DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

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

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

Graduation Year: 2023-2027

SCHEME - B.TECH – 2023-24 ONWARDS

I SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
				L	T	P	J	C		CIE	SEE	TM
1	101-105, 121–123 & 141	23EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	0	0	0	3	3	60	40	100
2	101-105, 121–123 & 141	23EN1102	C PROGRAMMING FOR PROBLEM SOLVING	2	1	2	0	4	3	60	40	100
3	101-105, 121–123 & 141	23EN1103	ENGINEERING CHEMISTRY	2	0	2	0	3	3	60	40	100
4	101-105, 121–123 & 141	23EN1104	INTRODUCTION TO MECHANICAL ENGINEERING	2	0	2	0	3	3	60	40	100
5	101-105, 121–123 & 141	23EN1105	INTRODUCTION TO ELECTRICAL ENGINEERING	2	0	0	0	2	3	60	40	100
6	101-105, 121–123 & 141	23EN1106	ENGINEERING MECHANICS	2	0	0	0	2	3	60	40	100
7	101-105, 121–123 & 141	23EN1107	TECHNICAL ENGLISH	2	0	0	0	2	1	100	–	100
8	101-105, 121–123 & 141	23EN1108	ENVIRONMENTAL SCIENCE	1	0	0	0	1	1	50	–	50
9	101-105, 121–123 & 141	23EN1109	KANNADA KALI / MANASU	1	0	0	0	0	1	50	–	50
TOTAL				17	1	6	0	20		560	240	800

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

SCHEME - B.TECH – 2023-24 ONWARDS

I SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
				L	T	P	J	C		CIE	SEE	TM
1	101-105, 121–123 & 141	23EN1101	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	0	0	0	3	3	60	40	100
2	101-105, 121–123 & 141	23EN1102	C PROGRAMMING FOR PROBLEM SOLVING	2	1	2	0	4	3	60	40	100
3	101-105, 121–123 & 141	23EN1110	ENGINEERING PHYSICS	3	0	2	0	4	3	60	40	100
4	101-105, 121–123 & 141	23EN1111	INTRODUCTION TO ELECTRONICS ENGINEERING	3	0	0	0	3	3	60	40	100
5	101-105, 121–123 & 141	23EN1112	ENGINEERING GRAPHICS AND DESIGN THINKING	2	0	2	0	3	3	60	40	100
6	101-105, 121–123 & 141	23EN1113	BIOLOGY FOR ENGINEERS	2	0	0	0	2	1	100	–	100
7	101-105, 121–123 & 141	23EN1114	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	1	0	0	0	1	1	50	–	50
			TOTAL	16	1	6	0	20	17	450	200	650

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

SCHEME - B.TECH – 2023-24 ONWARDS

II SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Duration in Hrs Exam	Examination (Maximum Marks)		
				L	T	P	J	C		CIE	SEE	TM
1	101-105, 121–123 & 141	23EN1201	SINGLE AND MULTIVARIATE CALCULUS	3	0	0	0	3	3	60	40	100
2	101-105, 121–123 & 141	23EN1202	OBJECT ORIENTED PROGRAMMING	2	1	2	0	4	3	60	40	100
3	101-105, 121–123 & 141	23EN1103	ENGINEERING CHEMISTRY	2	0	2	0	3	3	60	40	100
4	101-105, 121–123 & 141	23EN1104	INTRODUCTION TO MECHANICAL ENGINEERING	2	0	2	0	3	3	60	40	100
5	101-105, 121–123 & 141	23EN1105	INTRODUCTION TO ELECTRICAL ENGINEERING	2	0	0	0	2	3	60	40	100
6	101-105, 121–123 & 141	23EN1106	ENGINEERING MECHANICS	2	0	0	0	2	3	60	40	100
7	101-105, 121–123 & 141	23EN1107	TECHNICAL ENGLISH	2	0	0	0	2	1	100	–	100
8	101-105, 121–123 & 141	23EN1108	ENVIRONMENTAL SCIENCE	1	0	0	0	1	1	50	–	50
9	101-105, 121–123 & 141	23EN1109	KANNADA KALI / MANASU	1	0	0	0	0	1	50	–	50
TOTAL				17	1	6	0	20		560	240	800

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

SCHEME - B.TECH – 2023-24 ONWARDS

II SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					Contact Hours /Week	Examination (Maximum Marks)		
				L	T	P	J	C		CIE	SEE	TM
1	101-105, 121–123 & 141	23EN1201	SINGLE AND MULTIVARIATE CALCULUS	3	0	0	0	3	3	60	40	100
2	101-105, 121–123 & 141	23EN1202	OBJECT ORIENTED PROGRAMMING	2	1	2	0	4	3	60	40	100
3	101-105, 121–123 & 141	23EN1110	ENGINEERING PHYSICS	3	0	2	0	4	3	60	40	100
4	101-105, 121–123 & 141	23EN1111	INTRODUCTION TO ELECTRONICS ENGINEERING	3	0	0	0	3	3	60	40	100
5	101-105, 121–123 & 141	23EN1112	ENGINEERING GRAPHICSAND DESIGN THINKING	2	0	2	0	3	3	60	40	100
6	101-105, 121–123 & 141	23EN1113	BIOLOGY FOR ENGINEERS	2	0	0	0	2	01	100	–	100
7	101-105, 121–123 & 141	23EN1114	CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS	1	0	0	0	1	01	50	–	
TOTAL				16	1	6	0	20	17	450	200	650

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

SCHEME AND SYLLABUS FOR THE FIRST YEAR B.TECH. PROGRAME

Definitions / Descriptions

Definition of Credit	
1 Hour Lecture (L) Per Week	01 Credit
1 Hour Tutorial (T) Per Week	01 Credit
1 Hour Practical (P) Per Week	0.5 Credit
1 Hour Project (J) Per Week	0.5 Credit

Course code and Definition	
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
IPCC	Integrated Professional Core Course
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
SEC	Skill Enhancement Courses
UHV	Universal Human Value Course
PROJ	Project Work
INT	Internship

LINEAR ALGEBRA & DIFFERENTIAL EQUATIONS

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

SEMESTER – I

Course Code	:	23EN1101	**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** the method of Gauss elimination to solve systems of linear equations and determine the row echelon form of a matrix
2. **Analyze** vector spaces, subspaces, and their properties to identify linear independence, span, and bases in the context of finite-dimensional vector spaces.
3. **Evaluate** and compute the dimensions of vector spaces by understanding the concepts of rank and nullity
4. **Analyze** the properties and characteristics of linear transformations and their corresponding matrices to gain a deeper understanding of their behaviour and applications.
5. **Utilize** the concepts of eigenvalues and eigenvectors, employing diagonalization techniques to determine the diagonal form of a matrix and its implications in various contexts.

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:

System of Linear equations. ***(Text Book-1: Chapter 1: 1.1)***

Row reduction and echelon form. ***(Text Book-1: Chapter 1: 1.2)***

Rank of a matrix by row echelon form. ***(Text Book-1: Chapter 4: 4.6)***

Gauss elimination, Inverse of a matrix by Gauss Jordan ***(Text Book-5: Chapter 3: 3.7 and 3.11)***

LU decomposition ***(Text Book-1: Chapter 2: 2.5)***,

UNIT – II	08 Hours
Vector spaces – Subspaces ***(Text Book-1: Chapter 4: 4.1)*** Linear independence – Span - Bases and Dimensions -Finite dimensional vector spaces ***(Text Book-1: Chapter 4: 4.3***) Dimensions, finite dimensional vector spaces ***(Text Book-1: Chapter 4: 4.5)***	
UNIT – III	**09 Hours**
Linear transformation - Matrices of linear transformations ***(Text Book-1: Chapter 1: 1.7 and 1.8)*** Vector space of linear transformations – Inner Product, Orthogonal Vectors - Projections ***(Text Book-1: Chapter 6: 6.1, 6.2 and 6.3)*** Gram- Schmidt Orthogonalization process ***(Text Book-1: Chapter 6: 6.4)***	
UNIT – IV	**07 Hours**
Introduction to Eigenvalues and Eigenvectors ***(Text Book-1: Chapter 5: 5.1)*** Diagonalization of a Matrix ***(Text Book-1: Chapter 5: 5.3)***	
UNIT – V	**07 Hours**
Linear second order ordinary differential equation with constant coefficients (***Text Book-5: Chapter 2***) Solutions of homogenous and non-homogenous equations ***(Text Book-5: Chapter 2: 2.2 to 2.7***) Method of variation of parameters ***(Text Book-5: Chapter 2: 2.10***) Solutions of Cauchy-Euler and Cauchy-Legendre differential equations ***(Text Book-5: Chapter2: 2.5***)	

Course Outcomes:

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

1. **Solve** systems of linear equations using Gauss elimination and determine the inverse of a matrix by applying the Gauss-Jordan method.
2. **Solve** problems involving row reduction and echelon form in linear algebra to demonstrate an understanding of the concepts and their applications in solving systems of linear equations and transforming matrices.
3. **Analyze** matrices and determine their rank by using row echelon form, examining the relationships between rows and columns, and identifying the motives or causes behind the rank.
4. **Apply** LU decomposition techniques to factorize a matrix into lower and upper triangular matrices, illustrating their understanding of the process and its applications.
5. **Apply** the concepts of vector spaces, subspaces, linear independence, span, bases, and dimensions to solve problems related to finite-dimensional vector spaces, applying acquired knowledge and techniques.

Table: Mapping Levels of COs to POs / PSOs

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

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

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, 4th 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.
5. Advanced engineering mathematics, Erwin Kreyszig, Wiley, London, 1972.

REFERENCE BOOKS:

1. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).
2. Higher Engineering Mathematics by B S Grewal, 42nd 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).

E-Resources:

1. https://nptel.ac.in/courses/111101115
2. https://nptel.ac.in/courses/111108066
3. Linear Algebra Basics | Coursera
4. https://nptel.ac.in/courses/111108081
5. https://nptel.ac.in/courses/111106100
6. Differential Equations for Engineers Course (HKUST) | Coursera

Activity Based Learning (Suggested Activities in Class)

1. Introduce the concept of matrix transformations, such as translation, rotation, scaling, and reflection. Provide visual examples and interactive tools that allow students to manipulate shapes and observe the effects of different transformation matrices.
2. Using real-life scenarios or word problems to make the activity of solving linear equations using matrix method.
3. Some real-world scenarios that can be modelled using ODEs, such as population growth, radioactive decay, or chemical reactions that can be discussed and solve using appropriate methods.

ENGINEERING CHEMISTRY

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

SEMESTER – I/II

Course Code	:	23EN1103	**Credits**	:	03
Hours / Week	:	04 Hours	**Total Hours**	:	26 + 26 Hours
L–T–P–J	:	2–0–2–0			

Course Learning Objectives:

This Course will enable students to:

- **Understand** the principles of chemical fuel towards energy production.
- **Apply** the concept of energy conversion from solar to electric energy in photovoltaic cells.
- **Understand** the basic principles of electrochemistry to measure the potential of redox reactions. **Illustrate** the construction, working, and applications of batteries, and fuel cells as energy storage devices.
- **Understand** the electrochemical theory of corrosion of metals and its prevention by metal finishing techniques.
- **Understand** the synthesis, structure–property relationship, and the applications of commercial polymers.
- **Understand** the different techniques for the purification of sewage water. **Analyse** the impurities present in waste water systems.

Teaching-Learning Process (General Instructions)

These are some of the innovative pedagogical approaches to accelerate the attainment of thevarious course outcomes.

1. **Lecture method**: Chalk and talk method, and demonstrations may be adopted to achievethe course outcomes.
2. **Interactive Teaching:** **Active learning** that includes brainstorming, group work, formulating questions, notetaking, and annotating.
3. Show **Video**s to explain and illustrate the various concepts.
4. Encourage **Collaborative** learning in the class.
5. **Problem Based Learning**, may foster students' analytical skills, ability to evaluate, and process the information.
6. Inculcate the culture of research and encourage students to come up with their own creativity.

UNIT – I Chemical Energy Source	**06 Hours**

Fuels: 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, and Biodiesel. ***(Text Book-1: Module-3)***

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. ***(Text Book-1: Module-3)***

UNIT – II Energy Science and Technology	06 Hours
Electrochemistry and Battery Technology: Single electrode potential - Definition, and sign conventions. Standard electrode potential- Definition. EMF of a cell-Definition, notation and conventions. Reference electrodes– Calomel electrode, Ag/AgCl electrode. Measurement of standard electrode potential. 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. ***(Text Book-2: Module-1)*** **Fuel Cells:** Introduction to fuel cells, types of fuel cells. Construction, working and application of Methanol-Oxygen fuel cell. ***(Text Book-2: Module-1)***	

UNIT – III Corrosion Science and Surface Modification Techniques	06 Hours
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. Factors affecting the rate of corrosion, Corrosion control: Metal coatings- Galvanization, Tinning and its disadvantages. Cathodic protection of Corrosion: Sacrificial anode method and current impression method. ***(Text Book-2: Module-2)*** **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. ***(Text Book-2: Module-2)***	

UNIT – IV Polymers	02 Hours
Polymers: Introduction to polymers, Glass transition temperature, structure and property relationship. Synthesis, properties and applications of Teflon. PMMA. Synthesis, properties and application of silicone rubber. ***(Text Book-1: Module-4)***	

UNIT – V Water Technology & Instrumental Methods of Analysis:	06 Hours
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. Alkalinity. Potable water treatment by Electro dialysis and Reverse Osmosis. Wateranalysis- Biochemical oxygen demand and Chemical oxygen demand. Determination of COD. Numerical problems on COD. Sewage treatment. ***(Text Book-2: Module-5)*** **Instrumental Methods of Analysis:** Instrumental methods of analysis, Principles of Potentiometry, Conductometry (Strong acid against strong base, weak acid against strong base, mixture of strong acid and a weak acid against strong base).	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Determination** of calorific value of fuels and **apply** the concepts of energy conversion for photovoltaic cells.	L3
2	**Apply** the basic principles of electrochemistry for the construction of energy storage devices.	L3
3	**Implement** the electrochemical theory to **analyze** the concept of corrosion of metals and its prevention by surface modifications.	L3
4	**Apply** the concept of polymerization for the synthesis of polymers and study their structure-property relationship for commercial applications.	L3
5	**Demonstrate** the techniques in the purification of sewage water. **Determine** the hardness and oxygen demand of the provided wastewater samples.	L2

Table: Mapping Levels of COs to POs

COs	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3	0	0	0	0	0	0	0	0	0
CO2	3	2	2	0	0	0	0	0	0	0	0	0
CO3	3	1	1	0	0	0	0	0	0	0	0	0
CO4	3	1	3	0	0	0	0	0	0	0	0	0
CO5	3	1	3	0	0	0	0	0	0	0	0	0

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

Text Books

1. Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN 978- 93-85155-70-3, 2022.
2. Engineering Chemistry - by Chandra Shekara B M and Basavaraju B C, Banbayalu (publications), Bengaluru, 2014, 294 pages.

Reference Books

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. Wiley's Engineering Chemistry (Wiley India), 2nd Edition, 2013, 1026 pages.

E-Resources

1. https://nptel.ac.in/

2. https://swayam.gov.in/

3.https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Electrochemistry/Basics_of_Electrochemistry

Activity Based Learning (Suggested Activities in Class)

1. Analyze research problems by reading research articles, group discussion, and presentations.
2. Demonstration of solution to a problem through experiential learning.
3. Demonstrations using real objects, taking students on an educational tour.

ENGINEERING CHEMISTRY-LABORATORY

Total: 26 Hrs

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

Instrumental methods of Analysis

1. Potentiometric titration–Estimation of FAS using standard K2Cr2O7 solution.
2. Conductometric estimation of a mixture of a weak and strong acid using standardsodium hydroxide solution
3. Determination of viscosity coefficient of a given liquid
4. Colorimetric estimation of copper in a given solution
5. Determination of pKa of given weak acid.

Reference Books

1. Dayananda Sagar University laboratory manual.
2. J. Bassett, R.C. Denny, G.H. Jeffery, Vogels, Text book of quantitative inorganic analysis, 4^{th} Edition.

SEMESTER	**I/II**					
COURSE CODE	**23EN1104**					
TITLE OF THE COURSE	**INTRODUCTION TO MECHANICAL ENGINEERING**					
SCHEME OF INSTRUCTION	L	T	P	J	Total Hours	Credits
	2	0	2	0	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 hydraulicturbines.
- 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 Taxonomy Level
CO1	Describe basic concepts of renewable energy resources andpower generation	L2
CO2	Distinguish various engineering materials and metal joining techniques	L2
CO3	Demonstrate different modern manufacturing tools andtechniques	L3
CO4	Make use of basic concepts of refrigeration and air-conditioningconcepts	L3
CO5	Illustrate essential knowledge of basic concepts of mechatronics and robotics	L2
CO6	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, NewYork, 2002
5. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Pearson Education (US).

INTRODUCTION TO ELECTRICAL ENGINEERING

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

SEMESTER – I/II

Course Code	:	23EN1105	**Credits**	:	02
Hours / Week	:	02 Hours	**Total Hours**	:	26 Hours
L–T–P-J	:	2–0–0-0			

Course Learning Objectives:

This course enables students to:

- **Demonstrate** a foundational understanding of electrical quantities, including current, voltage, power, and energy.
- **Apply** fundamental laws of electric circuits, such as Ohm's law and Kirchhoff's laws to evaluate electrical circuits.
- **Explain** fundamental concepts of electro-magnetic circuits.
- **Demonstrate** a foundational understanding of the working principles, construction, and characteristics of DC machines.
- **Illustrate** the construction, operation, and types of transformers, considering their significance in electrical systems.
- **Explain** the structure and components of electrical power system, highlighting their interconnections.
- **Explain** emerging trends of green energy technologies and smart metering.
- **Explain** the importance of earthing, protective devices, and proper wiring for ensuring electrical safety.

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	**10 Hours**

Fundamentals laws of Electrical circuit and elements: Electrical charge, potential; current; power and energy; AC and DC current (mathematical treatment); Ohm's law; KCL and KVL in resistive circuits; series and parallel combination of resistors; voltage and current division rule;

V-I relationships for inductor and capacitor under AC voltage; impedance and admittance (series RC and RL); Overview of active power, reactive power and power factor; Introduction to 3 phasesystems; Simulation using LTspice software to demonstrate voltage division, current division in resistive circuits. Simulation using LTspice software to show voltage and current waveform for RC and RL circuit.

(TextBook-1: Chapter 1: 1.1 to 1.4, 1.6 to 1.8. Chapter 2: 2.1 to 2.3. Chapter 4: 4.1 to 4.4 Chapter 6: 6.1 to 6.4)

UNIT – II	**10 Hours**

Electromagnetic circuits:
Magnetic circuits: Basics of magnetic circuits (flux, mmf, permeability, reluctance, B and H); Relation between field theory and circuit theory; Faraday's and lenz's laws, Lorentz force; Self and Mutual inductance.
DC machines: Principle of operation of DC generator; generated EMF equation; classification; characteristics and applications. (Introductory treatment only); Principle of operation of DC Motor; back EMF; speed and torque; classification; characteristics and applications. Losses and efficiency in DC machines.
Transformers: Construction, working principle, induced emf equation; step-up and step down; losses and efficiency.

(TextBook-2: Chapter 7: 7.1 to 7.12; Textbook 1: 10.1, 10.2, 10.4, 10.5, 10.8, 10.9, 10.11 and 10.12; Chapter 8: 8.1, 8.2 and 8.9)

UNIT – III	**06Hours**

Powers system fundamentals: Power system structure; generations sources; green energy; smart meters; power tariff calculations; Electrical safety and standards (IS: 732-2019, IEC: 60446): Colour code of wires for single phase supply, earthing, fuse and MCB.

(Textbook 1: , Chapter 16: 16.1 to 16.5; Textbook 2: Chapter 24: 24.1 to 24.6)

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
CO1	**Solve** for voltage, current, power and energy in purely R, series RL and RC circuits under DC and AC voltages.	L3
CO2	**Demonstrate** understanding of principle of operation of DC machines and its applications.	L2
CO3	**Demonstrate** understanding of the working principle of transformers.	L2
CO4	**Demonstrate** understanding of the working principle of transformers, generation sources, the significance of renewable energy sources in electrical engineering, and safety practices.	L2
CO5	Demonstrate proficiency in using simulation software (e.g., LTspice)to simulate and **solve** electrical parametrs.	L3

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

TEXT BOOKS:

1. D.P.Kothari and I.J. Nagrath, "Basic Electrical Engineering", 4th Edition, Tata McGraw Hill, 2019.
2. B.L. Theraja and A.K. Therja, "A textbook of electrical technology, Vol. I (Basic electrical Engineering)", S. Chand Publishing, 23rd Rev Ed, 2006.

REFERENCE BOOKS:

1. Clayton Paul, Syed A Nasar and Louis Unnewehr, "Introduction to Electrical Engineering", 2nd Edition, McGraw-Hill, 1992.
2. William H Hayt and Jack E Kimberly and Steven M Durbin, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill, 2013.

E-Resources:

1. https://nptel.ac.in/courses/108/108/108108076

Activity Based Learning (Suggested Activities in Class):

1. Real world problem solving using group discussion and hands-on activities. E.g., Interfacing different types of sensors using Arduino.
2. Simulation of different electrical circuits. E.g., RL and RC circuits.

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C PROGRAMMING FOR PROBLEM SOLVING

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

SEMESTER – I

Course Code	:	23EN1102	**Credits**	:	04
Hours/Week	:	05 Hours	**Total Hours**	:	26(L) + 13(T) + 26 (P) Hours
L–T–P–J	:	2–1-2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Elucidate** the basic architecture and functionalities of C programming language.
2. **Apply** programming constructs of C language to solve the complex problems
3. **Explore** data structures like arrays, structures, unions and pointers in implementing solutions to real world problems
4. **Design** and Develop Solutions to problems using structured programming constructs suchas functions.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainmentof 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 recallit.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that possible, it helps improve the students' understanding.

UNIT – I	**07 Hours**

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 andswitch statements, iterative statements (loops)-while, for, do-while statements, Loop examples, Nested loops, break, continue, go to statement.

(Text Book-1: Chapter 2 & Chapter 3)

UNIT – II	**05 Hours**

Arrays: Introduction, declaration & initialization of array, reading and writing array elements,

Operations on array: Traversal, searching (Linear and Binary search), sorting (Bubble sort and Selection Sort). 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.

(Text Book-1: Chapter 5:5.1 to 5.9 & Chapter 6)

UNIT – III	**06 Hours**

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.

(Text Book-1: Chapter 7: 7.1 to 7.17 & Chapter 4:4.1 to 4.8, 4.10)

UNIT – IV	**04 Hours**

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.

(Text Book-1: Chapter 8: 8.1, 8.2,8.6)

UNIT – V	**04 Hours**

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, open, read, write, seek and closing of both textual and random files.

(Text Book-1: Chapter 7: 7.18 to 7.20 & Chapter 9: 9.1 to 9.5, 9.8)

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Apply** programming constructs of C language to solve the real-world problem.	L3
2	**Choose** appropriate data type for implementing solutions to solve problems like searching and sorting.	L3
3	**Examine** suitable user-defined data structures in implementing solutions, using modular programming constructs.	L4
4	**Analyze** efficient ways for managing data and storage.	L4
5	**Justify** a solution using a modern IDE and associated tools, conduct a code review and contribute in a small-team.	L5

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

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

TEXT BOOKS:

1. Reema Thareja, "Programming in C". Oxford University Press, Second Edition, 2016.

REFERENCE BOOKS:

1. Brian W. Kernigham and Dennis M. Ritchie, (2012) "The C Programming Language", 2nd Edition, PHI.
2. Behrouz A. Forouzan, Richard F. Gilberg, "Computer Science - A Structured Approach Using C", Cengage Learning, 2007.
3. Vikas Gupta, "Computer Concepts and C Programming", Dreamtech Press 2013.

E-Resources:

1. https://nptel.ac.in/courses/106/105/106105171/ MOOC courses can be adopted for more clarity in understanding the topics and verities of problem-solving methods.
2. https://www.w3schools.com/c/index.php
3. https://www.guvi.in/courses/web-development/c-programming/
4. https://www.tutorialspoint.com/cprogramming/index.htm
5. https://pythontutor.com/

Activity Based Learning (Suggested Activities in Class)

- Demonstration of solution to a problem through designing the Flowchart or any design notations using **draw.io** in the group of four and justify using snippets or algorithms.

C PROGRAMMING FOR PROBLEM SOLVING LABORATORY

Total Contact Hours: 26

List of Laboratory/Practical Experiments activities to be conducted
1. Programming Basics: Swapping Numbers, Simple Interest, and Factorial. 2. Quadratic Equation Solver 3. Number Operations: Palindrome Check and Power Calculation. 4. Fibonacci Series and Greatest Common Divisor (GCD) Calculation. 5. Calculator Emulation 6. String Manipulation 7. Sorting an Array of Integer Elements. 8. Searching an Array of Elements. 9. Pointer Demonstration using Functions. 10. Case Study on Strings and Functions.

ENGINEERING MECHANICS

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

SEMESTER – I/II

Course Code	:	23EN1106	**Credits**	:	02
Hours / Week	:	02 Hours	**Total Hours**	:	26 Hours
L–T–P–J	:	2–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Illustrate** Couples and equivalent force couple system
2. **Understand the** principles of resolution and composition of forces
3. **Calculate** moment of coplanar concurrent and coplanar non-concurrent forces
4. **Draw** free body diagrams of objects subjected to coplanar concurrent and non-concurrentforce systems
5. **Calculate** center of gravity/centroid for various planar figures
6. **Determine** area moment of inertia for various planar geometrical objects and standard symmetrical sections
7. **Explain** Limiting friction and Laws of Friction
8. **Solve numerical on** wedge friction, ladder friction
9. **Explain** assumptions made in analysis of Trusses
10. **Determine** axial forces in members of Planar determinate Truss
11. **Illustrate** rectilinear, plane curvilinear and projectile motions

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainmentof 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 Introduction to Engineering Mechanics	**06 Hours**

INTRODUCTION:

Introduction to Engineering Mechanics, Force Systems Basic concepts, Particle Equilibrium in 2-D; System of Forces, Co-planar Concurrent Forces, Resultant- Moment of Forcesnd its Application; Couples and Resultant of force System, Equilibrium of System of Forces,

UNIT – II Centroid, Centre and gravity and Moment of inertia	05 Hours
Introduction, Centroid of simple figures from first principle, centroid of standar sections Centreof 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	
UNIT – III Friction	**05 Hours**
Introduction, Free body diagrams, Equations of Equilibrium. Types of friction, Limiting friction, Cone of Friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, related problems.	
UNIT – IV Dynamics	**05 Hours**
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, Kinetics- Newton's laws of motion and related problems.	
UNIT – V Analysis of Trusses	**05 Hours**
Introduction, Classification of trusses, Equilibrium in two and three dimension; Method of Joints; To determine if a member is in tension or compression; Simple Trusses; Zero force members.	

Course Outcomes:

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

1. **Compute** Resultant and reactions by principles and resolution of forces in a plane.
2. **Analyse** the objects under the action of applied and frictional forces in a plane by equations of equilibrium.
3. **Determine** the Moment of Inertia of composite geometrical sections in a plane
4. **Analyse** determinate two-dimensional truss by the method of joints and method of section.
5. **Analyze** the motion of objects by equations of motion, equations of equilibrium, and Newton's laws of motion and **calculate** quantities in projectile motion by equations of motion.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2	0	0	1	1	0	0	0	0	1	3	2
CO2	2	2	2	2	0	0	1	0	0	0	0	0	2	2	0
CO3	3	3	2	2	0	0	1	0	1	0	0	0	3	2	0
CO4	3	3	2	2	0	0	1	0	0	0	0	0	3	3	0
CO5	3	2	2	2	0	0	1	0	0	0	0	0	2	2	0

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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.
2. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
3. H.J. Sawant, S.P Nitsure (2018), Elements of Civil Engineering and Engineering Mechanics, Technical Publications.

E-Resources:

1. https://archive.nptel.ac.in/courses/105/105/105105108/
2. https://onlinecourses.nptel.ac.in/noc22_ce46/preview
3. https://www.youtube.com/watch?v=LIZ-PQbGZkA

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion.
2. Demonstration of solution to a problem through experiential learning.
3. Demonstrations using real objects, taking students on an educational tour.

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TECHNICAL ENGLISH

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

SEMESTER – I / II

Course Code	:	23EN1107	**Credits**	:	02
Hours / Week	:	02 Hours	**Total Hours**	:	26 Hours
L–T–P-J	:	2-0- 0-0			

Objective:

Developing Communicative competence: Enhancing the Language competence in the technical discourse and augmenting the strategic competence in the social and professional environment.

Course Learning Objectives:

This course will enable students to:

a. To enable students to improve their lexical and grammatical competence.
b. To enhance their verbal and nonverbal communication in a professional environment
c. To optimize oral and written communication.
d. To familiarize the students with employability and job search skills.
e. To enhance the students with soft skills
f. To inculcate critical thinking

Teaching-Learning Process (General Instructions)

These are some of the innovative pedagogical approaches to accelerate the attainment of thevarious course outcomes.

1. ***Lecture method***: Anecdotes, case studies and Examples from real-life situations may be adopted along with the traditional method of chalk and talk to achieve the course outcome.
2. ***Interactive Teaching: Active learning*** may be adopted which includes brainstorming, Teamwork, focused listening, formulating questions, note-taking, and Role play.
3. ***Collaborative*** learning through Debates and Group Discussion
4. ***Activity-based learning*** to inculcate Critical ***thinking*** – conceptualizing, applying, analyzing, synthesizing, and/or evaluating information from observation, perception,and expression. Minimum three higher-order questions from the real-world context
5. ***Problem-Solving method through*** Activities and discussion / Minimum of three situations to inculcate ***Problem-Solving skills*** and encourage the students to come upwith creative ways to solve the problem
6. ***Audio-visual methods*** through language Lab in the teaching of LSRW skills.
7. ***Short films/ Ted talks/ Videos/Animation*** films to explain the functioning of various concepts.
8. ***Flipped learning***
9. ***Peer learning / Peer tutoring***

Module – I	**06 Hours**

Grammar and Usage, Language and Communication.

(Branches of Grammar and Vocabulary Word Formation and Types of Word Formation. Communication process diagram. Types of Communication: Managerial, Corporate, Technical and Other Organizational Communication. Barriers to Effective Communication. Listening: Types and their Importance. Difference between hearing and listening. Speaking: Different aspects of Effective Speaking. Oral presentation Pronunciation Guidelines- Common Errors of Pronunciation-Various Techniques for Neutralization of Mother Tongue Influence)

Objective:

- Revising and practicing grammar will help students to optimize their language Competence
- Listening steps up language learning and improves pronunciation
- Speaking improves one's ability to construct phrases naturally and spontaneously in everyday discussions, Clarity and comprehensiveness in speech.
- Communicating effectively in the Professional environment, to interact with the colleagues and to involve in collaborate initiatives

Module – II	**06 Hours**

Reading: Extensive and Intensive. ***Technical Paper Writing and Minutes of the Meeting***.

Objective:

- Reading provides exposure to the chosen field and helps in the coherence of the thought process
- Technical writing techniques enable the knowledge in the relevant domain and createsbetter content based on the need of the target group
- Meeting minutes allows to access information such as facts, opinions, votes cast, conflicts, attendees, and other crucial elements at the workplace.

Module – III	**05 Hours**

Memo and E-mail Etiquette. Referencing Skills for Academic Report Writing.

Objective:

- Familiarizing with email etiquettes and correspondence provides learners to form an excellent first impression, establishing trust and confidence.
- Following the Academic conventions helps the students to optimize their referenceskills and use references to acknowledge the input of other authors and scholars intheir work and avoid plagiarism.
- Writing technical reports develop competence in creating a legally bound account of efforts and choices and engineering technical report propose a solution to a problem inorder to inspire action.

Module – IV	**04 Hours**

Group Discussion: Definition, How GD Helps in Student Life & Corporate Life.

Objective: GD helps individuals to achieve the skills of organizing and presenting the ideas and concepts in a cohesive manner and to overcome the inhibition of expression in communication

Module – V	**05 Hours**

***Drafting Curriculum Vitae, Resumes, and Cover- Letters. Job Applications*.**

{Types of Resumes, Preparing Resume, CV and Cover- Letter. Filling Job Application. Difference between Curriculum Vitae, Interview techniques: Telephonic interviews, Group interviews, face-to-face interviews -Mannerism and etiquette}.

Objective: Learning the specifics of creating a CV or Resume helps in the effective presentation of their achievements and skills, and a cover letter is a chance for them to exhibit a few aspects of their personality.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Developing language competence **improves** one's ability toconstruct phrases naturally in everyday discussions and Communication skills and soft skills enhance the self-confidence of students,	L3
2	**Applying** the fundamentals of technical writing techniques provides adequate exposure to the respective domain and createsbetter content. **Implementing** the technicalities of writing provides better exposure in the domain.	L3
3	**Following** an appropriate style of email reveals the aspect of professionalism. **Develop** technical writing skills to increase the quality of the work and testimony of conduct.	L3
4	**Practicing** communication with greater clarity and ease enable the students to discuss a wide spectrum of topics.	L3
5	Writing resumes or curriculum vitae provides a practice to exhibittheir skills and achievements concisely and writing a coveringletter enables them to express their personality in the formal context.	L3

Table: Mapping Levels of COs to POs / PSOs

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

TEXT BOOKS:

1. Dhanavel, S.P. "English and Communication Skills for Students of Science and Engineering". Orient Blackswan Pvt. Ltd., 2009.
2. Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice". 3rd Edition, Oxford University Press, 2009.
3. Murphy R. "English Grammar in Use", Cambridge University Press,2012.
4. N. Krishnaswamy and T. Sri Raman. "Creative English for communication", Macmillan Publication, 2005.

REFERENCE BOOKS:

1. Day. R A. "Scientific English: A Guide for Scientists and Other Professional". 2nd Edition, Hyderabad: Universities Press, 2000.
2. Ashraf Rizvi M. "Effective Technical Communication". McGraw Hill Education, 2017.
3. Eastwood J. "Oxford Practice Grammar". Oxford University Press, 1999.

4. Swan M and Walter C. “Oxford English Grammar Course”. Oxford University Press, 2011.
5. Dale, Carnegie. “The Quick and Easy Way to Effective Speaking”. JAICO Publishing House, 2019.
6. Chauhan, Gajendra S and Smita, Kashiramka. “Technical Communication”. India: Cengage Learning India Private Limited, 2018.
7. Bailey, Stephen. “Academic Writing: A Handbook for International Students”. 5th Edition, Routledge, 2017.
8. Kumar, Shiv K and Nagarajan, Hemalatha. “Learn Correct English: Grammar, Composition and Usage”**.** 1st edition, India: Pearson, 2005.
9. Board of Editors. Language and Life: A Skills Approach. Orient BlackSwan, 2018.
10. Sudharshana, NP and C Savitha. English for Engineers. Cambridge University Press, 2018.
11. Kumar, Sanjay and Pushp Lata. English Language and Communication Skills for Engineers. Oxford University Press, 2018.
12. Thomson, A.J. and Martinet, A.V. A Practical English Grammar, OUP, New Delhi: 1986
13. Anne Laws, ―Writing Skills‖, Orient Black Swan, Hyderabad, 2011
14. Richards, C. Jack. Interchange Students’ Book-2 New Delhi: CUP, 2015.

E-Resources:

1. https://gnindia.dronacharya.info/ME/Common-Subjects/Downloads/Technical-Communication/Books/Technical-Communication-Book-9.pdf. Web.
2. https://projects.iq.harvard.edu/files/hks-communications-program/files/ho_murphy_michael-pp-slides_9_30_14.pdf. Web.
3. https://www.youtube.com/watch?v=TR0JZiapxXM. Web.
4. file:///C:/Users/rochn/Downloads/ManualofEnglishGrammarandComposition_10012575.pdf. Web.
5. https://www.youtube.com/watch?v=f5Tao6KHV5w. Web.
6. https://www.sastra.edu/nptel/download/Prof%20GPRagini/pdf_New/Unit%202 6.pdf. Web.
7. https://www.hansrajcollege.ac.in/hCPanel/uploads/elearning/elearning_document/English_communication_chapter_13.pdf. Web.
8. https://www.youtube.com/watch?v=voyGGhlpBR8. Web.

Activity Based Learning (Suggested Activities in Class)

1. Observing and responding appropriately to the real-life situations.
2. Encouraging students to participate in Group discussions.
3. Articulating internal observations precisely and confidently through extempore.
4. Producing sentences easily without any grammatical errors in speaking, writing essays, and creative writing.
5. Conducting mock interviews, to refine their expressions, familiarize them with the interview techniques, and provide training for the spontaneous response to tricky questions.
6. Directing students for PowerPoint presentations and orienting them towards thehigher order skills of expressing their ideas and concepts with cohesion.

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ENVIRONMENTAL SCIENCES

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

SEMESTER – I/II

Course Code	:	23EN1108	**Credits**	:	01
Hours / Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Understand the concepts of environment, pollution, energy resources Understand basic engineering principles imminently run physiological processes particularly about engineering designs and solutions are arrived citing body functional examples.
2. Learn water as a resource, rain water harvesting as a method of conversation of water.
3. Explain solid waste and its management.
4. Understand environmental Protection Act laws, environmental Impact Analysis and air monitoring

Teaching-Learning Process (General Instructions)

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

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* like power point presentations and group discussion 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. Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the students' understanding.

COURSE CONTENT:

UNIT 1: Environment and ecosystem	**3 Hrs**

Definition of environment; Scope and importance of environmental studies; Basic concepts: Xenobiotic, natural & anthropogenic; why are we concerned? Eco-kinetic & Bio-kinetic Propertiesof a xenobiotic, Dose-Response Relationships;3 T's, Chronic and acute effects.

UNIT 2 : Pollution and management	**4 Hrs**

Air Pollution: Criteria 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.

UNIT 3: Energy	**2 Hrs**
Energy Types of energy: Conventional sources of energy, fossil fuel, Coal, Solar, wind; Non-conventional Sources of Energy, Biofuels - biomass, biogas.	
UNIT 4: Disaster	**2 Hrs**
Disasters & Management; Definition, Natural (Earthquakes, landslides, floods), Man-madedisasters (biological, chemical, nuclear, radiological explosions) – definition, causes and management and/or mitigation strategies; Bhopal & Chernobyl Disasters.	
UNIT 5: Environmental acts	**2 Hrs**
Environmental Impact Assessment (EIA); Air pollution monitoring and Ambient Air Quality Standards (AAQS); Environment Protection Act, 1986.	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Critically elucidate** the basic concepts that govern environmental quality, ambient air quality standards.	L3
2.	**Distinguish** different Energy resources and their environmental implications	
3.	**Distinguish** natural and manmade disasters and prevention	L3
4.	**Demonstrate** different types of pollution and waste streams	L3
5.	**Apply** the process of environmental impact assessment and implications of Indian Environment Laws	

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion.
2. Demonstration of solution to a problem through experiential learning.
3. Demonstrations using real objects, taking students on an educational tour.

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.

KANNADA KALI

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

SEMESTER – I/II

Course Code	:	23EN1109	**Credits**	:	01
Hours / Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P-J	:	1–0–0-0			

Course Learning Objectives:

This course enables students:

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

Teaching-Learning Process (General Instructions)

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

1. ***Lecture method*** means it includes not only traditional lecture method, but different *typeof 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.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.

UNIT – I	**08 Hours**
Introduction to Karnataka & Kannada Culture, Evolution of Kannada. Introduction to Kannada Alphabets. Introduction to Kannada Numbers.	
UNIT – II	**08 Hours**
Kannada words, sentences & phrase making for colloquial communication.	

TEXT BOOKS:

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.

SINGLE AND MULTI VARIABLE CALCULUS

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

SEMESTER – II

Course Code	:	23EN1201	**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** sophisticated techniques of differential calculus to solve problems involvingfunctions of multiple variables.
2. **Apply** double and triple integrals in various coordinate systems (Cartesian, polar, cylindrical, and spherical) and effectively employ them to calculate areas, volumes.
3. **Acquire** a comprehensive understanding of fundamental concepts related to functionsof multiple variables, including limits, continuity, and partial derivatives.
4. **Analyze** critical points of functions of two or more variables using partial derivativesand Lagrange multipliers, evaluate extreme values.
5. **Apply** vector calculus principles, such as line integrals, surface integrals, and the divergence theorem effectively to vector field.
6. **Analyze** the convergence and divergence of sequences and infinite series of realnumbers by employing various convergence criteria and tests.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainmentof 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	**09 Hours**

Differential Calculus

Functions of two or more variables: Definition, Region in a plane, Level curves, Level surfaces, Limits, Continuity, Partial derivatives, Differentiability, Extreme values and saddle points, Lagrange multipliers. (***Textbook 1: Chapter 14: 14.1 – 14.4, 14.7, 14.8***)

Self-Learning Component: Single variable calculus

UNIT – II	09 Hours

Integral calculus

Double integral and iterated integrals - Cartesian and polar coordinates, Triple integral, Changeof variables, Multiple integrals in cylindrical and spherical coordinates. (***Textbook 1: Chapter 15: 15.1 – 15.5, 15.7***)

UNIT – III	09 Hours

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, Surfacearea of solid of revolution, Parametrized surfaces, Stokes' theorem, The Divergence theorem. (***Textbook 1: Chapter 16: 16.1-16.8***), (***Textbook 2: Chapter 10: 10.1, 10.2, 10.4 – 10.7, 10.9***)

UNIT – IV	6 Hours

Sequence and Series I:

Sequences of real numbers and their convergence criteria, Infinite series, Sequence of partial sums, Tests for convergence/divergence - nth term test, Boundedness and monotonicity, Integral, Condensation, Comparison, Ratio and root tests (***Textbook 1: Chapter 10: 10.1-10.5***)

UNIT – V	06 Hours

Sequence And Series II:

Alternating series, Absolute and conditional convergence, Rearrangement theorem, Power series, Taylor and Maclaurin series (one and two variables). (***Textbook 1: Chapter 10: 10.6- 10.8***)

Course Outcomes:

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

1. **Apply** the principles of differential calculus to solve problems involving functions of two or more variables.
2. **Utilize** double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinates to compute areas, volumes, and evaluate mathematical expressions**.**
3. **Extend** a comprehensive understanding of the concepts related to functions of multiple variables, encompassing topics such as limits, continuity, and partial derivatives, and effectively apply them to practical situations and problem-solving scenarios.
4. **Analyze** and evaluate critical points, including extreme values and saddle points, in functions of two or more variables using partial derivatives and Lagrange multipliers.
5. **Analyze** vector calculus concepts, such as line integrals, surface integrals, and the divergence theorem, in the context of vector fields and their applications.
6. **Apply** convergence criteria and various tests, such as the nth term test, boundedness and monotonicity, integral, condensation, comparison, ratio, and root tests, to analyze and determine the convergence or divergence of sequences and infinite series of real numbers.

Table: Mapping Levels of COs to POs / PSOs

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

CO3	3	2	1						1					
CO4	3	2	1						1					
CO5	3	2	1						1					
CO6	3	2	1						1					

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

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.

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.
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

E-Resources:

1. https://www.youtube.com/playlist?list=PLtKWB-wrvn4nA2h8TFxzWL2zy8O9th_fy
2. https://www.youtube.com/playlist?list=PLU6SqdYcYsfJqbZvQECrwnlQrp4fg6isX

Activity Based Learning (Suggested Activities in Class)

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

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ENGINEERING PHYSICS

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

SEMESTER – I /II

Course Code	:23EN1110		**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39 + 26 Hours
L–T–P-J	:	3–0–2-0			

Course Learning Objectives:

This Course will enable students to:

1. To introduce the fundamental ideas of quantum mechanics that are necessary for understanding and addressing engineering challenges.
2. To comprehend solids' band structure, semiconductors' electrical conductivity, and semiconductor devices such as LEDs, photodiodes, and solar cells, as well as their applications.
3. To examine many types of engineering materials, including electronic, electrical, mechanical, and magnetic materials, as well as dielectric material properties and applications in science and engineering.
4. To comprehend various crystal systems and determine structure using miller-indices.
5. Describe thin-film phenomena, thin-film production processes, and applications in science and engineering.
6. To understand how to create Nano materials utilizing a top-down and bottom-up method, as well as to explore Nano science and technology, as well as its practical applications in engineering, biology, and medicine.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainmentof 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.

SYLLABUS

MODULE – I	08 Hours

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. Basics of Quantum computing - Concepts of Superposition, entanglement, Interference and Qubit. [5 hours]
  (Text book 1: Chapter 1.5 and Chapter 2 all units)

- **LASER PHYSICS:** Introduction to lasers. Conditions for laser action. Requisites 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 [3 hours]
  (Text book 1: Chapter 5.1, 5.2, 5.3, 5.4, 5.5)

MODULE – II	08 Hours

- **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. (5 hours)
  (Text Book-2: Chapter 24.1 to 24.9, Chapter 25.9 to 25.11)

- **Semiconducting devices for optoelectronics applications**: - Principle and working of LED, photodiode, Solar cell, BJT [3 hours]
  (Text Book-2: Chapter 25.1 to 25.8)

MODULE – III	08 Hours

- **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. (4hours)
  (Text book 1: Chapter 4.1, 4.2, 4.3, 4.4, 4.5)

- **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. Numiricals (4 hours)
  (Text book 1: Chapter 4.9, 4.10, 4.11)

MODULE – IV	08 Hours

- **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 [4 hours]
  (Text book 1: Chapter 7 all units)

- **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& Numiricals- (4 hours)
  Text Book-2: Chapter 2.1 to 2.7)

MODULE – V	07 Hours

- **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. [3hours]
  (Ref. Text Book-2: Chapter 2. All units)

- **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. [4 hours]
  (Text Book-1: Chapter 8.1 to 8.7)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	Describe the concepts of Quantum mechanics and applications of Schrodinger time independent wave equation in one dimension.	L1 & L3
2	Illustrate Semiconductors, Semiconductor devices like Photodiode, LED, Solar cell and its applications.	L2 & L3
3	Distinguish the different engineering materials such as Electronic, electrical and mechanical materials properties and their applications in engineering.Apply the concept of magnetism to magnetic data storage devices.	L2 & L3
4	Classify Lattice parameters of different crystalline solids by using X-ray diffraction methods and its applications in science and engineering	L1 & L3
5	Interpret Basic concepts of thin films and thin film deposition processes and their applications leads to Sensors and engineering devices.	L2
6	Categorize Nano materials, Properties, and fabrication of Nano materials by using Top-down and Bottom –up approach's - Applications for Science and technology.	L2 & L3

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2													1
CO2	2													1
CO3	2													1
CO4	1													1
CO5	1											1		2
CO6	3											2		3

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

TEXT BOOKS:

1. P. S. Aithal, H. J. Ravindra, Textbook of Engineering Physics (2011), Acme learning Private Limited, New Delhi, India.
2. Shatendra Sharma, Jyotsna Sharma, Engineering Physics (2019), Pearson, Noida, Uttar Pradesh, India.

REFERENCE BOOKS:

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.

E-Resources:

1. https://nptel.ac.in/courses/106/101/106101060/
2. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms

Activity Based Learning (Suggested Activities in Class)

1. Demonstration of solution to a problem through Project demo model.

ENGINEERING PHYSICS LAB

Total Contact Hours: 26

Following are experiments to be carried out in Engineering Physics Lab

LABORATORY EXPERIMENTS:

List of Experiments:

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)

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INTRODUCTION TO ELECTRONICS ENGINEERING

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

SEMESTER – I/II

Course Code	:	23EN1111	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P-J	:	3–0–0			

Course Learning Objectives:

This course enables students to

1. **Understand** the fundamental principles of diodes and their applications, including the band diagram of insulators, conductors, and semiconductors, diode construction, and V-I characteristics.
2. **Analyze** diode circuits under different biasing conditions and comprehend the behavior of diodes in applications such as AND gates, OR gates, rectifiers, and voltage regulators and simulate the same circuits using LTspice software.
3. **Comprehend** the construction, operation, and characteristics of bipolar junction transistors (BJTs), including input and output characteristics, different biasing techniques, and transistor amplification.
4. **Simulate** common emitter amplifier circuits with voltage divider bias using LTspice software.
5. **Demonstrate** an understanding of operational amplifiers (Op-amps), including their symbols, operation modes, properties, and applications such as amplifiers, comparators, and oscillators.
6. **Demonstrate** an understanding of digital electronics, including binary number systems, Boolean algebra, logic gates, sequential logic circuits, and the application of Flip-Flops.
7. **Simulate** digital circuits and components using LTspice software.
8. **Familiarize** themselves with microprocessors and microcontrollers, specifically Arduino boards, and understand their architecture and components.
9. Set up the Arduino development environment, write and upload code to the Arduino board, and **execute** simple Arduino programs.
10. Interface various sensors and engage in hands-on activities to reinforce understanding, including LED blinking and **designing** and **implementing** a complete Arduino-based system as a student project.

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	**09 Hours**

Diodes and its application: Band diagram of insulators, conductors and semiconductors; semiconductor types: intrinsic and extrinsic (n-type and p-type); overview of diode construction; diode under no-bias, forward bias and reverse bias; V-I characteristics of diode; simplified equivalent circuit of practical diode and ideal diode; overview of diode specifications: peak inverse voltage, reverse leakage current and maximum forward current; numerical on series diode configuration with DC input.

Applications: AND gate and OR gate using diodes, half wave rectifier and full-bridge full wave rectifier with smoothing capacitor; simulation of rectifier circuits with smoothing circuit using LTspice software; zener diode: zener region and voltage regulator; numerical on rectifier and voltage regulator.

(Textbook 1: Chapter 1: 1.1 to 1.7, 1.9, 1.12, 1.15, Chapter 2: 2.3, 2.5, 2.6, 2.7, 2.11)

UNIT – II	**08 Hours**

Transistors: Construction of npn and pnp BJT transistors; transistor operation; input and output characteristics of CB and CE configurations; significance of different regions of operation: active, cut-off and saturation (transistor as a switch); alpha, beta and current relations; transistor amplifying action; numerical on current relations and amplification; Need for biasing: Q-point; types of biasing: fixed, emitter stabilized and voltage divider; simulation of common emitter amplifier with voltage divider bias using LTspice software; numerical on biasing circuits; construction and characteristics of n-channel depletion type MOSFET;

(Textbook 1: Chapter 3: 3.1 to 3.5, Chapter 4: 4.1 to 4.5, Chapter 6.1 and 6.7)

UNIT – III	**08 Hours**

Operational amplifiers: Op-amp symbols, terminals and operation: single mode, differential mode and common mode; basic properties of ideal and practical Op-amp: input offset voltage, input resistance, output resistance, gain, bandwidth, CMRR, slew rate; basic Op-map applications: inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, differentiator and integrator; Op-amp comparator; feedback: positive and negative feedback; criteria for stability and oscillations (Barkhausen criterion); RC phase shift and Wein bridge oscillators; simulation of summing amplifier and oscillators in LTspice software;

(Textbook 1: Chapter 10: 10.1, 10.4 to 10.7, Chapter 14: 14.5 to 14.7)

UNIT – IV	**08 Hours**

Digital Electronics: Binary number system: conversion and representation; logic levels: high and low; Boolean algebra: operators and DeMorgan's law; logic gates with truth-table and

representation: AND, OR, NOT, XOR, NAND, NOR; combination of gates and associated numerical; sequential logic circuits: SR latch using NAND/NOR gate, SR FLIP-FLOP, J-K Flip-Flop, D Flip-Flop; application of Flip-Flops: 4 bit binary counter and 4 stage shift register; simulation of counter using LTspice;

(Textbook 2: Chapter 1: 1.1 to 1.3, Chapter 2: 2.1 to 2.5, Chapter 4: 4.1 to 4.3, Chapter 5.1 to 5.5, Chapter 6.1 to 6.4)

UNIT – V	**06 Hours**

Electronic Prototyping with Arduino: Introduction to microprocessor and microcontrollers (Architecture) , introduction to the Arduino board (UNO, R3) and components; setting up the Arduino development environment; writing and running a simple Arduino program in *wokwi* environment; introduction to various sensors and actuators compatible with Arduino in *wokwi* environment; student project: Designing and implementing a complete Arduino-basedsystem.

E-Resources: 1 and 2

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Demonstrate** a solid understanding of the fundamental principles underlying electronic components, such as diodes, transistors, operational amplifiers, logic gates, and microcontrollers.	L2
2	Apply knowledge of electronic components to **analyze** circuits for various applications, such as rectification, amplification, filtering, and digital logic operations.	L4
3	**Analyze** the performance of operational amplifiers (Op-amps) in various circuit configurations, including amplifiers, comparators, and oscillators, to optimize their functionality and address design requirements.	L4
4	Demonstrate proficiency in using simulation software (e.g., LTspice) to simulate and **analyze** electronic circuits, validatedesigns, and troubleshoot circuit performance**.**	L4
5	**Design** and implement electronic systems using Arduino microcontrollers, integrating sensors, actuators, and programming concepts to achieve specific functionalities and solve practical problems.	L6

Table: Mapping Levels of COs to POs / PSOs

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

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

TEXT BOOKS:

1. R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", 11th Ed, Pearson Education, 2013.
2. M. Moris. Mano and Michael D. Ciletti, "Digital Electronics", 4th Ed, Pearson Education, 2006.

REFERENCE BOOKS:

1. David A Bell, "Electronic Devices and Circuits", 5th Ed, Oxford university press, 2008.
2. Millman & Halkias, "Electronics Devices and Circuits", 2nd Ed, McGraw Hill, 2010.

E-Resources:

1. Arduino- https://docs.arduino.cc/learn/
2. Wokwi- https://wokwi.com/arduino/
3. NPTEL- https://nptel.ac.in/courses/122/106/122106025
4. Virtual Labs- http://vlabs.iitkgp.ac.in/be/

Activity Based Learning (Suggested Activities in Class):

1. Real world problem solving using group discussion and hands-on activities. E.g., Interfacing different types of sensors using Arduino.
2. Simulation of different electronic circuits. E.g., Rectifiers and Amplifiers.

OBJECT ORIENTED PROGRAMMING

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

SEMESTER – II

Course Code Code	:	23EN1202	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	26(L) + 13(T) + 26(P) Hours
L–T–P–J	:	2–1–2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Understand** different programming paradigms, significance of object-oriented programming approach and their applications.
2. **Make use of** Python programming environment to develop programs using conditionals, iterations, functions, strings and files to store and retrieve data in system.
3. **Gain** skills to develop python programs using core data structures like Lists, Tuples, Sets and Dictionaries.
4. **Describe** the concepts of object-oriented concept using class, objects, methods. Polymorphism and different levels of inheritance.
5. **Explain** operator overloading, overriding, single and multiple exception handling capabilities in python.

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	**05 Hours**

INTRODUCTION TO OBJECT ORIENTED PROGRAMMING AND PYTHON

Programming paradigms, Object oriented programming features, applications, merits & demerits, Features of Python, variables, Data types, input operation, Reserved words, Indentation, Expressions, String operations, Type conversions.

(Text Book-1: Chapter 2: 2.3,2.4,2.5,2.6 Chapter 3: 3.1,3.6,3.7,3.8,3.10,3.11,3.13,3.14,3.16)

DECISION AND LOOP CONTROL STATEMENTS:

Conditional branch statements, Iterative statements, Nested loops, break, continue, pass, The elsestatement used with loops.

(Text Book-1: Chapter 4: 4.1-4.8)

UNIT – II	**5 Hours**

FUNCTIONS AND MODULES:

Need for functions, Function definition, Function call, Scope, Return statement, Lambdafunctions,Recursive functions, Modules.

(Chapter 5: 5.1 to 5.11)

PYTHON STRINGS:

String operations, Immutable, string formatting operator, built-in string methods, string slices, membership operator, comparing strings, Iterating strings.

(Chapter 6: 6.1 to 6.9)

UNIT – III	**6 Hours**

DATA STRUCTURES IN PYTHON:

Sequence, List, Tuple, sets, dictionaries

(Chapter 8: 8.1, 8.2, 8.4 to 8.6)

FILE HANDLING METHODS:

File path, File types, File operations, File positions, Rename and delete files.

(Chapter 7: 7.1 to 7.7)

UNIT – IV	**5 Hours**

USER DEFINED CLASSES & OBJECTS:

Classes, Objects, class method and self Argument, constructor, destructor, class variables, publicand private data members, private methods, Calling methods, static methods.

(Chapter 9: 9.1 to 9.10, 9.15)

INHERITANCE:

Introduction, Polymorphism, overriding, types of inheritance

(Text Book: Chapter 10: 10.1 to 10.6)

UNIT – V	**5 Hours**

OPERATOR OVERLOADING:

Introduction, Implementation of operator overloading, Reverse addition, overriding methods andfunctions.

(Text Book: Chapter 11: 11.1 to 11 .7)

ERROR AND EXCEPTION HANDLING:

Errors, Handling exceptions, Multiple except blocks, Multiple exceptions, Except block without exception, The else clause, Raising exceptions, Built-in and user defined exceptions, Finally block, clean-up action

(Text Book: Chapter 12: 12.1 to 12.7, 12.10 to 12.12)

Course Outcomes:

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

1. **Write** a python program using 4 conditionals, definite loop, indefinite loop withjump statements.
2. **Write** an application using lambda, recursive functions, strings and files to store andretrieve the data from the system.
3. **Write python** programs using Core data structures like Lists, Tuples, Sets and Dictionaries.
4. **Implement** the concepts of object-oriented concept using class, objects, methods. Polymorphism and different levels of inheritance.
5. **Implement** operator overloading, overriding, single and multiple exception handlingprogram capability in python

Table: Mapping Levels of COs to POs / PSOs

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

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

TEXT BOOKS:

1. Reema Thareja, “Python programming: Using problem solving approach”, 2nd Edition,Oxford university press, 2019.

REFERENCE BOOKS:

1. John V Guttag, “Introduction to Computation and Programming Using Python”, The MITpress, 3rd edition, 2021.
2. Tony Gaddis, “Starting out with python”, 4th edition, Pearson, 2019.
3. Allen Downey, Jeffrey Elkner and Chris Meyers, "How to think like a Computer Scientist, Learning with Python", Green Tea Press, 2014.
4. Richard L. Halterman, “Learning to Program with Python”, 2011.
5. Charles Dierbach, “Computer Science Using Python: A Computational Problem-Solving Focus”, John Wiley, 2012.

Activity Based Learning (Suggested Activities in Class)

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

OBJECT ORIENTED PROGRAMMING LABORATORY

Total 26 Hours

List of Programming Experiments:

1. Python Program for Data Handling and Expression Evaluation.
2. Python Program for Quadratic Equation Roots and Number Analysis.
3. Python Program for Function Illustration and Module Creation.
4. Python Program for String Operations and Data Validation.
5. Python Program for File Handling and Script Copying.
6. Python Program for Data Structures and Built-in Methods.
7. Python Program for Object-Oriented Concepts and Inheritance.
8. Python Program for Operator Overloading and Special Methods.

ENGINEERING GRAPHICS & DESIGN THINKING

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

SEMESTER – I/II

Course Code	:	23EN1112	**Credits**	:	03
Hours / Week	:	04 Hours	**Total Hours**	:	26+26 Hours
L–T–P–J	:	2–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Create** awareness and emphasize the need for Engineering Graphics & design thinking through Manual Sketching & Autocad Software
2. **Learn** using professional CAD software for construction of geometry
3. **Understand** the concepts of orthographic and isometric projections
4. **Draw** orthographic projection of points, lines, planes and solids by Manual Sketching & AutoCad Software
5. **Draw** development of surfaces of solids
6. **Draw** isometric projections of planes and solids
7. **Create** simple engineering 3D components
8. **Work** in a team for creating conceptual design of products
9. **Learn** application of design methods and tools on real world problem through Autocad Software & Physical Models

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.

MANUAL & COMPUTER SKETCHING

UNIT – I Introduction	**06 Hours**

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) **(For CIA only)**
(Text Book-1: Chapter 3 & 8)

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 andcreation 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)**
(Text Book-2: Chapter 23 &24; Text Book-1: Chapter 26)

UNIT – II Projections of Points, Lines and Planes	**12 Hours**

Projection of Points - Orthographic projections of points in all the quadrants,
Orthographic projections of lines- inclined to both the principal planes - Determination oftrue lengths and true inclinations by rotating line method.
Orthographic projections of planes -triangle, square, rectangle, pentagon, hexagon andcircular laminae.
(First Angle Projection only)
(Text Book-1: Chapter 9,10,12)

UNIT – III Projection of Solids & Development of Surfaces	**14 Hours**

Projection of regular solids like prisms, pyramids, cylinder & cone inclined to both the planes (change of position method)
(First Angle Projection only)
(Text Book-1: Chapter 13)

Development of lateral surfaces of regular solids – Prisms, pyramids cylinders and cones***.(Text Book-2: Chapter 16)***

UNIT – IV Isometric Projections	**14 Hours**

Isometric projection - Principles of Isometric Projection, Isometric Scale, Isometric View, Isometric projection of combination of two solids
(Text Book-1: Chapter 17)

Transformation of Projections- Conversion of Isometric Views to Orthographic Views & Conversion of orthographic views to isometric projections.
(Text Book-1: Chapter 20; Text book- 2: Chapter 21)

UNIT – V Introduction to Design Thinking for Innovations	**10 Hours**

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)
(Text Book-3: Part 1- Chapter 1&2, Part3-Chapter 10)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Make use of** instruments, dimensioning & tolerance principles, conventions and standards related engineering drawing	L1
2	**Construct** orthographic projections of points, lines, planes and solids	L3
3	**Develop** lateral surfaces of solids and **construct** isometric projections of solids	L3
4	**Apply** the design thinking principles for innovative product development	L3
5	**Make use of** AutoCad for modelling engineering components	L3

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	0	0	0	0	0	0	0	0	0	0	3	0	2
CO2	2	1	0	0	0	0	0	0	0	0	0	0	3	0	2
CO3	2	1	0	0	0	0	0	0	0	0	0	0	3	0	2
CO4	2	1	0	0	0	0	0	0	0	0	0	0	3	0	2
CO5	3	1	0	0	0	0	0	0	0	0	0	0	3	0	2

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

TEXT BOOKS:

1. Engineering Drawing, Bhatt N.D., 54th Edition, Charotar Publishing House, Gujarat, India, 2023
2. Engineering Drawing & Graphics+Autocad, K Venugopal, Fifth Edition, New Age International Publishers, 2011.
3. Engineering Design- A Project Based Introduction, C. L. Dym and Patrick Little, John Wiley & Sons, 2022

REFERENCE BOOKS:

1. A Textbook of Computer Aided Engineering Drawing, Gopalakrishna, K. R. and Sudheer Gopala Krishna, Subash Publishers, Bangalore, India, 2017
2. Engineering Drawing with Introduction to AutoCAD, Dhananjay .A .J, Tata McGraw-Hill Publishing Company Ltd, 2018
3. Product Design and Development, Karl T Ulrich, Steven D Eppinger, Seventh Edition, McGraw-Hill Education, 2020

E-Resources:

1. https://archive.nptel.ac.in/courses/112/102/112102304/
2. https://nptel.ac.in/courses/112103019
3. https://nptel.ac.in/courses/112/105/112105294/
4. https://fractory.com/engineering-drawing-basics/

Activity Based Learning (Suggested Activities in Class)

1. Activity which makes students to apply the concepts learned in the course to thepractical engineering graphics will be discussed in class.
2. Activity provides space to students giving responsibility for their own design & engineering drawing methods for the products
3. Activity that makes the students for the development of skill set in computer drafting
4. Activity that makes the students to have critical thinking, developing a mind set, problem-solving and teamwork in design thinking process.
5. Real world problem solving and puzzles using group discussion.
6. Demonstration of solution to a problem through experiential learning.

ENGINEERING GRAPHICS & DESIGN THINKINGLABORATORY

Total Contact Hours: 26

Following are practical/laboratory experiments to be carried out:

1. Problems to be solved in first quadrant system.
2. Manual & Computer Sketching problems for all the modules in sketch book and alsotake print out of the problems.
3. Usage of various commands in AutoCad software and few simple exercises on the above commands
4. Practice Problems on Projections of Points, Lines and Planes using Manual Sketching& AutoCad Software
5. Solve Problems on Projection of Solids & Development of Surfaces
6. Practice problems on Isometric Projections
7. Individual/Group work on Introduction to Design Thinking for Innovations (Examples on Solid Modeling - Using 3D Modelling Software & Physical Model Prototype).

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BIOLOGY FOR ENGINEERS

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

SEMESTER – I/II

Course Code	:	23EN1113	**Credits**	:	02
Hours / Week	:	02 Hours	**Total Hours**	:	26 Hours
L–T–P–J	:	2–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Acquire an understanding on basic modern biological concepts with an emphasis on how bio-processes are analogous to engineering field, as a multidisciplinary field.
2. Understand basic engineering principles imminently run physiological processes particularly about engineering designs and solutions are arrived citing body functional examples.
3. Explain aspects that many bio-solutions could be foundational to design, develop better processes, products and useful to achieve quality of life.

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* like power point presentations and group discussion 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. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

COURSE CONTENT:

UNIT 1 : Biomimetics	**5 Hrs**
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	
UNIT 2 : Bioenergy	**5 Hrs**
Unit of life: Human and Plant cell, Metabolism: Enzymes as Bio-catalysts and physiological entities, Anabolism- Bioenergy from Sun-Photosynthesis, catabolism	

UNIT 3 : Biomechanics (Human Body Movement Mechanics)	**5 Hrs**
Normal Human Movement: Force-Vector of Body; Movement Angles; Muscle contraction - Relaxation; Posture – Static & Dynamic; Ideal and abnormal posture, Practical: Stepping-Lifting- Sit-Stand.	
UNIT 4 : Bioelectronics	**6 Hrs**
Brain & Computer: Senso-neural networks, Biosensors and IoT as applied to biology, Bionic Eye: Mechanism of Vision, Electronic Nose: Bio-olfactory mechanisms (Science of smell), Impulses: Cardiac and Nerve, Biological Clock and Circadian rhythm	
UNIT 5 : Biopharma	**5 Hrs**
Metabolic syndromes, Cancer and its diagnostics, Lab on a chip, Drug Discovery	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Apply and Utilize** essential knowledge of the biological mechanisms of living organisms from the perspective of engineers and find solutions to solve bio-engineering problems withappropriate tools.	L3
2	**Distinguish and make use of** 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
3	**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

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion.
2. Demonstration of solution to a problem through experiential learning.
3. Demonstrations using real objects, taking students on an educational tour.

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.

CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS

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

SEMESTER – I/II

Course Code	:	23EN1114	**Credits**	:	01
Hours / Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Acquaint the students with legacies of constitutional development in India and help thoseto understand the most diversified legal document of India and philosophy behind it.
2. Make students aware of the theoretical and functional aspects of the IndianParliamentary System.
3. Channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.
4. Acquaint students with latest legislation and Laws with related regulatory framework.

Teaching-Learning Process (General Instructions)

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

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* like power point presentations and group discussion 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. Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the students' understanding.

COURSE CONTENT

UNIT 1 : Introduction and Basic Information about Indian Constitution	**6 Hrs**

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Enforcement of the Constitution, Indian Constitution and its Salient Features, The Sources of Indian Constitution. The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule,

Financial Emergency, and Local Self Government – Constitutional Scheme in India	
UNIT 2 : Union Executive and State Executive	**7 Hrs**
Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Court	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	Identify and explore the basic features and modalities about Indian constitution.	L1
2	Differentiate and relate the functioning of Indian parliamentary system at the Centre and State level.	L2
3	Differentiate different aspects of Indian Legal System and its related bodies.	L2
4	Discover and apply different laws and regulations related to engineering practices.	L1
5	Correlate role of engineers with different organizations and governance models	L1

TEXT BOOKS:

1. The Indian Constitution, Madhav Khosla, Oxford University Press.
2. The Constitution of India, PM Bakshi. Latest Edition, Universal Law Publishing.

REFERENCE BOOKS:

1. The Indian Constitution: Cornerstone of a Nation (Classic Reissue), Granville Austin:,Oxford University Press.
2. Our Constitution: An Introduction to India's Constitution and Constitutional Law, Subhash C. Kashyap, NBT, 2018.
3. Introduction to the Indian Constitution, Brij Kishore Sharma, 8th Edition, PHI Learning Pvt. Ltd.

III SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL. NO	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	BSC	23AM2301	Probability & Statistics	3	0	0	0	60	40	100	03
2	IPCC	23AM2302	Data Structures	3	0	2	0	60	40	100	04
3	IPCC	23AM2303	Computer Networks	3	0	2	0	60	40	100	04
4	PCC	23AM2304	Discrete Mathematics and Graph Theory	3	0	0	0	60	40	100	03
5	PCC	23AM2305	Computer Organization and Architecture	3	0	0	0	60	40	100	03
6	SEC	23AM2306	Skill Enhancement Course – I	1	0	2	0	100	--	100	02
7	PEC	23LSXXXX	Liberal Studies	1	0	0	0	100	--	100	01
8	AEC	23AM2307	Cognitive and Technical Skills-I	0	0	4	0	100	--	100	02
			Total	17	0	10	0				**22**

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

DATA STRUCTURES

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

SEMESTER – III

Course Code	:	23AM2302	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P-J	:	3–0–2-0			

Prerequisites:

Proficiency in a C programming language.

Course Objectives:

This Course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

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

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

Table: Mapping Levels of COs to POs / PSOs

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

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

TEXT BOOKS (TB):

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

DATA STRUCTURES LABORATORY

Total Contact Hours: 26

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

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

9. To implement binary tree traversal techniques.

OPEN-ENDED EXPERIMENTS

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

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

COMPUTER NETWORKS

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

SEMESTER –III

Course Code	: 23AM2303	**Credits**:	04
Hours / Week	: 05 Hours	**Total Hours**:	39(T)+26(P) Hours
L–T–P-J	: 3–0–2-0		

Course Learning Objectives:

This Course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

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

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

Mapping Levels of COs to POs / PSOs

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

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

TEXT BOOKS:

1. Behrouz A. Forouzan—Data Communications and Networking with TCP/IP Protocol Suite‖ TataMcGraw- Hill, 6th Edition, 2022.
2. Andrew S. Tanenbaum, David Wetherall, —Computer Networks‖ Prentice-Hall, 6th Global Edition, 2021.

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

LABORATORY EXPERIMENTS

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

present. Implement the above program using message queues or FIFOs as IPC channels

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

DISCRETE MATHEMATICS AND GRAPH THEORY

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

SEMESTER – III

Subject Code	:	23AM2304	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

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

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

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

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

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

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

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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COMPUTER ORGANIZATION AND ARCHITECTURE
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 23AM2305	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P-J	: 3–0–0-0		

Course Learning Objectives:
This Course will enable students to:

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

Teaching-Learning Process

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

UNIT – I	**05 Hours**

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

UNIT – II	**05 Hours**

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

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

UNIT – III	**05 Hours**

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

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

UNIT – IV	**12 Hours**

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

UNIT – V	**12 Hours**

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

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

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

Mapping Levels of COs to POs / PSOs														
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		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.

PROBABILITY AND STATISTICS

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

SEMESTER – III

Course Code	:	23AM2301	**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 theclass.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students tocome up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I : Probability	**09 Hours**

Definitions of Probability, Addition Theorem, Conditional Probability, Multiplication Theorem, Bayes' Theorem of Probability

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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

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

2. **Case Study 1: Customer Arrivals at a Coffee Shop**
    a. A coffee shop wants to analyze the number of customer arrivals during its morning rush hour (7:00 AM to 9:00 AM). The shop has been recording the number of customer arrivals every 15 minutes for the past month.
    b. Data: The data consists of the number of customer arrivals recorded at the coffee shop during each 15-minute interval for the past month.
    c. Here is a sample of the data:

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

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

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

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

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

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

4. **Case study 3:** testing independence between two categorical variables.
    a. Data: Sample of 100 employees, and each employee is classified as either Male or Female.They were asked to rate their job satisfaction on a scale of 1 to 5, where 1 represents lowsatisfaction 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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SKILL ENHANCEMENT COURSE-I
JAVA PROGRAMMING
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 23AM2306	**Credits**	: 02
Hours / Week	: 03 Hours	**Total Hours**	: 26 Hours
L–T–P–J	: 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

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	C
				L	T	P	J				
1	IPCC	23AM2402	Design and Analysis of Algorithms	3	0	2	0	60	40	100	04
2	IPCC	23AM2403	Database Management System	3	0	2	0	60	40	100	04
3	IPCC	23AM2404	Theory of Computation	3	1	0	0	60	40	100	04
4	BSC	23AM2401	Transform and Numerical Techniques	3	0	0	0	60	40	100	03
5	PCC	23AM2405	Artificial Intelligence	3	0	0	0	60	40	100	03
6	PCC	23AM2406	Full Stack Development	3	0	0	0	60	40	100	03
7	SEC	23AM2407	Skill Enhancement Course -II	1	0	2	0	100	--	100	02
8	AEC	23AM2408	Cognitive and Technical Skills-II	0	0	4	0	100	--	100	02
			Total	19	1	10	0				**25**

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

DESIGN AND ANALYSIS OF ALGORITHMS
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23AM2402	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P–J	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	08 Hours
INTRODUCTION: What is an Algorithm? Fundamentals of Algorithmic Problem Solving. ***(Text Book-1: Chapter 1: 1.1 to 1.2)*** **FUNDAMENTALS OF THE ALGORITHMS EFFICIENCY:** Analysis Framework, Asymptotic Notations and Standard notations and common functions ***(Text Book-2: Chapter 3: 3.1, 3.2)***, Mathematical Analysis of Non-recursive and Recursive Algorithms, ***(Text Book-1: Chapter 2: 2.1, 2.3, 2.4,)***	
UNIT – II	**08 Hours**
BRUTE FORCE: Background, Selection Sort, Brute-Force String Matching. TSP ***(Text Book-1: Chapter 3: 3.1, 3.2)*** **DIVIDE AND CONQUER:** General method, Recurrences: The substitution method, The recursion-tree method, The master method. ***(Text Book-2: Chapter 4: 4.4, 4.5***), Merge sort, Quick sort, Binary Search, Multiplication of large integers, **Case study:** Strassen's Matrix Multiplication. ***(Text Book-1: Chapter 4: 4.1 to 4.3, 4.5)***	
UNIT – III	**06 Hours**
DECREASE & CONQUER: General method, Insertion Sort, Graph algorithms: Depth First Search, Breadth First Search, Topological Sorting **TRANSFORM AND CONQUER:** **Case study:** Heaps and Heap sort. **TIME AND SPACE TRADEOFFS:** Input Enhancement in String Matching: Horspool's algorithm, Hashing: Open and Closed hashing. ***(Text Book-1: Chapter 5: 5.1 to 5.3, Chapter 6: 6.3 to 6.4, Chapter 7: 7.2 to 7.3)***	
UNIT – IV	**9 Hours**
GREEDY TECHNIQUE: General method of Greedy technique, Single-Source Shortest Paths: General method, The Bellman-Ford algorithm, Single-Source Shortest Paths in DAGs, Dijkstra's Algorithm ***(Text Book-2: Chapter 24: 24.1 to 24.3).*** Minimum Spanning Trees: Prim's Algorithm, Optimal Tree problem: Huffman Trees; **Case study:** Kruskal's Algorithm. Fractional Problem ***(Text Book-1: Chapter 9: 9.1, 9.2, 9.4).*** **DYNAMIC PROGRAMMING:** General method, The Floyd-Warshall Algorithm, Johnson's algorithm for sparse graphs ***(Text Book-2: Chapter 25: 25.1 to 25.3)***, The Knapsack problem ***(Text Book-1: Chapter 8: 8.4).***	
UNIT – V	**08 Hours**
LIMITATIONS OF ALGORITHMIC POWER	

P, NP and NP-complete problems ***(Text Book-1: Chapter 11: 11.3***)
BACKTRACKING:
General method, N-Queens problem, Subset-sum problem.
(Text Book-1: Chapter 12: 12.1)
BRANCH AND BOUND:
General method, Travelling Salesman problem, Approximation algorithms for TSP.
Case study: Knapsack Problem.
(Text Book-1: Chapter 12: 12.2, 12.3)

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

LABORATORY EXPERIMENTS

Total Contact Hours: 26

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

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

Open ended experiments

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

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DATABASE MANAGEMENT SYSTEM

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

SEMESTER – IV

Course Code	: 23AM2403	**Credits**	: 04
Hours / Week	: 05 Hours	**Total Hours**	: 39(Th)+26(P) Hours
L–T–P–J	: 3–0–2–0		

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**10 Hours**

INTRODUCTION TO DATABASE SYSTEMS :

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

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

ENTITY-RELATIONSHIP MODEL:

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

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

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

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Third Edition, McGraw-Hill, 2003.

2. Silberschatz, Korth and Sudharshan: "Database System Concepts", Seventh Edition, Mc-GrawHill, 2019.

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

LABORATORY EXPERIMENTS

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

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

Open Ended Experiments

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

table: employees

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

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

Table: sales

TRANSACTION_ID|SALESMAN_ID|SALE_AMOUNT|

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

Table: salesman

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

THEORY OF COMPUTATION

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

SEMESTER – V

Subject Code	: 23AM2404	**Credits**:	04
Hours / Week	: 04 Hours	**Total Hours**:	52 Hours
L–T–P–J	: 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														
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	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
4. Computation, 3rd Edn. PHI, New Delhi, 2007
5. Elaine Rich, Automata, Computability and Complexity, 1st Edition, 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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TRANSFORMS AND NUMERIAL TECHNIQUES

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

SEMESTER – IV

Course Code	: 23AM2401	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 Hours
L–T–P–J	: 3–0–0–0		

Course Learning Objectives:

This Course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

class.

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

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

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

Laplace Transforms $e^{at}f(t), t^{n}f(t)$ and $\frac{f(t)}{t}$ of Periodic fu

(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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ARTIFICIAL INTELLIGENCE

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

SEMESTER – IV

Course Code	: 23AM2405	**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. 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														
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	2				2	1			1	1			2	2
CO2	3	2			2	1			1	1			2	2
CO3	3	2			2	1			1	1			2	2
CO4	3	2			2	1			1	1			2	2
CO5	3	3	2		2	1			1	1			2	2

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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FULL STACK DEVELOPMENT

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

SEMESTER – IV

Course Code	: 23AM2406	**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. To demonstrate the ability to design basic web pages using HTML and CSS
2. To utilize advanced CSS methods to design the web page, background and components.
3. To experiment with Bootstrap, Javascript and DOM for to create dynamic webpages.
4. To build web pages with the ReactJS and NodeJS as front end and back end.
5. To Model a complete web-page with mangoDB CRUD operations.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

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

UNIT – II	**08 Hours**

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

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

Table: Mapping Levels of COs to POs / PSOs

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

Text Books:

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

Reference Books:

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

E-Resources:

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

SKILL ENHANCEMENT COURSE-II
UNIX AND SHELL PROGRAMMING

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

SEMESTER – IV

Course Code	: 23AM2407	**Credits**	: 02
Hours / Week	: 01	**Total Hours**	: 26 Hours
L–T–P–J	: 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	C
				L	T	P	J				
1	IPCC	23AM3501	Machine Learning	3	0	2	0	60	40	100	04
2	IPCC	23AM3502	Operating Systems	3	0	2	0	60	40	100	04
3	IPCC	23AM3503	Natural Language Models	3	1	0	0	60	40	100	04
4	IPCC	23AM3504	Innovation and Entrepreneurship	3	1	0	0	60	40	100	04
5	HSMC	23AM3505	Compiler Design and System Software	2	0	0	0	60	40	100	02
6	SEC	23AM3506	Skill Enhancement Course -III	1	0	2	0	100	--	100	02
7	PEC	23AM35XX	Professional Elective Course -I	3	0	0	0	60	40	100	03
8	AEC	23AM2512	Cognitive and Technical Skills-III	-	-	-	-	--	--	--	P/F
			Total	18	2	6	4				**23**

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

SL	Course Type	Course Name	Teaching Hours / Week				Examination			
			Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	C
			L	T	P	J				
1	PEC	Optimization Techniques	3	0	0	0	60	40	100	**03**
2	PEC	Fundamentals of Robotics	3	0	0	0	60	40	100	**03**
3	PEC	Fundamentals of IoT	3	0	0	0	60	40	100	**03**
4	PEC	Data Science & Analytics	3	0	0	0	60	40	100	**03**

MACHINE LEARNING

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

SEMESTER – V

Subject Code : 23AM3501		**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. **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

LIST OF LABORATORY/PRACTICAL EXPERIMENTS ACTIVITIES TO BE CONDUCTED
1. Implementation of linear and logistic regression. 2. Implementation of SVM, KNN, Naïve Bayes ML algorithms. 3. Implementation of Decision trees, Random Forest classifiers 4. Implement ensemble algorithms such as Boosting and Bagging. 5. Implementation of different clustering algorithms (K Means, Gaussian Mixture Model) and PCA. 6. Mini project in specific domains (Health care, Transportation, Retail and Commerce, Finance and Economics, Text and Image Processing etc.)

OPERATING SYSTEMS [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – V**				
Subject Code	: 23AM3502	**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. To understand the basic concepts, types, and functions of operating systems.
2. To understand the Processes and Threads.
3. To analyze the process Scheduling algorithms.
4. To understand the concept of Deadlocks and process synchronization.
5. To analyze various Memory management techniques.
6. To understand the various file management approaches.
7. To analyze the disk scheduling algorithms.

Teaching-Learning Process (General Instructions)

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

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

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

Introduction to operating systems and System structures, Computer System organization; Computer System architecture; Operating System structure; Operating System operations;
Different types of operating system: Batch Processing, multi-programmed, time-sharing, real-time, distributed, parallel.
Operating System Services: User and operating System interface; System calls; Types of system calls; operating system structure; Virtual machines.

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

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

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

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

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

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

Deadlocks: Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.

UNIT – IV: Memory Management	**08 Hours**

Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation.

Virtual Memory Management: Background; Demand paging; Performance; Page

replacement algorithms (FCFS, LRU, Optimal); Allocation of frames; Thrashing.	
UNIT – V File & Disk Management	**08 Hours**
File Systems: File concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping). Disk Management: Disk structure, Disk scheduling (FCFS, SSTF, SCAN, C-SCAN).	

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

Mapping Levels of COs to POs / PSOs

				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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NATURAL LANGUAGE MODELS

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

SEMESTER – V

Subject	: 23AM3503		**Credits**:	04

Code			
Hours / Week	: 04 Hours	**Total Hours**:	52 Hours
L–T–P–J	: 3–1–0–0		

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**
Past, present, and future of NLP; Classical problems on text processing; Necessary Math concepts for NLP; Regular expressions in NLP. Parts of Speech and Morphology, Phrase Structure, Semantics and Pragmatics, Corpus-Based Work: Getting Set Up, Looking at Text, Marked-up Data Text processing: lemmatization, stop word, tokenization, stemming, Spelling errors corrections–Minimum edit distance, Bayesian method	
UNIT – II	**08 Hours**
Words & Sentences, N-grams: Simple unsmoothed n-grams; smoothing, backoff, spelling correction using N-grams, Metrics to evaluate N-grams. Parts of Speech tagging: Word classes, POST using Brill's Tagger and HMMs; Information Extraction: Introduction to Named Entity Recognition and Relation Extraction WordNet and WordNet-based similarity measures, Concept Mining using Latent Semantic Analysis	
UNIT – III	**08 Hours**
Sequence to sequence & Language Modelling, Word embedding: skip-gram model, CBOW, GloVe, Language Modelling: Basic ideas, smoothing techniques, Language modeling with RNN and LSTM	
UNIT – IV	**08 Hours**
Case studies on Generative AIs in NLP : History of generative AI,ChatGPT technical overview, Generative pre-trained Transformer – 1, Generative pre-trained Transformer – 2, 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
3. Daniel Jurafsky and James H. Martin. 2009. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. Prentice-Hall.
4. Tiwary, U. S., & Siddiqui, T. (2008). Natural language processing and information retrieval. Oxford University Press, Inc.

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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

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COMPILER DESIGN AND SYSTEM SOFTWARE

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

SEMESTER – V

Subject Code	: 23AM3505	**Credits**:	04
Hours / Week	: 04 Hours	**Total Hours**:	52 Hours
L–T–P–J	: 3–1–0–0		

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

PROGRAMS

1. Program to count no of: i.+ve and –ve integers ii. +ve and –ve fractions
2. 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 +,-,*,/
3. Program to recognize the strings using the grammar (an b n ;n>=0)
4. C Program to implement Pass1 of Assembler
5. C Program to implement Shift Reduce Parser for the given grammar E →E+E E→E*E E→(E) E → id

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Explain 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													
Cos				Program Outcomes (POs)								PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	1		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

INNOVATION AND ENTREPRENEURSHIP

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

SEMESTER – V

Subject Code	: 23AM3504	**Credits**	: 02
Hours / Week	: 02 Hours	**Total Hours**	: 26 Hours
L–T–P–J	: 2–0–0–0		

Course Learning Objectives:

This course will enable students:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I **08 Hours**

Overview Of Entrepreneurship: The Entrepreneurial Perspective:

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

Case Study: Successful Entrepreneurs Narayana Murthy Infosys

UNIT – II **08 Hours**

THE ENTREPRENEURIAL AND ENTREPRENEURIAL MIND:

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

Case study: How to develop effective Business Plan

UNIT – III **08 Hours**

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

UNIT – IV	**08 Hours**

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

UNIT – V	**07 Hours**

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Soltanifar, Mariusz, Mathew Hughes, and Lutz Göcke. *Digital entrepreneurship: Impact on business and society*. Springer Nature, 2021.
2. Aulet, Bill. *Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Expanded & Updated*. John Wiley & Sons, 2024.
3. Havinal, Veerabhadrappa. Management and entrepreneurship. New Age International, 2009.
4. Janakiram, B. *Management & Entrepreneurship*. Excel Books India, 2010.

E-Resources:

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

Activity-Based Learning (Suggested Activities in Class)

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

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CLOUD COMPUTING
(skill Enhancement Course - III)

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

SEMESTER – V

Subject Code	:	23AM3506	**Credits**	:	02
Hours / Week	:	03 Hours	**Total Hours**	:	26 Hours
L–T–P–J	:	1–0–2–0			

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

INTRODUCTION TO CLOUD COMPUTING

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

UNIT – II	**08 Hours**

TYPES OF CLOUDS

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

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

UNIT – III	**08 Hours**

CLOUD SERVICES AND PLATFORMS

Building Cloud Computing Environments, Application Development, Infrastructure and System Development.

Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com, Manjrasoft Aneka.

Cloud Computing Architecture-Introduction, Cloud Reference Model- Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service.

Text Book 1: Chapter 1, Chapter 4

UNIT – IV	**08 Hours**

AWS CLOUD APPLICATION PLATFORM

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

Text Book 1

UNIT – V	**07 Hours**

CLOUD PLATFORMS IN INDUSTRY

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

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

Text Book 1: Chapter 9

LABORATORY EXPERIMENTS

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

Tools: VirtualBox or VMware

Tasks:

Install VirtualBox

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

Understand virtualization vs cloud

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

Tools: Ubuntu + Eucalyptus (or DevStack for OpenStack)

Tasks:

Install Eucalyptus/DevStack

Launch a VM instance inside the private cloud

Access the dashboard

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

Tools: AWS EC2 / Azure VM / GCP Compute Engine

Tasks:

Launch an EC2 instance

Connect via SSH

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

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

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

Tasks:

Initialize EB environment

Deploy app using CLI or Console

Monitor deployment logs

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

Tools: AWS S3

Tasks:

Create an S3 bucket

Upload and download files

Set permissions and enable static website hosting

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

Tools: AWS Elastic Load Balancer + Auto Scaling Groups

Tasks:

Create multiple EC2 instances

Attach to Load Balancer

Setup auto-scaling rules

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

Tools: AWS CloudWatch

Tasks:

Set up basic alarms (CPU usage, memory)

View application logs

Create a dashboard

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

Tools: AWS RDS or Firebase

Tasks:

Launch an RDS instance (MySQL/PostgreSQL)

Connect from a web app

Perform CRUD operations

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

Tools: AWS IAM

Tasks:

Create users and groups

Assign policies (S3 access, EC2 control)

Test access restrictions

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

Tasks:

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

Deployed on EC2 or Beanstalk

Use S3 for static content and RDS for database

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

Cisco Packet Tracer – For network simulation in cloud labs

Google Cloud Shell – In-browser terminal for experiments

Course Outcomes:

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

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Activity Based Learning (Suggestion Activities in Class)

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

Optimization Techniques

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

SEMESTER – V

Subject Code	:	23AM3507	**Credits**	:	3
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. Introduces various optimization techniques i.e classical, linear programming, simplex algorithm, and constrained and unconstrained optimization techniques.
2. Apply different optimization techniques for solving and optimizing engineering problems in real-world situations.
3. Illustrate population-based optimization techniques.
4. To provide a clear understanding of heuristic optimization techniques and multi-objective optimization techniques.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**07 Hours**

MODULE 1: Introduction and Classical Optimization Techniques:

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

UNIT – II	**07 Hours**

MODULE 2: Linear Programming:

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

UNIT – III	**08 Hours**

MODULE 3: Transportation Problem & Unconstrained Optimization

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

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

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

UNIT – IV	**09 Hours**

MODULE 4: Genetic Algorithms & Particle Swarm Optimization

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

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

UNIT – V	**09 Hours**

MODULE 5: Colony Optimization and Evolutionary Computing

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

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

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

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

Course Outcomes:

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

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Activity-Based Learning (Suggested Activities in Class)

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

FUNDAMENTALS OF ROBOTICS

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

SEMESTER – V

Subject Code	: 23AM3508	**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. 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	: 23AM3509	**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. To study fundamental concepts of IoT
2. To understand roles of sensors in IoT
3. To Learn different protocols used for IoT design
4. To be familiar with data handling and analytics tools in IoT
5. Appreciate the role of big data, cloud computing and data analytics in a typical IoT system.
6. Understand the role of IoT in various domains of Industry.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

FUNDAMENTALS OF IOT:

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

UNIT – II	**08 Hours**

SENSORS NETWORKS:

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

WIRELESS SENSOR NETWORKS:

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

UNIT – III	**08 Hours**

FUNDAMENTALS OF PYTHON PROGRAMMING & RASPBERRY PI:

Introduction to python programming, working with functions, classes, REST full Web

services, Client Libraries, Introduction & programming Raspberry Pi3, Integrating input-output devices with Raspberry Pi3.
UNIT – IV **08 Hours**
IOT PLATFORM, CLOUD COMPUTING PLATFORMS FOR IOT DEVELOPMENT: IOT platform Architecture (IBM Internet of things & Watson Platform); API Endpoints for platform Services; Devices Creation & Data Transmission; Introduction to NODE-RED and Application deployment. **CYBER PHYSICAL SYSTEMS:** Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis
UNIT – V **07 Hours**
APPLICATIONS OF IOT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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DATA SCIENCE & ANALYTICS

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

SEMESTER – V

Subject Code	:	23AM3510	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This course will enable students to:

1. **Understand** the fundamental concepts of 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.
3. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, Hand book of Data Visualization, ISBN - 9783540330363Springer Publication, 2008.
4. Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Christian Heumann · Michael Schomaker, Springer 2017.
5. SC Gupta and VK Kapoor, "Fundamentals of mathematical statistics", Sultan Chand & Sons Publication, New Delhi, 2014.
6. Learning Predictive Analytics with Python– Ashish Kumar, PACKT Publishing, 2016.

REFERENCE BOOKS:

1. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly, 1st edition, 2015.
2. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications Co., 1st edition, 2016.

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

VI SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	C
				L	T	P	J				
1	IPCC	23AM3601	Deep Learning	3	0	2	0	60	40	100	04
2	IPCC	23AM3602	Image Processing and Computer Vision	3	0	2	0	60	40	100	04
3	PCC	23AM3603	Designing MLOps for Enterprises	3	0	0	0	60	40	100	03
4	PEC	23AM36XX	Professional Elective Course – II	3	0	0	0	60	40	100	03
5	PEC	23AM36XX	Professional Elective Course – III	3	0	0	0	60	40	100	03
6	OEC	23OEXXXX	Open Elective – I	3	0	0	0	60	40	100	03
7	PROJ	23AM3604	Minor Project	0	0	0	4	--	100	100	02
8	AEC	23AM2613	Cognitive and Technical Skills-IV	-	-	-	-	--	--	--	P/F
			Total	19	0	6	0				**22**

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

SL	Course Type	Course Name	Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	C
			L	T	P	J				
1	PEC	Explainable AI	3	0	0	0	60	40	100	**03**
2	PEC	Reinforcement Learning	3	0	0	0	60	40	100	**03**
3	PEC	Cryptography & Network Security	3	0	0	0	60	40	100	**03**
4	PEC	Predictive Analytics	3	0	0	0	60	40	100	**03**

SL	Course Type	Course Name	Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	C
			L	T	P	J				
1	PEC	Generative AI	3	0	0	0	60	40	100	**03**
2	PEC	Robot Operating System (ROS)	3	0	0	0	60	40	100	**03**
3	PEC	Embedded System Design	3	0	0	0	60	40	100	**03**
4	PEC	Financial Technology (FinTech)	3	0	0	0	60	40	100	**03**

SL	Course Type	Course Name	Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	
			L	T	P	J				
1	OEC	Industrial Robotics	3	0	0	0	60	40	100	**03**
2	OEC	Machine Learning for Health Care	3	0	0	0	60	40	100	**03**

DEEP LEARNING

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

SEMESTER – VI

Subject Code	: 23AM3601	**Credits**:	04
Hours / Week	: 05 Hours	**Total Hours**:	39 (T) +26(p)
L–T–P–J	: 3–0–2–0		

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

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

Introduction to Perceptron, 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

Lab Programs:

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

a. Load the dataset as input.

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

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

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

i. Base Model
ii. Model with L1 Regularization
iii. Model with L2 Regularization
iv. Model with Dropout

6. Model with both L2 (or L1) and Dropout

7. Implement the standard VGG-16, Resnet architecture model to classify multi category image dataset and check the accuracy.
8. Implement the standard Densenet architecture model to classify multi category image dataset and check the accuracy.
9. Implement and Compare RNN and LSTM for sentiment analysis on movie reviews/other dataset and tabulate the results.
10. Implement and Compare LSTM and Bidirectional LSTM for sentiment analysis on movie reviews/other dataset and tabulate the results.
11. Implement Generative Adversarial Networks to generate realistic Images. Use MNIST, Fashion MNIST or any human face datasets.
12. Implement Auto encoders for image denoising on MNIST, Fashion MNIST or any suitable dataset.
Open Ended Experiments:
1) "Smart Diagnosis" – Disease Prediction Using Medical Imaging. 2) "Smart Yield" – Predicting Crop Yield with Satellite and Environmental Data. 3) "Stock Sense" – Predicting Stock Market Trends Using Deep Learning.
Course Outcomes: At the end of the course the student will be able to: 1. **Apply** deep learning models such as Artificial Neural Networks (ANN) and Convolutional Neural Networks (CNN) for classification tasks on various datasets. 2. **Evaluate and compare** the performance of deep learning architectures using different hyperparameters and regularization techniques on image data. 3. **Implement** Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) networks for learning, predicting, and classifying real-world problems within the deep learning domain. 4. **Apply** Autoencoders and Generative Adversarial Networks (GANs) for tasks such as image denoising and data augmentation.

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

4	Build an image classifier model, applying CNN and evaluating associated hyperparameters.	L4, L5
5	Construct deep learning-based models for healthcare applications and compare effectivity of advanced networks.	L5

Mapping Levels of COs to POs / PSOs

				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))

IMAGE PROCESSING AND COMPUTER VISION

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

SEMESTER – VI

Subject Code	: 23AM3602	**Credits**	: 04
Hours / Week	: 05 Hours	**Total Hours**	: 39 + 26 Hours
L–T–P–J	: 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														
Cos				Program Outcomes (POs)									PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	2	2											2	2
CO2	3	2	2		2								2	1
CO3	2	2		2									2	2
CO4	3	2		2	2								2	1
CO5	3	2	2		2				2				2	2

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

1. Image Processing/Open CV| Udemy

2. Introduction to Computer Vision and Image Processing | Coursera

Activity-Based Learning (Suggested Activities in Class)

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

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. Implement different Region-based Image segmentation techniques and threshold-based image segmentation techniques.
5. Write a program to implement the Image Compression technique such as Huffman Coding Algorithm.
6. Implement the Harris Corner Detector algorithm without the inbuilt Open CV() function.
7. Write a program to compute the SIFT feature descriptors of a given image.
8. Write a program to detect the specific objects in an image using HOG.
9. Write a Python program to Implement face detection using HOG descriptors and a pre-trained SVM model. Also, Evaluate the detection accuracy and challenges posed by low-resolution images.
10. Write a Python program to Implement a basic hand detection algorithm using HSV color space to segment the skin region from a single-color image. Also, Extract and display the hand contour.

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DESIGNING MLOPS FOR ENTERPRISES

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

SEMESTER – VI

Subject Code	: 23AM3603	**Credits**:	03
Hours / Week	: 3 Hours	**Total Hours**:	39 Hours
L–T–P–J	: 3–0–0–0		

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

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

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

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

Mapping Levels of COs to POs / PSOs

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Activity Based Learning (Suggested Activities in Class)

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

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MINOR PROJECT

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

SEMESTER – VI

Subject Code	:	23AM3604	**Credits**	:	02
Hours / Week	:	02	**Total Hours**	:	26 Hours
L–T–P–J	:	0–0–0–4			

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

COURSE CONTENT:

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

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

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

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

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

Evaluation:

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

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

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

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

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EXPLAINABLE AI

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

SEMESTER – VI

Subject Code	:	23AM3605	**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. 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														
COs				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2	1		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	:	23AM3606	**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. Use Reinforcement Learning Methods for the agents to learn an optimal, or nearly optimal, policy that maximizes the "reward function" or other user-provided reinforcement signal .
2. Apply such Reinforcement Learning mechanisms to various learning problems.
3. Learn about several algorithms that can learn near optimal policies based on trial and error interaction with the environment---learning from the agent's own experience

Teaching-Learning Process (General Instructions)

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

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

UNIT – I :	**08 Hours**

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

UNIT – II:	**08 Hours**

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

UNIT – III:	**07 Hours**
Dynamic Programming : Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming Textbook 1: Ch 4.1 to 4.8 RBT: L1, L2, L3	
UNIT – IV:	**08 Hours**
Monte Carlo Methods : Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, O-policy Prediction via Importance Sampling, Incremental Implementation, O-Policy Monte Carlo Control, Importance Sampling on Truncated Returns Textbook 1: Ch 5.1 to 5.8 RBT: L1, L2, L3	
UNIT – V	**08 Hours**
Deep Reinforcement Learning : Methods for learning from demonstrations, model-based and model-free deep RL methods, Case study-Methods for learning from offline datasets and more advanced techniques for learning multiple tasks such as goal-conditioned RL, meta-RL, and unsupervised skill discovery.	

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

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

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO 1	3	2											2	1
CO 2	3	2	2	1							2		1	1
CO 3	3	2			2								2	2
CO 4	3				2								1	2
CO 5	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	:	23AM3607	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**10 Hours**

INTRODUCTION:

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

UNIT – II	**10 Hours**

SYMMETRIC CRYPTOGRAPHY:

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

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

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

Activity Based Learning (Suggested Activities in Class)

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

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PREDICTIVE ANALYTICS

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

SEMESTER – VI

Subject Code	: 23AM3608	**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. 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	L3

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

1. Practical based Learning.
2. Mini Project

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GENERATIVE AI

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

SEMESTER – VI

Subject Code	:	23AM3609	**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. 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	**08 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														
Cos				**Program Outcomes (POs)**									**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	2			2				1				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. 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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ROBOT OPERATING SYSTEM (ROS)

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

SEMESTER – VI

Subject Code	: 23AM3610	**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. To be able to outline the architecture and file system of ROS.
2. To make use of Libraries such as turtlesim and Gazebo for ROS programming and simulation.
3. To be able to Examine the behaviour of robot programming to debug.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

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

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

UNIT – II	**08 Hours**

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

Chapter 5(ROS for absolute beginners)

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

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

UNIT – III	**08 Hours**

Debugging Robot Behavior: Log Messages: /rosout and rqt_console, Nodes, Topics, and

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

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

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

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EMBEDDED SYSTEM DESIGN

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

SEMESTER – VI

Course Code	: 23AM3611	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 39 hours
L–T–P-J	: 3–0–0-0		

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the fundamental concepts of embedded system design.
2. Gain **knowledge** of various hasardware 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. Jonathan Valvano," Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers", 2nd Edition, CreateSpace Independent Pub, 2012.
3. 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.

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.

FINANCIAL TECHNOLOGY (FINTECH)

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

SEMESTER – VI

Subject Code	:	23AM3612	**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. Recall the fundamentals of machine learning in finance for risk assessment and investment optimization.
2. Identify the key concepts and future trends in payment technologies, emphasizing security and efficiency.
3. Apply knowledge of blockchain and cryptocurrency to explain their roles and applications in financial systems.
4. Relate the methods of raising capital through credit tech, coin offerings, and crowdfunding.
5. Utilize innovations in investment technology driven by artificial intelligence to enhance portfolio management and risk analysis.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**07 Hours**

Fundamentals of AI&ML in Finance

Introduction to Fundamentals of Machine Learning in Finance - Support Vector Machines – Tree based Classifiers – PCA & concepts of Dimension Reduction – Clustering Algorithms - Sequence Modeling - Neural Architecture for Sequential Data

UNIT – II	**08 Hours**

Payment Technologies

Fintech Innovations - Digital Wallets – Payment like consumer-to-business (C2B), consumer-to-consumer (C2C), and business-to-business (B2B) - Social-Network-Based Payment Innovations - Credit Card network and Transactions - PayTech in India - M-Pesa: Business

Model	
UNIT – III	**08 Hours**
Blockchain and Cryptocurrency in Finance Introduction to Blockchain and Cryptocurrency - Network and Data Processing – Blockchain Consensus - Crypto Mining - Buying and Selling Cryptocurrencies - Crypto Risk Factors	
UNIT – IV	**08 Hours**
Capital Understanding and Raising Credit Analysis and Scoring - Data Analysis – Concept of Crowdfunding - Equity Based Models - ICO: Pricing, compliance, and returns - Smart Banking – Concept and Implementation	
UNIT – V	**08 Hours**
Innovations in Investment Technology Building an Efficient Portfolio - Diversified Investments - Exchange Traded Funds - Stock Selection: Fundamental Analysis - AI/ML in investment management	

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

Mapping Levels of COs to POs / PSOs

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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INDUSTRIAL ROBOTICS

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

SEMESTER – VI

Subject Code	:	23OE0016	**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 configuration space with specific reference to roboticmotion
2. Understand different types of kinematics used in industrial robotics.
3. To understand motion planning in industrial robotics.
4. Understand Computational Motion Planning and Mobility
5. Understand the concept of grasping and manipulation.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I :	**08 Hours**

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

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

UNIT – II:	**08 Hours**
Forward Kinematics: Forward Kinematics Example- Velocity Kinematics and Statics: Introduction to Velocity Kinematics and Statics-Space Jacobian-Body Jacobian, Inverse Kinematics: Inverse Kinematics of Open Chains.	
UNIT – III:	**08 Hours**
Kinematics of Closed Chains: Dynamics of Open Chains- Lagrangian Formulation of Dynamics-Understanding the Mass Matrix, Newton-Euler Inverse Dynamics, Trajectory Generation: Point-to-Point Trajectories-Polynomial Via Point Trajectories- Time-Optimal Time Scaling.	
UNIT – IV:	**07 Hours**
Motion Planning: Overview of Motion Planning, Robot Control, Control System Overview-Error Response-Linear Error Dynamics-First-Order Error Dynamics- Second-Order Error Dynamics-Motion Control with Velocity Inputs - Motion Control with Torque or Force Inputs.	
UNIT – V:	**08 Hours**
Grasping and Manipulation: First-Order Analysis of a Single Contact Contact Types: Rolling, Sliding, and Breaking-Multiple Contacts, Force Closure-Duality of Force and Motion Freedoms, Omnidirectional Wheeled Mobile Robots- Controllability of Wheeled Mobile Robots	

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

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

	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO1	3	3	2	-	1	-	-	-	2	2	-	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 and Control, 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	:	23OE0017	**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. **Summarize** the different types of medical data and its Medical Standards, Challenges.
2. **Apply** the different techniques to handle the missing and imbalanced problems and perform data analytics on the clinical and image data.
3. **Apply** Modelling techniques, Reinforcement Learning and Natural Language Processing for healthcare data.
4. **Utilize** the suitable Machine Learning and Deep Learning algorithms for various types of healthcare applications**.**
5. **Develop** a project using the appropriate case study in the healthcare.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

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

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

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

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

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO 1	2	1							2	2			1	1
CO 2	3	2			1				2	2			2	2
CO 3	3	2			1				2	2			2	2
CO 4	2	1			1				2	2			2	2
CO 5	3	3			1				2	2			2	2

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

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

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VII SEM – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	PEC	23AM47XX	Professional Elective Course – IV	2	0	0	2	100	--	100	03
2	PEC	23AM47XX	Professional Elective Course – V/ MOOC	2	0	0	2	100	--	100	03
3	OEC	23OEXXXX	Open Elective – II	3	0	0	0	60	40	100	03
4	PROJ	23AM4701	Capstone Project Phase-I	0	0	0	6	60	40	100	04
5	SEC	23AM4702	Agentic AI and LLM	0	0	0	2	100	--	100	01
			Total	7	0	0	12				**14**

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

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

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

Open Elective Course (OEC-II)

SL	Course Type	Course Name	Teaching Hours / Week				Examination				Credits
			Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
			L	T	P	J					
1	OEC	Responsible AI & Ethics	3	0	0	0	03	60	40	100	**03**

CAPSTONE PROJECT PHASE - I

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

SEMESTER – VII

Subject Code	:	23AM4701	**Credits**	:	04
Hours / Week	:	06	**Total Hours**	:	52 Hours
L–T–P–J	:	0–0–0–6			

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

COURSE CONTENT:

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

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

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

Evaluation:

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

COURSE CONTENT:

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

b. Department staff as course guide

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

b. Student Team

1. To be dedicated and committed to work on a new research topic by learning new technical skills
2. To have fair knowledge on what is product development or research topic
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Evaluation:

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

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

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

Mapping Levels of COs to POs / PSOs													
				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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AGENTIC AI AND LLM

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

SEMESTER - VII

Course Code	**:**	23AM4702	**Credits**	**:**	01
Hours / Week	**:**	02	**Total Hours**	**:**	**15**
L–T–P–J	**:**	0–0–0–2			

Course Vision:

To cultivate engineers capable of designing, implementing, and responsibly deploying AI agents that reason, plan, use tools, and collaborate — integrating modern agentic frameworks, NVIDIA DLI certified learning pathways, and sound judgment about human oversight in autonomous systems.

Course Objectives:

This course will enable students to:

1. To understand the foundations of agentic AI: agent taxonomies, perception-reasoning-action loops, and environments.
2. To apply reasoning patterns (ReAct, Reflexion, Chain-of-Thought) and build self-correcting memory-augmented agents.
3. To implement tool use, retrieval-augmented generation, and agent orchestration with LangChain, LangGraph, CrewAI.
4. To design multi-agent systems with role specialization, delegation, and supervisor-worker architectures.
5. To evaluate agent safety, alignment, and production deployment with human-in-the-loop oversight and benchmarking.

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** 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

MODULE – I	**09 Hours**

Foundations of Agentic AI

Topics: Evolution from rule-based systems to LLM-powered agents; defining agency

(autonomy, reactivity, proactivity, social ability); perception-reasoning-action loop; environment types (observable, deterministic, static/dynamic); agent taxonomies (reflex, model-based, goal-based, utility-based, learning); structured outputs and JSON mode for reliable tool interfaces; local LLM inference setup (complemented by DLI for NIM-specific deployment). **Applications:** Virtual assistants, autonomous coding agents, customer support bots, educational tutoring systems.	
MODULE – II	**09 Hours**
Agent Architectures & Reasoning Patterns **Topics:** Advanced reasoning frameworks: ReAct (Reasoning + Acting) implementation from scratch; Chain-of-Thought and Tree-of-Thought prompting; Reflexion and self-critique loops — agents evaluating their own outputs; memory systems (short-term working, long-term vector stores, episodic); state and context window management; cognitive architectures (BDI model, ACT-R parallels in LLM agents); code generation and self-debugging agent patterns. (Prompt engineering fundamentals, LangChain LCEL, structured outputs, and basic tool invocation are covered in depth via the 8-hour DLI course.) **Applications:** Research assistants, code generation and review agents, document analysis pipelines, automated debugging tools.	
MODULE – III	**09 Hours**
Tool Use, RAG & Orchestration **Topics:** Production-grade patterns beyond the DLI course: error handling and retry strategies; circuit breakers for unreliable tools; advanced structured output schemas with Pydantic; function and tool calling API patterns across providers (OpenAI, Anthropic, open-source); RAG evaluation discussion — when retrieval helps vs. hurts. (RAG architecture fundamentals, vector databases, LangGraph state machines, dialog management, and base RAG evaluation metrics are covered in depth via the 8-hour DLI RAG Agents course.) **Applications:** Enterprise search agents, data analysis pipelines with tool chains, automated report generation, domain-specific Q&A systems.	
MODULE – IV	**09 Hours**
Multi-Agent Systems & Collaboration **Topics:** Multi-agent communication protocols and message passing; role-based agent design (planner, researcher, writer, critic, executor); cooperative vs competitive strategies; debate and consensus mechanisms for improved reasoning; agent-to-agent delegation; supervisor/worker patterns; hierarchical orchestration with LangGraph; swarm architectures; game-theoretic foundations; multimodal agents reasoning across text, images, and tool outputs. **Applications:** Multi-agent software development teams (planner + coder + tester); collaborative research agents; supply chain optimization; automated content pipelines.	
MODULE – V	**09 Hours**
Agent Safety, Evaluation & Deployment **Topics:** Agent safety and alignment — sandboxing, permission models, guardrails, policy enforcement; evaluation metrics for agents (task completion, efficiency, safety violations);	

benchmarking frameworks (AgentBench, SWE-bench, WebArena); human-in-the-loop design patterns; interrupt/resume primitives for supervised execution; deployment architecture (containerization, monitoring, observability with LangSmith); red-teaming agents; regulatory considerations (EU AI Act Article 14 human oversight, NIST AI RMF). (Inference sizing and cost-latency trade-offs covered in depth via DLI.)
Applications: Production AI assistants, autonomous DevOps agents, healthcare decision support, financial advisory agents, compliance agents.

Course Outcome

Course Outcomes (COs)	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	Explain foundations of agentic AI including agent taxonomies, perception-reasoning-action loops, and environment classifications.	L2
2	Apply reasoning patterns (ReAct, Reflexion, CoT) and implement memory-augmented agents from scratch and with frameworks.	L4
3	Analyze and implement tool use, RAG, and agent orchestration with LangChain, LangGraph, and CrewAI.	L4
4	Design multi-agent systems with role specialization, delegation patterns, and supervisor-worker architectures.	L3
5	Evaluate agent safety, alignment, and production deployment with HITL oversight, benchmarking, and regulatory awareness.	L5

Mapping Levels of COs to POs / PSOs

Table: Mapping Levels of COs to POs / PSOs

COS	Program Outcomes (POs)											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO-1	3	2	1	–	1	–	–	1	1	–	–	3	2	1
CO-2	3	3	3	2	3	–	–	–	–	–	2	3	3	3
CO-3	3	3	3	–	3	1	–	–	2	1	2	3	3	3
CO-4	3	2	2	3	1	2	1	–	–	–	3	3	3	2
CO-5	3	3	3	–	3	2	–	3	2	–	3	3	3	3

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

TEXT BOOKS:

1. Stuart Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2021.

2. Michael Wooldridge, *An Introduction to MultiAgent Systems*, 2nd Edition, Wiley, 2009.

REFERENCE BOOKS:

1. Chip Huyen, *AI Engineering: Building Applications with Foundation Models*, O'Reilly Media, 2025.
1. Shunyu Yao et al., *ReAct: Synergizing Reasoning and Acting in Language Models*, ICLR 2023.
2. Noah Shinn et al., *Reflexion: Language Agents with Verbal Reinforcement Learning*, NeurIPS 2023.

E-RESOURCES:

1. https://langchain-ai.github.io/langgraph/ (LangGraph Documentation)
2. https://microsoft.github.io/autogen/ (AutoGen Documentation)
3. https://www.deeplearning.ai/short-courses/ (Multi AI Agent Systems with CrewAI)
4. https://lilianweng.github.io/posts/2023-06-23-agent/ (Lilian Weng: LLM Powered Autonomous Agents)
5. https://www.anthropic.com/engineering/building-effective-agents (Anthropic: Building Effective Agents)
6. **RECOMMENDED TOOLS**
7. Python 3.10+, LangChain, LangGraph, CrewAI, AutoGen
8. LLM Inference: Ollama, OpenAI API, Anthropic API, NVIDIA NIM
9. Vector Stores: ChromaDB, FAISS, Pinecone
10. Observability: LangSmith, OpenTelemetry, Weights & Biases
11. Vector Stores: ChromaDB, FAISS, Pinecone — chromadb.com

LAB EXERCISES

S.No	Exercise Title	Aim / Objective	Tools & Dataset	Hrs	CO
MODULE I · Exercises 1–3 : Agentic AI Foundations (06 Hours)					
1	**Agent Development Environment Setup**	**Configure Python agent stack (LangChain, Ollama); run local LLM inference; test structured JSON output for tool interfaces.**	**Python, LangChain, Ollama Dataset: *Local LLM (Llama 3, Mistral, Qwen)***	**2 h**	**CO1**
2	**Single-Turn**	**Build a basic agent**	**Python,**	**2 h**	**CO1**

	Tool-Calling Agent	**that calls calculator and web search tools; test structured output validation and error recovery.**	**LangChain, Tavily API Dataset: *Multi-step calculation tasks***		
3	**ReAct Agent from Scratch**	**Implement the ReAct loop without frameworks; observe Thought-Action-Observation traces; identify hallucinated tools and infinite loops.**	**Raw OpenAI/Anthropic API, Python Dataset: *Multi-hop factual questions***	**2 h**	**CO1**
MODULE II · Exercises 4–5 : Reasoning Patterns & Memory (04 Hours)					
4	**Chain-of-Thought vs Tree-of-Thought**	**Implement CoT and ToT on the same benchmark (GSM8K subset); measure accuracy vs cost and latency trade-offs.**	**LangChain, Python Dataset: *UCI Adult Income Dataset***	**2 h**	**CO1**
5	**Memory-Augmented Agent**	**Add ChromaDB vector memory to an agent; evaluate long-conversation consistency; test Reflexion self-critique on reasoning errors.**	**LangChain, ChromaDB Dataset: *UCI Adult Income Dataset***	**2 h**	**CO1**
MODULE III · Exercises 6–7 : RAG & Orchestration (04 Hours)					

6	**Production-Style RAG Pipeline**	**Build a RAG pipeline with dense + sparse retrieval, query transformation, and re-ranking; measure MRR, NDCG, faithfulness.**	**LangChain, ChromaDB, rerankers Dataset: *Enterprise document corpus***	**2 h**	**CO2**
7	**LangGraph Stateful Agent with Error Handling**	**Design a stateful LangGraph workflow with conditional routing; implement error handling and retry with circuit breakers to handle tool failures gracefully.**	**LangGraph, Pydantic Dataset: *Customer service / triage scenarios***	**2 h**	**CO2**
MODULE IV · Exercises 8–10 : Multi-Agent Systems (06 Hours)					
8	**CrewAI Role-Based Multi-Agent System**	**Build a CrewAI team with planner, researcher, writer, and critic agents; measure end-to-end task quality vs. single-agent baseline.**	**CrewAI, Python Dataset: *Research report generation tasks***	**2 h**	**CO2**
9	**Multi-Agent Debate for Reasoning**	**Two agents argue opposing positions; a judge agent synthesizes;**	**LangChain, Python Dataset: *GSM8K subset, logic***	**2 h**	**CO3**

		measure accuracy improvement over single-agent on reasoning benchmarks.	***puzzles***		
10	**Supervisor-Worker Orchestration**	**Build a supervisor agent that dynamically routes to specialized worker agents (coder, researcher, validator); evaluate routing accuracy.**	**LangGraph, Python Dataset: *Mixed task stream (code, search, math)***	**2 h**	**CO4**
MODULE V · Exercises 11–12 : Safety & Capstone (10 Hours)					
11	**Agent Red-Team & Guardrail Design**	**Red-team a deployed agent with prompt injection and unauthorized tool-use attempts; design and test guardrails; quantify safety improvement.**	**LangChain, guardrails-ai, Python Dataset: *Custom adversarial prompt suite***	**4 h**	**CO4**
12	**Production-Grade Agent with HITL (Capstone)**	**Design a production agent: LangGraph state machine → interrupt/resume primitives →**	**Full stack: LangGraph, LangSmith, guardrails-ai, OpenTelemetry, NVIDIA NIM**	**6 h**	**CO5**

		guardrails → observability (LangSmith) → cost tracking → regulatory documentation.	**Dataset: *Student-chosen enterprise workflow domain***		

AI ETHICS

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

SEMESTER – VII

Subject Code	: 23AM4703	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 45 Hours
L–T–P–J	: 2–0–0–2		

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**
Data, Individuals, and Society: The power and impact that analytics and AI/ML have on individuals and society, especially concerning issues such as fairness and bias, ethics, legality, data collection and public use.	

UNIT – II	**08 Hours**
Big Data: Components of big data, basic statistical techniques to data scenarios, and understand the issues faced when learning from big data, ranging from data biases, overfitting, causation vs correlation, etc.	

UNIT – III	**09 Hours**
Privacy and Fairness in AI/ML: Use of AI/ML techniques to data scenarios, with a focus on identifying fairness and bias issues found in the design of decision-making systems. Technical approaches to current AI/ML applications such as facial recognition, natural language processing, and predictive algorithms, all while being mindful of its social and legal context.	

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

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

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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INDUSTRY 5.0 [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – VII**			
Subject Code	: 23AM4704	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 45 Hours
L–T–P–J	: 2–0–0–2		

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.

APPLICATIONS:

No.	Industry 5.0 Application	Example Project
1	Human–Robot Collaboration (Cobots)	**Smart Assembly Line with Cobots** – Develop a robotic assistant that helps workers assemble products while ensuring safety through sensors.
2	Personalized Manufacturing	**AI-Based Customized Product Manufacturing System** – Create a system that automatically adjusts production parameters according to customer orders.
3	Predictive Maintenance	**Machine Health Monitoring System** – Build an IoT-based platform that collects vibration and temperature data to predict equipment breakdowns.
4	Digital Twin Technology	**Digital Twin of a Production Line** – Design a virtual replica of a factory line to analyze performance and optimize operations.
5	Smart Healthcare	**AI-Powered Patient Monitoring System** – Develop a system

No.	Industry 5.0 Application	Example Project
		that tracks vital signs and alerts healthcare providers about abnormalities.
6	Sustainable Manufacturing	**Energy-Efficient Smart Factory** – Implement IoT sensors to monitor and optimize energy usage in a manufacturing unit.
7	Smart Supply Chain Management	**IoT-Based Supply Chain Tracking System** – Track goods throughout the supply chain using RFID and cloud-based analytics.
8	Precision Agriculture	**Smart Farming with IoT and Drones** – Develop a system for monitoring soil moisture, crop health, and irrigation requirements.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth	L2
2	Analyze enhanced new production models in electronics	L3
3	Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization	L4
4	Design suitable sensors for smart world real time applications with virtual reality experience	L4
5	Evaluate the performance of various cyber physical systems	L5

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

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

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

TEXT BOOKS:

1. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial internet of things and industry 4.0. CRC Press, 2021.
2. Elangovan, Uthayan. Industry 5.0: The future of the industrial economy. CRC Press, 2021.
3. Saini, Aarti, and Vikas Garg, eds. Transformation for Sustainable Business and Management Practices: Exploring the Spectrum of Industry 5.0. Emerald Publishing Limited, 2023.

REFERENCE BOOKS:

1. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
2. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016..
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
4. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
5. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016

E-Resources:

1. https://www.udemy.com/course/digital-transformation-from-industry-40-to-industry-50/

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

GPU ARCHITECTURE

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

SEMESTER – VII

Subject Code	: 23AM4705	**Credits**:	03
Hours / Week	: 03 Hours	**Total Hours**:	45 Hours
L–T–P–J	: 2–0–0–2		

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***)	

APPLICATIONS:

1	**Artificial Intelligence & Machine Learning**	**GPUs accelerate the training and inference of deep learning models through massive parallel processing.**	**Image Classification Using CNN on GPU – Train a convolutional neural network using CUDA-enabled GPUs for object recognition.**
2	**Scientific Computing**	**GPUs perform complex numerical simulations much faster than CPUs.**	**Weather Simulation Accelerator – Implement parallel algorithms for weather forecasting using GPU computing.**
3	**Computer Graphics & Rendering**	**GPUs render 2D/3D graphics, animations, and visual effects in real time.**	**Real-Time Ray Tracing Renderer – Develop a GPU-based ray tracing engine for realistic lighting and shadows.**
4	**Video Processing & Encoding**	**GPUs accelerate video editing, compression, streaming, and transcoding tasks.**	**GPU-Accelerated Video Transcoder – Create a system that converts videos into multiple formats using CUDA/OpenCL.**
5	**Cryptocurrency & Blockchain**	**GPUs perform parallel hash computations required for blockchain applications.**	**Blockchain Hash Performance Analyzer – Analyze and compare GPU-based hashing performance across algorithms.**
6	**High-Performance Computing (HPC)**	**GPUs speed up large-scale computations in research, engineering, and data analysis.**	**Parallel Matrix Multiplication System – Implement and benchmark matrix operations on GPU versus CPU.**

7	**Autonomous Vehicles**	**GPUs process camera, LiDAR, and sensor data in real time for navigation and object detection.**	**Real-Time Object Detection for Self-Driving Cars – Use GPU acceleration to run YOLO or similar detection models.**
8	**Gaming & Virtual Reality (VR)**	**GPUs provide high-frame-rate graphics and immersive virtual environments.**	**VR Environment Rendering Engine – Build a GPU-powered virtual reality application with real-time rendering.**

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course, the student will be able to:		
1	Outline the historical evolution of GPU architectures, the fundamental concepts of parallelism, and typical GPU components, including threads, blocks, grids, warps, and scheduling.	L2
2	Apply CUDA programming principles to develop solutions that utilize single and multi-GPU setups, focusing on problem decomposition, memory considerations, and efficient thread usage.	L3
3	Analyze common problems in CUDA programming, including error handling, parallel programming issues, and synchronization challenges.	L4
4	Utilize OpenCL to create basic examples and demonstrate how it can be used for heterogeneous computing tasks, enhancing their ability to work across different hardware platforms	L3
5	Evaluate the effectiveness of these algorithms in programming heterogeneous clusters, ensuring efficient and scalable solutions for complex computational problems	L5

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

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

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

TEXT BOOKS:

1. Robey, Robert, and Yuliana Zamora. *Parallel and high performance computing*. Simon and Schuster, 2021.
2. Deakin, Tom, and Timothy G. Mattson. *Programming Your GPU with OpenMP: Performance Portability for GPUs*. MIT Press, 2023.
3. Shane Cook, CUDA Programming: —A Developer's Guide to Parallel Computing with GPUs(Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012

REFERENCE BOOKS:

1. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, —Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
2. Learn CUDA Programming - Jaegeun Han, Bharatkumar Sharma Packt Publishing, 27-Sept-2019 - 508 pages.
3. Parallel Computing for Data Science (Chapman & Hall/CRC The R Series) 1st Edition

E-Resources:

1. https://developer.nvidia.com/cuda-toolkit
2. https://developer.nvidia.com/opencl
3. https://leonardoaraujosantos.gitbook.io/opencl/chapter1
4. https://github.com/topics/opencl
5. https://github.com/mikeroyal/OpenCL-Guide

Activity Based Learning (Suggested Activities in Class)

1. Group discussion on how to optimize the machine learning algorithms or a whole neural network using CUDA.
2. Collaborative Activity is minor project development with a team of 4 students.

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BIG DATA ANALYTICS

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

SEMESTER – VII

Subject Code : 23AM4706	**Credits** : 03
Hours / Week : 03 Hours	**Hours** 45 Hours
L–T–P–J : 2–0–0–2	

Course Learning Objectives:

This course will enable students to:

1. **Explain** the fundamental concepts of big data and analytics.
2. **Make Use of** the Hadoop Distributed File System components and Hadoop Daemons for storing large data sets of structured or unstructured data across various nodes.
3. **Develop** a MapReduce paradigm for the analysis of Big Data of different applications.
4. **Execute** the commands using Pig Hadoop ecosystem tools.
5. **To analyze and interpret** the data by executing the queries using Hive Hadoop Ecosystem tools.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I :	**07 Hours**

INTRODUCTION TO BIGDATA: Understanding Big Data, Types of Data: Structured, Unstructured and Semi-structured, Different sources of Data Generation, Different V's: Volume, Variety, Velocity, Veracity, Value.

Phases of Big Data Analytics, Types of Data Analytics, Apache Hadoop, Need for the Hadoop, Apache Hadoop Architecture, How Does Hadoop Work? Advantages of Hadoop, Apache Hadoop Ecosystem.

Textbook 1 Chapter 1

UNIT – II:	**09 Hours**

Hadoop Distributed File System: Hadoop Distributed File System, Features of HDFS, HDFS Architecture, Commands and description of HDFS, Hadoop File system, Replication factor, Name Node, Job Tracker, Task tracker, Data Node, FS Image, Edit-logs, Check-pointing Concept, HDFS federation, Architectural description for Hadoop Cluster, Hadoop – File Blocks and Replication Factor.

Textbook 1 Chapter 3

UNIT – III:	08 Hours

Processing Unit:

MapReduce, Internal architecture, Record Reader, Mapper Phase, Reducer Phase, Sort and Shuffle Phase, Data Flow, Counters, Combiner Function, Partition Function, Joins, Map Side Join, Reduce Side Join, writing a simple MapReduce program to Count Number of words, YARN, YARN Architecture, YARN Components, Resource Manager.

Textbook 1 Chapter 6

UNIT – IV:	08 Hours

Apache Pig

Apache Pig, Pig on Hadoop, Pig Latin, Local Mode and MapReduce Mode, Pig's Data Model, Scalar, Complex, Load, Dump, Store, Foreach, Filter, Join, group, Order by, Distinct, Limit, Sample, Parallel, User Defined Function, Program for Word Count Job, Comparison Apache Pig and MapReduce.

Textbook 1 Chapter 11

UNIT – V:	08 Hours

Apache Hive

Apache Hive, Features of Apache Hive, History of Apache Hive, Hive Data Types & Files Formats, Creating Managed Table, External Table, Partitioned Tables, loading data into Managed Table, Inserting Data into Tables from Queries, Dynamic Partitions inserts, Exporting data, SELECT from clauses, WHERE Clauses, GROUP BY Clauses, JOIN Statements, DISTRIBUTE BY, CLUSTER BY, bucketing, View, Hive Metastore.

Textbook 1 Chapter 12

APPLICATIONS:

No.	Application Area	Project Title	Brief Description
1	Healthcare Analytics	Disease Prediction Using Big Data	Analyze patient records to predict diseases such as diabetes or heart disease using machine learning and large healthcare datasets.
2	Social Media Analytics	Sentiment Analysis of Social Media Posts	Collect and analyze social media data to determine public sentiment about products, events, or policies.
3	E-Commerce Analytics	Product Recommendation System	Build a recommendation engine using customer purchase history and browsing behavior.
4	Smart Cities	Traffic Flow Prediction System	Analyze traffic sensor and GPS data to predict congestion and optimize traffic management.

No.	Application Area	Project Title	Brief Description
5	Financial Analytics	Credit Card Fraud Detection	Use transaction data to identify fraudulent activities through anomaly detection techniques.
6	Education Analytics	Student Performance Prediction	Analyze academic records and attendance data to predict student performance and identify at-risk students.
7	IoT Analytics	Smart Energy Consumption Monitoring	Process smart meter and IoT sensor data to analyze and optimize household or industrial energy usage.
8	Retail Analytics	Customer Churn Prediction	Analyze customer purchase patterns and engagement data to predict customer attrition and improve retention strategies.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Summarize the concept of big data and its phases, architecture, features and compare it with traditional RDBMS.	L2
2	Make Use of the Hadoop Distributed File System components and Hadoop Daemons for storing large data sets of structured or unstructured data across various nodes.	L3
3	Illustrate and develop a MapReduce paradigm for the analysis of Big Data of various applications.	L4
4	Make use of the Pig Hadoop Ecosystem tool for performing data processing operations.	L4
5	Apply Hive Hadoop Ecosystem tool for performing data processing operations and to store the data in Hive Meta store .	L5

Mapping Levels of COs to POs / PSOs

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

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

Text Books:

1. Hands-on introduction to Big Data Analytics: Funmi obembe, Ofer Engel , 1st Edition, SAGE Publication, 2024, Isbn: 9781529600087.
2. Hadoop: The Definitive Guide, By: Tom White, O'REILLY, 4th Edition,2015.
3. Programming Pig, By: Alan Gates, Published by O'Reilly Media, Inc., 2016.
4. Programming Hive, By: Edward Capriolo, Dean Wampler & Jason Rutherglen, Published by O'REILLY, 2012.

Reference Books:

1. Dirk deRoos, Paul C. Zikopoulos, Bruce Brown, Rafael Coss, and Roman B. Melnyk , "Hadoop for Dummies", A Wiley brand, 2014.
2. Programming Hive, By: Edward Capriolo, Dean Wampler & Jason Rutherglen, Published by O'REILLY, 2012.

E-Resources:

1. https://www.ibm.com/ae-en/analytics/hadoop/big-data-analytics
2. https://www.tableau.com/learn/articles/big-data-analytics

Activity Based Learning (Suggested Activities in Class)

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

HUMAN COMPUTER INTERACTION

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

SEMESTER – VII

Subject Code	:	23AM4707	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	45 Hours
L–T–P–J	:	2–0–0–2			

Course Learning Objectives:

This course will enable students to:

1. **Describe** effective and usable graphical computer interfaces.
2. **Describe and apply** core theories, models, and methodologies from the field of HCI.
3. **Choose** an appropriate approach for interface designing.
4. **Make use of** the components to build new and navigation schemes in windows.
5. **Build** the model in the field of HCI.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**

Introduction: Introduction: Importance of user Interface – definition, the importance of 8 good designs. Benefits of good design. A brief history of Screen design. The graphical user interface – the popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface
popularity, characteristics- Principles of user interface.

UNIT – II	**08 Hours**

Design Process: Human interaction with computers, the importance of 8 human characteristics human consideration, Human interaction speeds, and understanding of business junctions. III Screen Designing:
Design goals – Score.

UNIT – III	**09 Hours**

Screen Designing: Design goals – Screen planning and purpose, 8 organizing screen elements, ordering of screen data and content – screen navigation and flow – visually pleasing composition – the amount of information – focus and emphasis – presentation of information simply and meaningfully – information
retrieval on the web – statistical graphics – Technological consideration in interface design.

UNIT – IV	**07 Hours**
Windows: New and Navigation schemes selection of window, 8 selection of devices based and screen- based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.	
UNIT – V	**07 Hours**
Software Tools Specification methods, interface – Building Tools. 8 Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers.	
Course Outcomes: At the end of the course the student will be able to: 1. **Summarize** effective and usable graphical computer interfaces**.** 2. **Design** effective HCI for individuals and persons with disabilities**.** 3. **Choose** an appropriate approach for interface designing and **assess the importance of user feedback.** 4. **Make use of** the components to build new and navigation schemes in windows. 5. **Demonstrate** the HCI implications for designing multimedia/eCommerce/e-learning websites.	

APPLICATIONS

No.	**Application Area**	**Project Title**	**Brief Description**
1	Healthcare Analytics	Disease Prediction Using Big Data	Analyze patient records to predict diseases such as diabetes or heart disease using machine learning and large healthcare datasets.
2	Social Media Analytics	Sentiment Analysis of Social Media Posts	Collect and analyze social media data to determine public sentiment about products, events, or policies.
3	E-Commerce Analytics	Product Recommendation System	Build a recommendation engine using customer purchase history and browsing behavior.
4	Smart Cities	Traffic Flow Prediction System	Analyze traffic sensor and GPS data to predict congestion and optimize traffic management.
5	Financial Analytics	Credit Card Fraud Detection	Use transaction data to identify fraudulent activities through anomaly detection techniques.
6	Education Analytics	Student Performance Prediction	Analyze academic records and attendance data to predict student performance and identify at-risk students.

No.	Application Area	Project Title	Brief Description
7	IoT Analytics	Smart Energy Consumption Monitoring	Process smart meter and IoT sensor data to analyze and optimize household or industrial energy usage.
8	Retail Analytics	Customer Churn Prediction	Analyze customer purchase patterns and engagement data to predict customer attrition and improve retention strategies.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	Engineering knowledge	Problem analysis	Design	Conduct investigations of complex problems	tool usage	The engineer and society	Environment and sustainability	Ethics	team work	Communication	Life-long learning	Project management and finance	Apply the principal concepts of AI Engineering	Apply the knowledge gained pertaining to data storage, data analytics and AI concepts	develop, and test principles of AI concepts on Intelligent Systems
CO 1	1	-		-	-	-	-	-	-	2	2	-	-	1	1
CO 2	3	2	2	-	1	-	-	-	2	2	-	-	2	2	2
CO 3	3	2	-	-	1	-	-	-	2	2	-	-	2	2	2
CO 4	3	2	-		-	1	-	-	-	2	2	-	-	2	2
CO 5	3	3	2	-	1	-	-	-	2	2	-	-	2	2	2

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

TEXT BOOKS:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale Human Computer Interaction, 3rd Edition rentice Hall, 2004.
2. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, Research Methods in Human Computer I nteraction, Wiley, 2010.
3. Samit Bhattacharya. (2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw Hill Education (1st ed).
4. Bruce R Maxim & Roger S Pressman (2019). Software Engineering: A Practitioner's Approach. (8th ed). McGraw Hill Education.

REFERENCE BOOKS:

1. Ben Shneiderman and Catherine Plaisant Designing the User Interface: Strategies for Effective Human-Computer

E-Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106177/
2. https://onlinecourses.nptel.ac.in/noc22_cs125/

Activity Based Learning (Suggested Activities in Class)

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

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ROBOTICS AND AUTOMATION APPLICATION

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

SEMESTER – VII

Subject Code	: 23AM4708	**Credits**	: 03
Hours / Week	: 03 Hours	**Total Hours**	: 45 Hours
L–T–P–J	: 2–0–0–2		

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.

APPLICATIONS:

No.	Application Area	Project Title	Brief Description
1	Industrial Automation	Automated Conveyor Belt Sorting Robot	Develop a robotic system that identifies and sorts objects based on color, size, or shape using sensors and actuators.
2	Agricultural Robotics	Smart Crop Monitoring and Irrigation Robot	Design a robot that monitors soil moisture, temperature, and crop conditions and automates irrigation.
3	Healthcare Robotics	Autonomous Medicine Delivery Robot	Create a robot that navigates hospital corridors and delivers medicines to designated locations.
4	Home Automation	Voice-Controlled Service Robot	Build a robot that performs simple household tasks and responds to voice commands.
5	Warehouse	Automated Pick-and-	Develop a robotic arm capable of

No.	Application Area	Project Title	Brief Description
	Automation	Place Robotic Arm	identifying, picking, and placing objects in predefined locations.
6	Surveillance and Security	Autonomous Patrol and Intrusion Detection Robot	Design a mobile robot equipped with cameras and sensors to monitor restricted areas and detect intrusions.
7	Disaster Management	Search and Rescue Robot	Create a robot that can navigate hazardous environments and locate victims using sensors and wireless communication.
8	Smart Transportation	Autonomous Line-Following Delivery Robot	Develop a robot that follows predefined paths to transport materials or packages within a campus or industry.

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

REFERENCE BOOKS:

1. Robotics and control - R K Mittal and I J nagrath, TataMcGraw Hill 2004.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering - integrated approach by Richard d Klafter-London: Prentice-HaJJ-1989.

E-Resources:

1. http://www.leamerstv.com/Free-Engineering-Video-lectures-ltv071-Page 1.htm
2. http://www.cadcamfunda.com/cam _computer_ aided_manufacturing
3. http://wings.buffalo.edu/eng/mae/courses/460-564/Course-Notes/cnc-classnotes.pdf
4. http://nptel.iitm.ac.in/courses.php?branch=Mechanical
5. http://academicearth.org/courses/introduction-to-roboticsVideo
6. http://nptel.iitm.ac.in/video.php?courseid= 1052
7. http://www.npteJ.iitm.ac.in/and iitb.ac.in,

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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QUANTUM COMPUTING

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

SEMESTER – VII

Subject Code	:	23AM4709	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	45 Hours
L–T–P–J	:	2–0–0–2			

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.	

APPLICATIONS:

No.	Application Area	Project Title	Brief Description
1	Quantum Cryptography	Quantum Key Distribution (QKD) Simulation	Simulate secure key exchange using quantum principles such as the BB84 protocol and analyze security against eavesdropping.
2	Quantum Search Algorithms	Implementation of Grover's Search Algorithm	Develop a quantum program that demonstrates faster searching in an unsorted database compared to classical methods.
3	Quantum Optimization	Traffic Route Optimization Using Quantum Algorithms	Model and solve route optimization problems using quantum-inspired optimization techniques.
4	Quantum Machine Learning	Quantum-Based Classification of Datasets	Implement a basic quantum machine learning classifier and compare its performance with classical algorithms.
5	Quantum Finance	Quantum Portfolio Optimization	Simulate portfolio selection and risk minimization using quantum optimization approaches.
6	Drug Discovery and Healthcare	Molecular Simulation Using Quantum Computing	Use quantum simulators to model simple molecular interactions relevant to drug discovery.
7	Quantum Communication Networks	Secure Quantum Communication System	Design and simulate a secure communication framework using quantum entanglement and quantum channels.
8	Quantum Error Correction	Quantum Error Detection and Correction Simulator	Implement and analyze basic quantum error correction codes to improve reliability in quantum computations.

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

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

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

SEMESTER – VII

Subject Code	:	23AM4710	**Credits**	:	03
Hours / Week	:	03	**Total Hours**	:	39 Hours
L–T–P–J	:	0–0–0–6			

Course Learning Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

COURSE CONTENT:

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

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

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

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

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

Evaluation:

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

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

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

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

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RESPONSIBLE AI & ETHICS

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

SEMESTER – VII

Subject Code	: 23OE0018	**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 impact of analytics and AI/ML on individuals and society.
2. **Identify** the problems associated with Big Data using the appropriate technique.
3. **Apply** AI/ML techniques on identifying fairness and bias issues.
4. **Use** Tools and methods to quantify bias.
5. **Develop** the project using the case study.

Teaching-Learning Process (General Instructions)

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

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

UNIT – I	**08 Hours**
Data, Individuals, and Society: The power and impact that analytics and AI/ML have on individuals and society, especially concerning issues such as fairness and bias, ethics, legality, data collection and public use.	

UNIT – II	**08 Hours**
Big Data: Components of big data, basic statistical techniques to data scenarios, and understand the issues faced when learning from big data, ranging from data biases, overfitting, causation vs correlation, etc.	

UNIT – III	**09 Hours**
Privacy and Fairness in AI/ML: Use of AI/ML techniques to data scenarios, with a focus on identifying fairness and bias issues found in the design of decision-making systems. Technical approaches to current AI/ML applications such as facial recognition, natural language processing, and predictive algorithms, all while being mindful of its social and legal context.	

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

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

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

	Engineering Knowledge	Problem Analysis	Design & Development	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual & Team Work	Communication	Project management and Finance	Life-long Learning	Cognitive Outcome	Skill & Design Outcome
CO 1	1	-	-	-	-	-	-	-	2	2	1	-	2	2
CO 2	3	2	-	-	1	-	-	-	2	2	1	-	2	2
CO 3	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO 4	3	2	-	-	1	-	-	-	2	2	-	-	2	2
CO 5	3	2	-	-	1	-	-	-	2	2	-	-	2	2

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

E-Resources:

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

Activity Based Learning (Suggested Activities in Class)

1. Group Discussion.

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VIII SEM- ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SL	Course Type	Course Code	Course Name	Teaching Hours / Week				Examination			
				Lecture	Tutorial	Practical	Project	CIE Marks	SEE Marks	Total Marks	Credit
				L	T	P	J				
1	PROJ	23AM4801	Capstone Project Phase-II	0	0	0	22	60	40	100	12
2	INT	23AM4802	Internship	0	0	0	6	100	--	100	02
			Total	0	0	0	28				**14**

PROJ-Project Work, INT-Internship, L – Lecture, T – Tutorial, P – Practical, J – Project, C – No. Of Credits

CAPSTONE PROJECT PHASE – II

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

SEMESTER – VIII

Subject Code	:	23AM4801	**Credits**	:	12
Hours / Week	:	12	**Total Hours**	:	156 Hours
L–T–P–J	:	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 the selected domain area and presentation of its technical information.
6. **To detail description** of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature.
7. **To analyze** and synthesize the new research findings.

Teaching-Learning Process (General Instructions)

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

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

COURSE CONTENT:

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

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

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

Evaluation:

1. The problem statement selected in Capstone Project Phase - I (VII semester) will be carried in the VIII semester.
2. Phase 2 comprises of the detailed design, implementation, and testing results during the internal and external review.
3. Each Project team needs to submit the technical paper or patent or participate in hackathons and project exhibitions as well as apply for various state and national funding agencies within the stipulated time frame by the university
4. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department.
5. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		

1	Identify and Select an Appropriate Research Problem	L1
2	Explain and Summarize Relevant Literature	L2
3	Compare and Critically Analyze Relevant Research Papers	L3
4	Construct a Research Model and Perform Evaluation	L4
5	Create and Draft Publications or Demonstrations	L5

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

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

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RESEARCH INTERNSHIP/ INDUSTRY INTERNSHIP/IN-HOUSE INTERNSHIP

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

SEMESTER – VIII

Subject Code	:	23AM4802	**Credits**	:	02
L–T–P–J	:	0–0–0–6			

Course Learning Objectives:

This course will enable students to:

1. To expose students to the industrial environment
2. To create competent professionals for the industry.
3. To provide possible opportunities to learn, understand and sharpen the real time technical/managerial skills required at the job
4. To work on a problem assigned by a mentor at industry, prepare action plan and complete within time limit
5. To learn, create/prepare report for Project/research as used in industry with productive and efficient way
6. To strengthen industry-institute linkage and increase employability of the students

Teaching-Learning Process (General Instructions)

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

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

COURSE CONTENT:

1. The course includes a 16 weeks of on-job training on current industry-relevant problem through supervised self-learning approach.
2. The internship is an individual activity.
3. The student should obtain approval from the chairman/supervisor to pursue.
4. A student shall submit a brief proposal about the work to be carried out in the internship, to a coordinator within 3 weeks, after starting the internship.
5. A comprehensive report is required to be prepared and submit to the department at the end of the semester.
6. A certificate shall be attached with this report duly signed by the competent authority of the industry for the successful completion of the internship.
7. An attendance report shall also be attached with this report.
8. The CIA evaluation will be done by faculty mentor or Industry Supervisor.
9. There is no SEE Exam for this course.

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course, the student will be able to:		
1	Comprehend the modern tools used in the field of AIML and engineering for product development.	L2
2	Demonstrate ethical conduct and professional accountability while working in a team for the benefit of society	L3
3	Analyze the resources requirement and planning to facilitate the project success	L4
4	Assess and adapt technical skills on industry environment	L5
5	Apply the modern industry practice for internship	L3

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

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

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