	03
5	OEC	22AM2305	Artificial Intelligence	AI& ML	3	0	0	0	03	60	40	100	03
6	PEC	22LS23XX	Liberal Studies	Not Specific	1	0	0	0	01	100	--	100	01
7	SEC	22AM2306	Skill Enhancement Course – I (JAVA Programming)	AI& ML	1	0	2	0	01	100	--	100	02
			Total		17	0	6	0					**20**

TRANSFORMS AND NUMERIAL TECHNIQUES

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

SEMESTER – III

Course Code	: 22AM2301	**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 of $e^{at}f(t)$, $t^n f(t)$ and $\frac{f(t)}{t}$ ***(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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DATA STRUCTURES

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

SEMESTER – III

Course Code	:	22AM2302	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P-J	:	3–0–2-0			

Prerequisites:

Proficiency in a C programming language.

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the basic approaches for analysing 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**

INTRODUCTION:

Introduction to Data Structure, Classification, C Structure and Union, Array Definition, Representation, Operations (Insertion, Deletion, Search and Traversal), Two/Multidimensional Arrays, sparse matrix, C Pointers

TB1: 1.1, 1.2,1.3.1-1.3.4; TB2: 2.5; RB1: 5.1 – 5.12, 6.4	
UNIT – II	**09 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: 2.1, 2.2, 2.3, 3.2, 3.3; TB2: 3.3,3.4,3.5	
UNIT – III	**09 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. TB1: 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 TB1: 5.5.3,5.5.4,5.6; TB2: 5.1,5.2,5.3,5.5,5.7	
UNIT – V	**05 Hours**
Efficient Binary Search Trees: Optimal Binary Search Trees, AVL Trees, Red Black Trees, Splay Trees. **Case Study**: B Trees TB2: 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	**Demonstrate** the key C programming concepts such as pointers, structures, unions and arrays data structures to perform operations such as insertion, deletion, searching, sorting, and traversing.	L3
2	**Utilize** the fundamental concepts of stacks and queues to solve the standard applications like tower of Hanoi, conversion and evaluation of expressions, job scheduling and maze.	L3

3	**Implement** Singly Linked List, Doubly Linked List, Circular Linked Lists, stacks and queues using linked list**.**	L3
4	**Develop** critical thinking and problem-solving skills by designing and implementing efficient algorithms for Non-linear tree data structure and perform insertion, deletion, search and traversal **operations** on it.	L3
5	**Apply** advanced techniques, such as balancing algorithms for AVL trees, Splay trees and Red-Black trees to maintain the balance and efficiency of binary trees.	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	
CO2	3		3									2	2	
CO3	3		3									2	2	
CO4	3	2	3									2	2	
CO5	3	2	3									2	2	

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

TEXT BOOKS:

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

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.,

LABORATORY EXPERIMENTS

Total Contact Hours: 26

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

1. To Implement C programs with concepts of pointers, structures.
2. To implement multidimensional array Matrix Multiplication.
3. To search elements in data structure with different search methods.
4. To implement stack, queue and their variations using arrays.
5. To implement stack, queue and their variations using singly linked lists
6. To implement conversion & evaluation of expression using stacks.
7. To Implement doubly circular Linked Lists and variations and use them to store data and perform operations on it.
8. To Implement Addition/multiplication of 2 polynomial using linked lists
9. To implement binary tree traversal techniques.

OPEN-ENDED EXPERIMENTS

1. A man in an automobile search for another man who is located at some point of a certain road. He starts at a given point and knows in advance the probability that the second man is at any given point of the road. Since the man being sought might be in either direction from the starting point, the searcher will, in general, must turn around many times before finding his target. How does he search to minimize the expected distance travelled? When can this minimum expectation be achieved?
2. The computing resources of a cloud are pooled and allocated according to customer demand. This has led to increased use of energy on the part of the service providers due to the need to maintain the computing infrastructure. What data structure will you use for allocating resources which addresses the issue of energy saving? Why? Design the solution.
3. Mini-Project on applying suitable data structure to a given real-world problem.

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DIGITAL LOGIC DESIGN

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

SEMESTER – III

Course Code	: 22AM2303	**Credits**	: 04
Hours / Week	: 03 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. **Translate** the elements of digital logic functions to digital system abstractions using Verilog.
2. **Illustrate** simplification of Boolean expressions using Karnaugh
3. **Mode**l combinational logic circuits for arithmetic operations and logical operations
4. **Analyse** and model sequestial elements flip-flops, counter, shift registers.
5. **Outline** the concept of Mealy Model, Moore Model and apply FSM to solve a given design 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: Number System- Binary, Hexa, Decimal, Octal and its conversion. Canonical Notation - SOP & POS forms, Minimization of SOP and POS forms. ***(Text Book-1: Chapter 1: 1.2 to 1.4, Chapter 2: 2.6)*** **ARITHMETIC CIRCUITS AND VERILOG MODELLING** Adders: Half adder, full adder, Ripple carry adder, parallel adder /subtractor, fast adders-CLA, comparator- 2 bit. Simplification using K-Maps ***(Text Book-2: Chapter 5: 5.2, 5.3.3, 5.4,5.5.2, 5.5.3)*** Introduction to Verilog, Syntax of Verilog coding, Modelling styles in Verilog, Verilog Operators, Test bench for simulation ***(Text Book-3: Chapter 1: 1.1, 1.2.2, 1.3.1, 1.3.2, 1.3.3, 1.4.2, 1.5.1.2, 1.5.2.2, 1.5.3.2, 1.5.4.2, 1.6.2)***	
UNIT – II	**07 Hours**
Combinational Circuit Building Multiplexers 4:1, 8:1, decoders 3:8, 2:4, demultiplexers 1:4, encoders 8:3, 4:2, code converters- B to G and G to B- Simplification using K-Maps **Verilog for combinational circuits**, if else, case-casex, casez, for loop, generate. ***(Text Book-2: Chapter 6: 6.1, 6.2, 6.3, 6.4, 6.6)***	
UNIT – III	**08 Hours**
Sequential Circuits-1 Basic Latch, Gated latches, Flip Flops SR, D, JK, T, master-slave flip-flops JK, Characteristic equations, 0's and 1's Catching Problem, Race round condition, Switch debounce, shift registers- SISO, SIPO, PISO, PIPO, Setup time, Hold time, Propagation Delay ***(Text Book-2: Chapter 7: 7.1, 7.2,7.3, 7.4,7.5,7.6, 7.8)***	
UNIT – IV	**08 Hours**
Sequential Circuits-2 Binary counters – asynchronous and synchronous, mod-n counter, ripple counter- 4 bit. Verilog blocking and non-blocking, Mealy Model, Moore Model, State machine notation, Construction of Finite State Machine. ***(Text Book-2: Chapter 7: 7.9, 7.11, 7.12.3, 7.12.4, 8.1, 8.2, 8.3, 8.4)***	
UNIT – V	**08 Hours**
Introduction to Electronic Design Automation: FPGA Design Flow, ASIC Design flow, architectural design, logic design, simulation, verification and testing, 3000 Series FPGA architecture. **Applications**: Design 4 Bit ALU, 7 Segment display, Vending Machine, 3 Pipeline. ***(Text Book-4: Chapter 1)***	
Laboratory Experiments	
Experiments are conducted using Verilog tool /Kits	
1. Introduction to Xilinx tool, FPGA flow	
2. Adder – HA, FA using data flow and behaviour modelling styles	
3. Adder – HA, FA using structural modelling style	

4.	Combinational designs – I (blocking and non-blocking/looping examples) **a.** Multiplexer: 4:1, 8:1 MUX. **b.** De Multiplexer: 1:4, 1:8 DEMUX.
5.	Combinational designs – II (different types of case statements) **c.** Encoder with and without Priority: 8:3 and 4:2. **d.** Decoder: 3:8 and 2:4.
6.	Design of 4-bit ALU
7.	Flip Flop: D FF, T FF, JK FF
8.	Design of Mod – n Up/Down Counter with Synchronous reset
9.	Design of Mod – n Up/Down Counter with Asynchronous reset.
10.	Design of Universal shift Register using FSM

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Interpret** Boolean Expressions of digital design in simplified form	L2
2	**Build** the various elements of digital logic system with Verilog	L3
3	**Construct** Combinational and Sequential logic circuits	L3
4	**Analyse** the hardware model of a digital system at different levels of abstraction in Verilog	L4
5	**Evaluate** the functionality of digital design by implementing on FPGA kits	L5
6	**Design digital** systems using FSM	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	-	1	-	-	-	-	-	-	-	1	-	1	-
CO2	3	2	1	2	3	-	-	-	1	-	1	1	2	1
CO3	3	2	3	1	2	-	-	1	1	-	1	1	2	1
CO4	3	3	2	3	3	1	-	1	-	1	2	1	2	2
CO5	3	3	2	3	3	1	-	-	-	1	-	-	2	2

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

TEXT BOOKS:

1. M. Morris Mano Michael D. Ciletti , "Digital Design with an Introduction to the Verilog HDL", 6th Edition, Pearson Education, 2014.
2. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog design", McGraw Hill, 2014.

REFERENCE BOOKS:

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2014.
2. Donald D. Givone, "Digital Principles and Design", McGraw Hill, 2015.
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, 2016.
4. Nazein M. Botros, "HDL programming (VHDL and Verilog)", Dreamtech Press, 2006.
5. Douglas J Smith, "HDL Chip Design", Doone publications 1996.

E-Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105165/
2. https://nptel.ac.in/courses/117105080

Activity Based Learning (Suggested Activities in Class)

1. Design problem solving and Programming using group discussion. E.g., Traffic light controller, Digital Clock, Elevator.
2. Demonstration of solution to a problem through simulation.

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DISCRETE MATHEMATICS AND GRAPH THEORY

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

SEMESTER – III

Course Code	: 22AM2304	**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 theirapplication.
3. **Illustrate** the association of functions, relations, partial ordered set and lattices withproblems 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.

1. ***Lecture method*** means it includes not only traditional lecture method, but different type ofteaching 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 thinkingskills such as the ability to evaluate, generalize, and analyse information rather than simplyrecall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come upwith 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 ofsets, The Addition Principle **RELATIONS AND ITS PROPERTIES:** Relations and their properties, N-Ary Relations and theirapplications, 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, PartialOrderings, 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	**09 Hours**
MATHEMATICAL INDUCTION AND RECURSION: Mathematical Induction, Recurrence Relations:Rabbits and the Fibonacci Numbers, The Tower of Hanoi, Code word Enumeration, Solving LinearRecurrence Relations **Self-Study:** Basic Connectives and Truth Tables ***Textbook-1: 4.1;6.1, 6.2;*1.1**	
UNIT – IV	**08 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, PlanarGraphs and their Applications, Graph Coloring and its applications. ***Textbook-1: 8.5, 8.7, 8.8***	
Course Outcomes: At the end of the course the student will be able to: 1. **Identify** the membership of the Set and Relations and perform basic Algebraic operations 2. **Illustrate** the concept of Mathematical Induction and create linear recurrence relations for the given problem 3. **Construct** different types of graphs based on the properties and the real time applications of graph theoretical concepts 4. **Analyze** the methods for optimizing the solution for graph coloring problem, Eulerian and Hamiltonian circuits/planes	

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 and Relations and perform basic Algebraic operations	L3

2	**Illustrate** the concept of Mathematical Induction and create linear recurrence relations for the given problem	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 Hamiltonian circuits/planes	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	1	2					1	1	1		2	2	1
CO2	3	3	2					1	1	1		2	2	1
CO3	3	3	3					1	1	1		1	2	1
CO4	3	3	3					1	1	1		2	2	1

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", 3rd Edition, 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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ARTIFICIAL INTELLIGENCE

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

SEMESTER – III

Course Code	:	22AM2305	**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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SKILL ENHANCEMENT COURSE-I
JAVA PROGRAMMING

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

SEMESTER – III

Course Code	: 22AM2306	**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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IV SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

IV SEMESTER													
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Department**	**Teaching Hours / Week**				**Examination**				**Credits**
					Lecture	**Tutorial**	**Practical**	**Project**	**Duration in Hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
					L	**T**	**P**	**J**					
1	BSC	22AM 2401	Probability & Statistics	MAT	3	0	0	0	03	60	40	100	03
2	IPCC	22AM 2402	Design and Analysis of Algorithms	CSE	3	0	2	0	03	60	40	100	04
3	PCC	22AM 2403	Database Management System	CSE	3	0	2	0	03	60	40	100	04
4	PCC	22AM 2404	Embedded Systems Design	ECE	3	0	2	0	03	60	40	100	04
5	IPCC	22AM 2405	Computer Organization and Architecture	CSE	3	0	0	0	03	60	40	100	03
6	AEC	22AM 2406	Special Topic	AI & ML	1	0	2	0	01	100	--	100	02
7	SEC	22AM 2407	Skill Enhancement Course -II (Unix And Shell Programming)	AI & ML	1	0	2	0	01	100	--	100	02
			Total		17	0	10	0					**22**

PROBABILITY AND STATISTICS

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

SEMESTER – IV

Course Code	: 22AM2401	**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 to analyze 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 as means, 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 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 : 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 problems in 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 data and 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

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		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. Pearson Education.

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 develop a skill to analyze the problem and providing solution.
2. Regular Chapter wise assignments/ Activity/Case studies can help students to have critical thinking, developing an expert mind set, problem-solving and teamwork.

Following are Assignments/ Activities Can be carried out using either R programming

language or Python Programming or excel solver.

1. There are n people gathered in a room. What is the probability that at least 2 of them will have the 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	Customer Arrivals
7:00 AM - 7:15 AM	**6**
7:15 AM - 7:30 AM	**4**
7:30 AM - 7:45 AM	**9**
7:45 AM - 8:00 AM	**7**
8:00 AM - 8:15 AM	**5**
8:15 AM - 8:30 AM	**8**
8:30 AM - 8:45 AM	**10**
8:45 AM - 9:00 AM	**6**

   analyze the customer arrivals and determine the probability distribution that best fits the data. 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 there is 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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DESIGN AND ANALYSIS OF ALGORITHMS

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

SEMESTER – IV

Course Code	:	22AM2402	**Credits**	:	04
Hours / Week	:	03 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

				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
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	: 22AM2403	**Credits**	: 04
Hours / Week	: 03 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, 2015.
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

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EMBEDDED SYSTEM DESIGN

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

SEMESTER – IV

Course Code	: 22AM2404	**Credits**	: 04
Hours / Week	: 03 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. **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 – I	**05 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	**10 Hours**
EMBEDDED SYSTEM HARDWARE DESIGN **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)*** **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 – III	**10 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)*** **Embedded Firmware Design and Development:** Embedded Firmware Design Approaches ***(Text Book 3: Chapter 9.1)***	
UNIT – IV	**10 Hours**

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)*** **Thread Management:** Introduction to RTOS, Function pointers, Thread Management, Semaphores, Thread Synchronization, Process Management, Dynamic loading and linking ***(Text Book 2: Chapter 3)*** **Time Management:** Cooperation, blocking semaphores, First In First Out Queue, Thread sleeping, Deadlocks, Monitors, Fixed Scheduling ***(Text Book 2: Chapter 4)*** **Real-time Systems:** Data Acquisition Systems, Priority scheduler, Debouncing a switch, Running event threads as high priority main threads, Available RTOS ***(Text Book 2: Chapter 5)***	
UNIT – V	**04 Hours**
EMBEDDED SYSTEM TESTING AND DEBUGGING **Integration and Testing of Embedded Hardware and Firmware:** Integration of Hardware and Firmware, Board Bring up ***(Text Book 3: Chapter 12),*** Tools used for testing and debugging**:** ***(Text Book 3: Chapter 13)***	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Apply** knowledge of embedded system design principles to solve real-world problems.	L4
2	**Design** and implement embedded systems using appropriate hardware and software components.	L5
3	**Analyze** and evaluate the performance of embedded systems through testing and debugging techniques.	L4
4	**Demonstrate** effective teamwork and communication skills in the development of embedded system projects.	L4
5	**Critically assess** the ethical and societal implications of embedded system design.	L6

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	3								2	2	3	3
CO2	3	3	3		3	2	2	1	3			2	3	3
CO3	3	3	1		3							2	3	2
CO4	3	3	3		3	2							3	3
CO5						3	3	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.
4. **Case Studies:** Provide students with real-world case studies of successful embedded system designs and ask them to analyze and present their findings.
5. **Prototyping Sessions:** Conduct hands-on sessions where students build and test small-scale embedded system prototypes using development boards and sensors.

LABORATORY EXPERIMENTS

Total Contact Hours: 26

1. Introduction to Microcontrollers: Familiarize students with microcontroller architecture and programming.
2. C as implemented in Assembly: Modify and compile a C program and observe the assembly listing and the map file.
3. General purpose I/O Lab: Implement a simple C program to read from and write to IO pins in the microcontroller.
4. Interrupt Handling: Understand interrupt handling and implement interrupt-driven tasks.
5. Analog-to-Digital Conversion: Learn how to perform analog-to-digital conversion using microcontrollers
6. Timer Lab Exercise: Signal Generator with precision Timing and Buffering
7. PWM Generation: Generate Pulse Width Modulation signals for controlling motor speed.
8. Communication Protocols: Implement I2C or SPI communication protocols between microcontrollers 9. Wireless Communication: Implement wireless communication between two or more embedded systems.
10. Power Management Techniques: Design power-efficient embedded systems using sleep modes and power management techniques
11. Real-Time Operating Systems: Implement a simple real-time task scheduler on a microcontroller.
12. System Debugging and Testing: Learn techniques for debugging and testing embedded systems.
13. Embedded System Project: Design and implement a complete embedded system project, integrating various hardware and software components.

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COMPUTER ORGANIZATION AND ARCHITECTURE

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

SEMESTER – IV

Course Code	: 22AM2405	**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 **Contrast** 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.

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SPECIAL TOPIC

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

SEMESTER – IV

Course Code	: 22AM2406	**Credits**	: 02
Hours / Week	: 01	**Total Hours**	: 26 Hours
L–T–P–S	: 0–0–0–4		

Course Learning Objectives:

This Course will enable students to:

1. To develop problem solving abilities
2. To build the necessary skill set and analytical abilities for developing computer based solutions for real life problems.
3. To train students in professional skills related to Software Industry
4. To prepare necessary knowledge base for research and development in Computer Science

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.

Following are some of the ways (but not limited to) of delivering the "Special Topics":

1. Engaging Students in Small Batches (maximum 3/batch) in Projects: DSU Faculty will define and supervise a project, which has a well-defined scope. Students will work from requirements to delivering a prototype.
2. Delivery from an Industry Expert: An industry Expert can offer a project for around 20-25 students, clearly defining the scope. The project will have 4-5 sub-modules. Each student group will work on one sub-module from requirements gathering and analysis all the way to a working module. The sub-teams will integrate the modules and will together deliver a working prototype. The industry expert will engage all the teams on one afternoon face to face. One or two SOE faculty will also co- supervise the project.
3. A Start-up company might have a few project ideas to try out and they would engage a team of 20-25 students (in 4-5 batches) to work on these project ideas from concept to a prototype, with a close supervision from the start-up company technologist together with DSU faculty.
4. Testing a new Product: A Company has come up with a new product and they require a

team of 30-40 students to thoroughly test all the features of the product and come up with a validation of the features of the product, a summary of features that fail to work and also a recommendation on a set of features that may have to be added to the product.

5. A professor from an elite university from within India or abroad, offering a short course on a domain which is very current and state of art. The content has a built in project component.
6. Industry Project: Students in a small team of 4-5 work on a project defined by an industry (including DERBI and AIC) during a semester and successfully complete the project.
7. Summer Internship: A group of students take up Summer Internship at DSU or outside, successfully complete the internship. If done within DSU, a project exhibition will also form a part of evaluation.
8. Visit to a University Abroad: A group of students participate in a well structured program in a University abroad and complete all the requirements of the university.
9. Working under a Research professor within DSU or from premium institutes such as IISc, IIT, IIIT etc on a specific project/task.

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	Elucidate 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

				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	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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SKILL ENHANCEMENT COURSE-II
UNIX AND SHELL PROGRAMMING

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

SEMESTER – IV

Course Code	: 22AM2407	**Credits**	: 02
Hours / Week	: 01	**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 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

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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	Credits
				L	T	P	J				
1	IPCC / PCC	22AM3501	Machine Learning	3	0	2	0	60	40	100	**4**
2	IPCC / PCC	22AM3502	Operating Systems	3	0	2	0	60	40	100	**4**
3	IPCC / PCC	22AM3503	Theory of Computation	3	1	0	0	60	40	100	**4**
4	IPCC / PCC	22AM3504	Computer Networks	3	0	2	0	60	40	100	**4**
5	SEC	22AM3505	Skill Enhancement Course – III (Web Development)	1	0	2	0	100	--	100	**2**
6	PEC	22AM35XX	Professional Elective Course -I	3	0	0	0	60	40	100	**3**
7	PROJ	22AM3506	Minor Project	0	0	0	4	100	--	100	**2**
8	AEC	22AM3507	Cognitive and Technical Skills - I	0	0	4	0	100	--	100	**2**
			Total	16	1	12	4				**25**

Professional Elective Courses Offering (PEC-I)											
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Hours / Week**				**Examination**			
				Lecture	**Tutorial**	**Practical**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
				L	**T**	**P**	**J**				
1	PEC	22AM3508	Pattern Recognition	3	0	0	0	60	40	100	**03**
2	PEC	22AM3509	Fundamentals of Robotics	3	0	0	0	60	40	100	**03**
3	PEC	22AM3510	Fundamentals of IoT	3	0	0	0	60	40	100	**03**
4	PEC	22AM3511	Data Science & Analytics	3	0	0	0	60	40	100	**03**

HSMC- Humanities and Social Sciences including Management Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, AEC-Ability Enhancement Course, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, OEC-Open Elective Courses, PROJ-Project Work, INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

MACHINE LEARNING

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

SEMESTER – V

Subject Code : 22AM3501		**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

				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	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

Exp No	Experiment Name
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. •Implement linear regression using sklearn library. •Split the obtained dataset into training and testing: 80-20, 70-30 ratio. •Evaluate the model using metrics: Accuracy, Mean Square Error.
3	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. Evaluate the model performance using different parameters: Accuracy, Confusion Matrix, Precision, Recall, F score, and AUC-ROC curve.
4	Apply Naïve Bayes Classifier to the given dataset and evaluate the model using a confusion matrix Precision, Recall, F score, and AUC-ROC curve.
5	Use K Nearest Neighbor technique on a given dataset and analyze the performance by changing the value of K. •Implement the KNN algorithm. •Apply KNN model on the dataset and perform testing on unseen dataset. •Change the value of K in KNN and analysis the performance of the model.
6	To 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.
7	To apply a Random Forest Classifier for classifying breast cancer tumors as benign or malignant based on features like radius and texture.
8	Use Support Vector Machine to perform the classification and regression on given dataset. •Import the dataset and perform the classification using SVM. •Evaluate the model's performance on testing dataset and validation dataset •Use Sklearn's Grid Search CV method for fine tuning of hyper-parameters.
9	Apply K-Means Clustering on the collected dataset. •Implement K-Means clustering using sklearn. •Check for the best k-value.
10	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
11	Write a Program to Implement 8-Puzzle problem using Python.

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OPERATING SYSTEMS

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

SEMESTER – V

Subject Code	:	22AM3502	**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 [3L]: Process concept; Process scheduling; Operations on processes.

Threads [2L]: Overview; Multithreading models; Threading issues, User and Kernel threads.

Process Scheduling Algorithms [4L]: Basic concepts; Scheduling Criteria; Scheduling Algorithms (FCFS, SJF, SRTF, RR, Priority).

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

Process Synchronization [3L]: The critical section problem; Peterson's solution; Synchronization

hardware; Semaphores; Classical problems of synchronization; Monitors. **Deadlocks [4L]:** 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 [4L]: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. **Virtual Memory Management [4L]:** Background; Demand paging; Performance; Page replacement algorithms (FCFS, LRU, Optimal); Allocation of frames; Thrashing.
UNIT – V File & Disk Management **08 Hours**
File Systems [4L]: File concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping). Disk Management [3L]: 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	**Elucidate** 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

				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													
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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THEORY OF COMPUTATION

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

SEMESTER – V

Subject Code	: 22AM3503	**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. Utilize regular expressions in practical applications like search and data extraction.
3. Analyze Properties of Regular and Context-Free Languages
4. Explore Context-Free Grammars and Pushdown Automata
5. Explain the working principles of Turing Machines as computational models.
6. Analyze the concept of undecidability and its implications in computation

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**
Introduction to Finite Automata. The Central Concepts of Automata Theory, Deterministic Finite Automata, Non deterministic Finite Automata, An application, Finite Automata with Epsilon Transitions. ***Textbook 1: Chapter 1.1.1, 1.5,2.1,2.2,2.3,2.4,2.5***	
UNIT – II	**10 Hours**
Regular Expression and Languages: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Properties of Regular Languages: Pumping Lemma for Regular Languages, Closure properties of Regular Languages, Equivalence and Minimization of Automata ***Textbook 1: Chapter 3.1,3.2,3.3,4.1,4.2,4.3,4.4***	

UNIT – III	11 Hours
Context Free Grammars and Languages: Context Free Grammars, Parse Tree, Applications of Context Free Grammar, Ambiguity in Grammars and Languages. Definition of Pushdown Automata, The Languages of a PDA, Equivalence of PDA's and CFG's, ***Textbook 1:Chapter 5.1,5.2,5.3,5.4,6.1,6.2,6.3***	
UNIT – IV	**10 Hours**
Deterministic Pushdown Automata, Properties of Context Free Languages, The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages. ***Textbook 1: Chapter 6.4,7.1,7.2,7.3***	
UNIT – V	**10 Hours**
Introduction to Turing Machines: The Turing Machines, Undecidability A language that is not Recursively Enumerable, An Undecidable Problem That is RE, Post Correspondence Problem, Other Undecidable Problems, Textbook 1: Chapter 8.1,8.2,9.1,9.2,9.4,9.5	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Analyze and Differentiate Automata Types.	L2
2	Formulate and Apply Regular Expressions for Text Processing.	L3
3	Demonstrate Understanding of Context-Free Grammars and Pushdown Automata	L4
4	Analyze and Prove Properties of Regular and Context-Free Languages	L4
5	Apply Turing Machines to Explore Undecidability and Computational Limits	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	3	1			2							2	
CO2	2	2											2	
CO3	2	3												

CO4	2	2											
CO5	2	2										2	

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.

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

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/

Activity Based Learning (Suggested Activities in Class)

Hands on activity, Quiz, Seminar

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COMPUTER NETWORKS

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

SEMESTER –V

Course Code	: 22AM3504	**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	**Describe** 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

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SKILL ENHANCEMENT COURSE-III
WEB DEVELOPMENT
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER –V

Course Code	: 22AM3505	**Credits**:	02
Hours / Week	: 03 Hours	**Total Hours**:	26 Hours
L–T–P-J	: 3–0–0-0		

Course Learning Objectives:

This Course will enable students to:

1. The increasing use of Internet and WWW encourages everyone to use web-based solutions for their requirements.
2. Web technology refers to the methods by which End-user devices like computers/mobiles communicate with each other.
3. This communication involves the use of web publishing languages like HTML, CSS, JavaScript and PHP.
4. Will attempt to give you a basic understanding of various aspects of web technologies

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	**05 Hours**
Introduction and **Web Design:** Introduction to Internet, WWW and Web 2.0, Web protocols and Web servers, Web Design Principles and Web site structure.	
UNIT – II	**05 Hours**
HTML AND CSS: Basics of HTML, HTML Tags and attributes, Meta tags, Character entities, hyperlink, lists, tables, images, forms, divs, XHTML	
UNIT – III	**06 Hours**
CSS: Basics of CSS, CSS properties for manipulating texts, background, colors, Gradients, Shadow Effects, borders, margins, paddings, transformations, transitions and animations, etc., CSS box modal and CSS Flex, Positioning systems of CSS, CSS media queries.	
UNIT – IV	**05 Hours**
JavaScript and jQuery: Basics of JavaScript and Client-side scripting language, JavaScript syntaxes for variables, functions, branches and repetitions. JavaScript alert, prompt and confirm. Objects in JavaScript, Access/Manipulate web browser elements using DOM Structure, forms and validations, JavaScript events.	
UNIT – V	**05 Hours**
j**Query:** Basics of jQuery, jQuery syntaxes, jQuery selectors, events, effects, Access/Manipulate web browser elements using jQuery **.**	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Recall the specifications and guidelines for constructing HTML/XHTML and CSS pages demonstrating valid structure and content.	L2
2	Comprehend the fundamentals of web hosting and domain name services.	L3
3	Identify various non-browser specific web design principles.	L2
4	Analyze the structure and components of HTML/XHTML and CSS pages.	L4
5	Demonstrate and Develop proficiency in crafting JavaScript/jQuery code to interact with the DOM and manipulate object properties effectively.	L3, 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		1	
CO2	3	3			2						2			2
CO3	3	3	3		2						2		2	
CO4	3	3	3	3	2						2		2	
CO5		2		1	2				2		2			2

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

TEXT BOOKS:

1. Ruby, Sam, David B. Copeland, and Dave Thomas. *Agile web development with rails 6*. Pragmatic Bookshelf, 2020.
2. bin Uzayr, Sufyan. *Mastering MySQL for Web: A Beginner's Guide*. CRC Press, 2022.

REFERENCE BOOKS:

1. Meloni JC, Kyrnin J. HTML, CSS, and JavaScript All in One: Covering HTML5, CSS3, and ES6, Sams Teach Yourself. Sams Publishing; 2018 Dec 4.
2. Moseley, Ralph. Developing web applications. John Wiley & Sons, 2007.
3. Lindley, Cody. jQuery Cookbook: Solutions & Examples for jQuery Developers. " O'Reilly Media, Inc.", 2009.
4. Benedetti, Ryan, and Ronan Cranley. Head First JQuery: A Brain-Friendly Guide. " O'Reilly Media, Inc.", 2011.
5. Connolly, Randy, Ricardo Hoar, Soumen Mukherjee, and Arup Kumar Bhattacharjee. Fundamentals of web development. Pearson, 2015.
6. Ranjan, Alok, Abhilasha Sinha, and Ranjit Battewad. JavaScript for modern web development: building a web application using HTML, CSS, and JavaScript. BPB Publications, 2020

E-Resources:

1. http://it5443.azurewebsites.net
2. https://www.w3schools.com
3. https://developer.mozilla.org
4. http://html.net

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 – V

Course Code	: 22AM3506	**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, 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.

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 inputand 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 specific on a topic were the students has to take up a for the minor project which caters an idea for their final year capstone project.
4. All minor 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 tocarry out the research by student
   3. Ability to provide and evaluate the strong literature review document forthe 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 todepartment 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 paperwithin the stipulated time framed by the university

Evaluation:

1. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department based on the rubrics
2. 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	Elucidate 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													
				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	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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PATTERN RECOGNITION

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

SEMESTER – V

Subject Code	: 22AM3508	**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 concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms.
2. **use** the feature extraction techniques on the given data**.**
3. **Make use of** both supervised and unsupervised classification methods to detect and characterize patterns of image, text data.
4. **Apply** the different Neural Network techniques to handle the given problems.
5. **Build** prototype of pattern recognition algorithms that can be used to study algorithm behaviour and performance against real-world 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. 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 Pattern Recognition, Phases in Pattern Recognition System, Different approaches to Pattern Recognition, Tools and process of finding patterns in data, Pattern Class, pattern recognition examples, Machine perception.

The Sub-problems of Pattern Classification Systems: Feature Extraction, cost of miss classification, Multiple Features, Model complexity, Missing Features, Segmentation and Pattern recognition systems-Two Phases.

Learning and Adaptation: Supervised Learning, Unsupervised Learning, Reinforcement Learning.

(Text-1-Chapter 1)

UNIT – II	**09 Hours**

Feature Extraction from The Pattern: Shape Feature Extraction: Chain Code, Differential Chain Code, Splitting Technique. Region Feature Extraction: Texture Feature-Spatial Domain Feature and Transformed Domain Feature.

Bayes Decision Theory: Decision Rule, Class-Conditional Probability Density Function, Bayes' Formula, Generalization of Bayes Theory. Minimum Error Rate Classification: Minimum Risk Classifier, Maximum Likelihood Estimation.

(Text 1: Chapter 2 And 3 And Text 2: Chapter 3)

UNIT – III	**07 Hours**
Introduction To Clustering; Different Distance Measures and Criterion Functions for Clustering, Techniques: K-Mean Clustering, Hierarchical Clustering - Agglomerative and Divisive Clustering, DB Scan, Mean Shift Clustering and appropriate Applications. (Text -1-CH:10)	
UNIT – IV	**08 Hours**
Introduction To Neural Network: Multilayer Neural Network: Feedforward Operation and Classification, Backpropagation Algorithm. Introduction To Hessian and Jacobian Matrix, Probabilistic Neural Network, Bayesian Neural Network and Convolutional Neural Networks (CNN), Recurrent Neural Network. (Text1: Chapter 6 , Text2:Chapter 5)	
UNIT – V	**07 Hours**
Feature Extraction Techniques on Speech Data - Fast Fourier Transform (FFT) Discrete Cosine Transforms; Image and Speech Based Machine Learning for Pattern Recognition Applications: (Eg. Approaches Like Speech Recognition, Fingerprint Recognition, Character Recognition, Pattern Recognition Approaches). (Case Study).	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	**Describe** the fundamentals, subproblems and phases in pattern recognition.	L2
2	**Make use of** the Shape, Texture, Region Based Feature Extraction techniques, and a statistical approach to extract patterns in the field of Computer Vision, Image and Speech Recognition Applications.	L3
3	**Utilize** the different clustering techniques for the recognition of patterns from the unlabeled data.	L3
4	**Apply** the different Neural Network techniques such as Probabilistic Neural Network, Bayesian Neural Network and Convolutional Neural Networks (CNN), Recurrent Neural Network to handle the linear and nonlinear data.	L3
5	**Develop** prototype of pattern recognition techniques that can be used to study the behavior of an algorithm and its performance in the field of Computer Vision, Image and Speech Recognition 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**

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

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

TEXT BOOKS:

1. Ulisses Braga-Neto "Fundamentals of Pattern Recognition and Machine Learning" ISBN-13 : 978-3030276584, 2021.
2. Richard O. Duda, peter E. Hart and David G. Stork" Pattern Classification", 2ND Edition, Wiley Interscience, 2012.
3. Christopher M. Bishop," Pattern Recognition and Machine Learning", Springer Science, Business Media, LLC, 2012.

REFERENCE BOOKS:

1. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
2. Robert J.Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, JohnWiley& Sons Inc., New York, 2007.

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

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FUNDAMENTALS OF ROBOTICS

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

SEMESTER – V

Subject Code	: 22AM3509	**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	: 22AM3510	**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	**Elucidate** 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

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.
5. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media,2016.
6. Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.
7. Adrian McEwen, Hakim Cassimally, "Designing the Inernet of Things", Wiley Publications, 2013

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	:	22AM3511	**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													
				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	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.

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.
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.

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.

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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	Credits
				L	T	P	J				
1	HSMC	22AM3601	Innovation and Entrepreneurship	2	0	0	0	60	40	100	**02**
2	IPCC / PCC	22AM3602	Deep Learning	3	0	0	0	60	40	100	**03**
3	IPCC / PCC	22AM3603	Compiler Design and System Software	3	0	2	0	60	40	100	**04**
4	IPCC / PCC	22AM3604	Image Processing and Computer Vision	3	0	2	0	60	40	100	**04**
5	PEC	22AM36XX	Professional Elective Course – II	3	0	0	0	60	40	100	**03**
6	PEC	22AM36XX	Professional Elective Course – III	3	0	0	0	60	40	100	**03**
7	OEC	22OEXXXX	Open Elective – I	3	0	0	0	60	40	100	**03**
8	AEC	22AM3605	Cognitive and Technical Skills - II	0	0	4	0	100	--	100	**02**
			Total	20	0	8	0				**24**

Professional Elective Courses Offering (PEC-II)											
SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credits
				L	T	P	J				
1	PEC	22AM3606	Explainable AI	3	0	0	0	60	40	100	**03**
2	PEC	22AM3607	Reinforcement Learning	3	0	0	0	60	40	100	**03**
3	PEC	22AM3608	Cryptography & Network Security	3	0	0	0	60	40	100	**03**
4	PEC	22AM3609	Predictive Analytics	3	0	0	0	60	40	100	**03**

Professional Elective Courses Offering (PEC-III)											
SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credits
				L	T	P	J				
1	PEC	22AM3610	Natural Language Models	3	0	0	0	60	40	100	**03**
2	PEC	22AM3611	Robot Operating System (ROS)	3	0	0	0	60	40	100	**03**
3	PEC	22AM3612	GPU Architecture	3	0	0	0	60	40	100	**03**
4	PEC	22AM3613	Financial Technology (FinTech)	3	0	0	0	60	40	100	**03**

Open Elective Course Offering (OEC-I)											
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Hours / Week**				**Examination**			
				Lecture	**Tutorial**	**Practical**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
				L	**T**	**P**	**J**				
1	OEC	22OE0026	Industrial Robotics	3	0	0	0	60	40	100	**03**
2	OEC	22OE0044	Machine Learning for Health Care	3	0	0	0	60	40	100	**03**

HSMC- Humanities and Social Sciences including Management Courses, IPCC-Integrated Professional Core Course, PCC-Professional Core Courses, AEC-Ability Enhancement Course, SEC-Skill Enhancement Courses, PEC-Professional Elective Courses, OEC-Open Elective Courses, PROJ-Project Work, INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

INNOVATION AND ENTREPRENEURSHIP

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

SEMESTER – VI

Subject Code	: 22AM3601	**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 **05 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 **05 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	**05 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	**05 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	**06 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	Elucidate organizing managing people, finance and customers	L2

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
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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DEEP LEARNING

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

SEMESTER – VI

Subject Code	: 22AM3602	**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 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, Types of Perceptron, Application of single layer perceptron. Introduction to Feedforward Neural Networks: Single layer, Single layer perceptron application and Multilayer Feedforward NN, training neural networks, Backpropagation in neural network, activation functions, loss functions, Model Selection.

Introduction to Deep Learning, Principles of Deep Networks, and Building blocks of deep networks. (Text 2: Chapters 2&3)

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

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

MODULE 3: INTRODUCTION TO CNN **08 Hours**

Convolutional Neural Networks (CNNs) - Biological inspiration, Mapping of Human Visual System and CNN. Convolution operation, Convolutional Layers, Padding and Stride, Batch normalization and layers, Subsampling, Pooling, Fully Connected CNN, Transfer Learning, Overview of Alex Net, VGG, Google Net, Res Net.

(Text1: Chapter 7)

MODULE 4: SEQUENCES TO MODEL **08 Hours**
Introduction to RNN: Basics of RNN, RNN's Computational Graph across Time, RNN's For Sequence Modeling- Language Modeling, Back Propagation Through Time, Standard RNN Gradient Flow, 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), Introduction to Generative Adversarial Networks (GANs), Restrictive Boltzmann Machines (RBMs Momentum Optimizer, Adam, Transformers. Deep Learning Applications in Healthcare and other areas (Case study) Text 1: chapter 20

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

				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	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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COMPILER DESIGN AND SYSTEM SOFTWARE

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

SEMESTER – VI

Subject Code	: 22AM3603	**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. Understand the basic system software components such as assembler, loader, linkers, compilers.
2. Provide an understanding of the fundamental principles in compiler design
3. Discuss the techniques of scanning, parsing & semantic elaboration well enough to build or modify front end.
4. Illustrate the various optimization techniques for designing various optimizing compilers.

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	**08 Hours**

Introduction to System Software, ASSEMBLERS

Introduction to System Software, Machine Architecture of SIC and SIC/XE. ASSEMBLERS: Basic assembler functions: A simple assembler, Assembler algorithm and data structures, Machine dependent assembler features: Instruction formats and addressing modes – Program relocation, Machine independent assembler features: Literals, Symbol-defining statements, Expressions, Program blocks

TextBook 1: Chapter 1,Chapter 2

UNIT – II	**08 Hours**

LOADERS AND LINKERS

Basic loader functions: Design of an Absolute Loader, A Simple Bootstrap Loader, Machine dependent loader features: Relocation, Program Linking, Algorithm and Data Structures for Linking Loader, Machine-independent loader features: Automatic Library Search, Loader Options, Loader design options: Linkage Editors, Dynamic Linking

TextBook 1: Chapter 3

UNIT – III	**08 Hours**

COMPILERS

Introduction: Language Processors, Structure of compiler, The science of building a compiler, Applications of compiler technology. 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: Lexical vs Syntactic Analysis, Eliminating ambiguity, Left recursion, Left factoring.

TextBook 2: Chapter 1,Chapter 4

UNIT – IV	**08 Hours**

SYNTAX ANALYSIS 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, S-Attributed Definition, L-Attributed Definition, Application: Construction of Syntax Trees.

TextBook 2: Chapter 4,Chapter 5

UNIT – V	**07 Hours**

INTERMEDIATE CODE GENERATION

Three Address Code: Addresses and Instructions, Quadruples, Triples, indirect triples. CODE GENERATION: Issues in the design of code generator, Basic Blocks, Optimization of Basic Blocks, The Code Generation Algorithm, Peephole optimization. MACHINE INDEPENDENT OPTIMIZATION: The Principal Sources of Optimization

TextBook 2: Chapter 6

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Elucidate the basic functions and features of assemblers, including machine-dependent and machine-independent aspects.	L2
2	Analyze the functions and design principles of loaders and linkers, considering both machine-dependent and machine-independent features.	L4
3	Discuss the components and structure of compilers, and evaluate the applications and importance of compiler technology.	L3, L5
4	Summarize various parsing techniques such as top-down and bottom-up parsing, including LR parsing, and illustrate syntax-directed translation methods.	L3
5	Evaluate the process of intermediate code generation and optimization techniques, including the design of code generators and machine-independent optimization strategies.	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							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	3	1		3						1	2	2	2
CO5	3	3	3	3	3						2	3	3	3

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

TEXTBOOKS:

1. "System Software: An Introduction to Systems Programming" by Leland L. Beck and D.Manjula was the 3rd edition, published in 2020.
2. "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. V. Raghavan, Principles of Compiler Design||, Tata McGraw Hill Education Publishers, 2010.
2. 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.

E-Resources

1. Compiler Design - Course (nptel.ac.in)

Activity Based Learning(Suggestion Activities in Class)

1. Presentation
2. Group Discussion

LABORATORY EXPERIMENTS

1. Program to count the number of characters, words, spaces and lines in a given input file.
2. Program to recognize and count the number of identifiers in a file.
3. Program to count the numbers of comment lines in a given C program. Also eliminate them and copy the resulting program into separate file. 2b. Program to recognize whether a given sentence is simple or compound.
4. Program to count no of: i.+ve and –ve integers ii. +ve and –ve fractions
5. Program to count the no of „scanf‟ and „printf‟ statements in a C program. Replace them with „readf‟ and „writef‟ statements respectively. 4.Program to evaluate arithmetic expression involving operators +,-,*,/
6. Program to recognize a valid variable which starts with a letter, followed by any number of letters or digits.
7. Program to recognize the strings using the grammar (an b n ;n>=0)
8. C Program to implement Pass1 of Assembler
9. C Program to implement Absolute Loader
10. C program to find the FIRST in context free grammar.
11. C Program to implement Shift Reduce Parser for the given grammar E →E+E E→E*E E→(E) E → id

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IMAGE PROCESSING AND COMPUTER VISION

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

SEMESTER – VI

Subject Code	: 22AM3604	**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:

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														
				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
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.

Laboratory Experiments:

1. Write a program for the simulation and display of an Image, Negative of an Image (Binary & Gray Scale), and Implementation of the Transformation of an Image.
2. Implement contrast stretching of a low-contrast image, Histogram, and Histogram Equalization.
3. Implement the different filtering techniques for noise removal based on spatial and frequency domains using OpenCV.
4. Write a program to implement the Canny Edge detection algorithm.
5. Implement different Region-based Image segmentation techniques and threshold-based image segmentation techniques.
6. Write a program to implement the Image Compression technique such as Huffman Coding Algorithm.
7. Write a program to implement different Morphological Image Processing Techniques.
8. Implement the Harris Corner Detector algorithm without the inbuilt Open CV() function.
9. Write a program to compute the SIFT feature descriptors of a given image.
10. Write a program to detect the specific objects in an image using HOG.
11. Implement forward and backward propagation for a simple neural network
12. Create and train a multilayer perceptron (MLP) for classifying handwritten digits from the MNIST dataset.
13. Use pre-trained models like VGG16 or ResNet50 for image classification on a custom dataset.
14. Develop a Time Series Forecasting model using Recurrent Neural Networks (RNN).
15. Use LSTM networks to classify sequences, such as sentiment analysis on text data
16. Implement an autoencoder for reducing the dimensionality of the MNIST dataset and visualize the reconstructed images.
17. Create a Generative Adversarial Network (GAN) to generate MNIST Handwritten Digits.

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EXPLAINABLE AI

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

SEMESTER – VI

Subject Code	:	22AM3606	**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	:	22AM3607	**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

				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	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	:	22AM3608	**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

				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	-	-	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	: 22AM3609	**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														
				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	-	-	-	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

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NATURAL LANGUAGE MODELS

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

SEMESTER – VI

Subject Code	: 22AM3610	**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 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, 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

				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									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

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.
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.

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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ROBOT OPERATING SYSTEM (ROS)

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

SEMESTER – VI

Subject Code	: 22AM3611	**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	**Elucidate** 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

				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	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)

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.
4. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy Paperback – Import, 25 May 2018 by Lentin Joseph

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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GPU ARCHITECTURE

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

SEMESTER – VI

Subject Code	: 22AM3612	**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

				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	
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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FINANCIAL TECHNOLOGY (FINTECH)

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

SEMESTER – VI

Subject Code	:	22AM3613	**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

				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					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).

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.
5. Chishti, Susanne. The AI book: the artificial intelligence handbook for investors, entrepreneurs and fintech visionaries. John Wiley & Sons, 2020.

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	:	22OE0026	**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 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 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	:	22OE0044	**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	Elucidate 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

				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	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.

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.
2. Sergio Consoli, Diego ReforgiatoRecupero, Milan Petkovic, Data Science for Healthcare Methodologies and Applications, 2019.
3. 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.

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	Credits
				L	T	P	J				
1	SEC	22AM4701	Skill Enhancement Course-IV (Designing MLOps For Enterprises)	1	0	2	0	100	--	100	**02**
2	PROJ	22AM4702	Capstone Project Phase-I	0	0	0	6	100	--	100	**03**
3	PEC	22AM47XX	Professional Elective Course – IV	3	0	0	0	60	40	100	**03**
4	PEC	22AM47XX	Professional Elective Course – V/ MOOC course	3	0	0	0	60	40	100	**03**
5	OEC	22OEXXXX	Open Elective – II	3	0	0	0	60	40	100	**03**
			Total	12	0	0	6				**14**

Professional Elective Courses Offering (PEC-IV)											
SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credits
				L	T	P	J				
1	PEC	22AM4703	AI Ethics	3	0	0	0	60	40	100	**03**
2	PEC	22AM4704	Industry 5.0	3	0	0	0	60	40	100	**03**
3	PEC	22AM4705	Quantum Computing	3	0	0	0	60	40	100	**03**
4	PEC	22AM4706	Big Data Analytics	3	0	0	0	60	40	100	**03**

Professional Elective Courses Offering (PEC-V)											
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Hours / Week**				**Examination**			
				Lecture	**Tutorial**	**Practical**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
				L	**T**	**P**	**J**				
1	PEC	22AM4707	Generative AI	3	0	0	0	60	40	100	**03**
2	PEC	22AM4708	Robotics and Automation Application	3	0	0	0	60	40	100	**03**
3	PEC	22AM4709	Blockchain Technology	3	0	0	0	60	40	100	**03**
4	PEC	22AM4710	UG Research Project	3	0	0	0	60	40	100	**03**

Open Elective Course Offering (OEC-II)											
SL	**Course Type**	**Course Code**	**Course Name**	**Teaching Hours / Week**				**Examination**			
				Lecture	**Tutorial**	**Practical**	**Project**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
				L	**T**	**P**	**J**				
1	OEC	22OE0045	Responsible AI & Ethics	3	0	0	0	60	40	100	**03**

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, OEC-Open Elective Courses, PROJ-Project Work,INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

SKILL ENHANCEMENT COURSE-IV
DESIGNING MLOPS FOR ENTERPRISES

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

SEMESTER – VII

Subject Code	: 22AM4701	**Credits**:	02
Hours / Week	: 3 Hours	**Total Hours**:	26 (T) + 13 (L) Hours
L–T–P–S	: 1–0–2–0		

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	Elucidate 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.

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.
4. Sculley, David, et al. "Machine learning: The high interest credit card of technical debt." (2014).
5. Jez Humble, David Farley. Continuous Delivery.,2011

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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CAPSTONE PROJECT PHASE - I

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

SEMESTER – VII

Subject Code	:	22AM4702	**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 theselected 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.

2. 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.
3. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
4. Show Video/animation films to explain the 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. 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:

6. The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further.
7. 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.
8. 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.
9. 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.
10. The following criteria will be checked by the department chairman to approve for theresearch proposal:

a. Department staff as course guide

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

b. Student Team

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

Evaluation:

3. Phase-1 comprises of Literature Survey, Problem identification, Objectives and Methodology.
4. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department based on the rubrics
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	Elucidate 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

				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	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	:	22AM4703	**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														
				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	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	:	22AM4704	**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

				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	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.

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
6. Saini, Aarti, and Vikas Garg, eds. Transformation for Sustainable Business and Management Practices: Exploring the Spectrum of Industry 5.0. Emerald Publishing Limited, 2023.

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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QUANTUM COMPUTING

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

SEMESTER – VII

Subject Code	:	22AM4705	**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 apply techniques of linear algebra to quantum mechanics
2. To analyze basic quantum circuits
3. To explore the techniques of quantum algorithms
4. To study the protocols of quantum cryptography
5. Apply Quantum Computing techniques to solve real world 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*** 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**

Linear Algebra For Quantum Mechanics& Introduction To Quantum Mechanics:

linear algebra for quantum mechanics : Linear Independence, Linear Operators and Matrices, Inner Products Eigen Vectors and Eigen Values.

Introduction to quantum mechanics: Basic principles of quantum mechanics, Dirac notation and bra-key notation and Quantum superposition and measurement.

UNIT – II	**08 Hours**

QUBITS AND QUANTUM GATES: Introduction to Qubits ,Quantum states in Hilbert space, The Bloch sphere, Density operators, generalized measurements, no-cloning theorem.Quantum gates: Quantum logic gates,Hadamard gate, CNOT , Quantum wire, Quantum well, Quantum dot, fullerenes, Graphene, Carbon nanotubes, Universal set of gates, quantum circuits.

UNIT – III	**08 Hours**

QUANTUM ALGORITHMS:Quantum search algorithm,Quantum parallelism and quantum speedup,Quantum teleportation, Deutsch- Jozsa algorithm and Grover's algorithm.

UNIT – IV	**07 Hours**

QUANTUM CRYPTOGRAPHY: Private Key Cryptography, Privacy Amplification, Quantum Key Distribution(BB84 protocol), Privacy and Coherent Information, Security of Quantum Key Distribution.Quantum secure communication,Post-quantum cryptography.

UNIT – V	**07 Hours**

QUANTUM MACHINE LEARNING AND APPLICATIONS:

Quantum Machine learning: Quantum Convolution Neural Network(QCNN),Differences between a Quantum CNN and Classical CNN.
Applications of Quantum Computing: Identify real-world problems that can be addressed using quantum computing techniques.Develop and propose solutions to real-world problems using quantum algorithms and methodologies.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Recall the fundamental principles of quantum mechanics, including superposition and quantum measurement.	L2
2	Implement the simple Quantum logic gates, Hadamard gate, Universal set of gates and quantum circuits.	L3
3	Analyse the behaviour of quantum algorithms such as Deutsch-Jozsa , Grover's algorithm .	L4
4	Summarise the concepts of Quantum Cryptography and Quantum key distribution and the protocols of quantum cryptography.	L2
5	Apply QCNN model to solve real world problems and analyse the difference between classical CNN and Quantum CNN .	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	-	1	2	1	-	-	-	-	-	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	3	-	-	-	-	-	-	-	-	-
CO4	3	2	-	3	3	3	-	2	-	-	3	-	-	3
CO5	3	3	2	3	3	3	-	-	3	3	3	-	3	3

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

TEXT BOOK:

1. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Cambridge, 2020
2. Nielsen, M. A., & Chuang, I. Quantum computation and quantum information.The Cambridge University Press, 2010 .

REFERENCES:

1. Phillip Kaye, Raymond Laflamme et. al., An introduction to Quantum Computing, Oxford University press, 2007.

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BIG DATA ANALYTICS

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

SEMESTER – VII

Subject Code	: 22AM4706	**Credits**	: 03
Hours / Week	: 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 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 :	**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														
				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	-	-	-	-	-	-	-	-	-	-	-
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.

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.
3. 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.

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GENERATIVE AI

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

SEMESTER – VII

Subject Code	:	22AM4707	**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 Generative AI.
2. To provide a basic exposition to different types of Prompt Engineering.
3. Make use of the different Generative AI models such as GPT, attention models and transformers.
4. Make use of the different Language Models for handling text data.
5. To design the Generative AI models for various applications related to handling the texand Image 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	**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	**08 Hours**

Prompt Engineering: Understanding the concept and significance of prompt engineering, Principles of Prompting, Strategies for designing effective prompts, Techniques for Prompt Engineering (Template-based prompts, Rule-based prompts, and Fine-tuning prompts), Best practices for prompt engineering in generative AI, Enhancing Model Outputs.

UNIT – III	**08 Hours**

Generative AI Concepts: Encoder/decoder architectures as basis for Generative AI, the role of the latent space, Transformer architectures and Attention, Conditional Generative Models, Introduction to GPT and its significance, Architecture and working of GPT models.

UNIT – IV	**09 Hours**
Language Models and LLM Architectures Introduction to language models and their role in AI, how do large language models work? Difference Between Large Language Models and Generative AI, Examples of LLMs (Generative Pre-trained Transformer 3, Bidirectional Encoder Representations from Transformers, Text-to-Text Transfer Transformer, Robustly Optimized BERT Pretraining Approach), Leading language models and their real-life applications.	
UNIT – V	**09 Hours**
Case Study of Generative AI and Language Models: using ChatGPT3, BERT, T5, RoBERTa; SRGAN, ESRGAN, Cycle GAN, StyleGAN, text-2-image, GAN in Computer Vision.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Recall the fundamental concepts of Generative AI.	L2
2	Utilize the different types of Prompt Engineering to generate the prompts.	L3
3	Make use of the different Generative AI models such as GPT, attention models and transformers to generate text and Image data.	L4
4	Make use of the different Language Models for handling text data.	L4
5	Design the Generative AI models for various applications related to handling the text and Image data.	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			2				1				2	2
CO2	3		1			2			1				1	2
CO3	2	2			1				1				2	2

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

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.

Reference Books:

1. 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
2. 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.
3. 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://www.datacamp.com/blog/what-is-prompt-engineering-the-future-of-ai-communication
2. https://www.promptengineering4u.com/learning/techniques/template-based-prompting#h.2n56pv37pv0c

Activity Based Learning (Suggested Activities in Class)

1. Flipped Class Activity on Searching techniques.
2. Problem Solving and Discussion.
3. GPT (Generative Pre-trained Transformer) Pre-training and fine-tuning processes.
4. Mini Project

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ROBOTICS AND AUTOMATION APPLICATION

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

SEMESTER – VII

Subject Code	:	22AM4708	**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													
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	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.

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.
4. Bhattacharyya, Siddhartha, Jyoti Sekhar Banerjee, and Debashis De, eds. *Confluence of Artificial Intelligence and Robotic Process Automation*. Vol. 335. Springer Nature, 2023.

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	:	22AM4709	**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. Learn the underlying principles and techniques associated with block chain Technologies.
2. Understand and describe how blockchain works
3. Familiarize with Ethereum, smart contracts and related technologies, and solidity language.
4. 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.

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 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:

1. Lantz, Lorne, and Daniel Cawrey. Mastering blockchain. O'Reilly Media, 2020.
2. Comuzzi, Marco, Paul Grefen, and Giovanni Meroni. Blockchain for Business: IT Principles into Practice. Routledge, 2023.

REFERENCE BOOKS:

1. Bashir, Imran. Mastering blockchain. Packt Publishing Ltd, 2017.
2. Raj, Pethuru, Kavita Saini, and Chellammal Surianarayanan, eds. Blockchain technology and applications. CRC Press, 2020.
3. 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.
4. 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	:	22AM4710	**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:

8. **To identify** key research questions within a field to carry out research in a team.
9. **To identify** and summarize the literature review of the relevant field.
10. **To demonstrate** relevant referencing and inculcate new skills in various aspects of academic writing.
11. **To demonstrate** the knowledge and understanding of writing the publication/report.
12. **To showcase** the strong evidence on the clarity of the argument, understanding of theselected domain area and presentation of its technical information.
13. **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.
14. **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.

6. 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.
7. Interactive Teaching: Adopt Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
8. Show Video/animation films to explain the functioning of various concepts.
9. Encourage Collaborative (Group Learning) Learning in the class.
10. To make Critical thinking, ask at least three Higher-order Thinking questions in the class.
11. 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
   11. Ability to provide research direction to the student in the chosen field of interest
   12. Ability to design an appropriate research strategy and methodology to carry out the research by student
   13. Ability to provide and evaluate the strong literature review document for the chosen research topic
   14. Ability to train students on research paper / technical writing skills
   15. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team
   9. To be dedicated and committed to work on a new research topic by learning new technical skills
   10. To have fair knowledge on what is product development or research topic
   11. To have constant interaction with allocated guide by providing weekly updates
   12. 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	Describe 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														
				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	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	:	22OE0045	**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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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	Credits
				L	T	P	J				
1	PROJ	22AM4801	Capstone Project Phase-II	0	0	0	22	100	--	100	**11**
2	INT	22AM4802	Research Internship/ Industry Internship	0	0	0	6	100	--	100	**03**
			Total	0	0	0	28				**14**

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, OEC-Open Elective Courses, PROJ-Project Work,INT-Internship, CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. Of Credits

CAPSTONE PROJECT PHASE - II

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

SEMESTER – VIII

Subject Code	:	22AM4801	**Credits**	:	11
Hours / Week	:	11	**Total Hours**	:	143 Hours
L–T–P–S	:	0–0–0–22			

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 theselected 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

				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	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

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

SEMESTER – VIII

Subject Code	:	22AM4802	**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													
				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	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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