School of Engineering Sciences

SEMESTER – I

Department of Mechanical Engineering

RAMDEOBABA UNIVERSITY, NAGPUR
Formerly Shri Ramdeobaba College of Engineering & Management (RCOEM) Est. 1984
LEARN | INNOVATE | ACCOMPLISH

PROGRAMME SCHEME (2025-26) & SYLLABUS (III & IV Sem)

B.Tech. Robotics and Artificial Intelligence 2025-26

SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	BSC	25HS03TP0107	Differential Calculus and Basics of Statistics	3	2	2	4	50	50	50	150	3
2	ESC	25EE07TP0106	Basics of Electrical Engineering	2	2	2	3	50	50	50	150	2
3	ESC	25ES03TH0101	Engineering Mechanics	3	0	1	3	50	-	50	100	3
4	ESC	25ES03TP0102	Engineering Graphics	2	2	1	3	50	50	50	150	2
5	ESC	25ES03TP0103	Programming for Problem Solving	2	2	2	3	50	50	-	100	-
6	AEC/ HSSM	25HS02TP0101	English for Professional Communication	2	2		3	50	25	50+25	150	2
7	VEC/ HSSM	25HS02TH0103-2	Foundational Course in Universal Human Values	1	0		1	50	-	-	50	-
			TOTAL	**15**	**10**	**9**	**20**	**350**	**225**	**275**	**850**	**13**

B.Tech. Robotics and Artificial Intelligence 2025-26

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester II												
SN	**Course Type**	**Course Code**	**Course Name**	**Hours/ week**			**Credits**	**Maximum Marks**				**ESE Duration (Hrs.)**
				L	**P**	**S**		**Cont. Evaluation**		**End Sem Exam**	**Total**	
								Th	**Pr**			
1	BSC	25HS03TH0217	Linear Algebra and Integral calculus	3	0	1	3	50	-	50	100	3
2	BSC	25HS05TP0203	Applied Physics	3	2	1	4	50	50	50	150	3
3	ESC	25ES03TH0201	Introduction to Artificial Intelligence	3	0	1	3	50	-	50	100	3
4	ESC	25ES03TH0202	Theory of Mechanisms & Elasticity	3	0	1	3	50	-	50	100	3
5	ESC	25ES03TP0203	Digital Logic Design	2	2	1	3	50	50	50	150	2
6	ESC	25ES03TP0204	Data Structure and OOPS	2	2	2	3	50	50	50	150	2
7	VSEC	25ES03TP0205	Fabrication Practices	1	2		2	50	50		100	-
8	CCA	25HS02PR0105-2-18	Liberal/Performing Arts Lab	0	2		1	-	25	25	50	-
9	CCA	25HS04PR0201	Health-Fitness-Wellbeing	0	2		1		50		50	
			TOTAL	**17**	**12**	**7**	**23**	**350**	**250**	**350**	**950**	**15**

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester III												
SN	**Course Type**	**Course Code**	**Course Name**	**Hours/Week**			**Credits**	**Maximum Marks**			**Total**	**ESE Duration (Hrs.)**
				L	**P**	**S**		**Cont. Evaluation**		**End Sem Exam**		
								TH	**PR**			
1	BSC	25HS03TH0303	Probability & Statistics	3	0	1	3	50	-	50	100	3
2	PCC	25ES03TH0301	Fundamentals of Robotics	3	0	1	3	50	-	50	100	3
3	PCC	25ES03TP0302	Design of Manipulator and End effector	2	2	1	3	50	50	-	100	-
4	PCC	25ES03TP0303	Microcontrollers and Interfacing	3	2	1	4	50	50	50	150	3
5	PCC	25ES03TP0304	Introduction to Python	2	2	1	3	50	50	-	100	-
6	OE	25ESOEC03TH0306	Open Elective-I/ MOOC	2	0	1	2	50	-	50	100	2
7	MDM	25ES03TH0307	MDM-I (Defense Platform)	3	0	1	3	50	-	50	100	3
8	VEC	25HS01TP0301	Environmental Science	1	2	0	2	50	50	-	100	-
			TOTAL	**19**	**8**	**8**	**23**	**400**	**200**	**250**	**850**	**14**

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester IV												
SN	**Course Type**	**Course Code**	**Course Name**	**Hours/Week**			**Credits**	**Maximum Marks**			**Total**	**ESE Duration (Hrs.)**
				L	**P**	**S**		**Cont. Evaluation**		**End Sem Exam**		
								TH	**PR**			
1	PCC	25ES03TP0401	Kinematics and Dynamics of Robot	3	2	2	4	50	50	50	150	3
2	PCC	25EE07TP0402	Control Systems for Robotics	3	2	2	4	50	50	50	150	3
3	PCC	25ES03TP0402	Machine Learning	3	2	2	4	50	50	50	150	3
4	PCC	25ES03TP0403	Mechatronics	2	2	1	3	50	50	50	150	2
5	CEP/FP	25ES03PR0404	Project-I	0	2	3	1	-	50	-	50	-
6	OE	25ESOEC03TH0406	Open Elective-II/ MOOC	2	0	1	2	50	-	50	100	2
7	MDM	25ES03TH0407	MDM-II (Warfare systems)	3	0	1	3	50	-	50	100	3
8	AEC	25ES03AECPR0408	Basic Competitive Coding Lab	0	2	2	1	-	50	-	50	-
9	AEC	25ES03TP0405	Design Thinking	1	2	1	2	50	50	-	100	-
			TOTAL	**17**	**14**	**14**	**24**	**350**	**350**	**300**	**1000**	**16**

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester V

SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	PCC	25ES03TP0501	Deep Learning	3	2	1	4	50	50	50	150	3
2	PCC	25ES03TP0502	Industrial Hydraulics and Pneumatics	3	2	1	4	50	50	50	150	3
3	PCC	25ES03TP0503	Industrial Internet of Things (IoT)	2	2	1	3	50	50	50	150	2
4	PSE	25ES03TH0504	Program Specific Elective I	3	0	1	3	50		50	100	3
5	PCC	25ES03TP0505	Robot Operating System (ROS)	1	2	2	2	50	50	-	100	-
6	PCC	25ES03PR0506	Comprehensive Viva	0	2	1	1	-	50	-	50	-
7	OE	25ESOEC03TH0506	Open Elective-III/ MOOC	2	0	1	2	50	-	50	100	2
8	MDM	25ES03TH0507	MDM-III	3	0	2	3	50		50	100	3
9	AEC/	25HS05TH0104	Business Communication	1	2	1	2	50	50	-	100	-
			TOTAL	**17**	**12**	**11**	**24**	**400**	**300**	**300**	**1000**	**15**

Program Specific Elective I

Sr. No.	Course Type	Course Code	Course Name
1	PSE	25ES03TH0504-1	Bio-Inspired Robotics
2	PSE	25ES03TH0504-2	Data Exploration and Visualization
3	PSE	25ES03TH0504-3	Computer Aided Design
4	PSE	25ES03TH0504-4	Work System Design

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester VI

SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	PCC	25ES03TP0601	Robotic vision System	3	2	1	4	50	50	50	150	3
2	PCC	25ES03TP0602	Reinforcement Learning	3	2	1	4	50	50	50	150	3
3	PCC	25ES03TP0603	Mobile Robotics	2	2	2	3	50	50	50	150	2
4	PSE	25ES03TH0604	Program Specific Elective II	3	0	2	3	50		50	100	3
5	AEC	25ES03PR0605	Product Innovation and Entrepreneurship Lab	0	4	1	2	-	50	-	50	-
6	AEC	25ES03AECPR0607	Advanced Competitive Coding	0	2	1	1	-	50	-	50	-
7	Project	25ES03PR0606	Project-II	0	4	1	2		50	-	50	
8	MDM	25ES03TH0607	MDM-IV	3	0	1	3	50		50	100	3
			TOTAL	**14**	**16**	**0**	**22**	**250**	**300**	**250**	**800**	**14**

Program Specific Elective - II

Sr. No.	Course Type	Course Code	Course Name
1	PSE	25ES03TH0606-1	Drone Technology and UAV Systems
2	PSE	25ES03TH0606-2	Database Design and Management
3	PSE	25ES03TH0606-3	3-D Printing Technology
4	PSE	25ES03TH0606-4	Facilities Planning

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester VII

SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	PSE	25ES03TH0701	Program Specific Elective III	3	0	2	3	50	-	50	100	3
2	PSE	25ES03TH0702	Program Specific Elective IV	3	0	1	3	50	-	50	100	3
3	PSE	25ES03TH0703	Robot safety and Maintenance	3	0	1	3	50	-	50	100	3
4	Project	25ES03PR0704	Major Project I	0	8	2	4	-	50	50	100	-
5	Audit Course	25ES03PR0705	Internship Evaluation (Min 6 weeks)			2	SF/ USF	-		-		-
6	AEC	University Policy	Participative Learning			15	1	-		-		-
			TOTAL	**9**	**8**	**8**	**14**	**150**	**50**	**200**	**400**	**9**

Program Specific Elective III

Sr. No.	Course Type	Course Code	Course Name
1	PSE	25ES03TH0705-1	Swarm Intelligence/ Swarm Robotics
2	PSE	25ES03TH0705-2	Data Engineering
3	PSE	25ES03TH0705-3	Computer Integrated Manufacturing System
4	PSE	25ES03TH0705-4	Lean Manufacturing and Value Engineering

Program Specific Elective IV

Sr. No.	Course Type	Course Code	Course Name
1	PSE	25ES03TH0706-1	Cognitive Robotics
2	PSE	25ES03TH0706-2	Data Privacy
3	PSE	25ES03TH0706-3	Sustainability and Green Manufacturing
4	PSE	25ES03TH0706-4	Human Factors Engineering

B.Tech. Robotics and Artificial Intelligence 2025-26

Semester VIII												
SN	**Course Type**	**Course Code**	**Course Name**	**Hours/Week**			**Credits**	**Maximum Marks**			**Total**	**ESE Duration (Hrs.)**
				L	**P**	**S**		**Cont. Evaluation**		**End Sem Exam**		
								TH	**PR**			
1	PCC	25ES03TH0801	Project Management	3	0	2	3	50		50	100	3
2	PCC	25ES03TH0802	Research Methodology	2	0	1	2	50		50	100	2
3	IKS	25HS02TH0205	Foundational Literature of Indian Civilization	1	0	1	1	50	-	-	50	-
4	Project	25ES03PR0803	Major Project II	0	12	2	6	-	50	50	100	-
			TOTAL	**6**	**12**	**6**	**12**	**150**	**50**	**150**	**350**	**5**
OR												
1	Project	25ES03PR0804	Full Semester Industry/ Research/TBI Internship	0	24	2	12		150	100	250	-
			TOTAL									

Honors scheme Track-l: Robotics & AI (B. Tech Program)

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	25ES03HT0301	Field & Service Robot	3	0	1	3	50	50	100	3
2	IV	25ES03HT0401	Advanced sensors & Actuators	3	0	1	3	50	50	100	3
3	V	25ES03HT0501	Mobile and Micro Robotics	4	0	1	4	50	50	100	3
4	VI	25ES03HT0601	Multi-Robot Systems and Swarm Intelligence	4	0	1	4	50	50	100	3
5	VII	25ES03HP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**6**	**18**				

Minors scheme Track- I: Robotics & AI (B.Tech. Program)

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	25ES03MT0301	Introduction to Robotics	3	0	1	3	50	50	100	3
2	IV	25ES03MT0401	Mechatronics and Automation	3	0	1	3	50	50	100	3
3	V	25ES03MT0501	Modelling and Simulation of Robotic Systems	4	0	1	4	50	50	100	3
4	VI	25ES03MT0601	Robot safety and maintenance	4	0	1	4	50	50	100	3
5	VII	25ES03MP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**6**	**18**				

MDM: Track-l: Defense Technology

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	25ES03TH0307-1	Defense Platforms	3	0	0	3	50	50	100	3
2	IV	25ES03TH0407-1	Warfare system	3	0	0	3	50	50	100	3
3	V	25ES03TH0507-1	Weapon Systems	3	0	0	3	50	50	100	3
4	VI	25ES03TH0607-1	Self-Defense & Protection system	3	0	0	3	50	50	100	3
			TOTAL	**12**	**0**	**0**	**12**				

MDM: Track-II: Robotics

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	25ES03TH0307-2	Fundamentals of Robots	3	0	0	3	50	50	100	3
2	IV	25ES03TH0407-2	Kinematics and Dynamics of Robots	3	0	0	3	50	50	100	3
3	V	25ES03TH0507-2	Mobile Robotics	3	0	0	3	50	50	100	3
4	VI	25ES03TH0607-2	Drone Technology	3	0	0	3	50	50	100	3
			TOTAL	**12**	**0**	**0**	**12**	**200**	**200**	**400**	**12**

School of Engineering Sciences

Department of Mechanical Engineering

RAMDEOBABA UNIVERSITY, NAGPUR

Formerly Shri Ramdeobaba College of Engineering & Management (RCOEM) Est. 1984

LEARN | INNOVATE | ACCOMPLISH

B.Tech. Robotics and Artificial Intelligence

Programme Syllabus

2025-26

B.Tech. Robotics and Artificial Intelligence

Programme Syllabus

Semester-I

Semester I					
Course Code	**Course Title**				**Category**
25HS03TP0107	**Differential Calculus and Basics of Statistics**				**BSC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	**2**	**1**	**50+50**	**50**	**04**

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus and basic knowledge of computer.

Course Objectives:

The objective of this course is to develop a strong foundation in differential equations, statistics, probability, and differential calculus, with a focus on their applications in Mechanical and Robotics &AI Engineering. The course integrates theoretical concepts with computational lab-based experiments to enhance students' ability to model, analyze, and solve engineering problems using mathematical and simulation tools.

Course Outcomes:

On successful completion of the course, the students will able to:

1. Solve and analyze first-order ordinary differential equations and apply them to model engineering problems using computational tools.
2. Formulate and solve higher-order differential equations using analytical techniques and interpret their applications through graphical models.
3. Analyze and interpret engineering data using curve fitting, regression, and correlation techniques to identify patterns and relationships.
4. Apply differential calculus methods to solve engineering problems and use computational tools to model and optimize systems involving several variables.
5. Construct and solve partial differential equations related to engineering boundary value problems and simulate their behavior using computational visualization techniques.
6. Implement fundamental matrix operations to simulate and interpret applications in fields such as image processing, computer graphics.

UNIT I: First order ordinary differential equations	**7 Hours**

Exact, linear and Bernoulli's equations, Euler's equations, Equations of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications of First order Differential Equations.

UNIT II: Ordinary differential equations of higher orders	**7 Hours**

Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation. Applications of Higher order Differential Equations.

UNIT III: Statistics	**6 Hours**

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering

UNIT IV: Differential Calculus	**8 Hours**

Taylor's and Maclaurin's series expansions, radius of curvature (Cartesian form), evolutes and involutes, Limit and continuity of functions of several variables and their partial derivatives, Eulers Theorem, chain rule, total derivative, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers.

Unit V: Partial Differential Equations	**8 Hours**

Introduction to PDE, solution of homogeneous PDE, solution of PDE with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Experiments:

Exp. No.	Name of Experiments	Mapped COs
1	To use mathematical software as an advance calculator	**CO1**
2	Graphical Representation of 2D Functions Relevant to Engineering Models	**CO1, CO2, CO3**
3	3D Plotting Techniques for Visualizing ODE-related Engineering Models	**CO1, CO2, CO3**
4	Analyzing Data Trends through Curve Fitting Techniques	**CO3**
5	Visualization and Interpretation of Differential Equation Solutions.	**CO1, CO2, CO5**
6	Differential Calculus Techniques for Modelling Engineering behaviour	**CO4**
7	Applied optimization (Maxima, minima and Gradient descent method)	**CO4**
8	Matrix Computations with various Applications	**CO6**

Textbooks

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

References:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary
2. Value Problems, 9th Edition, Wiley India, 2009
3. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).

Semester I					
Course Code	**Course Title**				**Category**
25EE07TP0106	**Basics of Electrical Engineering**				**ESC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	**2**	**2**	**50+50**	**50**	**3**

Prerequisite:

Course Objectives:

The objective of this course is to provide mechanical engineering students with a comprehensive understanding of electrical and electronics principles and their application in electromechanical systems.

Additionally, the course will explore various case studies to demonstrate the real-world applications of these concepts in industries such as automation, electric vehicles, and medical devices.

Course Outcomes: On successful completion of the module students will be able to:

1. Explain the basics of Electrical systems and various components.
2. Identify the various components in Electro-mechanical systems.
3. Classify the types of power converters as per the applications.
4. Select the battery for specific application.

UNIT I: INTRODUCTION TO ELECTRICAL SYSTEM — **7 Hours**

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with DC excitation.

AC Circuits: Representation of sinusoidal wave forms, peak and RMS values. Concept of Impedance, Power, Energy. Introduction to 3-phase systems

UNIT II: INTRODUCTION TO POWER CONVERTERS — **7 Hours**

Basic schematic introduction to power converters, Types of Power converter, AC-DC, DC-DC, DC-AC converters, applications

UNIT III: ELECTRICAL MACHINES — **8 Hours**

Introduction to DC motors

Single Phase Transformer: Construction, principle of operation, EMF Equation. Regulation and Efficiency of a Transformer.

Three Phase Induction Motor: Construction and Principle of Operation, Slip and Torque, Speed Characteristics.

Stepper motor: Construction, working principle and modes of operation

UNIT IV: ELECTROMECHANICAL SYSTEMS — **8 Hours**

Introduction to electromechanical systems: Basics of electric motors, actuators, and sensors, Design considerations for integrating electrical and mechanical components, Applications of power electronics in mechanical systems. Selection and sizing of motors for mechanical systems, Motor control techniques and applications.

TEXT BOOKS:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. Electrical Technology: B. L. Thereja, S. Chand Publications.
3. Electrical & Electronic Instruments & Measurement by A. K. Sawhney, Dhanpat Rai and Co. 19th Edition, 2015.
4. Mechatronics: Principles, Concepts and Applications, Mahalik N. P., Tata McGraw Hill

REFERENCE BOOKS:

1. D. C. Kulshreshtha, "Basic Electrical Engineering", McGrawHill,2009.
2. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
3. Basic Electrical Engineering: S.B. Bodkhe, N. M. Deshkar, P. P. H. Pvt. Ltd.
4. Electronic Instrumentation & Measurement Technique by W. D. Cooper & A. D. Helfrick, Prentice Hall, 3rd revised Edition, 1985.

Course Outcomes: On successful completion of the module students will be able to:

1. Perform experiments on basis DC and AC circuits and make valid conclusions from observed results.
2. Study the operation of DC-DC converters.
3. To reverse the direction of rotation of a dc shunt motor and control it's speed by different methods.
4. Calculate the energy bill and verify the same with that provided by the utility for a specific installation and specific period.
5. Write effective reports based on observations and conclusions.

List of Experiments:

1. To verify Kirchhoff's laws of DC circuits.
2. To verify Kirchhoff's laws for RLC series circuits.
3. To verify Kirchhoff's laws for RLC parallel circuits.
4. To study DC – DC Buck converter.
5. To study DC – DC Boost converter.
6. To study battery charging.
7. Study of actuators and sensors for electro-mechanical systems.
8. To calculation and verification of energy bill of a house.
9. To reverse the direction of rotation of a dc shunt motor and control it's speed by different methods.
10. To measure power in DC circuit using shunt and voltage divider circuit.
11. To study the charging/ discharging characteristics of super capacitor.
12. Open-ended experiments.

Course Code	Course Title				Category
25ES03TH0101	Engineering Mechanics				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	0	1	50	50	03

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus, along with an understanding of Physics fundamentals such as force, motion, and Newton's laws. They should also be familiar with vector operations like addition and subtraction, and have an elementary understanding of units and measurements.

Course Objectives:

After completing this course, students will be able to:

1. Develop a strong foundation in force systems, equilibrium, and vector mechanics for engineering applications.
2. Understand and analyse frictional forces and mechanical properties such as centroid and moment of inertia.
3. Apply principles of kinematics and kinetics to study motion of particles.
4. Analyse mechanical systems using work-energy and impulse-momentum principles.
5. Understand and solve problems related to motion and dynamics of rigid bodies in engineering systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Apply concepts of force systems, equilibrium, and free body diagrams (FBD) to analyse engineering problems including trusses and structures.
2. Evaluate frictional forces and compute centroid, centre of gravity, and moment of inertia for simple and composite bodies.
3. Analyse motion of particles using kinematic and kinetic principles including Newton's laws and projectile motion.
4. Apply work-energy and impulse-momentum principles to solve problems involving particle motion and systems.
5. Analyse kinematics and kinetics of rigid bodies, including rotation, rolling motion, and general plane motion.

UNIT I: Basics of Mechanics & Force Systems — **8 Hours**

Introduction and need of Engineering Mechanics, Units of Measurement, Force Vectors, Vector Addition of Forces, Equilibrium of a Particle, Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams (FBD), Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy.

Introduction to Trusses: Structural Analysis of Simple Trusses by joint and section method. Introduction to space trusses, frames.

UNIT II: Friction and Properties of Surfaces & Solids — **8 Hours**

Friction: Basics of friction, Application of friction phenomenon, ladder friction, wedge friction, rolling resistance.

Properties of Surfaces & Solids: Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections

from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia.

UNIT III: Dynamics of Particle	**8 Hours**

Kinematics of a Particle: Introduction to kinematics**,** Rectilinear motion, General Curvilinear Motion, Two-dimensional motion with constant acceleration, Uniform circular motion, Tangential and normal acceleration, Projectile motion.

Kinetics of a Particle: Newton's Second Law of Motion, D'Alembert Principle, Motion of connected bodies (block, pulleys, etc) with and without friction, linear and angular momentum.

UNIT IV: Work-Energy and Impulse-Momentum Principle	**8 Hours**

Work-Energy Principle: The Work of a Force, Principle of Work and Energy for translation, Work-Energy applied to particle motion and connected system and fixed axis rotation, Power and Efficiency, Conservation of Energy.

Impulse-Momentum Principle: Principle of Linear Impulse and Momentum, Angular Momentum, Relation between Moment of a Force and Angular Momentum, Principle of Angular Impulse and Momentum, Principle of Linear Impulse and Momentum for a System of Particles

Unit V: Dynamics of Rigid Body	**8 Hours**

Kinematics of a Rigid Body: Introduction, Types of rigid body motion: translation, rotation about fixed axis, general plane Motion.

Kinetics of rigid body: Introduction, Newton's Second Law of Motion for rotational motion, Equation of translational motion, Equation of rotational motion Fixed-axis rotation, Rolling Bodies, General Plane Motion.

TEXT BOOKS:

1. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
2. F. L. Singer, Engineering Mechanics, Statics & Dynamics, BS Publications

REFERENCE BOOKS:

1. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, Pearson Educations, Forth edition, 2003.
2. Beer and Johnson, Vector Mechanics for Engineers, Vol.1 "Statics" and Vol.2 "Dynamics, McGraw Hill International Edition, 1995.
3. S.S. Bhavikatti, Engineering Mechanics, New Age Publications

Course Code	Course Title				Category
25ES03TP0102	**Engineering Graphics**				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	2	2	50+50	50	3

Prerequisite: Nil

Course Objectives:

The objective of the course is to prepare the students:

1. To develop the ability of visualization of different objects through technical drawings.
2. To acquire computer drafting skills for communication of concepts, ideas in the design of engineering products.

Course outcomes

At the end of this course students will be able to:

1. Draw and interpret technical drawings
2. Convert 2-D to 3-D drawing and vice versa.
3. Draw the projection of points and lines located in different quadrants.
4. Develop the solid surface for sheet metal working
5. Use & demonstrate drafting package.

UNIT I: Introduction to Engineering Drawing and Engineering Curves	**5 Hrs.**

Principles of Engineering Graphics and their significance, usage of drawing instruments, Lettering and dimensioning, Engineering Curves - Conic sections, Cycloid and Involute etc.

UNIT II: Orthographic Projections	**6 Hrs.**

Orthographic Projections: Theory of Projections, Concept of Projection, and First & Third angle projection methods. Conversion of given 3-dimensional view to 2-dimensional representation.

UNIT III: Projections of Lines and Planes	**6 Hrs.**

Projections of Lines and Planes: Projections of lines (line inclined to both planes),

Projections of planes (inclined to both the planes), Concept of auxiliary plane method for

projections of the plane.

UNIT IV: Sections of Solids and Development of Surfaces	**7 Hrs.**

Sections of Solids and Development of Surfaces: Projection of solids, Theory of sectioning, sections of prism, pyramid, cylinder and cone, Development of lateral surfaces of solids, Real-world applications of surface development.

UNIT V: Isometric Projections	**6 Hrs.**

Isometric Projections: Principles of Isometric projection - Isometric Scale, Isometric View, and Conversion of Orthographic views to Isometric Views / Projection.

Text Books:

1. Agarwal B & Agarwal C.M. Engineering Graphics, Tata McGraw Hill Publications.
2. Engineering Drawing by N.D. Bhatt, Charotar Publishing House Pvt. Ltd.
3. Engineering Drawing with an Introduction to AutoCAD" by D. A. Jolhe Tata McGraw Hill Publications
4. Engineering Drawing by R.K. Dhawan, S. Chand Publications
5. Engineering Drawing by K.L. Narayana & P. Kannaiah, SciTech Publication

Reference Books:

1. AutoCAD 14 for Engineering Drawing by P. Nageshwara Rao, Tata McGraw Hill Publications.
2. A text book of Engineering Drawing by P.S. Gill, S.K. Kataria & sons, Delhi.
3. Engineering Drawing and Computer Graphics by M. B. Shah & B.C. Rana, Pearson Education.

Course Code: 25ES04TP0102	**Course: Engineering Graphics Lab**

Introduction to Computer Aided Drawing:

Introduction, Drawing Instruments and their uses, relevant BIS conventions and standards.
Lettering, line conventions, dimensioning, material conventions and free hand practicing.
Computer screen, layout of the software, standard tool bar / menu and description of most commonly used tool bars, and navigational tools.
Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale.
Commands and creation of lines, coordinate points, axes, poly-lines, square, rectangle, Polygon, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz., tangency, parallelism, inclination and perpendicularity.
Practical's to be performed from the list as below

List of sheets

1 Engineering Curves
2 Orthographic Projection
3 Projection of Straight Lines and Planes
4 Section of solids and Development of surfaces
5 Isometric projection

Course Code	**Course Title**				**Category**
25ES04TP0103	Programming for Problem Solving				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

2	2	2	50+50		3

Prerequisite: Nil

Course Objectives: Develop foundational programming skills to design, implement, and analyze simple algorithms and data structures, using the C programming language, with a focus on solving real-world problems

Course outcomes

At the end of this course students will be able to:

1. Understand the components of a computer system and develop algorithms using flowcharts and pseudo-code.
2. Demonstrate proficiency in C programming, including the use of data types, operators, control statements, loops, and functions.
3. Utilize arrays, implement basic sorting algorithms, and understand the concept of algorithm complexity through example programs.
4. Apply pointers and structures in programming, and perform file handling operations including file input/output in C.

Unit - I : Introduction to Programming

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart /Pseudo code with examples. Arithmetic expressions and precedence

Unit - II : C Programming Language

Introduction to C language: Keywords, Constant, Variable, Data types, Operators, Types of Statements, Pre-processor Directives, Decision Control Statement-if, if-else, nested if-else statement, switch case, Loops and Writing and evaluation of conditionals and consequent branching.

Unit - III : Arrays and Basic Algorithms

Arrays: 1-D, 2-D, Character arrays and Strings. Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit - IV : Functions and Recursion

User defined and Library Functions, Parameter passing in functions, call by value, passing arrays tofunctions: idea of call by reference. Recursion: As a different way of solving problems. Exampleprograms, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Mergesort.

Unit - V : Pointers and Structures	
Structures, Defining structures, Array of Structures, Introduction to pointers, Defining pointers, Pointer arithmetic, pointer operators, Use of Pointers in self-referential structures, notion of linked list(no implementation)	
Unit - VI : File handling	
Streams in C, Types of Files, File Input/ Output Operations: Modes of file opening, Reading andwriting the file, Closing the files etc.	
Text Books 1. Programming in ANSI C: E. Balguruswami McGraw Hill 2. Mastering C: K. R. Venugopal and S. R. Prasad, Tata McGraw Hill	
Reference Books 1. Programming with C: Byron Gottfried, Schaums Outline Series. 2. Let Us C: Yashwant Kanetkar, BPB Publication	

Course Code	Course Title				Category
25HS02TP0101	Foundations of Business English				AEC/ HSSM
Contact Hours per Week			CA	FE	Credits
L	P	S			
2	2	1	50 +25	50 +25	3

Prerequisite:

Course Objectives:

The main objective of this course is to enhance the employability skills of students as well as prepare them for effective work place communication.

1. Demonstrate effective use of word power in written as well as oral communication.
2. Understand the techniques of listening and apply the techniques of reading comprehension used in professional communication.
3. Apply the principles of functional grammar in everyday as well as professional communication.
4. Effectively implement the comprehensive principles of written communication by applying various writing styles.
5. Create precise and accurate written communication products.

UNIT I: Vocabulary Building — **03 Hours**

1.1 Importance of using appropriate vocabulary.
1.2 Techniques of vocabulary development.
1.3 Commonly used power verbs, power adjectives and power adverbs.
1.4 Synonyms, antonyms, phrases & idioms, one-word substitutions and standard abbreviations.

UNIT II: Listening and Reading Comprehension — **03 Hours**

2.1 Listening Comprehension: active listening, reasons for poor listening, traits of a good listener, and barriers to effective listening.
2.2 Reading Comprehension: types and strategies.

UNIT III: Functional Grammar and Usage — **03 Hours**

3.1 Identifying Common Errors in use of: articles, prepositions, modifiers, modal auxiliaries, redundancies, and clichés.
3.2 Tenses
3.3 Subject-verb agreement, noun-pronoun agreement 3.4 Voice

UNIT IV: Writing Skills — **03 Hours**

4.1 Sentence Structures
4.2 Sentence Types
4.3 Paragraph Writing: Principles, Techniques, and Styles

UNIT V: Unit-5: Writing Practices — **03 Hours**

5.1 Art of Condensation: Précis, Summary, and Note Making
5.2 Correspondence writing techniques and etiquettes – academic writing
5.3 Essay Writing

TEXT BOOKS:

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 10031.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4. On Writing Well. William Zinsser. Harper Resource Book. 2001
5. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Course Objective

To enhance competency of communication in English among learners

Course Outcomes

On completion of English Lab course, students will be able to achieve the following:

1. Apply effective listening and speaking skills in professional and everyday conversations.
2. Demonstrate the techniques of effective Presentation Skills
3. Evaluate and apply the effective strategies for Group Discussions
4. Analyze and apply the effective strategies for Personal Interviews
5. Implement essential language skills- listening, speaking, reading, and writing

List of Practical

1. Computer Assisted + Activity Based Language Learning

Practical 1: Everyday Situations: Conversations and Dialogues – Speaking Skills
Practical 2: Pronunciation, Intonation, Stress, and Rhythm
Practical 3: Everyday Situations: Conversations and Dialogues – Listening Skills

2. Activity Based Language Learning

Practical 4: Presentation Skills: Orientation & Mock Session
Practical 5: Presentation Skills: Practice
Practical 6: Group Discussions: Orientation & Mock Session
Practical 7: Group Discussions: Practice
Practical 8: Personal Interviews: Orientation & Mock Session
Practical 9: Personal Interviews: Practice

Course Code	Course Title				Category
25HS02TH0103-2	Foundation course in Universal Human Values				VEC
Contact Hours per Week			CA	FE	Credits
L	P	S			
1	-	1	25+25	-	1

Prerequisites: NA

Course Objectives:

After completing this course, students will be able to:

To help the students in holistic development and maintaining harmony at all the levels of a human being, i.e. individual, family, society and nature/existence.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Understand value education in life and implement self-exploration.

CO2: Create an in-depth understanding of harmony within a human being.

CO3: Understand and implement values to maintain harmony in a family.

CO4: Understand and implement values to maintain harmony in a society

CO5: Understand and implement values to maintain harmony in nature/existence and develop a holistic perspective of life.

UNIT I: Course Introduction - Understanding Value Education	**04 Hrs.**

1.Meaning of Value Education

2.Need of value education, guidelines and content of value education.

3.Exploring our aspirations and concerns: Self-exploration (Content and process of selfexploration)

4. Basic human aspirations: Continuous happiness and prosperity

5. Role of UHV; Strengthening of self-reflection.

UNIT II: Understanding Harmony in Human Being	**03 Hrs.**

1.Harmony of the self and the body.

a. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’

b. Understanding the needs of Self (‘I’) and ‘Body’.

c. Understanding the activities of Self (‘I’) and ‘Body’

d. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer).

2. Programs to ensure Sanyam and Health

UNIT III: Understanding Harmony in the Family: Harmony in Human-	**03 Hrs.**

Human relationship	
1. Understanding values in human-human relationship: a. Trust as the foundational value of a relationship and respect in a family b. Ensuring health of family and friends by implementing values c. Understanding the meaning of trust; d. Difference between intention and competence e. Understanding the meaning of respect, f. Difference between respect and differentiation	
UNIT IV: Understanding harmony in the society: Harmony in Human-Human relationship	**02 Hrs.**
1. Understanding harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) 2. Visualizing a universal harmonious order in society: Undivided Society, Universal Order-from family to world family.	
UNIT V: Understanding Harmony in Nature and Existence:	**03 Hrs.**
1. Understanding harmony in Nature 2. Interconnectedness and mutual fulfilment among the four orders of Nature 3. Holistic perception of harmony at all the levels of existence	
Text Books: 1. A Foundation Course in Human Values and Professional Ethics, R.R Gaur, R Athana, G.P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 948-93-87034-47-1 2. A Textbook on Professional Ethics and Human Values by R S Naagarazan, New Age International Private Limited; First edition, 2020.	
Reference Book: 1. Human Values, A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004. 2. Human Values and Professional Ethics by Gurpreet Singh Uppal, 2015. 3. Values and Ethics in Profession by Prof. Mazumdar, Everest Publishing House; 3rd Edition, 2013. 4. Human Values and Professional Ethics by Jayshree Suresh, B S Raghavan, S Chand; Fourth edition, 2003. 5. https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php 6. dp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php 7. https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php 8. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008 9. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers. 10. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991 11. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins,	

USA
12. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
13. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
14. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
15. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.

B.Tech. Robotics and Artificial Intelligence

Programme Syllabus

Semester-II

Course Code	Course Title		Category
25HS03TH0217	Linear Algebra and Integral calculus		BSC
Contact Hours per Week	CA	FE	Credits

L	P	S			
3	0	1	50	50	03

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus.

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in Calculus and multivariate analysis. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes: On successful completion of the course, the students will able to:

1. Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices.
2. Evaluate definite and improper integrals using Beta, Gamma functions, and trace the Cartesian curves.
3. Solve multiple integration by change of order, change of variable methods and apply it to find area, volume, mass and center of gravity.
4. Interpret the geometrical meaning of gradient, curl, divergence
5. Perform line, surface and volume integrals of vector-valued functions.

UNIT I: Linear Algebra — **7 Hours**

Rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvalues and eigenvectors; Diagonalization of matrices; Orthogonal transformation and quadratic to canonical forms, Introduction to n-dimensional space, Singular value decomposition and its application in reducing the dimensionality of images and data .

UNIT II: Integral Calculus — **7Hours**

Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Tracing of curves(Cartesian form)

UNIT III: Multiple Integral — **8 Hours**

Multiple Integration: Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: area, mass and volume by double integration, Center of mass and Gravity (basic concepts).

UNIT IV: Vector Calculus (Differentiation) — **7 Hours**

Scalar point function, Vector point function, vector differentiation, gradient, divergence and curl, directional derivatives with their physical interpretations, solenoidal and irrotational motions, Scalar potential function.

Unit V: Vector Calculus (Integration) — **7 Hours**

Vector integration: Line integrals, work done, conservative fields, surface integrals and volume integrals, Stoke's theorem, Gauss divergence theorem, Green's theorem and their simple applications.

Topics for self-learning

Rolle’s theorem, Mean value theorems, Indeterminate forms, Applications of definite integrals to evaluate perimeter, area, surface areas and volumes of revolutions.

Textbooks

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition,2000.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

References

1. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).

Course Code	Course Title				Category
25HS05TP0203	Applied Physics				BSC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	02	02	50+50	50	4

Prerequisites:

Course Objectives:

After completing this course, students will be able to:

1. To develop ability to correlate basic physics principles involved in Robotic operations.
2. To help to improve fundamental robotic operations.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Use LASER beam and its various applications.
2. Apply knowledge of Ultrasonics for robotic operations.
3. Study and apply fundamental principles of electromagnetics to Mechanical Engineering.
4. Apply fundamental knowledge of fluid dynamics to underwater and arial robotics. Explore various sensing mechanisms pertaining to various Robotic operations.
5. Prepare for measurements used in various experiments and analyze errors involved in the measurements and prepare reports.
6. Explore various methods for finding wavelength of light, magnetic field intensity, speed of waves.

UNIT I: Laser Physics	**08 Hrs.**

Basics of Laser light emission: Spontaneous and stimulated emission of radiations, thermal equilibrium, condition for light amplification, population inversion, pumping schemes, optical resonator, He-Ne Laser/ Ruby Laser.

Laser beam characteristics: Monochromaticity, Coherence, Directionality, Focusibility, Intensity, Beam divergence and applications thereof.

UNIT II: Ultrasonics	**08 Hrs.**

Basics of Ultrasonics: Ultrasonic waves, production and detection of ultrasonic waves, piezoelectric effect, properties and types of ultrasonic waves, measurement of ultrasonic velocity in liquids.

Applications of Ultrasonic waves: in the measurement of elastic constants in liquids, application of ultrasonic waves in drilling, welding, soldering, in non-destructive testing of various materials, in generating 3D maps.

UNIT III: Electromagnetism	**08 Hrs.**

Magneto-statics: Lorenz Force, Biot-Savart and Ampere's Laws and their applications, Magnetic vector potential, force and torque on a magnetic dipole, and applications.

Electrodynamics: Ohms law, motional emf, Faraday's law, Lenz's law, Mutual induction, energy storage in magnetic fields, Maxwell's equations and applications.

UNIT IV: Aeronautics Physics	**08 Hrs.**

Fluid mechanics for underwater and aerial robotics. Buoyancy, floatation, stability of floating body. Hydro-dynamics: Boundary layer concepts of drag, lift, its real-world applications to smart skies, mobile accelerometers, parachutes, helicopters, numerical on drag & lift forces, parachute design.

UNIT V: Sensors and Actuators	**08 Hrs.**

Design and working principles of Sensors. Various types of Sensors requited for Robotics: Strain, pressure, ultrasonic, piezoelectric, chemical, thermal, optical, electrical, etc, as required for various types of detection.

TEXT BOOKS:

1. Engineering Electromagnetics, Sixth Edition, William H. Hayt, John A. Buck, McGraw-Hill Higher Education, 2001.
2. Applied Physics by S. Jain, G. G. Sahasrabudhe and S. M. Pande, Universities Press 2013.

REFERENCE BOOKS:

1. Ultrasonics: Fundamentals, Technologies, and Applications, Dale Ensminger, Leonard J. J. Bond. 2011, CRC press, 2011.
2. Fundamentals of Aerodynamics 5ED (SIE), McGraw Hill Education, 2017.
3. Fundamentals of Sensors for Engineering and Science (English, Paperback, Dunn Patrick F.), CRC Press, Taylor & Francis Inc, 2011.
4. Engineering Physics by M.N. Avadhanulu and Kshirsagar S. Chand Publication, 2014.

Course Code	Course Title				Category
25ES03TH0201	Introduction to Artificial Intelligence				PCC
Contact Hours per Week			CA	ESE	Credits
L	P	S			
03	00	00	50	50	03

Course Objectives:

After completing this course, students will be able to:

1. Basic problem-solving techniques, intelligent agents, and AI applications in real-world scenarios.
2. Representation of problems using state space and solving them using classical and heuristic search techniques.
3. Adversarial search, constraint satisfaction, and introductory learning approaches in AI.
4. Knowledge representation, uncertainty handling, and introductory concepts of modern AI such as Transformers & LLMs.

Course Outcomes (CO)

After successful completion of the course, students will be able to:

CO1: Explain fundamental concepts of artificial intelligence and intelligent agents
CO2: Apply search algorithms to solve simple AI problems
CO3: Analyze adversarial and constraint satisfaction problems
CO4: Evaluate knowledge representation and uncertainty techniques
CO5: Explain basic concepts of modern AI including neural networks, Transformers, LLMs, and RAG

UNIT I: Introduction to Artificial Intelligence and Agents	**08 Hrs.**

Introduction to AI, history and applications, task domains, Basics of problem solving, problem characteristics, problem representation (toy and real-world problems); Intelligent agents, rational agents, task environment, performance measures, simple real-world examples of AI systems

UNIT II: Uninformed Search Techniques	**08 Hrs.**

State space representation, Breadth First Search, Depth First Search, Uniform Cost Search, Depth Limited Search, Iterative Deepening DFS, Bidirectional Search, simple problem-solving examples

UNIT III: Informed Search and Learning Basics	**08 Hrs.**

Heuristic based search, Greedy Best First Search, A* Search; Local search algorithms: Hill-climbing, Genetic Algorithms (conceptual); Introduction to learning in AI, basic idea of machine learning

UNIT IV: Adversarial Search and Constraint Satisfaction	**8 Hrs.**

Two-player games, Min-Max algorithm, Alpha-Beta pruning (conceptual); Constraint Satisfaction Problems, backtracking search, constraint propagation, real-world examples (puzzles, scheduling)

UNIT V: Knowledge Representation and Introduction to Modern AI	**8 Hrs.**

Propositional logic, First Order Logic (basic syntax and semantics), inference mechanisms (forward and backward chaining); Introduction to probability and Bayes' theorem, Naïve Bayes (concept only);

Basics of neural networks, Introduction to Transformer (attention concept), overview of Large Language Models (LLMs), basic prompt engineering.

TEXT BOOKS:

1. Artificial Intelligence: A Modern Approach — Stuart Russell, Peter Norvig, Pearson, 4th Edition
2. Artificial Intelligence — Elaine Rich, Kevin Knight, McGraw-Hill Education

REFERENCE BOOKS:

1. Machine Learning — Tom M. Mitchell, McGraw-Hill Education
2. Pattern Recognition and Machine Learning — Christopher M. Bishop, Springer
3. Deep Learning — Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press

Course Code	Course Title				Category
25ES04TH0202	Theory of Mechanisms & Elasticity				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	00	01	50	50	3

Prerequisites:

Students should have:

1. Knowledge of **Mathematics**, including algebra, trigonometry, and elementary calculus.

2. Knowledge of Engineering Mechanics course.

Course Objectives:

Course Objective: To impart the basic knowledge the machines and mechanisms as well as mechanics of material.

1.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1. Describe the functioning of a machine, the relationship between the number of links and joints and to determine its mobility.

CO2. Explain the inversions of mechanism and their applications.

CO3. Classify and synthesize the cams for different follower motions.

CO4. Understand basic concept of stress, strain and their relations based on linear elasticity, material behaviour due to different types of loading.

CO5. Learnanalyticalandgraphicalanalysisofcompoundstressesandanalysisofstrainenergy.

CO6. Develop shear force – bending moment diagram of beams under different loading conditions & support conditions and analyse bending & shear stresses in beams.

UNIT I: Basics of Mechanisms and Machines	**08 Hrs.**

Basics of Mechanisms and Machines: Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, machine, simple & compound chain, Degree of freedom, Kutzbach's theory, Grubber's criterion. Harding's notations, Class-I& Class-II mechanisms

UNIT II: Applications of Inversion of Mechanisms	**08 Hrs.**

Inversions and applications of a four-bar chain, single slider crank chain and double slider chain. Limiting positions, Mechanical advantage, Transmission angle, various types of mechanism such as Geneva wheel, Pawl and ratchet mechanism, and mechanism used in various toys, Introduction to Belt drive, Chain drive and gear drives **(7)**

UNIT III: Cams and Followers	**08 Hrs.**

Classification of cams and followers-Terminology and definitions- Displacement diagrams-uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions, and pressure angle and its significance, radial follower and offset followers

UNIT IV: Concept of simple stresses and strains	**08 Hrs.**

Concept of stress and strain, Types of stresses: Direct and tangential stresses, Types of strains: longitudinal, lateral, volumetric, Simple and modified Hooke's Law and elastic constants (E, G, K, μ)

Stress-strain diagram (ductile & brittle materials), Factor of safety, Poisson's ration, Deformation of bars under axial load and due to self-weight, Axial force diagram, Thermal stresses and strains.

UNIT V: Compound Stresses & Strain and Strain Energy	**08 Hrs.**

Compound Stresses & Strain: Stress on inclined plane, Significance of principal stresses and principal planes, maximum shear stresses, Mohr's circle of stress

Strain energy: Strain energy and resilience, Proof resilience and modulus of resilience, Strain energy in axial, shear, bending, and torsion, Impact and suddenly applied loads

Unit–VI: Shear force and bending moment	**08 Hrs.**
Relation between load, shear force and bending moment, Shear force and bending moment diagrams for different types of beams subjected to different types of loads.	

TEXT BOOKS:

1. Theory of Machines: S.S. Rattan, Tata McGraw Hill Publishers, 3rd edition onwards
2. Strength of Materials by S.S. Rattan, McGraw-Hills Education (India) Publication, India.
3. Strength of Materials by S.S. Bhavikatti, Vikas Publishing house, Noida, India.

REFERENCE BOOKS:

1 Deepak Khemani. A First Course in Artificial Intelligence.McGraw Hill Education (India), 2013.

Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

2. Kinematics & Dynamics of Machinery: R.L. Norton Tata McGraw Hill Publishers
3. Mechanism and Machine Theory: J.S. Rao&Rao V. Dukkipati, New Age International
4. Strength of Materials by F.L. Singer, Harper and row Publication.
5. Engineering Mechanics of Solid by Egor P. Popov, Prentice Hall of India Publication.

Course Code	Course Title				Category
25ES03TP0203	Digital Logic Design				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
2	2	1	50 +50	50	3

Prerequisite: None.

Course Objectives:
Apply various optimization techniques to minimize digital circuits and design combinational logic circuits.

Course Outcomes: On successful completion of the module students will be able to:
CO1. After completing this course, students will be able to
CO2. Apply various optimization techniques to minimize digital circuits.
CO3. Design combinational logic circuits.
CO4. Analyze and design asynchronous and synchronous sequential circuits.
CO5. Discuss x 86 architecture

UNIT I: Introduction to Digital Logic System **09 Hrs.**

Basics of Digital Electronics: Motivation for digital systems: Number Systems and arithmetic's, Logic and Boolean algebra, logic gates & truth tables, SOP, POS, Minimization of combinational circuits using Karnaugh- maps.

UNIT II: Circuit Design **09 Hrs.**

Combinational Circuit Design: Multiplexers, De-multiplexers, Encoders, Decoders, Code Converters, Adders, Subtractor (Half, Full), BCD Adder/ Subtractor, ripple and carry look-ahead addition, Unsigned Multiplier.

UNIT III: Sequential Circuit Design – I **9 Hrs.**

Sequential circuit Design-I: Storage elements, Flip-flops and latches: D, T, J/K, S/R flip-flops: level triggered, edge triggered, Master Slave flip-flop, flip flop conversion, timing analysis.

UNIT IV: Sequential Circuit Design – II **9 Hrs.**

Sequential circuit Design-II: Design of asynchronous and synchronous counters, Registers & Shift registers, Application of shift register: ring counter, Johnson counter, sequence generator and detector, serial adder; Linear feedback shift register (LFSR)

UNIT V: Synchronous Sequential Circuit Design **9 Hrs.**

Design of synchronous sequential circuit using Mealy model and Moore model: state transition diagram, algorithm state machine (ASM) chart.

TEXT BOOKS:
1. Donald P. Leach, Albert P. Malvino and GoutamSaha, "Digital Principles & Applications 8e", McGraw Hill
2. Douglas V. Hall "Microprocessors and Interfacing" Tata McGraw Hill Education Private Limited, 2005

REFERENCE BOOKS:

1. Thomas L Floyd, “Digital Fundamentals 9e”, Pearson
2. M. Morris Mano and Michael D. Ciletti, “Digital Design 5e”, Pearson
3. Taub and Shilling, “Digital Integrated Electronics”, McGraw Hill
4. A. Anand Kumar, “Fundamentals of Digital Circuits” Fourth Edition, PHI
5. Kip R. Irvine, “Assembly Language for x86 Processors” Seventh Edition, Pearson Education

List of Experiments

1. To verify truth table of different logic gates.
2. Design basic logic gates using universal gate and verify its truth table.
3. To verify following Boolean expressions using gates and Multisim software.

a) A+AB+AB
b) AB(C+AC)

4. To implement the following arithmetic circuits using (a) logic gates IC’s and (b) using Multisim software.

a) Full adder
b) Half subtractor

5. Implement the function F = Σm (1,3,5,7,8,9,11,13,15) using 16:1 and 8:1 multiplexer.
6. Verify the truth table of SR, JK, JKMS, T and D flip flop.
7. To study the following functions of Shift register using IC 7495

a) SIPO
b) PIPO
c) PISO
d) SISO

8. Design and verify 2-bit synchronous down counter using S-R flip-flop.
9. Design and verify the functionality of a sequence detector to detect the sequence 1101 using Melay and Moore model and use J-K flop-flop to implement the design.

Course Code	Course Title				Category
25ES03TP0204	**Data Structure and OOP**				**ESC**
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	**02**	**01**	**50+50**	**50**	**04**

Prerequisite: Programming for Problem Solving

Course Objective:

To provide students with a strong foundation in data structures and object-oriented programming concepts, enabling them to design, implement, and analyse efficient programs using arrays, linked structures, stacks, queues, and core OOP principles such as encapsulation, inheritance, and polymorphism.

Course Outcomes: On successful completion of the module students will be able to:

CO1 - Explain fundamental data structure concepts, abstract data types (ADT), and perform operations on Array ADT using appropriate memory representations.

CO2 - Design and implement linear data structures such as linked lists, stacks, and queues, and apply their operations to solve computational problems.

CO3 - Demonstrate understanding of object-oriented programming concepts including classes, objects, and key OOP features to model real-world problems.

CO4 - Apply constructors, destructors, access specifiers, static members, and object passing techniques to develop modular and reusable programs.

CO5 - Implement polymorphism and inheritance concepts using function/operator overloading and virtual functions to achieve code flexibility and runtime efficiency.

Module I: Data Structure Basics	**08 Hrs.**

Introduction: Basic terminologies, elementary data organizations, data structure operations; Abstract data types (ADT) and their characteristics.

Array ADT: Definition, operations and representations – row-major and column- major.

Module II: Linked List, Stacks and Queues	**08 Hrs.**

Singly Linked Lists: representation in memory, algorithms of several operations: traversing, searching, insertion, deletion, etc. Types of Linked list

Stack ADT: Allowable operations, applications of stacks,

Queue ADT: Allowable operations, simple queue and circular queue, double-ended queues and priority queues.

Module III: Basics of Object Oriented programming	**08 Hrs.**
Concept of a class, Object, Features of Object-Oriented Programming, Need for OOP.	
Access control of members of a class, constructors, Destructor, Friend Function, Static class members, member functions, Object as a variable, object as an argument, array of objects.	**08 Hrs.**
Module IV: Constructors and passing of object	
Module V: Polymorphism	**08 Hrs.**
Static and Dynamic bindings, Function/Operator overloading, Virtual functions, Concept of Inheritance, forms of inheritance.	

TEXT BOOKS:

1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.

2. Object Oriented Programming Using C++: E. Balaguruswamy, 4th (any recent) edition. Tata Mcgraw Hill.

REFERENCE BOOKS:

1. ReemaThareja, Data Structures using C, Third Edition, Oxford University Press, 2023

2. NarasimhaKarumanchi, Data Structures and Algorithms Made Easy: Data Structuresand Algorithmic Puzzles Fifth Edition, CareerMonk Publications, 2016.

3. The Complete Reference: Herbert Schildt, 4th (any recent) Edition, Tata McGraw Hill

2. Object oriented Programming in C++, 4th Edition, Robert Lafore by Sams Publishing

List of Experiments

1. Write a program to perform basic Array operations – insertion, deletion, traversal, searching, and updating elements.
2. Implement matrix representation using row-major and column-major order for two-dimensional arrays.
3. Create and perform operations on Singly Linked List (SLL) – insertion, deletion, traversal, reversal, and sorting.
4. Implement Doubly Linked List (DLL) and Circular Linked List (CLL) with creation and basic operations.
5. Implement Stack using Linked List and perform push, pop, peek, and display operations.
6. Implement Queue using Linked List and perform enqueue, dequeue, and display operations.
7. Implement Circular Queue, Deque, and Priority Queue for different queue applications.
8. Create Binary Tree and Binary Search Tree (BST) and perform insertion, deletion, searching, and tree traversals.
9. Represent Graph using adjacency matrix/list and perform DFS and BFS traversals.
10. Implement Sorting and Searching techniques – Quick Sort, Merge Sort, Heap Sort, Linear Search, Binary Search, and Hashing with collision resolution.

Course Code	Course Title				Category
25ES03TP0205	Fabrication Practices				VSEC
Contact Hours per Week			CA	FE	Credits
L	P	S			
1	2	1	50 +50		2

Prerequisite: Manufacturing Processes.

Course Objectives:

The objective of the course is to prepare the students:

1. Identify the different manufacturing process for various workshop trades including fitting, carpentry, smithy/foundry and welding, etc.

2. To get acquainted with the knowledge of various machine tools and equipment.

Course outcomes

At the end of this course students will be able to:

1. Understand casting technique for the production of casted components.
2. Identify an appropriate moulding pattern and various carpentry joints.
3. Understand the machining parameters and cutting tool for various machining operations.
4. Distinguishwithhotandcoldworkingmethodforthemanufacturingofmetalcomponents.
5. Understand various fitting joints and sheet metal operations.
6. Apply the knowledge of suitable joining processes to carryout fabrication work.

Foundry and Carpentry	**3 Hrs.**

Introduction to foundries, metal casting, types of sand, introduction to moulding tools & different casting process. Introduction to pattern making for metal casting, different types of carpentry tools, holding devices, different types of carpentry joints.

Metal Cutting	**3 Hrs.**

Fundamentals of metal cutting, Lathe machine specification and operations, metal cutting parameters, single point cutting tool.

Smithy and Forging	**2 Hrs.**

Smithy and forging, hot working and cold working of metals, forging tools like chisels, hammers, types of furnaces.

Fitting	**2 Hrs.**

Fitting operations and associated measuring and marking tools, sheet metal operations. Laser Cuting.

Welding	**2 Hrs.**

Metal joining Process, types of welding, mechanics of welding, soldering and brazing. Robotic welding.

Text Books:

1. Workshop Technology, Volume-I&II, Hajra Choudhary, Media Promoters & Publishers Pvt. Ltd.
2. Manufacturing Technology, Volume-I&II- P.N.Rao, Tata McGraw Hill Pub. Company, New Delhi.

Reference Books:

Manufacturing Science - A.Ghosh & A.K.Malik – East West Press Pvt. Ltd. New Delhi.

Course Code: 26ES03PR0205	Course: Fabrication Practices Lab

Course Objectives:

The Objective of the course:

1. To familiarize with major manufacturing process and required Machine Tools.
2. To get acquainted with and hands on experience on machine tools and equipment.

Course Outcomes:

The expected learning outcome is that the students will be able to:

1. Prepare and mould for casting and perform pattern making.
2. Perform different machining operations on lathe machine and parts fitting job.
3. Apply the knowledge of joining processes to carry out fabrication work.

List of Experiments:

Introduction of tools, equipment, material & process along with demonstration and preparation of simple job using various workshop trades such as:

1. Metal casting and moulding practice
2. Pattern making practice
3. Machining practices
4. Smithy and forging practice
5. Fitting job practice
6. Welding practice

*Case study: To prepare simple model/project using various workshop facilities (Group Activity)

Text Books

1. Workshop Technology, Volume - I & II - By Hajra Choudhary, Media Promoters &Publishers Pvt. Ltd.
2. Manufacturing Technology, Volume - I & II - P.N. Rao, Tata McGraw Hill Pub. Company, New Delhi.
3. Manufacturing Science - A.Ghosh & A.K.Malik – East West Press Pvt. Ltd. New Delhi.

Reference Books

1. Kalpak Jain and Schimd, Manufacturing processes for engineering materials, 5th Edition - Pearson India, 10034.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and System.
3. Production Engineering - P. C. Sharma, S. Chand and Company Ltd., New Delhi.

Course Code	Course Title				Category
25HS02PR0105-1	Liberal/Performing Art Courses Course: Fundamentals of Indian Classical Dance: Bharatnatayam				Regular
Contact Hours per Week			CA	FE	Credits
L	P	S			

0	**2**	**1**	**25**	**25**	**1**

Prerequisite: None.

Course Objectives:

The course aims to introduce the students to Bharatnatyam, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

Course Outcomes

On completion of the course, students will be able to achieve the following:

CO1: Understand the importance of dance and Bharatnataym as an Indian dance form

CO2: Develop skills to perform the dance form at its basic level.

CO3: Evaluate their strengths and interest to take bridge course to give Pratham (1st level formal exam of Bharatnatayam).

Syllabus

Practical -1: Orientation in Bharatnatayam

Practical-2: Tattu Adavu till 8, Naatta Adavu 4 Steps, Pakka Adavu 1 step, Metta Adavu 1 Step, Kuditta Metta Adavu 4 Steps,

Practical -3: Practice sessions

Practical-4: Tatta Kuditta Adavu (Metta), Tatta Kuditta Adavu (Metta) 2 Steps, Tirmanam Adavu 3 Steps, Kattu Adav - 3 Steps, Kattu Adav - 3 Steps

Practical-5: Practice sessions

Practical-6: Tiramanam (front) 3 Steps, Repeat of Tiramanam (Overhead) 3 Steps,

Practical-7: practice sessions

Practical – 8: final practice sessions and performances.

Recommended reading

1. Introduction to Bharata's Natyasastra, Adya Rangacharya, 2011
2. The Natyasastra and the Body in Performance: Essays on the Ancient Text, edited by Sreenath Nair, 2015
3. Bharatanatyam How to ... : A Step-by-step Approach to Learn the Classical Form, Eshwar Jayalakshmi, 2011

Course Code	Course Title				Category
25HS02PR0105-2	**Liberal/Performing Art Courses** **Course: Fundamentals of Indian Classical Dance: Kathak**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective

The course aims to introduce the students to Kathak, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

Course Outcomes

On completion of the course, students will be able to achieve the following:

CO1: Understand the importance of dance and Kathak as an Indian dance form

CO2: Develop skills to perform the dance form at its basic level.

CO3: Evaluate their strengths and interest to take bridge course to give Prarambhik (1st level formal exam of Kathak).

Syllabus

Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),

Practical -2: practice sessions of practical 1

Practical -3: Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings

Practical -4: practice sessions of practical 3

Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,

Practical -6: practice sessions of practical 5

Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda, practice sessions

Practical -8: Final performances.

Recommended reading

1. Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book), Marami Medhi & Debasish Talukdar, 2022, Anshika Publication (13 September 2022)

Course Code	Course Title			Category
25HS02PR0105-3	**Liberal/Performing Art Courses** **Course:** Introduction to Digital Photography			Regular
Contact Hours per Week		**CA**	**FE**	**Credits**

L	P	S			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective

The course aims to develop basic skills of students in digital photography to lay a foundation for them as a hobby and/or a profession.

Syllabus

Practical 1: Orientation in digital photography: Genres, camera handling and settings
Practical 2: Rules of Composition
Practical 3: Rules of Composition: practice sessions
Practical 4: Understanding Exposure and Art of Pre-Visualization
Practical 5: Rules of Composition and Art of Pre-Visualization: practice sessions
Practical 6: Post Processing Photographs and Portfolio creation
Practical 7: Post Processing Photographs: practice sessions
Practical 8: Portfolio finalization and presentation in selected genre.

Syllabus

Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),
Practical -2: practice sessions of practical 1
Practical -3: Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings
Practical -4: practice sessions of practical 3
Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,
Practical -6: practice sessions of practical 5
Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda, practice sessions
Practical -8: Final performances.

Reference material

1. Scott Kelby (2020) The Digital Photography Book: The Step-by-Step Secrets for how to Make Your Photos Look Like the Pros, Rocky Nook, USA
2. Larry Hall (2014) Digital Photography Guide: From Beginner to Intermediate: A Compilation of Important Information in Digital Photography, Speedy Publishing LLC, Newark
3. J Miotke (2010) Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro, AMPHOTO Books, Crown Publishing Group, USA

Course Code	Course Title				Category
25HS02PR0105-8	**Liberal/Performing Art Courses Course: Art of Painting**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective

Painting is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in painting to lay a foundation for them as a hobby and/or a profession.

Course outcome:

At the end of the course the students will be able to achieve the following:

CO1: Become familiar with the basic methods, techniques & tools of painting.

CO2: Train the eye and hand to develop sense of balance, proportion and rhythm.

CO3: Develop the ability to observe and render simple natural forms.

CO4: Enjoy the challenging and nuanced process of painting.

Syllabus

Practical 1: Orientation in Painting tools & basics of lines, shapes, light, shadows and textures

Practical 2: The art of observation - how to see shapes in drawing

Practical 3: Introduction Water color - how to handle water paints

Practical 4: Introduction to acrylic colors - how to handle acrylic paints

Practical 5: Explore layering paint and capturing the quality of light with paint.

Practical 6: Create landscape painting

Practical 7: Create Abstract painting

Practical 8: Paint on Canvas (try to recreate any famous painting)

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Alla Prima II Everything I Know about Painting--And More by Richard Schmid with Katie Swatland
3. Daily Painting: Paint Small and Often To Become a More Creative, Productive, and Successful Artist by Carol Marine

Course Code	**Course Title**				**Category**
25HS02PR0105-9	**Liberal/Performing Art Courses Course: Art of Drawing**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective

Drawing is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in drawing to lay a foundation for them as a hobby and/or a profession.

Course outcome:

At the end of the course the students will be able to achieve the following:

CO1: Become familiar with the basic methods, techniques & tools of drawing.

CO2: Train the eye and hand to develop sense of balance, proportion and rhythm.

CO3: Develop the ability to observe and render simple natural forms.

CO4: Enjoy the challenging and nuanced process of drawing.

Syllabus

Practical 1: Orientation in Drawing tools & basics of lines, shapes, light, shadows and textures

Practical 2: The art of observation how to see shapes in drawing

Practical 3: One/two-point basic linear perspective

Practical 4: Nature drawing and landscapes

Practical 5: Gestalt principles of visual composition

Practical 6: Figure drawing: structure and proportions of human body

Practical 7: Gesture drawing: expression and compositions of human figures

Practical 8: Memory drawing: an exercise to combine the techniques learnt

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Perspective Made Easy (Dover Art Instruction) by Ernest R. Norling

Course Code	**Course Title**				**Category**
25HS02PR0105-10	**Liberal/Performing Art Courses** **Course: Nature Camp**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**
Prerequisite: None.					

Course Objective: To create an opportunity for the students to develop affinity with nature and thus subsequently impact their ability to contribute towards sustainability of nature.

Course outcome:

After the completion of the course the students will be able to do the following:

CO1: Develop an affinity with nature by observing and understanding it marvels with guidance from experts

CO2: Develop an understanding of the challenges and solutions associated with nature and its conservation.

Course content

In collaboration with the Forest Department and/or a local NGO working in the field of environment conservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve in Central Indian region or Forest fringe villages or work with an NGO from Central Indian region working on natural resource management. The camps (for 2 days) will cover any one of the following topics as decided by the course coordinator:

1. Awareness about each element of biodiversity (camps on moths, butterflies, birds, other wildlife etc)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing a tiger reserve, and other aspects of water and forest conservation.
3. Sustainable natural resource management - initiatives by rural communities and local NGOs
4. Man-animal conflict and solutions (socio-economic and technical) – role of local communities and Forest Department
5. Traditional practices in environment conservation – role of local communities and local NGOs

Course Code	**Course Title**				**Category**
25HS02PR0105-11	**Liberal/Performing Art Courses** **Course: Developing Self-awareness**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objectives:

The course aims to develop students in their personal as well as professional life by means of graphotherapy, NLP, and Neurobics

Course Outcomes:

On completion of the course, students will be able to achieve the following:

CO1: Gain foundational understanding of graphology and through self-analysis will achieve greater awareness about their strengths and weaknesses & areas for personal growth

CO2: students will be equipped with tools and techniques for continuous self-improvement, using signature analysis and graphotherapy as part of their personal development journey

CO3: understand how to use Neuro Linguistic Programming (NLP) strategies to set and achieve goals effectively, overcoming mental blocks and limiting beliefs.

CO4: Enhance ability to absorb, retain, and recall information, which can benefit academic and professional performance.

Syllabus:

Practical 1: The Power of Handwriting (Handwriting is Brainwriting)

Practical 2: Know yourself through handwriting

Practical 3: The Role of Signature in your life

Practical 4: Graphotherapy to enhance yourself in all ways

Practical 5: Neurolinguistic Programming , S.M.A.R.T Goal

Practical 6: Effective Communication Model, Rapport Building and Anchor

Practical 7: Brain Directives & Linguistic Presuppositions

Practical 8: Neurobics

Course Code	Course Title				Category
25HS02PR0105-12	**Liberal/Performing Art Courses** **Course: Art of Poetry**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Outcomes:

To familiarize the students with the art of poetry and develop a sense of appreciation for the art.

At the end of the course the student will be able to achieve the following:
CO1: Understand the origin and development of poetry
CO2: Appreciate the art of poetry in life
CO3: Develop aesthetic sense
CO4: Develop holistic perspective to their personality

Syllabus:
Practical 1: The Power of Handwriting (Handwriting is Brainwriting)
Practical 2: Know yourself through handwriting
Practical 3: The Role of Signature in your life
Practical 4: Graphotherapy to enhance yourself in all ways
Practical 5: Neurolinguistic Programming , S.M.A.R.T Goal
Practical 6: Effective Communication Model, Rapport Building and Anchor
Practical 7: Brain Directives & Linguistic Presuppositions
Practical 8: Neurobics

Reading material

I. The Art of Poetry

1. Fry, S. (2005). The ode less travelled: Unlocking the poetic mind. HarperCollins.
2. Addonizio, K., & Laux, D. (1997). The poet's companion: A guide to the pleasures of writing poetry. W.W. Norton & Company.
3. Lucy, J. (Ed.). (2001). The art of poetry. Penguin Books.

II. Understanding and Interpretation of Poetry

1. Hirsch, E. (1999). How to read a poem: And fall in love with poetry. Harcourt Brace & Company.
2. Pinsky, R. (1998). The sounds of poetry: A brief history. Farrar, Straus and Giroux.
3. Meyer, M. (2005). Poetry: An introduction. Bedford/St. Martin's.

III. Writing Poetry

1. Hugo, R. (1979). The triggering town: Lectures and essays on poetry and writing. W.W. Norton & Company.
2. Bradbury, R. (1990). Zen in the art of writing: Releasing the creative genius within you. Bantam Books.
3. Behn, R., & Twichell, C. (Eds.). (1992). The practice of poetry: Writing exercises from poets who teach. HarperCollins.

Course Code	Course Title				Category
25HS02PR0105-13	Liberal/Performing Art Courses Course: Creative and content writing				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective:

The objective of the course is to equip students with comprehensive skills in creative and content writing through experiential learning and real-world applications.

Course outcomes:

On completion of the course, student will be able to achieve the following:

CO1: Understand and apply fundamental concepts and techniques of creative writing.

CO2: Apply storytelling techniques to create engaging narratives.

CO3: Develop and implement effective SEO and digital content strategies

CO4: Create and refine content using various tools and applying diverse writing styles and formats.

CO5: Utilize digital tools to craft multimedia narratives and create a professional portfolio.

Syllabus

Creative Writing

Practical 1: Introduction to Creative and Content Writing

Practical 2: Character and Story Development

Practical 3: Crafting Compelling Narratives

Content Writing

Practical 4: SEO and Digital Content Strategies

Practical 5: Writing for Media

Practical 6: Tools

Content Creation

Practical 7: Digital Storytelling

Practical 8: Creative Portfolio Launch

Course Code	Course Title				Category
25HS02PR0105-14	**Liberal/Performing Art Courses** **Course: Science of life through Bhagwad Gita**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Objective

The objective of the course is to seek directions from the Bhagwad Gita to garner life skills for a successful and happy life

Course Outcome

CO1: To understand the methodology to correctly interpret and analysis the scripture

CO2: To understand the application of various teaching of the Bhagwad Gita

CO3: Use meditation and breathing techniques for healthy mind and body.

Syllabus

Practical 1: Introduction to Bhagwad Gita - methodology
Practical 2: Real life application of chapter 1-3
Practical 3: Real life application of chapter 4-6
Practical 4: Real life application of chapter 7-9
Practical 5: Real life application of chapter 10-12
Practical 6: Real life application of chapter 13-15
Practical 7: Real life application of chapter 16-18
Practical 8: Meditation and breathing techniques

Course Code	Course Title				Category
25HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to French Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Objectives:

To help build a foundation and interest in Spanish language so that the students can pursue the proficiency levels of the language in higher semesters.

Course Outcomes:

On completion of the course, students will be able to achieve the following:

CO1. Demonstrate basic knowledge about Spain, the culture and similarities/differences between India and France
CO2. Learn to use simple language structures in everyday communication.
CO3. Develop ability to write in basic Spanish about themselves and others.

CO4. Develop ability to read and understand beginner level texts in Spanish

Syllabus

Practical-1: Orientation about Spain, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical -3: Practice sessions
Practical-4: Reading and writing Skills: Reading and writing simple text in Spanish
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic Spanish and practice
Practical-8: WritingSkills:WritebasicFrenchandpractice

Recommended reading

1. 15-Minute Spanish by Ana Bremon
2. Aula Internacional 1 by Jaime Corpas ,Eva Garcia, Agustin Garmendia.
3. ChicosChicasLibro del Alumno by MaríaÁngeles Palomino

Course Code	Course Title				Category
25HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to French Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Objectives:

To help build a foundation and interest in the French language so that the students can pursue the proficiency levels of the language in higher semesters.

Course Outcomes:

On completion of the course, students will be able to achieve the following:

CO1. Demonstrate basic knowledge about France, the culture and similarities/differences between India and

France.

CO2. Learn to use simple language structures in everyday communication.
CO3. Develop the ability to write in basic French about themselves and others.
CO4. Develop the ability to understand beginner-level texts in French

Syllabus

Practical-1: Orientation about France, the language, and culture

Practical-2: Communication Skills 1: Vocabulary building for everyday conversations

Practical-3: Practice sessions

Practical-4: Reading and writing Skills: Reading and writing simple text in French

Practical-5: Practice sessions

Practical-6: Communication Skills2: listening comprehension

Practical-7: Practice sessions

Practical-8: Writing Skills: Write basic French and practice

Course Code	Course Title				Category
25HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to Basic Japanese Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**T**	**D/P**			
0	0	2	25	25	**1**

Prerequisite: None.

Course Objectives:

The course aims to develop basic communication skills in the Japanese Language and help develop a basic understanding of Japanese cross-cultural communication.

Course Outcomes: On successful completion of the module, students will be able to:

After completing this course, students will be able to

CO1. Gain a brief understanding of Japan as a country and Japanese culture.
CO2. Developability to use vocabulary required for basic level communication in the Japanese language.

CO3. Able to write and read the first script in the Japanese language.
CO4. Able to frame simple sentences in Japanese to handle everyday conversations
CO5. Able to write in basic Japanese about the topics closely related to the learner.

Syllabus

Practical-1: Orientation about Japan, its language, and its culture
Practical-2: Communication Skills 1: Vocabulary for basic Japanese language
Practical-3: Practice sessions
Practical-4: Writing Skills 1: Reading and writing the first script in Japanese
Practical-5: Practice sessions
Practical-6: Communication Skills 2: framing sentences
Practical-7: Practice sessions
Practical-8: Writing Skills 2: Write basic Japanese and practice

Recommended reading

1. Marugoto Starter (A1) Rikai - Course Book for Communicative Language Competences, by the Japan Foundation, Goyal Publishers &Distributors Pvt. Ltd (ISBN: 9788183078047)
2. Japanese Kana Script Practice Book – Vol. 1 Hiragana, by Ameya Patki, Daiichi Japanese Language Solutions (ISBN: 9788194562900)

SEMESTER II					
Course Code	**Course Title**				**Category**
25HS04PR0201	**Health, Fitness & Wellbeing**				**CCA**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	**2**	**1**	**25**	**25**	**01**

Aim of the Course: The course aims to foster Health and wellness through Healthy and Active Lifestyle and creating awareness about the fundamentals of Physical Education, Sports, Yoga, Recreation and its effectiveness through practical experiences and hands on activities.

Course Objectives:

1. To impart the students with basic concepts of Sports, Yoga and Recreational activities for health and wellness.
2. To familiarize the students with health-related Exercise and evaluate their Health-related Fitness.
3. To make Overall growth & development with team spirit, social values and leadership qualities among students through various sports, games and Yogic activities.
4. To create Environment for better interaction and recreation among students as neutralizer for stress through various minor and recreational games.

Course Outcomes:

On successful completion of the course, student shall be able to

CO1: (Imitation & Manipulation): Practice and perform general and specific fitness exercises and observe the fundamental skills of Sports, Games and basic Yogic exercises.
CO2: (Precision & Articulation): Demonstrate accuracy in measuring health & skill related fitness components and coordinate with the psychomotor skills to execute fundamental skills of Sports, Games and Yogic Activities.
CO3: (Naturalization): Design personal daily energy requirements and adapt health & fitness conscious habits for sustainable active lifestyle.

UNIT I: **6 Hours**

- Warm up and Cool Down and Stretching Exercises.
- Calculation of BMI & Resting Pulse Rate.
- General and Specific exercises for strength, Speed, Agility, Cardiovascular Endurance, Flexibility, Coordination.
- Practice of Fundamental Skills of Volleyball, Table Tennis and Chess, etc.
- Knowledge and practice of the Equipment used in a Gymnasium and its application.

UNIT II: **7Hours**

- Various Fitness Drills: walking, jogging, running, rope skipping, circuit training, interval training, fartlek training. etc.
- Yog: Standing, Sitting, Prone & Supine positions
- Suryanamaskar.
- Overall Wellness: Pranayama, Meditation and Relaxation Techniques.
- Practice of Recreational Games.
- Dietary Habits, Daily Energy Requirements.
- Practice of Fundamental Skills of Basketball, Football, Carrom, etc.
- Health related Physical Fitness Test.

Textbooks/ Reference Books:

- Uppal, A.K. (2023). Fitness, Wellness & Nutrition. New Delhi: Friends Publication.

- Russell, R.P. (1994). Health and Fitness Through Physical Education. USA: Human Kinetics.
- Kumar, Ajith. (1984) Yoga Pravesha. Bengaluru: Rashtrothanna Prakashana.
- Dr. Devinder K. Kansal, A Textbook of Test Evaluation, Accreditation, Measurements and Standards (TEAMS 'Science)

SEMESTER III				
Course Code	**Course Title**			**Category**
25HS03TH0303	**Probability & Statistics**			**BSC**
Contact Hours per Week		**CA**	**FE**	**Credits**

L	P	S			
3	0	1	50	50	03

Prerequisite: Basics of Probability and Statistics

Course Objectives:

The objective of this course is to expose student to understand the basic importance fundamental principles of probability, including probability distributions, random variables, basic statistical methods used for data analysis, inferential statistics, hypothesis testing, confidence intervals, and regression analysis in Robotics and AI.

Course Outcomes:

On successful completion of the course, student shall be able to

1. Grasp the meaning of discrete and continuous random variables, probability distribution. Interpret the meaning of probabilities derived from distributions. This involves understanding what the calculated probabilities represent in practical terms and drawing conclusions from the results.
2. Compute probabilities and statistical measures using Binomial, Poisson, and Normal distributions.
3. Calculate joint, marginal, and conditional probabilities using joint probability mass functions (PMFs) and joint probability density functions (PDFs).
4. Understand the concept of a sampling distribution and its importance in inferential statistics. Also understand null hypothesis (H0) and alternative hypothesis (H1), significance levels, p-values, and the basic logic behind hypothesis testing.
5. Apply the F-test to determine whether two population variances are significantly different and conduct a Chi-square test to evaluate the association between categorical variables.

UNIT I: **6 Hours**

Probability spaces, conditional probability, Discrete and continuous random variables, expectation and variance of random variable.

UNIT II: **7Hours**

Binomial distribution, Poisson distribution, Normal distribution and their applications, exponential distribution.

UNIT III: **8 Hours**

Joint probability function for discrete and continuous random variables, Marginal probability functions, expectation and variance of multivariate random variables, covariance.

UNIT IV: **10 Hours**

Small and large sampling, Sampling Distributions, Point and Interval Estimations, Testing of Hypothesis for single mean and proportion for both small and large sample size, testing the means of paired observation

Unit V: **7 Hours**

Testing of Hypothesis for difference of mean and proportion, Test for ratio of variances, Chi-square test for goodness of fit and independence of attributes

Textbooks:

1. Murray R. Spiegel, Schaum's Outline of Probability and Statistics, McGraw-Hill Education 4th Edition 2012
2. DeGroot, M. H., & Schervish, M. J. (2012). *Probability and statistics* (4th ed.). Addison-Wesley.

Reference Books:

1. MaurtisKaptein, Statistics for data science, An introduction to probability, statistics and Data Analysis, Springer 2022.
2. Jay L Devore,Probability and Statistics for Engineering and sciences, 8th edition, Cenage learning.

Course Code		Course Title				Category
25ES03TH0301		Fundamentals of Robotics				PCC
Contact Hours per Week				CA	ESE	Credits
L	P	S	Total			
03	00		03	50	50	03

Prerequisite:

Course Objectives:

1. To introduce the fundamental concepts of robot anatomy, configurations, and workspace.
2. To familiarize students with the working principles of various sensors and actuators used in robotics.
3. To provide an overview of robot control, programming methods, and their role in modern industry.

Course Outcomes: On successful completion of the module students will be able to:

CO1 Explain basic concepts, structure, robot configurations, and classification of robots.
CO2 Explain the working principles of robotic sensors and select suitable sensors for robotic applications.
CO3 Analyze robot drive and actuation systems.
CO4 Develop basic robot programs and control strategies.
CO5 Discuss robotic applications for industrial use.

UNIT I: INTRODUCTION — **07 Hrs.**

Definitions, history of robotics, benefit of robot, need of robot, laws of robotics, robot anatomy, types of robot, coordinate system, work envelope, robot specifications, robot parts and their functions, wrist and orientation.

UNIT II: SENSORS IN ROBOTICS — **08 Hrs.**

Definition of sensors, requirement of sensors, characteristics of sensors, classifications of sensors, **Internal Sensors**: Position sensors (Potentiometers, Encoders, LVDT), Velocity sensors (Tachometer, Hall effect sensor), acceleration sensors, **External Sensors:** Tactile (Touch sensors and force sensors), Proximity (Inductive, capacitive, ultrasonic), Range Sensors (LiDAR and IR sensors).

UNIT III: ROBOT ACTUATION AND DRIVE SYSTEMS — **08 Hrs.**

Definition, factors considered for selecting drive system, actuators, types of actuators: **Electric Drives:** Stepper motors, DC Servo motors, and BLDC motors; selection criteria for torque and speed. **Fluid Power:** Principles of Pneumatic and Hydraulic actuators; applications in industries. Comparison of pneumatic, hydraulic electrical drives. **Transmission Systems:** Gear transmission, Belt drives, Rollers, chains, Links, Linearto-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearings.

UNIT IV: ROBOT CONTROL AND PROGRAMMING — **07 Hrs.**

Open-loop vs. Closed-loop systems; basic concepts of PID control for joint stability, Point-to-Point (PTP) vs. Continuous Path (CP) motion, methods for robot programming**:** Lead-through, textual, and Off-line programming defining a program, Method of defining position in space, Motion interpolation, Basic programming commands in workcell control (wait, signal and delay commands), Branching, Robot programming languages, Structure of robot language, VAL programming.

UNIT V: APPLICATIONS OF INDUSTRIAL ROBOT — **06 Hrs.**

anufacturing applications of robot: Material handling, Machine loading / unloading, Spray painting, Welding, Machining, Assembly, pick and place, Inspection. **Non-manufacturing robotic applications:** Hazardous environment, Medical, Mining, Space, Defence, Security, Domestic, Entertainment, Agriculture, Distribution and others; Future of robotics. **Case Study for Robotic Applications** including Robot Selection considerations for a typical industrial application.

TEXT BOOKS:

1. S.K. Saha, *Introduction to Robotics*, McGraw Hill Education.

2. R.K. Mittal & I.J. Nagrath, *Robotics and Control*, Tata McGraw Hill.

REFERENCE BOOKS:

1. John J. Craig, *Introduction to Robotics: Mechanics and Control*, Pearson Education.
2. Saeed B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, Wiley.
3. Mikell P. Groover, *Industrial Robotics: Technology, Programming, and Applications*, McGraw Hill.

SEMESTER III					
Course Code	**Course Title**				**Category**
25ES03TP00302	**Design of Manipulator and End effector**				PPC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	02	1	50	50	**03**

Prerequisites:

Students should have:

- Basic knowledge of Engineering Mechanics (forces, equilibrium, stress–strain).
- Understanding of Strength of Materials (deformation, bending, torsion).
- Familiarity with Theory of Machines/Kinematics of Mechanisms.
- Basic knowledge of materials science and manufacturing processes.

Course Objectives:

After completing this course, students will be able to:

1. Understand the **structural and mechanical design requirements** of robotic systems.
2. Apply principles of **material selection and manufacturing** in robotic component design.
3. Analyze and design **joints, transmission systems, and actuating mechanisms**.
4. Evaluate and design **end effectors and gripping systems** for various robotic applications.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze mechanical structures of robotic manipulators considering strength, stiffness, and dynamic effects.
2. Select appropriate materials and manufacturing techniques for efficient and lightweight robotic designs.
3. Design and evaluate robotic joints and transmission systems based on performance and efficiency.
4. Perform force analysis and design of end effectors suitable for different industrial and service applications.

UNIT I: Fundamentals of Robotic Mechanical Design	**07 Hrs.**

Structural requirements of robotic manipulators: rigidity, stability, and precision, Design criteria: stiffness, strength, weight optimization, natural frequency, payload capacity, Static vs dynamic loading in robotic arms (impact, inertia, cyclic loading), Structural design vs kinematic design, Geometric considerations in link design (cross-sections, slenderness ratio), Application of beam theory and torsion theory in robotic links, Mass distribution and centre of gravity effects on stability and control, Deformation and deflection analysis under loading conditions, Vibration and resonance considerations in robotic structures, Fatigue analysis and failure modes in repetitive robotic operations

UNIT II: Material Selection and Manufacturing Considerations	**07 Hrs.**

Criteria for material selection: strength-to-weight ratio, stiffness, durability, cost, Mechanical properties: yield strength, modulus of elasticity, toughness, fatigue strength, Advanced materials: Composites (carbon fiber, glass fiber), Lightweight alloys (aluminium, titanium), Introduction to additive manufacturing (3D printing) for robotic components, Surface treatment and coatings for wear and corrosion resistance, Design for manufacturability (DFM) and design for assembly (DFA) principles.

UNIT III: Joints and Transmission Systems	**07 Hrs.**

Design of joints: revolute, prismatic, spherical joints, Bearings: types (ball, roller, plain), selection and load considerations, Couplings: rigid and flexible couplings and their applications, Role and requirements of Power transmission in robotic systems, Gear systems: Spur, helical, bevel, and planetary gears, Gear ratio design and torque transmission, Backlash, wear, and efficiency considerations, Belt and chain drives: Kinematics and velocity ratios, Tension analysis and slip conditions, Lead screws and ball screws: efficiency and precision,

UNIT IV: Force Analysis of End Effectors	**07 Hrs.**

Role and classification of end effectors in robotics, Force transmission mechanisms in grippers, Gripping force calculation and safety factors, Contact mechanics and friction in gripping, Structural design of gripper arms and fingers, Design of frames, fixtures, and holding mechanisms, Material and topology selection for different applications.

TEXT BOOKS:

1. Budynas, R.G. & Nisbett, J.K., *Shigley's Mechanical Engineering Design*, McGraw-Hill, 11th/12th Ed.
2. **Robert L. Norton, Machine Design: An Integrated Approach,** 6th Edition, Pearson Education
3. Eugene I. Rivin, **Mechanical Design of Robots,** McGraw-Hill, 1st Edition

Reference Book:

1. Vigen (Vladimir) S. Arakelian, **Dynamic Decoupling of Robot Manipulators,** 1st Edition (2018), Springer International Publishing (Springer, Cham), Mechanisms and Machine Science, Vol. 56, **ISBN:** 978-3-319-74362-2 (Hardcover), 978-3-319-74363-9 (eBook)
2. Springer Handbook of Robotics, Editors: Bruno Siciliano, Oussama Khatib, Edition: 2nd Edition (2016), Publisher: Springer
3. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, Robotic Engineering: An Integrated Approach, (Mechanical Design Sections), Publisher: Prentice Hall
4. Siciliano, B. & Khatib, O., *Springer Handbook of Robotics*, Springer, 2nd Ed., 2016.

List of Experiments

1. Study of Different Types of Robotic Configurations
2. Design and Analysis of Robotic Arm Links
3. Forward Kinematics of Robotic Manipulator
4. Inverse Kinematics of Robotic Manipulator
5. Design of Robotic Gripper Mechanism
6. Torque Calculation and Motor Selection for Robot Joints
7. CAD Modeling of Robotic Arm
8. Finite Element Analysis of Robot Components
9. Design of Gear Train for Robotic Systems
10. Design of Belt and Chain Drives in Robots
11. Design and Analysis of End Effectors
12. Workspace Analysis of Robotic Manipulator
13. Dynamic Analysis of Robotic Arm
14. Design of Mobile Robot Chassis

Course Code	**Course Title**			**Category**	
26ES03TP0303	**Microcontroller and Interfacing**			PCC	
Contact Hours per Week			**CA**	ES	**Credits**
L	**P**	**S**	50	50	03
03	00	02			

Prerequisite: Basic knowledge of digital electronics, logic gates, and number systems; fundamentals of electrical circuits; introductory programming concepts in C language; and basic understanding of signals and systems.

Course Objectives: To provide fundamental knowledge of microprocessors and microcontrollers including 8051 microcontroller, 8086 microprocessor, and ARM Cortex-M series; to develop programming and interfacing skills using GPIO and communication protocols (wired and wireless); and to enable the design of real-time embedded systems for robotics and AI applications.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Explain the architecture and operation of microprocessors and microcontrollers, including 8086 microprocessor and 8051 microcontroller.
CO2: Develop and implement programs for modern embedded systems using ARM Cortex-M series with proper use of timers, interrupts, and peripherals.
CO3: Design and implement GPIO interfacing and communication interfaces using UART, SPI, I2C, and wireless protocols such as Bluetooth and Wi-Fi.
CO4: Interface sensors and actuators and apply control techniques such as PID control for robotic systems.
CO5: Design and analyze embedded systems using RTOS concepts and integrate AI-based functionalities for robotics and automation applications.

UNIT I: Fundamentals of Microprocessors and Microcontrollers (8086 & 8051)	**08 Hrs.**

Introduction to embedded systems and their role in robotics and automation; comparison of microprocessors and microcontrollers; architecture of 8086 microprocessor—register organization, addressing modes, instruction set overview; architecture of 8051 microcontroller—memory organization, I/O ports, timers, interrupts; comparison and suitability for control-oriented applications.

UNIT II: ARM Cortex Architecture and Programming	**08 Hrs.**

Limitations of traditional controllers and need for 32-bit systems; architecture of ARM Cortex-M series core registers, Embedded C programming; register-level configuration; timers, interrupts, and PWM generation.

UNIT III: GPIO Interfacing and Communication Protocols	**08 Hrs.**

GPIO interfacing concepts—pin configuration, input/output modes, pull-up/pull-down resistors; interfacing of LEDs, switches, and digital devices; serial communication fundamentals; communication protocol interfacing (data formats, timing, configuration); interfacing sensors and peripherals using these protocols

UNIT IV: Wireless Communication and Sensor–Actuator Interfacing	**07 Hrs.**

Wireless communication fundamentals; interfacing of wireless protocols (Bluetooth, Wi-Fi, and Zigbee in embedded systems; integration with microcontrollers using UART/SPI); sensor interfacing (ultrasonic, IR, temperature, IMU); actuator interfacing (DC motors, servo, stepper motors); motor drivers; PWM-based control.

UNIT V: Real-Time Embedded Systems and AI-Based Robotics Applications	**07 Hrs.**

Introduction to real-time systems; task scheduling and synchronization; RTOS fundamentals using FreeRTOS; embedded system design methodology; IoT-based robotic systems; edge AI concepts; deployment using TensorFlow Lite; applications such as autonomous robots, smart automation, and remote-controlled robotic systems

TEXT BOOKS:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin McKinlay, *"The 8051 Microcontroller and Embedded Systems"*, Pearson Education.
2. Douglas V. Hall, *"Microprocessors and Interfacing: Programming and Hardware"* (for 8086 microprocessor), McGraw-Hill.
3. Joseph Yiu, *"The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors"* (for ARM Cortex-M series), Elsevier.

REFERENCE BOOKS:

1. Kenneth J. Ayala, *"The 8051 Microcontroller"*, Cengage Learning.
2. A.K. Ray and K.M. Bhurchandi, *"Advanced Microprocessors and Peripherals"*, McGraw-Hill.
3. Raj Kamal, *"Embedded Systems: Architecture, Programming and Design"*, McGraw-Hill.
4. Qing Li and Caroline Yao, *"Real-Time Concepts for Embedded Systems"* (for FreeRTOS concepts), CRC Press.

Experiment List

Exp No	Experiment	CO Mapped
1	Write and execute an Assembly language program for basic data transfer and arithmetic operations in 8051 microcontroller	CO1, CO2
2	Write an Assembly language program to implement decision-making and array processing (largest/smallest number)	CO2
3	Write a program to interface a 4×4 matrix keypad with microcontroller and display the pressed key on an LED/LCD**.**	CO3, CO4
4	Write a program to interface an ADC with microcontroller to read analog input (e.g., temperature sensor or potentiometer) and display the digital output on LED/LCD**.**	CO2, CO5
5	Interface a 16×2 LCD with microcontroller and display dynamic messages	CO3
6	Interface and control a DC/Stepper motor for direction and speed control	CO4
7	Implement a traffic light control system using LEDs with timing logic	CO2, CO5
8	Implement UART communication between microcontroller and PC/controllers	CO3
9	Interface wireless module (Bluetooth/ZigBee/Wi-Fi) for sensor data transmission	CO3, CO5
10	Develop an ARM-based application using ARM Cortex-M series for sensor-based decision making	CO2, CO4, CO5

Course Code	Course Title			Category
25ES03TP0304	Introduction to Python			PCC
Contact Hours per Week			CA	ESE	Credits
L	P	S			
02	02	02	50	-	02 + 01

Prerequisite: Basic programming concepts/fundamentals

Course Objectives

1. To provide students with a strong foundation in Python programming and computational thinking.
2. To develop problem-solving skills using Python programming constructs, functions, and data structures.
3. To enable students to build simple applications using files, libraries, and exception handling.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain Python fundamentals, development environment, syntax, variables, operators, and input/output statements.

CO2: Develop Python programs using decision-making statements, loops, and other control structures to solve computational problems.

CO3: Design modular programs using functions and built-in data structures such as strings, lists, tuples, dictionaries, and sets.

CO4: Implement file handling, exception handling, and utilize Python standard libraries for data processing and application development.

CO5: Develop, test, and document simple Python-based applications by integrating programming concepts for real-world problem solving.

UNIT I: INTRODUCTION TO PYTHON AND PROGRAMMING FUNDAMENTALS (04 HRS.)

Introduction to Python, installation of Python, Python IDEs (IDLE and VS Code), structure of a Python program, Python syntax, keywords and identifiers, variables, data types, type casting, input and output functions, comments, and indentation.

UNIT II: OPERATORS AND CONTROL STRUCTURES (07 HRS.)

Arithmetic, relational, logical, assignment, and membership operators; conditional statements including **if, if-else, nested if,** and **elif ladder**; looping statements using **while** and **for** loops; loop control statements including **break, continue,** and **pass**; development of simple programs using control structures.

UNIT III: FUNCTIONS AND BUILT-IN DATA STRUCTURES (06 HRS.)

Function definition and function calling, parameters and return values, local and global variables, user-defined functions, strings and string methods, lists, tuples, dictionaries, sets, iteration through collections, and selection of appropriate data structures for solving programming problems.

UNIT IV: FILE HANDLING, EXCEPTION HANDLING AND PYTHON LIBRARIES (07 HRS.)

File operations including reading, writing, and appending files; working with CSV files; exception handling using **try, except, finally,** and **raise** statements; use of Python standard libraries such as **math, random,** and **datetime**; introduction to **NumPy** and **Pandas** for basic numerical computation and data handling.

UNIT V: PYTHON APPLICATIONS AND MINI PROJECT (06HRS.)

Data processing and data cleaning using Python, problem identification, algorithm development, coding and debugging, testing and documentation, development of a mini project by integrating Python programming concepts, and project presentation.

Textbooks

1. Dr. Charles Severance, Python for Everybody: Exploring Data in Python 3, CreateSpace Independent Publishing, 2016.
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd Edition, O'Reilly Media, 2016.
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, 2013.

Reference Books

1. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No Starch Press, 2019.
2. Paul Barry, Head First Programming: A Learner's Guide to Programming Using Python, O'Reilly Media, 2010.
3. Luciano Ramalho, Fluent Python: Clear, Concise, and Effective Programming, 2nd Edition, O'Reilly Media, 2022.
4. Wes McKinney, Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.

Course Code	Course Title				Category
26HS01TP0301	Environmental Science				VEC
Contact Hours per Week			CA	FE	Credits
L	P	S			
01	02	00	50+50	-	02

Prerequisite:

Course Objectives:

1. To create awareness of environmental pollution, natural resources, and sustainability among engineering students.
2. To impart knowledge on ecological systems, biodiversity, and their conservation strategies.
3. To understand the causes and impacts of environmental degradation and climate change.
4. To familiarize students with various environmental policies, legal frameworks, and green technologies.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Understand the importance of the environment, natural resources, and associated problems.

CO2: Explain the structure and function of ecosystems and the need for biodiversity conservation.

CO3: Analyze the causes of pollution and global environmental issues and evaluate control measures.

CO4: Apply knowledge of sustainable development and environmental protection laws in practical contexts.

UNIT I: Introduction to Environmental Studies and Natural Resources — **09 Hrs.**

Definition, scope and importance of environmental studies, Need for public awareness, Renewable and non-renewable resources, Forest resources: uses, overexploitation, deforestation and its impacts, Water resources: use and overutilization, water conflicts, floods, droughts, Mineral resources: exploitation and environmental effects, Energy resources: growing energy needs, solar, wind, geothermal and nuclear energy, Land resources: land degradation, soil erosion, desertification, Role of an individual in conservation of natural resources

UNIT II: Ecosystems and Biodiversity — **09 Hrs.**

Concept and structure of ecosystem, Components of ecosystem: producers, consumers, decomposers, Functions of ecosystem: energy flow, food chains, food webs, and ecological pyramids, Types of ecosystems: forest, grassland, desert, aquatic (freshwater and marine), Biodiversity: definition, levels (genetic, species, ecosystem), Biodiversity hotspots in India, Threats to biodiversity: habitat loss, poaching, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: in-situ and ex-situ methods

UNIT III: Environmental Pollution and Global Issues — **9 Hrs.**

Types of pollution: air, water, soil, noise, causes, effects and control measures, Solid waste management: causes, effects and control measures of urban and industrial wastes, Wastewater treatment methods and recycling, Global warming and climate change: causes and impacts, Acid rain, ozone layer depletion, nuclear hazards, Disaster management: floods, earthquakes, cyclones, landslides, Role of technology and individuals in pollution control

UNIT IV: Social Issues, Environmental Laws and Sustainable Development — **9 Hrs.**

Architecture of microcontrollers (e.g., 8051, Arduino), Programming fundamentals, I/O interfacing: sensors, motors, display, Timers, interrupts, PWM, Communication protocols: UART, SPI, I2C.

UNIT V: Programmable Logic Controllers (PLC) and System Integration	**9 Hrs.**

Concept of sustainable development and green practices, Urban problems related to energy and population growth, Environmental ethics: issues and possible solutions, Environmental legislation in India: Water Act (1974), Air Act (1981), Environmental Protection Act (1986), Forest Conservation Act (1980), Role of Central and State Pollution Control Boards, Environmental impact assessment (EIA), Environmental management systems (ISO 14001), Green buildings and carbon footprint, Case studies on successful environmental movements (Chipko, Narmada Bachao Andolan)

TEXT BOOKS:1.

Erach Bharucha – Textbook of Environmental Studies for Undergraduate Courses, University Grants Commission, Orient BlackSwan Pvt. Ltd..

REFERENCE BOOKS:

1. R. Rajagopalan – Environmental Studies: From Crisis to Cure, Oxford University Press

2. Anubha Kaushik and C. P. Kaushik – Environmental Studies, New Age International Publishers

3. P. D. Sharma – Ecology and Environment, Rastogi Publications

4. Benny Joseph – Environmental Studies, Tata McGraw-Hill Education

5. G. Tyler Miller and Scott Spoolman – Environmental Science, Cengage Learning

Laboratory Experiments (Environmental Science Lab)

1. Determination of pH and conductivity of water samples
2. Estimation of Total Dissolved Solids (TDS) in drinking water
3. Measurement of air quality parameters (SO_2, NOx, PM2.5/PM10 using secondary data)
4. Analysis of soil texture, pH, and moisture content
5. Demonstration of water filtration and purification techniques
6. Study of biodiversity in a nearby area (quadrant method or campus flora survey)
7. Measurement of noise levels in different areas (e.g., residential vs traffic zones)
8. Visit to a water treatment plant or solid waste management facility
9. Simulation of climate change impact using a digital tool or case-based analysis
10. Preparation of a report on environmental problems in the local area and possible mitigation strategies.

B.Tech. Robotics and Artificial Intelligence

Programme Syllabus

Semester-IV

SEMESTER IV					
Course Code	**Course Title**				**Category**
25ES03TP0401	**Kinematics and Dynamics of Robot**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
03	02		50+50	50	**04**

Prerequisites:

Students should have:

- Basic knowledge of **mathematics** (linear algebra, trigonometry, and calculus).
- Understanding of **engineering mechanics, rigid body motion, coordinate systems, and machine kinematics**.

Course Objectives:

After completing this course, students will be able to:

1. Understand and apply coordinate transformations and frame mapping for representing robotic systems.
2. Develop forward kinematic models of robotic manipulators using D-H parameters.
3. Formulate and solve inverse kinematics problems for different robotic configurations.
4. Analyze velocity relationships, Jacobian matrix, and singularities in robotic manipulators.
5. Model and analyze robot dynamics and trajectory planning for controlled motion.

Course Outcomes (CO)

After successful completion of the course, students will be able to:

CO1: Apply coordinate frame transformations and homogeneous matrices to represent position and orientation of robotic systems.
CO2: Develop and analyze forward kinematics models of manipulators using Denavit–Hartenberg (D-H) convention.
CO3: Solve inverse kinematics problems and evaluate multiple solutions, singularities, and workspace constraints.
CO4: Analyze Jacobian matrices, velocity relationships, and manipulability of robotic systems.
CO5: Formulate dynamic models and trajectory plans for robotic manipulators using Lagrangian and Newton–Euler methods.

UNIT I: Coordinate Frames, Mapping & Transforms	**08 Hrs.**

Significance of Coordinate Frames, Mapping & Transforms in robotics. Description of object in space, Mapping between rotated frames, translated frame and combined rotation & translation. Homogeneous transformation, Difference between fixed & movable frame, Composite/multiple transformation, Fixed angle rotation and Euler angle rotation.

UNIT II: Forward Kinematics of Robot	**08 Hrs.**

Introduction manipulator kinematics, Mechanical structure and notation, Description of links and joints, kinematic modelling of the manipulator, Difference between direct and inverse kinematics, Denavit-Hartenberg (D-H) notation and algorithms, Kinematic relationship between adjacent link, Manipulator Transformation Matrix, Workspace analysis.

UNIT III: Inverse Kinematics of Robot	**08 Hrs.**

Problem formulation of inverse kinematics, Analytical and numerical methods, Closed-form solutions for simple manipulators (2R and 3R planer), Redundant manipulators, Multiple solutions and singular configurations, Workspace and reachability analysis

UNIT IV: Jacobian and Singularity Analysis	**8 Hrs.**

Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, Jacobian matrix and its significance, Jacobian inverse, Jacobian Singularity, Manipulability, Dexterity analysis of manipulators, Redundancy and its impact on kinematic performance.

UNIT V: Dynamic modelling & Trajectory planning	**8 Hrs.**

Lagrangian mechanics, Dynamic model of n-DOF manipulator, Lagrange-Euler and Newton-Euler formulation to dynamic solution. Inverse Dynamics, Terminology related to trajectory planning, trajectory planning to determine the joint velocity and acceleration.

TEXT BOOKS:

- Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
- Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2005.
- Odrey, Mikell P. Groover& Nicholas G., Mitchel Weiss, Roger N. Nagel, and Ashish Dutta. "Industrial Robotics,
- Technology programming and Applications.", McGraw Hill Education; 2nd edition (July 2017).

REFERENCE BOOKS:

- P. A. Janaki Raman, Robotics and Image Processing An Introduction, Tata MCGraw Hill Publishing company Ltd., 1995.
- Shames I. H., Engineering Mechanics- Statics and Dynamics" $/e Prentice-Hall of India Pvt. Ltd., 2005.

Kinematics and Dynamics of Robot Lab

Course Objectives:

The objectives of this course are to:

1. **Develop proficiency** in using MATLAB, RoboAnalyser, and industrial robot programming tools for robotic system analysis.
2. **Understand and validate** the kinematic and dynamic behavior of robotic manipulators through modeling and simulation.
3. **Apply** trajectory planning and motion control techniques for robotic manipulators using simulation software.
4. **Gain hands-on experience** in programming and operating a six-axis industrial robot for various robotic tasks.
5. **Perform industrial robotic applications**, including path planning and welding operations, while following standard safety and operational practices.

Course Outcomes:

After successful completion of this course, the students will be able to:

1. Apply MATLAB and RoboAnalyser tools to model and analyze robotic systems.
2. Develop and validate kinematic models of robotic manipulators using analytical and simulation techniques.
3. Analyze robot motion, trajectory planning, and dynamic behaviour using computational tools.
4. Demonstrate robot programming and motion control for industrial robotic applications.
5. Execute robotic path planning and welding operations using a six-axis industrial robot.

List of Experiments:

1. Introduction to MATLAB symbolic tool box
2. Familiarization with the structure and working of six axis YASKAWA arc welding robot.
3. Study and Implementation of Homogeneous Transformations in Robotics using RoboAnalyser
4. Forward kinematics (FK) of n-DOF robots using RoboAnalyser and validate the FK solution with MATLAB.
5. Forward Kinematic Modeling of a Six-Axis YASKAWA Arc Welding Robot via Physical Measurement of D-H Parameters.
6. Inverse kinematics (FK) of n-DOF robots using RoboAnalyser and validate the FK solution with MATLAB.
7. Trajectory Planning of n-DOF robots using RoboAnalyser.
8. Forward dynamics of n-DOF robots using RoboAnalyser.
9. Inverse dynamics of n-DOF robots using RoboAnalyser.
10. Robot programming of six axis YASKAWA arc welding robot.
11. Straight-Line Butt-Welding Path Planning using six axis YASKAWA arc welding robot.
12. Circular Welding on Pipe or Plate Path Planning using six axis YASKAWA arc welding robot.

Course Code	Course Title				Category
25EE07TP0402	Control Systems for Robotics Semester IV				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	2	-	50 + 50	50	04

Prerequisite: Students should have basic knowledge of Engineering Mathematics, Differential Equations, Laplace Transform and basic Electrical Engineering. Familiarity with Mechanical Systems and Sensors will be beneficial.

Course Objectives:

After completing this course, students will be able to:

1. Understand fundamental concepts of control systems and their role
2. Analyse mathematical models of dynamic systems
3. Understand stability of control systems and analyse control techniques for engineering systems

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Understand the basic concepts of control systems, including open-loop control systems and closed-loop control systems and their working principles
CO2: Develop mathematical models of systems using transfer functions
CO3: Analyse time response and frequency response of control systems
CO4: Evaluate stability of control systems by plotting bode and polar plots
CO5: Understand and apply controllers such as PID for industrial applications

UNIT I: Introduction to Control Systems	**8 Hours**

Basic concepts of control systems, open-loop and closed-loop systems, examples from robotics, mathematical modeling of physical systems (mechanical and electrical), transfer function representation, block diagrams and signal flow graphs.

UNIT II: Time Response Analysis	**7 Hours**

Standard test signals, time response of first and second order systems, transient and steady-state response, time domain specifications, error analysis and steady-state error constants.

UNIT III: Stability Analysis	**7 Hours**

Concept of stability, Routh-Hurwitz stability criterion, root locus technique, construction of root locus, effects of poles and zeros on system behaviour.

UNIT IV: Frequency Response Analysis	**7 Hours**

Frequency response concepts, Bode plots, Polar plots, gain margin and phase margin, stability analysis using frequency response methods.

UNIT V: Controllers and its Applications	**7 Hours**

Introduction to controllers, types of controllers, working of controllers, controller tuning methods, applications of controllers, introduction to modern controllers, case studies and examples.

TEXT BOOKS:

1. K. Ogata, *Modern Control Engineering*, Prentice Hall.
2. I. J. Nagrath & M. Gopal, *Control Systems Engineering*, New Age Publications.

REFERENCE BOOKS:

1. Benjamin C. Kuo, *Automatic Control Systems*, Wiley.
2. Norman S. Nise, *Control Systems Engineering*, Wiley.
3. Richard C. Dorf & Robert H. Bishop, *Modern Control Systems*, Pearson.

List of Practical

1. To study the basic concepts of control systems with suitable examples of open-loop and closed-loop systems.

2. To demonstrate the potentiometer as an error detector using block diagram representation.

3. To demonstrate the synchro system as an error detector based on transmitter-receiver configuration.

4. To demonstrate the DC position control system using servo potentiometer and analyse the effect of controller gain on system performance.

5. To obtain and plot the torque-speed characteristics of an AC servo motor.

6. To demonstrate a temperature control system for oven using PID controller and analyse the time response characteristics of a second-order system.

7. To demonstrate and plot the time response of a second-order system using an RLC circuit.

8. To analyze the root locus of given open-loop transfer functions and check system stability using MATLAB (for two cases).

9. To analyze Bode plot of a given open-loop transfer functions and evaluate gain margin, phase margin and system stability using MATLAB.

10. To analyze Polar plot of given transfer function and evaluate gain margin and phase margin using MATLAB (for single case)

SEMESTER IV					
Course Code	**Course Title**				**Category**
25ES03TP0402	**Machine Learning**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
03	02	01	50+50	50	04

Prerequisite: Introduction to Python.

Course Objectives:

1. To equip students with machine learning concepts and their applications in the robotics and AI field.
2. To learn data preprocessing techniques, supervised and unsupervised learning models, and deep learning approaches for mechanical systems.

Course Outcomes: On successful completion of the module students will be able to:

CO1. Explain the fundamental concepts, types, and workflow of machine learning, and perform data preprocessing using Python tools.

CO2. Apply supervised learning algorithms for regression and classification tasks, and evaluate their performance using appropriate metrics.

CO3. Implement unsupervised learning and dimensionality reduction techniques for exploratory data analysis and pattern discovery.

CO4. Utilize ensemble methods, model selection strategies, and optimization techniques to improve predictive model performance.

CO5. Develop and apply basic neural network models and evaluate real-world ML applications with consideration for ethical implications.

UNIT I: Foundations of Machine Learning and Data Preprocessing	**09 Hrs.**

Introduction to machine learning & sklearn libraries, types of machine learning (supervised, unsupervised, reinforcement), machine learning workflow, data collection and cleaning, handling missing values, outlier detection, encoding categorical variables, feature scaling (normalization, standardization), train-test split, K-fold cross-validation

UNIT II: Supervised Learning – Regression and Classification Techniques	**09 Hrs.**

Simple linear regression, multiple linear regression, polynomial regression, assumptions of regression, overfitting and underfitting, ridge regression (L2), lasso regression (L1), elastic net, evaluation metrics (MAE, MSE, RMSE, R^2 score), logistic regression, k-nearest neighbors (k-NN), decision trees (Gini index, entropy), random forest classifier, support vector machines (SVM) with kernel trick, confusion matrix, accuracy, precision, recall, F1-score, ROC curve, AUC, stratified sampling, model visualization using matplotlib and seaborn, implementation in scikit-learn

UNIT III: Unsupervised Learning and Dimensionality Reduction	**9 Hrs.**

k-means clustering, elbow method, silhouette score,hierarchical clustering, dendrograms, DBSCAN algorithm, principal component analysis (PCA), t-SNE for data visualization, comparison of clustering techniques, customer segmentation, anomaly detection

UNIT IV: Ensemble Learning, Model Selection, and Optimization	**9 Hrs.**

Ensemble learning concepts, bagging, boosting, stacking, random forest (bagging), AdaBoost, gradient boosting (GBM, XGBoost), bias-variance trade-off, model selection, hyperparameter tuning with grid search and random search, K-fold and stratified cross-validation, feature importance, building pipelines

in scikit-learn

UNIT V: Neural Networks and Applications of Machine Learning	**9 Hrs.**

Introduction to neural networks, perceptron model, activation functions (sigmoid, tanh, ReLU), multilayer perceptron (MLP), forward and backward propagation (conceptual), gradient descent optimization, introduction to TensorFlow and Keras.

TEXT BOOKS:

1. Pattern Recognition and Machine Learning by Christopher M. Bishop – A comprehensive guide to statistical pattern recognition and machine learning with a strong mathematical foundation.
2. Machine Learning by Tom M. Mitchell – A classic introductory book covering key ML algorithms with intuitive explanations.

REFERENCE BOOKS:

1. An Introduction to Statistical Learning by Gareth James et al. – Beginner-friendly ML book with R-based applications and statistical insights.
2. The Elements of Statistical Learning by Hastie, Tibshirani, Friedman – Advanced text on statistical models and learning theory for experienced readers.

List of Experiment

1. Implement data preprocessing techniques: handling missing values, encoding categorical variables, feature scaling.
2. Perform exploratory data analysis (EDA) using statistical summaries and visualization.
3. Implement Simple Linear Regression using Scikit-learn.
4. Perform Multiple Linear Regression and evaluate model performance (R^2, MSE).
5. Implement Logistic Regression for binary classification.
6. Perform classification using K-Nearest Neighbors (KNN) algorithm.
7. Implement Decision Tree classifier and visualize the tree.
8. Implement K-Means clustering and visualize clusters.
9. Perform Hierarchical clustering and plot dendrogram.
10. Apply Principal Component Analysis (PCA) for dimensionality reduction.
11. Compare clustering results before and after dimensionality reduction.
12. Analyze real datasets using clustering techniques.
13. Implement Random Forest algorithm for classification and regression and Apply Cross-Validation techniques for model evaluation.
14. Perform Bagging and Boosting techniques (AdaBoost).
15. Perform hyperparameter tuning using Grid Search.

Course Code	**Course Title**	**Category**

25ES03TP0403	Mechatronics				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
02	02	01	50+50	50	03

Prerequisite: Basic Electronics

Course Objectives:

1. To introduce the fundamentals and interdisciplinary nature of Mechatronics.
2. To select and apply appropriate sensors and actuators for measurement and control applications.
3. To explain and analyze signal conditioning, data acquisition, and interfacing for mechatronic applications.
4. To understand fundamentals of embedded control hardware, software concepts, and basic control techniques.
5. To apply systematic design principles to develop integrated Mechatronic systems

Course Outcomes: On successful completion of the module students will be able to: CO1:
Explain the basic concepts and structure of mechatronic systems.
CO2: Apply signal conditioning, data acquisition techniques for interfacing and perform A/D and D/A conversion.
CO3: Develop and implement control strategies using microcontrollers and PLCs.
CO4: Explain complete mechatronic systems for real-world applications.

UNIT I: Introduction to Mechatronics	**06 Hrs.**

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, measurement system, microprocessor-based controllers, Products, and design. Comparison between Traditional and Mechatronics approach, Industrial sensor & actuator selection criteria.

UNIT II: Signal Conditioning and Data Acquisition	**07 Hrs.**

Transducers & signal characteristics, Analog and digital signals, Analog to Digital (A/D) and Digital to Analog (D/A) converters, Signal conditioning (sensor → amplifier → ADC) using op-amps, filtering, amplification, noise reduction techniques, Introduction to DAQ hardware.

UNIT III: Programmable Logic Controllers (PLC)	**07 Hrs.**

Introduction to embedded systems, PLC architecture and components, PLC programming concepts, I/o Processing, Ladder logic diagrams: logic gates, timers, counters, PLC-based system control, sequencing, Timers and counters, shift registers, PLC applications in industrial automation and robotics.

UNIT IV: System Modelling and Mechatronic System Design	**07Hrs.**

Introduction to system modeling and simulation, Mechatronic system design methodology, Integration of sensors, actuators, controllers, and control logic, Case studies: Washing machine, ABS, pick-and-place robots

TEXT BOOKS:

- Bolton, W. Mechatronics, Pearson Education.
- Alciatore, D.G., and Histand, M.B. Introduction to Mechatronics and Measurement Systems, McGraw Hill.
- Shetty, D., and Kolk, R., A., Mechatronics System Design

REFERENCE BOOKS:

- N.P. Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw-Hill.
- F.D. Petruzella, Programmable Logic Controllers, McGraw-Hill.
- Ghosh & Raj, Fundamentals of Microprocessors and Microcontrollers, S. Chand.

List of Experiments:

1. Angular Displacement Measurement using Variable Capacitive Transducer
2. Speed Measurement using Inductive and Optical Transducer
3. To interface ADC 0809 with a clock generator and observe digital outputs using LED indicators
4. Study and Characterization of 8-bit Weighted Resistor Digital-to-Analog Converter using DAC0808
5. Introduction to PLC Hardware and Programming Environment
6. PLC architecture, ladder logic programming
7. PLC Programming for Digital Input–Output Control - Implementation of basic logic operations (AND, OR, NOT, NOR, NAND, XOR)
8. Control Using Counters: - Event counting and sequencing applications
9. Sequential Control using timers- ON-delay and OFF-delay timers
10. IoT-Based Monitoring and Control of a Mechatronic System

Course Code	Course Title				Category
25ES03PR0404	**Project-1**				CFP/MP
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
00	02	02	50	-	01

Prerequisite: Introduction to Python,

Course Objectives:

1. To enable students to identify, analyze, and define a real-world engineering problem and develop an appropriate problem statement through literature review and preliminary investigation.
2. To develop skills in project planning, research methodology, and initial design or model development using appropriate tools and techniques.

Course Outcomes: On successful completion of the module students will be able to:

CO1 Identify and define a real-world problem related to Robotics and Artificial Intelligence by reviewing relevant literature and understanding system requirements.

CO2 Analyze and design an appropriate methodology or system architecture using fundamental concepts of AI, ML, robotics, sensors, and automation.

CO3 Implement a basic hardware/software solution using suitable tools, programming languages, or simulation platforms to address the identified problem.

CO4 Evaluate and interpret results obtained from the developed system and analyze performance with respect to objectives and constraints.

CO5 Demonstrate effective teamwork and technical communication through seminars, presentations, documentation, and viva-voce.

SYLLABUS	**25 Hrs.**

Introduction to project-based learning, identification of problem domains, literature survey and review of research papers, formulation of problem statement and objectives, feasibility analysis, selection of methodology and tools, basic design or model development, data collection and preliminary analysis, use of computational or experimental techniques, project planning and scheduling, documentation practices, report writing, and presentation of progress work.

Course Code	Course Title		Category
26ES03AECPR0408	Basic competitive coding Lab		AEC
Contact Hours per Week	**CA**	**FE**	**Credits**

L	P	S			
00	02	00	50	00	01

Prerequisite: Basics of Python and Data Structure

Course will be delivered by Industry Vendor.

Course Objectives:

- To develop fundamental problem-solving skills using basic data structures and algorithms.
- To enable students to solve coding problems using online competitive platforms.

Course Outcome :

1. Understand problem statements and implement basic algorithms.
2. Apply arrays and string manipulation techniques.
3. Solve problems using recursion and basic backtracking.
4. Implement searching and sorting techniques.
5. Use online assessment effectively for coding practice.

Module 1: Fundamentals & Problem Solving 04x2 Hrs

1. Algorithm basics, pseudocode, flowcharts
2. Time & space complexity (intro level)
3. Input/output handling in coding platforms

Module 2: Arrays, Strings & Recursion 04x2 Hrs

1. 1D/2D arrays
2. String operations
3. Recursion basics (factorial, Fibonacci, simple problems)

Module 3: Searching, Sorting & Basic Data Structures 04x2 Hrs

- Linear & binary search
- Basic sorting (bubble, selection, insertion)
- Introduction to stacks & queues

LIST OF EXPERIMENTS

1. Solve 5 problems on basic input/output and logic building
2. Implement array operations (search, sum, reverse)
3. String manipulation problems (palindrome, substring, frequency count)
4. Recursive problems (factorial, Fibonacci, sum of digits)
5. Searching & sorting implementation and problem-solving
6. Solve at least 10 problems on HackerRank (Easy level)
7. Mini contest (timed coding test)

Recommended Books

1. "Data Structures Using C" – Reema Thareja
2. "Introduction to Algorithms" – Cormen (Basic reference)
3. "Programming in C/C++/Java" – Standard texts

Web Resources

- HackerRank
- HackerEarth
- LeetCode
- CodeChef, GeeksforGeeks

Course Code	Course Title				Category
25ES03TP0405	**Design Thinking**				AEC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
01	02	02	50	-	02
Prerequisite: Basic Engineering Design, Innovation Thinking					

Course Outcomes: On successful completion of the module students will be able to:
CO1: Practice thinking as a tool for solving problems and generating ideas
CO2: Apply logical thinking in professional and quasi situations
CO3: Transduce the ideas into practically feasible inventions.
CO4: Incorporate design innovation in the product/processes.
CO5: Understand the importance of intellectual property

Expt. 1: Problem Identification and Need Analysis
Identification of real-world problems in Robotics & AI domain and formulation of problem statement.

Expt. 2: User Research and Survey Analysis
Design and conduct surveys/interviews to understand user needs and analyze collected data.

Expt. 3: Idea Generation Techniques
Application of brainstorming and SCAMPER techniques to generate multiple solution ideas.

Expt. 4: Concept Screening using Weighted Scoring Matrix
Evaluation and ranking of ideas based on defined criteria.

Expt. 5: Concept Selection using Pugh Matrix
Comparison of alternative concepts with a reference using + / – / 0 method.

Expt. 6: Technology Readiness Level (TRL) Assessment
Determination of maturity level of selected concept and analysis of associated risks.

Expt. 7: Concept Design and Product Planning
Development of design concepts using sketches and/or CAD models.

Expt. 8: Prototype Development (Minimum Viable Product)
Development of basic working prototype using suitable tools, hardware, and software.

Expt. 9: Testing, Validation and Iteration
Performance testing of prototype and implementation of design improvements.

Expt. 10: Business Model Canvas (BMC) Development
Preparation of BMC including customer segments, value proposition, and revenue streams.

Expt. 11: Cost Estimation and Market Analysis
Preparation of basic Bill of Materials (BOM), cost estimation, and identification of target market.

Expt. 12:Pitch Deck Preparation and Presentation
Development and presentation of pitch deck covering problem, solution, product, and business model.

Semester V

Course Code	Course Title				Category
25ES03TP0501	Deep Learning				PCC
Contact Hours per Week			CA	ESE	Credits
L	T	D/P			
03	02	00	50 + 50	50	04

Prerequisite: Introduction to Python, Machine Learning Concepts

Course Objectives:

1. To provide a strong foundation in deep learning concepts, architectures, and algorithms for solving complex real-world problems.
2. To develop practical skills in implementing deep learning models using modern frameworks for applications such as image processing, sequence modeling, and predictive analytics.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Understand fundamental concepts of neural networks and deep learning architectures.
CO2: Apply deep learning techniques for classification and regression problems.
CO3: Analyze and implement convolutional and recurrent neural networks for real-world applications.
CO4: Evaluate and optimize deep learning models using appropriate techniques.
CO5: Design and develop end-to-end deep learning solutions for practical problems.

UNIT I: Introduction to Deep Learning and Neural Networks — **09 Hrs.**

Machine Learning vs Deep Learning, biological neuron vs artificial neuron, perceptron model, multilayer perceptron (MLP), activation functions (sigmoid, ReLU, tanh), loss functions, gradient descent and variants, forward propagation, backpropagation algorithm, challenges in training deep networks (vanishing gradient, overfitting), introduction to TensorFlow and Keras.

UNIT II: Deep Feedforward Networks and Optimization Techniques — **09 Hrs.**

Deep feedforward networks, weight initialization techniques, regularization (L1, L2, dropout), batch normalization, optimization algorithms (SGD, Adam, RMSProp), hyperparameter tuning, model evaluation metrics.

UNIT III: Convolutional Neural Networks (CNNs) — **9 Hrs.**

Introduction to CNN, convolution operation, pooling layers, padding and stride, feature maps, CNN architectures, transfer learning, image classification, object detection basics, applications in computer vision

UNIT IV: Recurrent Neural Networks (RNNs) and Sequence Models — **9 Hrs.**

Sequence data and time series, recurrent neural networks, vanishing gradient problem in RNN, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), bidirectional RNN, sequence-to-sequence models.

UNIT V: Advanced Deep Learning and Applications — **9 Hrs.**

Autoencoders, Generative models (GANs), transformers basics, deep learning for reinforcement learning, model deployment basics.

TEXT BOOKS:

Pattern Recognition and Machine Learning by Christopher M. Bishop – A comprehensive guide to statistical pattern recognition and machine learning with a strong mathematical foundation.
Machine Learning by Tom M. Mitchell – A classic introductory book covering key ML algorithms with intuitive explanation.

REFERENCE BOOKS:

1. Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville
2. Neural Networks and Deep Learning – Charu C. Aggarwal
3. Deep Learning with Python – François Chollet
4. Pattern Recognition and Machine Learning – Christopher M. Bishop
5. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
6. Machine Learning Yearning – Andrew Ng

List of Experiment

1. Build and train a Multilayer Perceptron (MLP) for classification.
2. Experiment with different activation functions and compare performance.
3. Implement gradient descent and visualize loss convergence.
4. Build and train a CNN for image classification (Project Based).
5. Implement transfer learning using pre-trained CNN models.
6. Visualize feature maps in CNN.
7. Implement RNN for sequence prediction.
8. Build LSTM model for time series forecasting.
9. Implement GRU and compare it with LSTM performance.
10. Develop an autoencoder for dimensionality reduction.
11. Implement a simple GAN for image generation.
12. Develop an end-to-end deep learning project (problem definition, preprocessing, model building, evaluation).
13. Perform model tuning, evaluation, and optimization.

Course Code	**Course Title**				**Category**
25ES03TP0502	**Industrial Hydraulics and Pneumatics**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	1	50+50	50	04
Prerequisite: Basics of Fluid Power Systems					

Course Objectives:

1. To understand the fundamental principles of industrial hydraulics and pneumatics, including fluid properties, system components, and working mechanisms.

2. To develop the ability to analyze, design, and troubleshoot hydraulic and pneumatic systems used in industrial applications.

Course Outcomes:

CO1: Explain the working principles of hydraulic and pneumatic systems and their components.

CO2: Identify and select suitable pumps, actuators, valves, and accessories for industrial applications.

CO3: Analyze hydraulic and pneumatic circuits used in machine tools and automation systems.

CO4: Design basic industrial circuits for given applications such as press, drilling, and pick-and-place systems.

CO5: Diagnose and troubleshoot faults in fluid power systems and suggest appropriate maintenance practices.

UNIT I: Fundamentals of Fluid Power Systems	**8Hrs.**

Introduction to fluid power systems , Advantages, limitations, and industrial applications, Comparison of hydraulic and pneumatic systems,Types of fluids: hydraulic fluids and compressed air, Properties of fluids: viscosity, density, compressibility, lubrication, contamination, Selection criteria for hydraulic fluids ,Basic principles of hydraulics, Pascal's Law and its applications,Sources of hydraulic power: pumps and compressors (overview), Classification of hydraulic pumps

UNIT II: Hydraulic Pumps and Actuators	**8Hrs.**

Hydraulic Pumps: Types: Gear, Vane, Piston pumps,Construction, working principle, and performance characteristics,Advantages, disadvantages, and industrial applications

Hydraulic Actuators :Hydraulic cylinders: Types (single acting, double acting, telescopic, etc.) ,Construction and working,Mounting methods and applications ,Hydraulic motors: Types, construction, and working , Introduction to hydraulic cushioning

UNIT III: Hydraulic Control Components and Circuits	**8Hrs.**

Control Valves: Direction control valves (DCV): types and operation ,Flow control valves: throttle, pressure compensated ,Pressure control valves: relief, reducing, sequence, unloading,**Hydraulic Circuits:**Basic and industrial circuits,Regenerative circuit ,Pump unloading circuit ,Double-pump system,Pressure intensifier circuit ,Sequence and interlocking circuits ,Speed control circuits ,Fail-safe circuits,Hydraulic accumulators and their applications ,& Pipes: Types, Materials, pressure drop in hoses/pipes. Hydraulic piping connections.

UNIT IV: Pneumatic Systems and Electro-Pneumatics	**8Hrs.**

Properties of compressed air,**Perfect Gas Laws** and their applications in pneumatics,Air generation and distribution: compressors and air receivers ,Air preparation units: Filter, Regulator, Lubricator

(FRL),Pneumatic control valves: DCV, flow and pressure control valves ,Special valves: quick exhaust valve, shuttle valve ,Pneumatic actuators: cylinders and air motors,**Electro-pneumatic systems:**Solenoid valves ,Sensors and limit switches ,Basic electro-pneumatic circuits.

UNIT V: Industrial Applications, Design and Troubleshooting	**8Hrs.**

Design of hydraulic circuits for industrial applications:Hydraulic press,Drilling machine,Surface grinding machine ,Forklift system

Design of pneumatic circuits:Pick-and-place operations ,Tool handling in CNC machines,Installation and maintenance practices, Common faults in hydraulic and pneumatic systems ,Troubleshooting techniques and remedies , Safety considerations in industrial fluid power systems

TEXT BOOKS:

1. Sahashtrabudhe N.V., Introduction to Fluid Power, Nirali Prakashan Pune.

2. Pipenger J.J., Industrial Hydraulics, McGraw Hill Co.

3. Mujumdar S.R., Pneumatics circuits.

REFERENCE BOOKS:

1. Pinches, Industrial Fluid Power, Prentice Hall.

2. Stewart H.L., Hydraulics & Pneumatics, Industrial Press.

3. Fluid Power Design Handbook, Yeaple.

LIST OF PRACTICAL ASSIGNMENTS: Any 8 (for lab course)

1) Study of hydraulic fluids and seals used in fluid power systems.

2) Study of contamination of hydraulic fluids and its control.

3) Study of symbols used in hydraulic and pneumatic systems.

4) Study of hydraulic pumps, accumulators and intensifiers.

5) Study of control valves used in hydraulic systems.

6) Study and demonstration of hydraulic circuits used in

(a) CNC Lathe (b) CNC Milling Machine (c) Universal Testing Machine

7) Study of air preparatory unit used in pneumatic systems.

8) Study of control valves used in pneumatic systems.

9) Study and demonstration of following pneumatic circuits on pneumatic circuit trainer:

[a] Control of single acting cylinder using 3/2 D.C. valves (Push button type, Hand lever

type and Foot pedal type)

[b] Meter in circuit using double acting cylinder

[c] Meter out circuit using double acting cylinder

[d] Automatic sequencing of motion of 2 double acting cylinders using 5/2 pilot operated D.C. valves

[e] Automatic sequencing of motion of 2 double acting cylinders using Solenoid actuated D.C. valves.

Course Code	Course Title				Category
25ES03TP0503	Industrial Internet of things (IIoT)				PCC
Contact Hours per Week			CA	ESE	Credits
L	P	S			
2	2	2	50+50	50	3

Prerequisite: Engineering Mathematics, Basics of Electrical Engineering, Python Programming,

Course Objectives: The objective of the course is to prepare the students

1. To understand architecture and components of Industrial IoT systems.
2. To develop skills for data acquisition, analysis, and smart manufacturing applications.

Course Outcomes: After completing this course, students will be able to:

CO1: Explain IIoT architecture, sensors, and communication protocols

CO2: Develop IoT-based data acquisition systems using hardware/software tools

CO3: Analyze industrial data using cloud platforms and basic analytics

CO4: Implement IIoT solutions with machine learning for predictive maintenance

CO5: Design smart manufacturing/monitoring systems for real-world applications

Unit I: The Industrial Edge (Hardware & Sensing)

IIoT Fundamentals: Definitions, evolution from M2M, and the 4-layer architecture (Perception, Network, Middleware, Application).

The Physical Layer: Sensors: Theory and application of Temperature, Pressure, Vibration, Flow, Proximity, and LVDT, Actuators: Solenoids, Servo drives, VFDs, and Pneumatic systems. Signal conditioning (Amplifiers, Filters), ADC/DAC, and Data Acquisition Systems (DAQ).

Unit II: Embedded Intelligence & Local Connectivity

Controller Platforms: Microprocessors vs. Microcontrollers; hands-on overview of Arduino, ESP32, and Raspberry Pi.

Edge Programming: GPIO programming with Python (Digital I/O, PWM) on Raspberry Pi.

Wired Bus Protocols: Principles and wiring for UART, SPI, and I2C.

Industrial Networking: Modbus (RTU/TCP): Architecture and frame structure, OPC-UA: The modern standard for industrial interoperability.

Unit III: IIoT Communication & Cloud Integration

Wireless Stack: Comparison of Wi-Fi, Zigbee, LoRaWAN, and NB-IoT (Range vs. Power vs. Reliability).

Messaging Protocols: MQTT: Deep dive into Broker, Pub/Sub model, and QoS levels, Web Protocols: HTTP/REST for IoT.

Cloud Ecosystems: Integration with AWS IoT Core, Microsoft Azure IoT Hub, and ThingSpeak, Middleware: Hands-on with HiveMQ or Mosquitto brokers.

Unit IV: Data Engineering & Industrial Analytics

Data Management: Time-series databases (InfluxDB), Data logging, and visualization with Grafana.

Preprocessing Pipeline: Using Python (Pandas, NumPy) for cleaning, normalization, and feature extraction.

Machine Learning for IIoT: Supervised (Regression and Classification) basics via scikit-learn.

Predictive Maintenance: Random Forest for Remaining Useful Life (RUL) prediction.

Unit V: Industry 4.0 Applications & Security

The Digital Twin: Concepts, architecture, and applications in manufacturing.

Smart Factory Operations: Condition monitoring and OEE (Overall Equipment Effectiveness) calculation, IIoT in Energy Management: Smart metering and demand response.

Capstone Case Study: End-to-end pipeline (Sensor - MQTT - Cloud - ML Model - Alert).

TEXT BOOKS:

1. Raj Kamal – Internet of Things

2. Programming the Internet of Things Andy King, O'Reilly Media 2021

3. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow

4. Raspberry Pi and Python for IIoT Applications Warren Gay, Apress 2019

REFERENCE BOOKS:

1. Aurélien Géron, O'Reilly Media 3rd Ed., 2022

2. Industrial Internet of Things, Sabina Jeschke, Christian Brecher et al., Springer 2017

List of Experiments

1. Introduction to Raspberry Pi / ESP32: GPIO configuration, LED blink, button input using Python
2. Interfacing Temperature & Humidity Sensor (DHT22) with Raspberry Pi; data logging to CSV
3. Interfacing Vibration Sensor (ADXL345) via I2C; reading accelerometer data using Python
4. PWM-based DC motor speed control using Python and L298N motor driver (Actuator experiment)
5. Serial communication (UART/Modbus RTU) between Arduino and Raspberry Pi; data exchange
6. MQTT communication: publish sensor data from ESP32, subscribe and display on

Raspberry Pi broker

7. Cloud data upload: send sensor readings to ThingSpeak / AWS IoT Core via Wi-Fi; real-time dashboard
8. Edge data processing: local anomaly detection on Raspberry Pi before cloud upload
9. Data pre-processing with Python (Pandas): cleaning noisy sensor dataset, normalization, feature extraction
10. Machine Learning Experiment – 1: Train a Random Forest regression model (scikit-learn) on industrial sensor data to predict Remaining Useful Life (RUL) of a simulated bearing
11. Machine Learning Experiment – 2: Anomaly detection using Isolation Forest on vibration/temperature dataset; visualize detected anomalies using Matplotlib
12. Mini-Project / Integration Experiment: End-to-end IIoT pipeline – sensor data acquisition → MQTT → cloud → ML anomaly alert → Grafana dashboard (group exercise)

Capstone projects linked experiments AI & IoT (One grop one project):

- Sensor Data Analytics using AI (Temperature & Humidity Prediction)
- Anomaly Detection in Sensor Data using Artificial Intelligence
- Smart Alert System for Fire / Equipment Overheating Detection using AI Rule-Based Classification
- Predictive Maintenance System using AI for Industry 4.0
- ML-Based Energy Consumption Prediction using Time-Series Forecasting

Additional Resources:

1. NPTEL 'Internet of Things' – Prof. Sudip Misra, IIT Kharagpur: https://nptel.ac.in/courses/106105173
2. NPTEL 'Introduction to Industry 4.0 and Industrial Internet of Things' – IIT Kharagpur: https://nptel.ac.in/courses/106105155
3. NPTEL 'Machine Learning' – Prof. Balaram Ravindran, IIT Madras: https://nptel.ac.in/courses/106106139
4. Platform Wokwi Online Arduino / ESP32 Simulator: https://wokwi.com
5. Platform ThingSpeak IoT Analytics Platform (free): https://thingspeak.com
6. Platform AWS IoT Core Free Tier: https://aws.amazon.com/iot-core
7. Platform HiveMQ Public MQTT Broker: https://www.hivemq.com/public-mqtt-broker
8. Coding Google Colab (free Python/Jupyter): https://colab.research.google.com
9. Coding Kaggle Datasets for IIoT ML: https://www.kaggle.com/datasets (search 'predictive maintenance', 'bearing fault')

Course Code	Course Title				Category
25ES03TP0505	Robot Operating Systems (ROS)				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	01	50	00	01

Prerequisite: C++/Python Programming, Fundamentals of Robotics

Course Objectives:

1. To introduce the structure and components of Robot Operating System (ROS).
2. To develop ROS nodes for robotic applications using publishers and subscribers.
3. To integrate ROS with sensors, actuators, and simulation tools.
4. To implement SLAM, path planning and control using ROS packages.

Course Outcomes: On successful completion of the module students will be able to:

CO1. Understand the architecture of ROS and its communication model.
CO2. Develop nodes, topics, services and actions in ROS using Python/C++.
CO3. Simulate robots using Gazebo and RViz.
CO4. Interface ROS with sensors and actuators.
CO5. Implement localization, mapping and path planning in ROS environment.

UNIT I: Introduction to ROS — **09 Hrs.**

Definition, need, components of IIoT, industrial automation and Industry 4.0, IIoT architecture. Discuss key drivers and benefits of IIoT, examples from smart factories, oil and gas, and energy sectors.

UNIT II: ROS Programming Basics — **09 Hrs.**

Smart sensors, wired and wireless protocols (Modbus, ZigBee, BLE, LoRa, MQTT), sensor interfacing. Deep dive into sensor characteristics, calibration, interfacing techniques, usecases of LoRa, MQTT, and BLE in industry.

UNIT III: Visualization and Simulation — **9 Hrs.**

Edge devices, gateways, data preprocessing, cloud platforms (AWS, Azure, Google Cloud) for IIoT. Edge analytics frameworks, data fusion, Fog computing, cloud architecture patterns and deployment models.

UNIT IV: Interfacing Sensors and Actuators — **9 Hrs.**

Data acquisition, storage, visualization, analytics using ML for predictive maintenance and fault detection. Database technologies for IIoT, timeseries databases, data cleaning, dashboards and analytics pipelines.

UNIT V: SLAM and Navigation — **9 Hrs.**

Cybersecurity in IIoT, encryption techniques, standards, industrial usecases and IIoT in robotics. Cyber threats in IIoT, intrusion detection systems, usecase studies from automotive, healthcare, and logistics.

TEXT BOOKS:

- Jason O'Kane, 'A Gentle Introduction to ROS', CreateSpace Independent Publishing.
- Morgan Quigley, Brian Gerkey, William D. Smart, 'Programming Robots with ROS', O'Reilly.

REFERENCE BOOKS:

- Aaron Martinez, Enrique Fernandez, 'Learning ROS for Robotics Programming', Packt Publishing.
- ROS Wiki: http://wiki.ros.org

Course Code	Course Title				Category
26ES03PR0505	Mini Project II				CEP/FP
Contact Hours per Week			CA	ESE	Credits
L	P	S			
00	02	00	50	00	01

Course Objectives:

1. To enable students to implement, test, and validate the proposed solution for the identified engineering problem using appropriate tools and techniques in a relevant industry.
2. To develop skills in analysis, interpretation of results, and effective presentation of the complete project work.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Implement the proposed solution using appropriate engineering tools, techniques, or software in Robotics and AI Field.

CO2: Conduct experiments or simulations and collect relevant data for validation.

CO3: Analyze and interpret results to evaluate system performance and effectiveness.

CO4: Optimise and refine the developed system based on observations and findings.

CO5: Prepare and present a comprehensive project report with effective demonstration of outcomes.

SYLLABUS	**25 Hrs.**

Implementation of the proposed methodology or system design, development of prototype/model/software solution for robotics and AI domain. Which may involves experimentation and data collection, performance evaluation and validation of results, analysis and interpretation of outcomes, optimization and refinement of the system, comparison with existing methods, preparation of detailed project report, documentation of results, and final presentation with demonstration of the

working model or system.

Course Code	Course Title				Category
26ESOEC03TH0506	Open Elective-III/ MOOC				CEP/FP
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	00	00	50	50	02

<table>
<tr><th>Course Code</th><th colspan="4">Course Title</th><th>Category</th></tr>
<tr><td>26ES03PR0508</td><td colspan="4">Robot Operating Systems (ROS)</td><td>PCC</td></tr>
<tr><td colspan="3">Contact Hours per Week</td><td rowspan="2">CA</td><td rowspan="2">FE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>P</td><td>S</td></tr>
<tr><td>00</td><td>02</td><td>01</td><td>50</td><td>00</td><td>01</td></tr>
<tr><td colspan="6">Prerequisite: C++/Python Programming, Fundamentals of Robotics</td></tr>
<tr><td colspan="6">Course Objectives:

5. To introduce the structure and components of Robot Operating System (ROS).
6. To develop ROS nodes for robotic applications using publishers and subscribers.
7. To integrate ROS with sensors, actuators, and simulation tools.
8. To implement SLAM, path planning and control using ROS packages.</td></tr>
<tr><td colspan="6">Course Outcomes: On successful completion of the module students will be able to:

CO1. Understand the architecture of ROS and its communication model.

CO2. Develop nodes, topics, services and actions in ROS using Python/C++.

CO3. Simulate robots using Gazebo and RViz.

CO4. Interface ROS with sensors and actuators.

CO5. Implement localization, mapping and path planning in ROS environment.</td></tr>
<tr><td colspan="5">UNIT I: Introduction to ROS</td><td>09 Hrs.</td></tr>
<tr><td colspan="6">Definition, need, components of IIoT, industrial automation and Industry 4.0, IIoT architecture. Discuss key drivers and benefits of IIoT, examples from smart factories, oil and gas, and energy sectors.</td></tr>
<tr><td colspan="5">UNIT II: ROS Programming Basics</td><td>09 Hrs.</td></tr>
</table>

Smart sensors, wired and wireless protocols (Modbus, ZigBee, BLE, LoRa, MQTT), sensor interfacing. Deep dive into sensor characteristics, calibration, interfacing techniques, usecases of LoRa, MQTT, and BLE in industry.

UNIT III: Visualization and Simulation	**9 Hrs.**

Edge devices, gateways, data preprocessing, cloud platforms (AWS, Azure, Google Cloud) for IIoT. Edge analytics frameworks, data fusion, Fog computing, cloud architecture patterns and deployment models.

UNIT IV: Interfacing Sensors and Actuators	**9 Hrs.**

Data acquisition, storage, visualization, analytics using ML for predictive maintenance and fault detection. Database technologies for IIoT, timeseries databases, data cleaning, dashboards and analytics pipelines.

UNIT V: SLAM and Navigation	**9 Hrs.**

Cybersecurity in IIoT, encryption techniques, standards, industrial usecases and IIoT in robotics. Cyber threats in IIoT, intrusion detection systems, usecase studies from automotive, healthcare, and logistics.

TEXT BOOKS:

- Jason O'Kane, 'A Gentle Introduction to ROS', CreateSpace Independent Publishing.
- Morgan Quigley, Brian Gerkey, William D. Smart, 'Programming Robots with ROS', O'Reilly.

REFERENCE BOOKS:

- Aaron Martinez, Enrique Fernandez, 'Learning ROS for Robotics Programming', Packt Publishing.
- ROS Wiki: http://wiki.ros.org

Course Code	Course Title				Category
26HS05TP0501	**Business Communication**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
01	02	01	50 + 50	00	02
9.					

SEMESTER VI

Course Code	Course Title				Category
26ES03TH0601	**Robot safety, maintenance and standards**				Professional Core
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
02	0	1	50	50	**02**

Prerequisites

Students should have:

1. Basic understanding of robotics and automation systems.
2. Knowledge of engineering mechanics and machine elements.
3. Familiarity with electrical and electronic components used in robots.
4. Basic understanding of control systems and sensors.

Course Objectives

After completing this course, students will be able to:

1. Understand **s**afety principles, hazards, and risk assessment in robotic systems.
2. Apply industrial safety standards and regulatory requirements.
3. Develop knowledge of maintenance strategies and troubleshooting techniques.
4. Analyse reliability, failure modes, and lifecycle safety of robotic systems.

Course Outcomes (CO)

After successful completion of the course, students will be able to:

CO1: Identify and assess hazards and risks in robotic systems and work environments.

CO2: Apply relevant robot safety standards and compliance requirements.

CO3: Plan and perform maintenance, diagnostics, and troubleshooting of robotic systems.

CO4: Analyze reliability, failure modes, and implement safe lifecycle practices.

Unit I: Robot Safety Fundamentals and Risk Assessment	**07 Hrs.**

Importance of safety in robotics and automation, Types of hazards: mechanical, electrical, thermal, environmental, Risk assessment techniques and hazard identification, Safety in human-robot interaction (HRI), Workspace design: safety zones, guarding, interlocks.

Unit II: Safety Standards and Regulatory Compliance	**07 Hrs.**

Overview of international standards (ISO, ANSI, IEC), Key standards: ISO 10218 (industrial robot safety), ISO/TS 15066 (collaborative robots), Machine safety directives and compliance procedures, Certification, documentation, and legal considerations.

Unit III: Maintenance and Diagnostics of Robotic Systems	**07 Hrs.**

Types of maintenance: preventive, predictive, corrective, Maintenance planning and scheduling, Inspection, lubrication, and calibration, Condition monitoring and fault diagnostics, Troubleshooting techniques

Unit IV: Reliability, Failure Analysis and Safety Integration	**07 Hrs.**

Reliability concepts (MTBF, MTTR), Failure modes and effects analysis (FMEA), Root cause analysis and risk mitigation, Fail-safe design and emergency systems, Safety integration in robotic cells and lifecycle management, Case studies of industrial robot safety

Textbooks:

1. Dhillon, B.S., Robot System Reliability and Safety: A Modern Approach, CRC Press, 2015.
2. Starr, J. & Quick, C., Robotic Safety Systems: An Applied Approach, CRC Press, 2024.

Reference Books

1. Etherton, J.R., Safe Maintenance Guide for Robotic Workstations, DIANE Publishing, 1994.
2. Nof, S.Y., Handbook of Industrial Robotics, Wiley.

<table>
<tr><th>Course Code</th><th colspan="4">Course Title</th><th>Category</th></tr>
<tr><td>26ES03TP0602</td><td colspan="4">Robotic Vision System</td><td>PCC</td></tr>
<tr><td colspan="3">Contact Hours per Week</td><td rowspan="2">CA</td><td rowspan="2">FE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>P</td><td>S</td></tr>
<tr><td>03</td><td>02</td><td>01</td><td>50+50</td><td>50</td><td>04</td></tr>
<tr><td colspan="6">Prerequisite: Fundamentals of Robotics, Basic Image Processing, Linear Algebra, C Programming</td></tr>
<tr><td colspan="6">Course Objectives:
1. To understand the principles of image formation and perception in robotics.
2. To apply image processing techniques to robotics tasks.
3. To study stereo vision, object detection, and segmentation for robotic perception.
4. To develop algorithms for feature extraction, classification, and scene interpretation.
5. To integrate vision systems with robotic manipulators and mobile platforms.</td></tr>
<tr><td colspan="6">Course Outcomes: On successful completion of the module students will be able to:
CO1. Understand the fundamentals of robotic vision and image sensing.
CO2. Apply techniques such as filtering, edge detection, and thresholding.
CO3. Analyze stereo vision and depth estimation for robot navigation.
CO4. Implement object detection, tracking, and feature-based matching.
CO5. Integrate robotic vision with perception and control tasks in real-time.</td></tr>
<tr><td colspan="5">UNIT I: INTRODUCTION TO ROBOTIC VISION</td><td>09 Hrs.</td></tr>
<tr><td colspan="6">Introduction to robot vision and applications, Components of vision system (camera, sensors, optics), Image formation and acquisition, Digital image representation (pixels, resolution, color models)</td></tr>
<tr><td colspan="5">UNIT II: IMAGE PROCESSING FUNDAMENTALS</td><td>09 Hrs.</td></tr>
<tr><td colspan="6">Image histograms and intensity distribution, Histogram contrast enhancing, Histogram scaling shifting and equalization , Image filtering (smoothing, sharpening), Histogram specification</td></tr>
<tr><td colspan="5">UNIT III: GEOMETRIC TRANSFORMATION AND MAPPING</td><td>09 Hrs.</td></tr>
</table>

Coordinate systems and homogeneous coordinates, Translation, rotation, scaling, Affine transformation (properties and applications), Homography and perspective transformation, Direct Linear Transformation (DLT)

UNIT IV: CAMERA MODELS AND 3D VISION	**9 Hrs.**

Pinhole camera model, Camera projection equation, Intrinsic and extrinsic parameters, Camera calibration techniques, 3D to 2D mapping and reconstruction basics

UNIT V: VISION-BASED CONTROL AND APPLICATIONS	**9 Hrs.**

Visual servoing, SLAM overview, object tracking, vision-guided pick and place, ROS integration, real-world case studies, Visual SLAM, EKF SLAM, 2-D LiDAR SLAM, Factor Graph (Multi-Sensor SLAM Framework), Pose Graphs

TEXT BOOKS:

[1] Szeliski, R. (2021). *Computer vision: Algorithms and applications* (2nd ed.). Springer.

[2] Corke, P., 'Robotics, Vision and Control: Fundamental Algorithms in MATLAB', Springer.

[3] Szeliski, R., 'Computer Vision: Algorithms and Applications', Springer.

REFERENCE BOOKS:

[1] Gonzalez, R. C., Woods, R. E., 'Digital Image Processing', Pearson.

[2]Simon J. D. Prince, 'Computer Vision: Models, Learning, and Inference', Cambridge University Press.

Lab Experiments: Robot Vision Systems

1. Analyze and perform histogram scaling and shifting using MATLAB (including histogram plotting)
2. Implement histogram equalization for image contrast enhancement using MATLAB
3. Apply histogram specification (histogram matching) using MATLAB
4. Perform geometric image transformations (rotation, scaling, affine, and perspective/homography) using MATLAB
5. Estimate stereo disparity for depth computation using MATLAB
6. Implement SLIC (Simple Linear Iterative Clustering) segmentation using MATLAB with interactive GUI features
7. Perform image registration using MATLAB
8. Implement visual simultaneous localization and mapping (vSLAM) with visual-inertial sensor fusion using a monocular camera
9. Implement feature-based visual SLAM with visual-inertial sensor fusion using an RGB-D camera.
10. Implement feature-based visual SLAM with visual-inertial sensor fusion using a stereo camera

Course Code	Course Title				Category
26ES03TP0603	**Deep Learning**				Professional Core
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**T**	**D/P**			
03	02	00	50 + 50	50	04

Prerequisite: Introduction to Python, Machine Learning Concepts

Course Objectives:

3. To provide a strong foundation in deep learning concepts, architectures, and algorithms for solving complex real-world problems.
4. To develop practical skills in implementing deep learning models using modern frameworks for applications such as image processing, sequence modeling, and predictive analytics.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Understand fundamental concepts of neural networks and deep learning architectures.

CO2: Apply deep learning techniques for classification and regression problems.

CO3: Analyze and implement convolutional and recurrent neural networks for real-world applications.

CO4: Evaluate and optimize deep learning models using appropriate techniques.

CO5: Design and develop end-to-end deep learning solutions for practical problems.

UNIT I: Introduction to Deep Learning and Neural Networks	**09 Hrs.**

Machine Learning vs Deep Learning, biological neuron vs artificial neuron, perceptron model, multilayer perceptron (MLP), activation functions (sigmoid, ReLU, tanh), loss functions, gradient descent and variants, forward propagation, backpropagation algorithm, challenges in training deep networks (vanishing gradient, overfitting), introduction to TensorFlow and Keras.

UNIT II: Deep Feedforward Networks and Optimization Techniques	**09 Hrs.**

Deep feedforward networks, weight initialization techniques, regularization (L1, L2, dropout), batch normalization, optimization algorithms (SGD, Adam, RMSProp), hyperparameter tuning, model evaluation metrics.

UNIT III: Convolutional Neural Networks (CNNs)	**9 Hrs.**

Introduction to CNN, convolution operation, pooling layers, padding and stride, feature maps, CNN architectures, transfer learning, image classification, object detection basics, applications in computer vision

UNIT IV: Recurrent Neural Networks (RNNs) and Sequence Models	**9 Hrs.**

Sequence data and time series, recurrent neural networks, vanishing gradient problem in RNN, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), bidirectional RNN, sequence-to-sequence models.

UNIT V: Advanced Deep Learning and Applications	**9 Hrs.**

Autoencoders, Generative models (GANs), transformers basics, deep learning for reinforcement learning, model deployment basics.

TEXT BOOKS:

Pattern Recognition and Machine Learning by Christopher M. Bishop – A comprehensive guide to statistical pattern recognition and machine learning with a strong mathematical foundation.

Machine Learning by Tom M. Mitchell – A classic introductory book covering key ML algorithms with intuitive explanation.

REFERENCE BOOKS:

7. Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville
8. Neural Networks and Deep Learning – Charu C. Aggarwal
9. Deep Learning with Python – François Chollet
10. Pattern Recognition and Machine Learning – Christopher M. Bishop
11. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
12. Machine Learning Yearning – Andrew Ng

List of Experiment

14. Build and train a Multilayer Perceptron (MLP) for classification.
15. Experiment with different activation functions and compare performance.
16. Implement gradient descent and visualize loss convergence.
17. Build and train a CNN for image classification (Project Based).
18. Implement transfer learning using pre-trained CNN models.
19. Visualize feature maps in CNN.
20. Implement RNN for sequence prediction.
21. Build LSTM model for time series forecasting.
22. Implement GRU and compare it with LSTM performance.
23. Develop an autoencoder for dimensionality reduction.

24. Implement a simple GAN for image generation.
25. Develop an end-to-end deep learning project (problem definition, preprocessing, model building, evaluation).
26. Perform model tuning, evaluation, and optimization.

Course Code	Course Title				Category
26ES03TH0604	**Mobile Robotics** **Semester VI**				**Professional Core**
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**Total**			
02	00	**02**	50	50	02

Prerequisite: Basics of Robotics, Engineering Mathematics (Matrices, Probability basics)

Course Description: This course introduces the fundamentals of robotics with an emphasis on mobile robots, which are integrated mechanical, electrical and computational systems functioning in the physical world. The course aims to provide both theoretical and practical experience to students through lectures and hands-on experiments with real robots and simulation software.

Course Objectives: This course will present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems.

1. To introduce fundamentals of mobile robots, locomotion, and hardware components.
2. To develop understanding of kinematics, dynamics, and motion constraints.
3. To provide knowledge of perception, sensing, and uncertainty handling.
4. To explain localization, mapping, and navigation techniques.
5. To expose students to path planning algorithms and intelligent robot design.

Course Outcomes: On successful completion of the module students will be able to:

CO1. *Explain* mobile robot types, locomotion mechanisms, and performance characteristics.

CO2. *Apply* kinematic and dynamic models to analyze motion of mobile robots.

CO3. *Analyze* sensor characteristics and perception techniques under uncertainty.

CO4. *Apply* localization methods to estimate robot position in uncertain environments.

CO5 *Evaluate* path planning and navigation algorithms for intelligent mobile robots.

UNIT I: FUNDAMENTALS OF MOBILE ROBOTICS	**06 Hrs.**

Introduction to mobile robots, classification (wheeled, legged, aerial). Applications in industrial and service domains. Locomotion principles,Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability, degrees of freedom, holonomic and non-holonomic systems. Overview of robot components: sensors, actuators, controllers.

UNIT II: KINEMATICS OF MOBILE ROBOTS	**06 Hrs.**

Kinematic modeling of wheeled mobile robots: differential drive and car-like robots. Coordinate

frames and transformations, robot pose representation. Forward kinematics and basic motion constraints. Odometry and dead reckoning.

UNIT III: PERCEPTION	**06 Hrs.**

Sensors Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.

UNIT IV: LOCALIZATION	**06 Hrs.**

Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems;

UNIT V: PATH PLANNING AND NAVIGATION	**07 Hrs.**

Introduction, Path Planning, offline and online path planning, obstacle avoidance, path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), Potential field etc.

Advanced Topics: AI based techniques for navigation, Bio Inspired Algorithm, Multiple robot coordination. Design of intelligent robots

TEXT BOOKS:

1. Siegwart, Nourbakhsh, Scaramuzza – *Introduction to Autonomous Mobile Robots*
2. Dudek & Jenkin – *Computational Principles of Mobile Robotics*

REFERENCE BOOKS:

Thrun, Burgard, Fox – *Probabilistic Robotics*

Howie Choset – *Principles of Robot Motion*

Selected readings from the research literature, to be distributed in class.

Course Code	Course Title				Category
26ESAEC03PR0605	Algorithmic Problem Solving-II				AEC
Contact Hours per Week			CA	ESE	Credits
L	T	S			
00	02	00	50		01

Course Code	Course Title	Category

26ES03PR0608	Project-I				Project
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
00	04	00	50		02

Prerequisite: Introduction to Python, Machine Learning Concepts

Course Objectives:

1. To expose students to real-world engineering problems through industry-linked projects.
2. To develop problem-solving, design, and implementation skills using modern tools and technologies.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Identify and define real-world engineering problems in collaboration with industry.

CO2: Apply engineering knowledge and tools to design feasible solutions

CO3: Analyze data and interpret results for problem-solving.

CO4: Demonstrate teamwork, project planning, and communication skills

CO5: Design and develop end-to-end deep learning solutions for practical problems.

Problem identification from industry domain, Literature survey, Problem definition and objective setting, Requirement analysis, Concept generation and design, Selection of methodology, Modeling and simulation (if applicable), Prototype development or implementation, Testing and validation, Data analysis and result interpretation, Documentation and report writing, Presentation and demonstration.

SEMESTER VII					
Course Code	**Course Title**				**Category**
26ES03TP0701	**Mechanical Design of Robotic System**				PPC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	02	1	50 + 50	50	**03**

Prerequisites:

Students should have:

- Basic knowledge of Engineering Mechanics (forces, equilibrium, stress–strain).
- Understanding of Strength of Materials (deformation, bending, torsion).
- Familiarity with Theory of Machines/Kinematics of Mechanisms.
- Basic knowledge of materials science and manufacturing processes.

Course Objectives:

After completing this course, students will be able to:

5. Understand the **structural and mechanical design requirements** of robotic systems.
6. Apply principles of **material selection and manufacturing** in robotic component design.
7. Analyze and design **joints, transmission systems, and actuating mechanisms**.
8. Evaluate and design **end effectors and gripping systems** for various robotic applications.

Course Outcomes:

After successful completion of the course, students will be able to:

5. Analyze mechanical structures of robotic manipulators considering strength, stiffness, and dynamic effects.
6. Select appropriate materials and manufacturing techniques for efficient and lightweight robotic designs.
7. Design and evaluate robotic joints and transmission systems based on performance and efficiency.
8. Perform force analysis and design of end effectors suitable for different industrial and service applications.

UNIT I: Fundamentals of Robotic Mechanical Design	**07 Hrs.**

Structural requirements of robotic manipulators: rigidity, stability, and precision, Design criteria: stiffness, strength, weight optimization, natural frequency, payload capacity, Static vs dynamic loading in robotic arms (impact, inertia, cyclic loading), Structural design vs kinematic design, Geometric considerations in link design (cross-sections, slenderness ratio), Application of beam theory and torsion theory in robotic links, Mass distribution and centre of gravity effects on stability and control, Deformation and deflection analysis under loading conditions, Vibration and resonance considerations in robotic structures, Fatigue analysis and failure modes in repetitive robotic

operations

UNIT II: Material Selection and Manufacturing Considerations	**07 Hrs.**

Criteria for material selection: strength-to-weight ratio, stiffness, durability, cost, Mechanical properties: yield strength, modulus of elasticity, toughness, fatigue strength, Advanced materials: Composites (carbon fiber, glass fiber), Lightweight alloys (aluminium, titanium), Introduction to additive manufacturing (3D printing) for robotic components, Surface treatment and coatings for wear and corrosion resistance, Design for manufacturability (DFM) and design for assembly (DFA) principles,

UNIT III: Joints and Transmission Systems	**07 Hrs.**

Design of joints: revolute, prismatic, spherical joints, Bearings: types (ball, roller, plain), selection and load considerations, Couplings: rigid and flexible couplings and their applications, Role and requirements of Power transmission in robotic systems, Gear systems: Spur, helical, bevel, and planetary gears, Gear ratio design and torque transmission, Backlash, wear, and efficiency considerations, Belt and chain drives: Kinematics and velocity ratios, Tension analysis and slip conditions, Lead screws and ball screws: efficiency and precision,

UNIT IV: Force Analysis of End Effectors	**07 Hrs.**

Role and classification of end effectors in robotics, Force transmission mechanisms in grippers, Gripping force calculation and safety factors, Contact mechanics and friction in gripping, Structural design of gripper arms and fingers, Design of frames, fixtures, and holding mechanisms, Material and topology selection for different applications.

TEXT BOOKS:

4. Budynas, R.G. & Nisbett, J.K., *Shigley's Mechanical Engineering Design*, McGraw-Hill, 11th/12th Ed.
5. **Robert L. Norton, Machine Design: An Integrated Approach,** 6th Edition, Pearson Education
6. Eugene I. Rivin, **Mechanical Design of Robots,** McGraw-Hill, 1st Edition

Reference Book:

5. Vigen (Vladimir) S. Arakelian, **Dynamic Decoupling of Robot Manipulators,** 1st Edition (2018), Springer International Publishing (Springer, Cham), Mechanisms and Machine Science, Vol. 56, **ISBN:** 978-3-319-74362-2 (Hardcover), 978-3-319-74363-9 (eBook)
6. Springer Handbook of Robotics, Editors: Bruno Siciliano, Oussama Khatib, Edition: 2nd Edition (2016), Publisher: Springer
7. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, Robotic Engineering: An Integrated Approach, (Mechanical Design Sections), Publisher: Prentice Hall
8. Siciliano, B. & Khatib, O., *Springer Handbook of Robotics*, Springer, 2nd Ed., 2016.

List of Experiments

15. Study of Different Types of Robotic Configurations
16. Design and Analysis of Robotic Arm Links
17. Forward Kinematics of Robotic Manipulator
18. Inverse Kinematics of Robotic Manipulator
19. Design of Robotic Gripper Mechanism
20. Torque Calculation and Motor Selection for Robot Joints
21. CAD Modeling of Robotic Arm
22. Finite Element Analysis of Robot Components
23. Design of Gear Train for Robotic Systems
24. Design of Belt and Chain Drives in Robots
25. Design and Analysis of End Effectors
26. Workspace Analysis of Robotic Manipulator
27. Dynamic Analysis of Robotic Arm
28. Design of Mobile Robot Chassis

Course Code	Course Title				Category
26ES03TH0702	**Agentic AI**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	02	1	-	-	**03**

Course Objectives:

After completing this course, students will be able to:

1. To understand the design and functioning of intelligent autonomous agents, including perception, reasoning, and decision-making.
2. To develop agent-based systems using modern AI technologies such as Transformers, Large Language Models (LLMs), and Retrieval-Augmented Generation (RAG).

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Explain the fundamentals of intelligent agents and agent architectures.

CO2: Apply search and planning techniques in agent decision-making.

CO3:Analyze reasoning and learning mechanisms in intelligent agents.

CO4: Evaluate LLM-based agents and their capabilities.

CO5: Develop simple agentic AI applications using modern tools and frameworks

Unit 1:Introduction to Agentic AI	**08 Hrs.**

Introduction to Artificial Intelligence, Intelligent agents and environments, Types of agents (simple reflex, model-based, goal-based, utility-based), Rational agents, PEAS representation, Agent memory and decision making, Applications of Agentic AI

Unit 2: Natural Language Processing and Text Understanding	**09 Hrs.**

Introduction to Natural Language Processing (NLP), Text preprocessing, Tokenization, Stop-word removal, Stemming and Lemmatization, Word embeddings (basic idea), Text classification, Applications of NLP

Unit 3: Transformers and Large Language Models	**09rs.**

Transformer architecture, Attention mechanism, Pre-trained models, Multi perceptron Neural Network, Large Language Models (LLMs),

Unit 4: Prompt Engineering and Agentic Systems	**08 Hrs.**

Prompt engineering techniques, Context handling, Memory in AI agents, Tool-using agents, Autonomous agents, Hallucination and limitations of LLMs, AI agent workflows and reasoning

Unit 5:RAG and Multi-Agent Systems **09 Hrs**

Retrieval-Augmented Generation (RAG), Vector databases (conceptual), Knowledge retrieval, Multi-agent systems, Agent communication and coordination, Applications in chatbots, robotics, automation, and intelligent assistants

TEXT BOOKS:

1. Multi-Agent Systems: Algorithmic, Game-Theoretic, and Logical Foundations — Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press

Reference Book:

1. Deep Learning — Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press
2. Multi-Agent Systems — Michael Wooldridge, Wiley
3. Machine Learning — Tom M. Mitchell, McGraw-Hill Education

List of experiments:

1. Study of Python libraries for AI and NLP (NLTK, Transformers) & Hardware understanding required for LLM.
2. Text preprocessing: tokenization, stop-word removal, stemming and lemmatization
3. Text classification using basic NLP techniques
4. Word embedding and semantic similarity analysis
5. Introduction to Hugging Face Transformer models
6. Text generation using pre-trained Transformer models
7. Prompt engineering techniques using LLM tools
8. Development of a simple chatbot using LLM APIs
9. Implementation of memory-based AI agent
10. Building a Retrieval-Augmented Generation (RAG) pipeline
11. Development of tool-using autonomous agents
12. Mini Project: Agentic AI application for automation, chatbot, or intelligent assistance

Course Code	**Course Title**	**Category**

26ES03PR0703	**Project-II**				Project
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
00	08	00	50	50	04

Prerequisite: Introduction to Python, Machine Learning Concepts

Course Objectives:

3. To expose students to real-world engineering problems through industry-linked projects.
4. To develop problem-solving, design, and implementation skills using modern tools and technologies.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Identify and define real-world engineering problems in collaboration with industry.

CO2: Apply engineering knowledge and tools to design feasible solutions

CO3: Analyze data and interpret results for problem-solving.

CO4: Demonstrate teamwork, project planning, and communication skills

CO5: Design and develop end-to-end deep learning solutions for practical problems.

Problem identification from industry domain, Literature survey, Problem definition and objective setting, Requirement analysis, Concept generation and design, Selection of methodology, Modeling and simulation (if applicable), Prototype development or implementation, Testing and validation, Data analysis and result interpretation, Documentation and report writing, Presentation and demonstration.

Course Code	**Course Title**	**Category**
26ES03PR0704	**Comprehensive Viva**	PCC

Contact Hours per Week			CA	FE	Credits
L	**P**	**S**			
00	02	01	50	00	01

Prerequisite: All previous core subjects till Semester IV

Course Objectives:

1. To assess the student's overall understanding of core subjects learned so far.
2. To develop the ability to articulate and defend technical concepts in oral format.
3. To prepare students for technical interviews and examinations.

Course Outcomes: On successful completion of the module students will be able to:

CO1. Demonstrate understanding of key concepts from previous semesters.

CO2. Communicate effectively using appropriate technical language.

CO3. Display confidence and clarity during oral evaluations.

CO4. Apply interdisciplinary knowledge in solving problems.

Syllabus

The Comprehensive Viva will cover the contents from the courses, both the theory and the lab practice which the student learnt during third to sixth semester of the undergraduate programme.

Course Code	Course Title				Category
26ES03PR0707	Participative Learning				CCA
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	01			01
4.					

Course Code	Course Title	Category

26ES03PR0708	Internship Evaluation				Audit
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
					SF/USF
5.					

SEMESTER VIII					
Course Code	**Course Title**				**Category**
26ES03TH0801	**Project Management**				**PCC**
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
03	**00**	**01**	**50**	**50**	**03**

Prerequisite: Robotics fundamentals

Course Objectives:

The Objectives of this course is;

1. To provide an understanding of project planning, scheduling, and execution.
2. To equip students with knowledge of project cost, time, and resource management.
3. To develop the ability to manage risk and quality within projects.
4. To introduce tools and techniques for effective project monitoring and control.
5. To build competency in handling industrial, research, and service-based projects.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Describe the fundamentals, phases, and types of project management.
CO2: Develop detailed project plans including scope, schedule, and resources.
CO3: Analyze project cost, budgeting, and risk factors using standard techniques.
CO4: Apply quality control and risk mitigation strategies during execution.
CO5: Monitor and evaluate project performance using project management tools.

UNIT I: INTRODUCTION TO PROJECT MANAGEMENT	**06 Hrs.**

Definition of project and project management, Project life cycle phases, Types of projects, Characteristics of successful projects, Role of project manager, Project selection methods, Feasibility analysis, Project charter, Organizational structures, Project stakeholders, Ethics in Project Management

UNIT II: PROJECT PLANNING AND SCHEDULING	**06 Hrs.**

Project scope definition, Work Breakdown Structure (WBS), Project time management, Gantt chart, Network diagrams, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT),

Milestone planning, Time-cost trade-offs, Resource allocation and levelling, AI tools in project planning

UNIT III: PROJECT COSTING AND BUDGETING	**06 Hrs.**

Cost estimation techniques, Project budgeting methods, Cost baseline, Earned Value Management (EVM), Project cash flows, Financial analysis: NPV, IRR, Payback period, Break-even analysis, Cost control methods

UNIT IV: PROJECT QUALITY AND RISK MANAGEMENT	**06 Hrs.**

Project quality planning, Quality assurance and control, Six Sigma in project management, Risk identification and classification, Qualitative and quantitative risk analysis, Risk response planning, Contingency planning, Risk monitoring and control, Lifecycle assessment and Environmental impact assessment.

UNIT V: PROJECT MONITORING, CONTROL, AND CLOSURE	**06 Hrs.**

Monitoring and control processes, Key performance indicators (KPIs), Project audits, Conflict resolution, Change management, Generative AI for documentation & reporting, Project evaluation and termination, Post-project review, Lessons learned, Project management software tools (MS Project, Power BI, Primavera)

TEXT BOOKS:

Harold Kerzner – *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, Wiley

REFERENCE BOOKS

1. P. Gopalan – Project Management, Wiley India
2. S. Choudhury – Project Management, Tata McGraw Hill
3. Rory Burke – Project Management: Planning and Control Techniques, Wiley
4. Prasanna Chandra – Projects: Planning, Analysis, Selection, Financing, Implementation and Review, McGraw Hill
5. PMI – A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute

Course Code	Course Title	Category
26ES03TH0802	**Research Methodology**	**PCC**

Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
2	**0**	**1**	**50**	**50**	**02**

Prerequisite:

Basic understanding of undergraduate-level subjects, fundamental mathematics/statistics, and general academic writing skills. Familiarity with computers and basic research concepts will be helpful.

Course objectives:

Students should be able

1. To introduce the fundamentals of research methodology, research process, and techniques of scientific inquiry.
2. To develop skills in identifying research problems, reviewing literature, and designing research methodology.
3. To familiarize students with various methods of data collection, analysis, and interpretation.
4. To create awareness about ethics in research paper writing
5. To enable students to understand Intellectual Property Rights (IPR), patents, copyrights, its evolution, significance and their applications in innovation.

Course Outcomes:

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

CO1: Understand the basic concepts, process, and importance of research methodology in academic and industrial research.

CO2: Formulate research problems, conduct literature reviews, and prepare structured research proposals.

CO3: Apply suitable methods of data collection, analysis, and interpretation to solve research problems.

CO4: Choose research topics, write structured research papers and adhere to plagiarism rules and ethical standards.

CO5: Understand the procedures for patent filing, copyright, and trademark registration, and apply IPR concepts in real-life case studies.

COURSE CONTENTS

UNIT I: INTRODUCTION TO RESEARCH METHODOLOGY	**08 hours**

Meaning of Research, How to do Research, Objective of Research, Motivation in Research, Types of Research, Various Research Approaches and Significance of Research. Research Methods and Research Methodology.

UNIT II: RESEARCH PROBLEM AND LITERATURE REVIEW	**07 hours**

Research Problem, Various Components of Research Problem, How to Identify the Research Problem, Necessity and Techniques involved in Defining Research Problem, Feasibility Check. Meaning and Importance of Literature Review, Sources of literature, Role in identifying Research Gaps and Framing Research Problem.

UNIT III: DATA COLLECTION AND ANALYSIS	**07 hours**

Hypothesis, its Characteristics, Examples, Types, Hypothesis Testing, Concepts and Procedure of Hypothesis Testing. Data Collection, Methods of data collection, Primary Data, Secondary Data, Analysis of data, Simple regression, Multiple regression, linear and non-linear correlation and regression.

Unit IV: Ethics in Research	**07 hours**

Research Paper and its contents, Choice on topic, Method of writing research paper, Ethics in Research, Plagiarism including rules of Plagiarism. Citation and Referencing Styles, Structure of a Research Report/Paper. Case studies of Research Papers in Science and Engineering. Presentation of Research Work.

Unit V: Introduction to Intellectual Property Rights (IPR)	**07 hours**

Introduction to IPR, Types of IPR, Common rules of IPR Practices, Patent Filing Procedure and Licensing Process. Case studies of Patents in Science and Engineering.

Text Books:

1. Research Methodology Methods and Techniques: Kothari C.K. (2004), New Age International, New Delhi
2. Simulation Modeling and Analysis, Law, A. M., and W. D. Kelton, 1991, McGraw Hill
3. Applied Statistics; Probability for Engineers: Montgomery, Douglas C.; Runger, George C. (2007), (Wiley India)
4. Patents myths and reality, Shiva, V., Penguin Books India (P) Ltd., New Delhi

Reference Books:

1. Schaum's Quick Guide to Writing Great Research Papers: Laurie Rozakis, 2nd edition, McGraw.
2. Intellectual Property Rights:Text And Cases, Radhakrishnan , R. &Balsubramaian, S., Excel Books Publishers, New Delhi.
3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2012.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", December 2018.

<table>
<tr><th>Course Code</th><th colspan="3">Course Title</th><th>Category</th></tr>
<tr><td>26ES03PR803</td><td colspan="3">Project III</td><td>Project</td></tr>
<tr><td colspan="3">Contact Hours per Week</td><td rowspan="2">CA</td><td rowspan="2">FE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>P</td><td>S</td></tr>
<tr><td>00</td><td>12</td><td>01</td><td>50</td><td>50</td><td>06</td></tr>
<tr><td colspan="6">Prerequisite: All previous core subjects till Semester IV</td></tr>
<tr><td colspan="6">Course Objectives:
1. To implement and validate the proposed engineering solution for a real-world problem.
2. To develop professional skills in design, experimentation, analysis, documentation, and presentation through project execution.</td></tr>
<tr><td colspan="6">Course Outcomes: On successful completion of the module students will be able to:
CO1. Implement the proposed methodology for solving an engineering problem
CO2. Analyze and interpret experimental/simulation results
CO3. Develop a functional prototype, model, software, or validated solution
CO4. Demonstrate teamwork, project management, and professional ethics
CO5. Prepare technical documentation and effectively present project outcomes</td></tr>
<tr><td colspan="5">Syllabus</td><td>40 Hrs</td></tr>
<tr><td colspan="6">Detailed implementation of project work, Design and development of prototype/model/software, Experimental investigation and testing, Simulation and validation, Data acquisition and analysis, Optimization and performance evaluation, Integration of hardware/software tools, Result interpretation, Technical documentation, Research paper/report preparation, Project presentation and demonstration.</td></tr>
</table>

Course Code	Course Title				Category
26HS02TH0804	**Foundational Literature of Indian Civilization**				**IKS**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
01	**00**	**01**	**50**	**-**	**01**

Prerequisite: Robotics fundamentals

Course Objectives:

1. To introduce the intellectual and cultural foundations of Indian civilization through its classical literature.
2. To explore human values, ethics, and social structures in early Indian texts.
3. To understand the evolution of language, aesthetics, and philosophy in ancient literary traditions.
4. To examine historical, political, and pedagogical ideas in ancient Indian treatises.
5. To develop analytical skills to interpret classical texts in a non-theological, cultural context.

Course Outcomes:

6. CO1: Identify major classical Indian texts and describe their historical and intellectual contexts.
7. CO2: Analyze ancient literary sources as expressions of ethical, aesthetic, and social ideas.
8. CO3: Compare diverse schools of thought in early Indian literature with critical reasoning.
9. CO4: Evaluate contributions of classical literature to knowledge systems and societal frameworks.
10. CO5: Reflect on the relevance of foundational Indian ideas in a contemporary, globalized society.

UNIT I: LITERARY AND KNOWLEDGE TRADITIONS OF EARLY INDIA	**06 Hrs.**

Oral and textual traditions, Vedic corpus: Rigveda and later texts, Development of Sanskrit and Prakrit, Transition from ritual to philosophy, Early Indian cosmology and nature inquiry, Concepts of knowledge (Vidya), Logic and debate culture, Linguistic heritage and grammar (Panini)

UNIT II: THE EPICS AS CULTURAL NARRATIVES	**06 Hrs.**

Mahabharata and Ramayana as cultural and ethical texts, Narrative complexity and character dilemmas, Ideas of duty, leadership, justice, and statecraft, Dialogue as a method of moral reflection, Gender and family structures, Representation of conflict and resolution, Literary significance and performance traditions

UNIT III: CLASSICAL DRAMA, POETRY, AND PROSE	**06 Hrs.**

Kalidasa’s Abhijnanasakuntalam and Meghadutam: aesthetics, language, nature, and emotions,

Natyashastra: theory of aesthetics and dramatic structure, Panchatantra and fables as educational tools, Kavya literature and courtly culture, Rasa theory and literary criticism, Role of art and imagination in public life

UNIT IV: ETHICAL AND POLITICAL THOUGHT IN TREATISES	**06 Hrs.**

Kautilya's Arthashastra: governance, economy, social policy, Manusmriti: legal codes, civil order (analyzed critically), Thirukkural: virtue, wealth, and conduct, Early legal and political systems, Comparative analysis of normative ethics in classical India

UNIT V: HUMAN VALUES, EDUCATION, AND KNOWLEDGE SYSTEMS	**06 Hrs.**

Concepts of education and learning in ancient institutions (Nalanda, Takshashila), Teacher-student relationships, Multilingual literary cultures, Knowledge dissemination methods, Dialogues from classical literature reflecting moral dilemmas, Relevance to modern human values and intercultural dialogue

REFERENCE BOOKS

1. G.N. Devy – Indian Literary Criticism: Theory and Interpretation, Orient Blackswan
2. Radhakrishnan and Charles Moore – A Sourcebook in Indian Philosophy, Princeton University Press
3. Sheldon Pollock (Ed.) – Literary Cultures in History: Reconstructions from South Asia, University of California Press
4. Romila Thapar – Cultural Pasts: Essays in Early Indian History, Oxford University Press
5. A.L. Basham – The Wonder That Was India, Picador India