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RAMDEOBABA UNIVERSITY, NAGPUR

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

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RAMDEOBABA UNIVERSITY, NAGPUR–440013

Established by the Maharashtra Private Universities

(Establishment and Regulation)Act2023 (Mah. ActNoVIIIof2024)

Formerly, Shri Ramdeobaba College of Engineering and Management, Nagpur-440013

School of Engineering Sciences

Department of

(Mechanical Engineering)

PROGRAMME SCHEME & SYLLABI

Of First Year as per National Education Policy (NEP)

(With effect from Academic Year 2024-25)

B. Tech.

Robotics & Artificial Intelligence

Scheme of Teaching
Semester I to VIII
Semester I

SN	Course Type	Course Code	Course Name	Hours/ week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS05TH0104	Applied Physics	3		3	50		50	100	3
2	BSC	24HS05PR0104	Applied Physics Lab		2	1		50		50	
3	BSC	24HS03TH0104	Differential Calculus and Basics of Statistics	3		3	50		50	100	3
4	BSC	24HS03PR0102	Computational Mathematics Lab		2	1		50		50	-
5	ESC	24ES03TH0101	Mechanical Marvels	1	0	1	50	-	-	50	-
6	ESC	24ES03TH0102	Engineering Mechanics	3	0	3	50	-	50	100	3
7	ESC	24ES03TH0103	Engineering Graphics	2		2	50		50	100	3
8	ESC	24ES03PR0103	Engineering Graphics		2	1		50		50	-
9	ESC	24EE07TH0106	Basics of Electrical Engineering	2		2	50		50	100	2
10	ESC	24EE07PR0106	Basics of Electrical Engineering		2	1		50		50	-
11	ESC	24ES03TH0104	Programming for Problem Solving	1		1	50		50	100	2
12	ESC	24ES03PR0104	Programming for Problem Solving		2	1		50		50	-
13	VEC/ HSSM	24HS02TH0104	Foundational Course in Universal Human Values	1	0	1	50	-	-	50	-
			TOTAL	**16**	**10**	**21**	**400**	**250**	**300**	**950**	**16**

Semester II

SN	Course Type	Course Code	Course Name	Hours/ week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS03TH0214	Linear Algebra and Integral calculus	3	0	3	50	-	50	100	3
2	ESC	24ES03TH0201	Artificial Intelligence	3	0	3	50	-	50	100	3
3	ESC	24ES03TH0202	Theory of Mechanisms & Elasticity	3	0	3	50	-	50	100	3
4	ESC	24ES03TH0203	Data Structure and Algorithms	2		2	50		50	100	2
5	ESC	24ES03PR0203	Data Structure and Algorithms Lab		2	1		50		50	-
6	ESC	24ES03TH0204	Digital Logic Design	2		2	50		50	100	2
7	ESC	24ES03PR0204	Digital Logic Design Lab		2	1		50		50	-
8	AEC/ HSSM	24HS02TH0201	English for Professional Communication	2		2	50		50	100	2
9	AEC/ HSSM	24HS02PR0201	English for Professional Communication Lab		2	1		50		50	-
10	VSEC	24ES03TH0205	Fabrication Practices	1		1	50		-	50	-
11	VSEC	24ES03PR0205	Fabrication Practices Lab		2	1		50	-	50	-
12	CCA	24HS02PR0106 -01 to 14	Liberal/Performing Arts Lab	0	2	1		50		50	
13	CCA	24HS04PR0201	Sports-Yoga-Recreation	0	2	1		50		50	
			TOTAL	**16**	**12**	**22**	**350**	**300**	**300**	**950**	**15**

NOTE: Liberal/Performing Art - To be selected from the basket of Liberal/Performing Art.

Semester III

SN	Course Type	Course Code	Course Name	Hours/ Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS03TH0303	Probability & Statistics	3	0	3	50		50	100	3
2	PCC	24ES03TH0301	Kinematics of Robot	2		2	50		50	100	2
3	PCC	24ES03PR0301	Kinematics of Robot Lab		2	1		50		50	-
4	PCC	24ES03TH0302	Mechanical Engineering Design	2		2	50		50	100	2
5	PCC	24ES03PR0302	Mechanical Engineering Design Lab		2	1		50		50	-
6	PCC	24ES03TH0303	Sensors and Actuators	3		3	50		50	100	3
7	PCC	24ES03PR0303	Sensors and Actuators Lab		2	1		50		50	-
8	BSC	24HS05TH030X	Fundamentals of Materials Science & Smart Materials	2	0	2	50		50	100	2
9	OE	24ES03TH0304	Open Elective-I/ MOOC	2	0	2	50		50	100	2
10	MDM	24ES03TH0305	MDM-I	3	0	3	50		50	100	3
11	AEC	24ES03TH0306	Design Thinking	1	0	1	50	-	-	50	-
12	PCC	24ES03TH0307	Programming for Machine Learning	1		1	50			50	
13	PCC	24ES03PR0307	Programming for Machine Learning Lab		2	1		50		50	
			TOTAL	**19**	**08**	**23**	**450**	**200**	**350**	**1000**	**17**

Semester IV

SN	Course Type	Course Code	Course Name	Hours/Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS03TH0401	Discrete Mathematics, Transforms and Optimization	3	0	3	50		50	100	3
2	PCC	24EE07TH04XX	Control Systems for robotics	3		3	50		50	100	3
3	PCC	24EE07PR04XX	Control Systems for robotics Lab		2	1		50		50	-
4	PCC	24EE07TH04XX	Microcontrollers and Interfacing	3		3	50		50	100	3
5	PCC	24EE07PR04XX	Microcontrollers and Interfacing Lab		2	1		50		50	-
6	PCC	24ES03TH0401	Machine Learning	3		3	50		50	100	3
7	PCC	24ES03PR0401	Machine Learning Lab		2	1		50		50	-
8	CEP/FP	24ES03PR0402	Project-1	0	2	1		50		50	
9	OE	24ES03TH0403	Open Elective-II/ MOOC	2	0	2	50		50	100	2
10	MDM	24ES03TH0404	MDM-II	3	0	3	50		50	100	3
11	AEC	CDPC	Basic Competitive Coding	0	2	1		50		50	
12	VEC	24HS03TH0104	Environmental Science	1		1	50			50	
13	VEC	24HS03PR0104	Environmental Science		2	1		50		50	
			TOTAL	**18**	**12**	**24**	**350**	**300**	**300**	**950**	**17**

Semester V

SN	Course Type	Course Code	Course Name	Hours/ Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	PCC	24ES03TH0501	Deep Learning	3		3	50		50	100	3
2	PCC	24ES03PR0501	Deep Learning Lab		2	1		50		50	-
3	PCC	24ES03TH0502	Robot Dynamics and Trajectory Planning	2		2	50		50	100	2
4	PCC	24ES03PR0502	Robot Dynamics and Trajectory Planning Lab		2	1		50		50	-
5	PCC	24ES03TH0503	Industrial Internet of Things (IoT)	2		2	50		50	100	2
6	PCC	24ES03PR0503	Industrial Internet of Things (IoT) Lab		2	1		50		50	-
7	PSE	24ES03TH0504	Program Specific Elective I	3	0	3	50		50	100	3
8	PCC	24ES03TH0505	Robot Operating System (ROS)	1		1	50			50	
9	PCC	24ES03PR0505	Robot Operating System (ROS) Lab		2	1		50		50	
10	PCC	24ES03PR0506	Comprehensive Viva	0	2	1		50		50	
11	OE	24ES03TH0507	Open Elective-III/ MOOC	2	0	2	50		50	100	2
12	MDM	24ES03TH0508	MDM-III	3	0	3	50		50	100	3
13	AEC/ HSSM	24HS05TH0104	Business Communication	1	2	2	50	50	-	100	
			TOTAL	**17**	**12**	**23**	**400**	**300**	**300**	**1000**	**15**

Semester VI

SN	Course Type	Course Code	Course Name	Hours/ Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	PCC	24ES03TH0601	Machine Vision	3		3	50		50	100	3
2	PCC	24ES03PR0601	Machine Vision		2	1		50		50	
3	PCC	24ES03TH0602	Reinforcement Learning	3		3	50		50	100	3
4	PCC	24ES03PR0602	Reinforcement Learning		2	1		50		50	
5	PCC	24ES03TH0603	Robot Navigation and Perception	2		2	50		50	100	2
6	PCC	24ES03PR0603	Robot Navigation and Perception		2	1		50		50	
7	PSE	24ES03TH0604	Program Specific Elective II	3	0	3	50		50	100	3
8	AEC	24ES03PR0605	Product Innovation and Entrepreneurship Lab	0	4	2		50		50	
9	AEC	CDPC	Advanced Competitive Coding	0	2	1		50		50	
10	Project	24ES03PR0606	Project-II	0	4	2		50		50	
11	MDM	24ES03TH0607	MDM-IV	3	0	3	50		50	100	3
12	PCC	24ES03PR0608	Robot Simulation Lab	0	4	2		50		50	
			TOTAL	**14**	**20**	**24**	**250**	**350**	**250**	**850**	**14**

Semester VII

SN	Course Type	Course Code	Course Name	Hours/ Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	EEM/ HSSM	24ES03 TH0701	Engineering Economics	2	0	2	50		50	100	2
2	PSE	24ES03 TH0702	Program Specific Elective III	3	0	3	50		50	100	3
3	PSE	24ES03 TH0703	Program Specific Elective IV	2	0	2	50		50	100	3
4	PSE	24ES03 TH0704	Program Specific Elective V	2	0	2	50		50	100	3
5	Project	24ES03 PR0701	Major Project I	0	8	4		100		100	
6	Audit Course	24ES03 PR0702	Internship Evaluation (Min 6 weeks)			SF/ USF					
			TOTAL	**9**	**8**	**13**	**200**	**100**	**200**	**500**	**11**

Semester VIII

SN	Course Type	Course Code	Course Name	Hours/ Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	PCC	24ES03 TH0801	Project Management	3	0	3	50		50	100	3
2	PCC	24ES03 TH0802	Research Methodology	2	0	2	50		50	100	2
3	IKS	24HS02T H0205	Foundational Literature of Indian Civilization	1	0	1	50	-	-	50	-
4	Project	24ES03 PR0801	Major Project II	0	12	6	-	50	50	100	
			TOTAL	**6**	**12**	**12**	**150**	**50**	**150**	**350**	**5**
OR											
1	Project	24ES03 PR0802	Full Semester Industry/ Research/TBI Internship	0	24	12		150	100	250	-
			TOTAL			**12**		150	100	250	

List of Electives for B. Tech. Robotics and AI

Semester	Track 1/Robotics	Track 2/Artificial Intelligence
Semester 5	Bio Inspired Robots	Big Data Analytics
Semester 6	Humanoid Robots	AI in Speech Processing
Semester 7	Underwater Robots	Cloud Computing
Semester 7	Aerial Robots	Digital Twins
Semester 7	Robotics in Healthcare	Augmented and Virtual Reality

Semester	Mechanical Engineering and Smart Manufacturing	Mechanical and Automation Engineering	Mechanical Engineering (Design Thinking)	Mechanical Engineering (Electric Vehicle Technology)	Logistics and Supply Chain Management
Semester 5	Lean and Intelligent Manufacturing	Material handling and MES	Product Design and Development	Electric Vehicle Technology	Productivity Improvement Technique
Semester 6	Additive Manufacturing and Reverse Engineering	Industrial Automation	Human Factors in Design	Battery Management systems	Transportation, Distribution and Warehouse Management
Semester 7	Machine Learning for Smart Manufacturing	PLC and SCADA	Design for Manufacturability	Vehicle Dynamics	Supply Chain Analytics
Semester 7	Smart Factory Design	Automation system & Control	Design Thinking for Innovation	Electric Vehicle Charging Infrastructure	Enterprise Resource Planning
Semester 7	Stress Analysis	Product lifecycle Management	System Design	Drone Technology	Multi-criteria Decision making

List of Electives for B. Tech. in Mechanical Engineering and Specializations

Scheme of Teaching
Semester I to VIII
Multi-Disciplinary Minor (For Schools other than SES)

Sem	CourseCode	Course Name	L	P	Cr	Cont. Evaluation	End Sem Exam	Total	ESE Duration Hrs
III		**Robotics Foundations**	3	0	3	50	50	100	3
IV		**Mobile Robotics**	3	0	3	50	50	100	3
V		**Modelling and Simulation of Robotic System**	3	0	3	50	50	100	3
VI		**Design of Robotic system**	3	0	3	50	50	100	3
		Total	**12**	**0**	**12**	**200**	**200**	**400**	

Scheme of Teaching
Semester I to VIII
Honours Specialization for Robotics & AI

Sem	Course Code	Course Name	L	P	Cr	Cont. Evaluation	End Sem Exam	Total	ESE Duration Hrs
		Advanced Robotics and Analysis (Cognitive Robotics)/SWAYAM - NPTEL	3	0	3				
		Advanced Artificial Intelligence/ SWAYAM - NPTEL	3	0	3				
		Human Machine Interface/ SWAYAM -NPTEL	4	0	4				
		Advanced Drones Technology/ SWAYAM -NPTEL	4	0	4				
		Al in Natural Language Processing/Capstone Project	4	0	4				
		Total	**18**	**0**	**18**				

Honours Specialization for Mechanical Engineering Specializations

Sem	Course Code	Course Name	L	P	Cr	Cont. Evaluation	End Sem Exam	Total	ESE Duration Hrs
3		**GD&T/SWAYAM -NPTEL**	3	0	3				
4		**Renewable Energy/ SWAYAM -NPTEL**	3	0	3				
5		**Micromachining/ SWAYAM -NPTEL**	4	0	4				
6		**Finite Element Analysis/ SWAYAM -NPTEL**	4	0	4				
7		**Computational Fluid Dynamics/ SWAYAM -NPTEL**	4	0	4				
		Total	**18**	**0**	**18**				

Honours courses to be pre-approved from the department at the beginning of the semester

Minor Specialization(MechanicalEngineering)

Sem	CourseCode	Course Name	L	T	P	Cr	Cont. Evaluation	End Sem Exam	Total	ESE Duration Hrs
III		Basics of Mechanical Engineering	3	0	0	3	50	50	100	3
IV		Computer Aided Design and Manufacturing	3	0	0	3	50	50	100	3
V		Automation and Robotics	4	0	0	4	50	50	100	3
VI		Energy conservation and Management	4	0	0	4	50	50	100	3
VII		Logistics and Supply Chain Management	4	0	0	4	50	50	100	3
		Total	**18**	**0**	**0**	**18**				

MDM offered by School of Computing Science

Semester	MDM	Track
Semester-III	MDM-I	Introduction to Web Development
Semester-IV	MDM-II	Front End Development
Semester-V	MDM-III	Backend Technologies
Semester-VI	MDM-IV	Cloud Technologies

MDM offered by school of Electronics and Computer Engineering & Electric and AI

Sr. No.	Semester	Course Code	Course Name
1	III	MDM-1	Elements of IoT
2	IV	MDM-2	IoT sensors and Devices
3	V	MDM-3	Industrial IOT and Industry 4.0
4	VI	MDM-4	Electric Vehicles

Semester I

<table>
<tr><th>Course Code</th><th colspan="4">Course Title</th><th>Category</th></tr>
<tr><td>24HS05TH0104</td><td colspan="4">Applied Physics</td><td>BSC</td></tr>
<tr><th colspan="3">Contact Hours per Week</th><th rowspan="2">CA</th><th rowspan="2">FE</th><th rowspan="2">Credits</th></tr>
<tr><th>L</th><th>P</th><th>S</th></tr>
<tr><td>03</td><td>00</td><td>01</td><td>50</td><td>50</td><td>3</td></tr>
<tr><td colspan="6">Course Objectives
• To develop ability to correlate basic physics principles involved in Robotic operations.
• To help to improve fundamental robotic operations.</td></tr>
<tr><td colspan="6">Course Outcomes
After successful completion of the course students will be able to:
CO1. Apply Laser beam characteristics in various robotic operations.
CO2. Apply principal knowledge of Ultrasonics in robotic operations.
CO3. Apply fundamental principles of electromagnetics to robotic operations.
CO4. Apply fundamental knowledge of fluid dynamics to underwater and arial robotics.
CO5. Apply various sensing mechanisms pertaining to various Robotic operations.</td></tr>
<tr><td colspan="5">Module 1: Laser Physics</td><td></td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="5">Module 2: Ultrasonics</td><td></td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6">Module 3: Electromagnetism</td></tr>
<tr><td colspan="6">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,</td></tr>
</table>

energy storage in magnetic fields, Maxwell's equations and applications.
Module 4: Aeronautics Physics
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.
Module 5: Sensors and Actuators
Design and working principles of Sensors requited for Robotics: Strain, pressure, ultrasonic, piezoelectric, chemical, thermal, optical, electrical, etc, as required for various types of detection.
Text Books:
Reference Books:

Course Code	Course Title				Category
24HS05PR0104	**Applied Physics Lab**				**BSC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	**02**	**01**	**50**	**00**	**1**

Course Objectives

The Physics for Robotics (Lab) course will consist of experiments illustrating the principles of physics relevant to the study of Robotics.

Course Outcomes

After successful completion of the course students will be able to

CO6. Prepare for measurements used in various experiments and analyze errors involved in the measurements.
CO7. Explore various methods for finding wavelength of light, magnetic field intensity, speed of waves.
CO8. Prepare laboratory reports on the experimental results with proper conclusions.
CO9. Interpret graphical results.
CO10. Identify principle involved in an experiment.

List of Experiments:

1. Error analysis and graph plotting.
2. To find magnetic field by deflection magnetometer.
3. To find wavelength of laser light by diffraction grating.
4. Determination of velocity of sound in liquid–standing ultrasonic waves.
5. Data analysis using Mathematica.

6. Study of Aerofoil Shapes.
7. Sensor based experiments.
8. Robot simulation on open-source software (e.g. – Gazebo, MuJoCo, SOFA, PhysX etc)
9. Mini project on sensor for application development.

Suggested References

Physics Lab Manual written by the Teaching Faculty of Physics Department, RCOEM.

Course Code	Course Title				Category
24HS03TH0104	Differential Calculus and Basics of Statistics				BSC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	00	01	50	50	3

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in Ordinary differential equation, statistics, probability and differential calculus.
It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Course Outcomes

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

CO1. Recognize first order ordinary differential equations that can be solved by each of the four methods – Linear DE, exact DE, reducible to linear DE and reducible to exact differential equations and use the appropriate method to solve them.
CO2. Solve higher order ordinary differential equations with constant and variable coefficients.
CO3. Find best fit curve by method of least square method and calculate correlation, regressions.
CO4. Internalize multivariable calculus and apply it find Jacobean, maxima and minima of function.
CO5. Solve partial differential equation by using Variable separable method

Module 1: ***First order ordinary differential equations***	**(07 Hrs)**
Exact, linear and Bernoulli's equations, Euler's equations, Equations not 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.	
Module 2: ***Ordinary differential equations of higher orders***	*08*
Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation. Applications of Higher order Differential Equations.	
Module 3: ***Statistics***	*07*
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolasand more general curves,correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering.	
Module 4: Differential Calculus	*10*

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.

Module 5: Partial differential equations	8 hours

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
5. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Theory and Problems of probability and statistics : 2nd ed :*J. R. Spiegal ,Schaum series*
8. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
9. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Reference Books:

Course Code	**Course Title**				**Category**
24HS03PR0102	**Computational Mathematics Lab**				**BSC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	**02**	**01**	**50**	**00**	**1**

Course Objectives: The computational Mathematics Lab course will consist of experiments demonstrating the principles of Mathematics relevant to the study of Science and Engineering. Students will show that they have learnt Laboratory skills that will enable them to properly acquire and analyze the data in the lab and draw valid conclusions.

By using open source software SageMath Students will be able to:

CO1. Download SageMath and use it as an advance calculator.
CO2. Sketch and analyze function graphs.
CO3. Apply the concepts of differential calculus to find extreme value of continuous functions and analyze solutions of differential equations
CO4. Evaluate improper integrals and its applications to find length, area, volume, centre of

gravity and mass.

CO5. Analyze and calculate eigen values, eigen vectors, rank nullity, and solve system of linear equations of a matrix / linear map.

CO6. Analyze the data to find best fit curve.

List of Experiments:

1. **To use SageMath as advanced calculator**
2. **2D Plotting with SageMath**
3. **3D Plotting with SageMath**
4. **Applied optimization with SageMath**
5. **Analysis of solutions of differential equations in SageMath**
6. **Linear Algebra with Various applications**
7. **Curve Fitting to identify trends and patterns within dataset by using SageMath**
8. **Practical Applications of Integral Calculus with SageMath**

Course Code	Course Title				Category
24ES03TH0101	Mechanical Marvels				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
01	00	01	50	00	1

Course Objective:

1. To create awareness about the past and recent developments in Mechanical Engineering.
2. To sensitize about the applications of Mechanical Engineering in various fields.

Course Outcomes:

CO1. To know about the evolution of Mechanical Engineering as a discipline.
CO2. To develop awareness about latest trends in Mechanical Engineering.

Syllabus:

- Industrial Revolutions (Industry 1.0 to Industry 5.0)
- Mechanical Engineering in day to day life
- Technical Disruptions
- Cutting edge technologies Drone, Robots, Electric vehicles, UAS
- Space Technology,
- Defence Technology
- Marine Technology
- Future Fuels
- Advanced Materials
- Green manufacturing
- Modern machines and infrastructure etc.

Course Code	Course Title				Category
24ES03TH0102	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	

Semester I

Course Code: 24ES03TP0101			Course: Engineering Graphics
L: 2	T: 0	P: 2	Total Credits: 3

Course Outcomes:
The expected learning outcome is that, the students shall be able to:

CO1. Draw and interpret technical drawings
CO2. Convert 2-D to 3-D drawing and vice versa.
CO3. Represent the various positions of planes and solids in different orientations.
CO4. Develop the solid surface for sheet metal working

UNIT 1: Introduction to Engineering Drawing and Engineering Curves: Principles of Engineering Graphics and their significance, usage of drawing instruments, Lettering and dimensioning, Engineering Curves - Conic sections, Cycloid and Involute etc.

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

UNIT 3: 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 4: Sections of Solids and Development of Surfaces: Theory of sectioning, sections of prism, pyramid, cylinder and cone, Development of lateral surfaces of solids,Real-world applications of surface development.

UNIT 5: 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.

LAB Course: Engineering Graphics

Course Outcomes:
Students are prepared for actual work situations through practical training in a new state of the art computer designed CAD laboratory using engineering software. The student shall be able to:

CO1. Draw and interpret technical drawings.
CO2. Convert 2-D to 3-D drawing and vice versa
CO3. Represent the various positions of planes and solids in different orientations.
CO4. Develop the solid surface for sheet metal working
CO5. Use & demonstrate drafting package.

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

SN	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

Suggested Text/ Reference Books:

1. Agarwal B & Agarwal C.M. Engineering Graphics, Tata McGraw Hill Publications
2. Bhatt N.D. Panchal V.M. & Ingle P.R., Engineering drawing, CharotarPublishing house.
3. Jolhe D.A., Engineering drawing with an Introduction to Auto CAD", Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Shah M.B. & Rana B.C., Engineering drawing and Computer Graphic, Pearson Education.
5. Narayana K.L & P Kannaiah, Text Book on Engineering Drawing, Scitech Publishers.
6. (Corresponding set of) CAD Software Theory and USER Manuals.

Semester I

Course Code: 24EE07TP0106			Course: Basics of Electrical Engineering.
L: 2	T: 0	P: 2	Total Credits: 3

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:

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

CO1. Explain the basics of Electrical systems and various components.
CO2. Identify the various components in Electro-mechanical systems.
CO3. Classify the types of power converters as per the applications.
CO4. Select the battery for specific application.

1. **Introduction to Electrical System:**
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-

2. **Introduction to power converters:**
Basic schematic introduction to power converters, Types of Power converter, AC-DC, DC-DC,DC-AC converters, applications

3. **Electrical Machines:**
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

4. **Electromechanical Systems:**
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,"BasicElectricalEngineering",TataMcGrawHill,2010
2. Electrical Technology: B. L. Thereja, S. Chand Publications.
3. Electrical&ElectronicInstruments&MeasurementbyA.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,"BasicElectricalEngineering",McGrawHill,2009.
2. L.S.Bobrow,"FundamentalsofElectricalEngineering",OxfordUniversityPress,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.

LABCOURSE:Basics of Electrical Engineering

Course Outcomes:

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

CO1. Perform experiments on basis DC and AC circuits and make valid conclusions from observed results.
CO2. Study the operation of DC-DC converters.
CO3. To reverse the direction of rotation of a dc shunt motor and control it's speed by different methods.
CO4. Calculate the energy bill and verify the same with that provided by the utility for a specific installation and specific period.
CO5. 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
24ES03TP0104	Programming for Problem Solving				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
1	0	1	50	50	01

Course Objective

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

Course Outcomes

CO1. Understand the components of a computer system and develop algorithms using flowcharts and pseudo-code.
CO2. Demonstrate proficiency in C programming, including the use of data types, operators, control statements, loops, and functions.
CO3. Utilize arrays, implement basic sorting algorithms, and understand the concept of algorithm complexity through example programs.
CO4. 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 to functions: idea of call by reference. Recursion: As a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

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 and writing 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: YashwantKanetkar, BPB Publication

Course Code	**Course Title**		**Category**		
24ES03PR0104	**Programming for Problem Solving Lab**		**ESC**		
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	**2**	**1**	**50**	**00**	**01**

.

Course Code	Course Title				Category
24HS02TH0103-2	Foundational Course in Universal Human Values				VEC/ HSSM
Contact Hours per Week			CA	FE	Credits
L	P	S			
1	0	1	50	-	1

Prerequisite:

Course Objectives:

1. To help the student see the need for developing a holistic perspective of life
2. To sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence.
3. To strengthen self-reflection.
4. To develop more confidence and commitment to understand, learn and act accordingly.

Course outcome: On completion of course, students will be able to achieve the following:
Develop a holistic perspective of life

1. Better understanding of inter-personal relationships and relationship with society and nature.
2. An ability to strengthen self-reflection

UNIT I: Aspirations and concerns — **5 Hours**

Need for Value Education: Guidelines and content of value education. Exploring our aspirations and concerns: Knowing yourself, Basic human aspirations Need for a holistic perspective, Role of UHV; Self-Management: harmony in human being

UNIT II: Health — **5 Hours**

Harmony of the self and Body, Mental and physical health; Health for family, friends and society.

UNIT III: Relationships and Society — **5 Hours**

Harmony in relationships, Foundational values: Trust, Respect, Reverence for excellence, Gratitude and love; harmony in society; harmony with nature.

TEXT BOOK:

1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 10030, ISBN 978-8-174- 46781-2

REFERNCE BOOKS:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, and Universe Books.
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
7. A Nagraj, 1998, Jeevan VidyaekParichay, Divya Path Sansthan, Amarkantak.
8. E.F. Schumacher, 1973, small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Course Code	Course Title				Category
24HS03TH0214	Linear Algebra and Integral Calculus				BSC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	0	1	50	50	3

Course Objective:

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

Course Outcomes

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

CO1. Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices, reduction of quadratic form to canonical form.

CO2. Evaluate definite and improper integrals using Beta, Gamma functions. Also trace Cartesian curves.

CO3. Solve multiple integration by change of order, change of variable methods and apply it to findarea, volume, mass and centerof gravity.

CO4. Understand geometric meaning of gradient, curl, divergence

CO5. Perform line, surface and volume integrals of vector-valued functions

Module 1: LinearAlgebra:(8hours)

Rank-nullity theorem; System of linearequations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvaluesand eigenvectors; Diagonalization of matrices; Orthogonaltransformation and quadratic to canonical forms, Introduction to n-dimensional space, Sinular value decomposition and its application in reducing the dimensionality of images and data .

Module 2: Integral *Calculus:* (8hours)

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

Module 3: ***Multiple Integrals*** (10 hours)

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

Module 4: 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.

Module 5: 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/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.
5. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
6. Biomedical Statistics –Shantikumar Yadav , Sompal Singh, Ruchika Gupta
7. Theory and Problems of Probability and Statistics - M.R. Spiegal (Mc Graw Hill) Schaum Series

Course Code	Course Title				Category
24ES03TH0201	Artificial Intelligence				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	0	1	50	50	3

Course Objectives:

- To introduce classical AI and rational intelligent agents.
- To introduce techniques for problem solving by search and adversarial games.
- To introduce constraints, logic, and inference techniques
- To introduce planning, acting, and multi-agent systems.
- To introduce knowledge-representation and reasoning.

Course Outcomes

After completing this course, students will be able to

CO1. Analyse different elements of an AI system.
CO2. Apply elementary principles of AI for problem solving and search
CO3. Apply constraints and logic for intelligent systems
CO4. Apply knowledge representation and reasoning for defining intelligent systems

Unit 1

History and Foundations of AI, Rational Intelligent Agents, Agents and Environments, Nature of Environments,
Structure of Agents.

Unit 2

Problem Solving by Search: Uninformed and Informed Search Strategies, Heuristic Functions; Adversarial Search:
Games, Optimal Decisions in Games, Alpha-Beta Pruning

Unit 3

Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining

Unit 4

Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in
Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.

Textbooks/ References:

Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United
Kingdom: Pearson, 2010.
Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.
Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

Course Code	Course Title				Category
24ES04TH0202	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
24ES03TH0203	Data Structure and Algorithms				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
02	00	01	50	50	02

Course Objective

Equip students with the knowledge and skills to design, implement, and analyse fundamental data structures and algorithms, enabling them to efficiently solve complex problems and optimize performance in computational applications.

Course Outcomes

On successful completion, of course student will able to:

CO1. Identify different ADTs, their operations and specify their complexities.
CO2. Apply linear data structures to address practical challenges and analyse their complexity.
CO3. Implement different sorting, searching, and hashing methods and analyse their time and space requirements.
CO4. Analyse non-linear data structures to develop solutions for real-world applications.

UNIT I: Data Structures and Algorithms Basics

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

Algorithms: Definition, characteristics, analysis of an algorithm, asymptotic notations, and time and space trade-offs.

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

UNIT II: Sorting, Searching and Hashing

Sorting: Different approaches to sorting, properties of different sorting algorithms (insertion, Shell, quick, merge, heap, counting), performance analysis and comparison.

Searching: Necessity of a robust search mechanism, searching linear lists (linear search, binary search) and complexity analysis of search methods.

Hashing: Hash functions and hash tables, closed and open hashing, randomization methods (division method, mid-square method, folding), collision resolution techniques.

UNIT III: Stacks and Queues

Stack ADT: Allowable operations, algorithms and their complexity analysis, applications of stacks–expression conversion and evaluation (algorithmic analysis), multiple stacks.

Queue ADT: Allowable operations, algorithms and their complexity analysis for simple queue

and circular queue, introduction to double-ended queues and priority queues.

UNIT IV: Linked Lists

Singly Linked Lists: Representation in memory, algorithms of several operations: traversing, searching, insertion, deletion, reversal, ordering, etc. Doubly and Circular Linked Lists: Operations and algorithmic analysis. Linked representation of stacks and queues.

UNIT V: Trees and Graphs

Trees: Basic tree terminologies, binary tree and operations, binary search tree (BST) and operations with time analysis of algorithms, threaded binary trees. Self-balancing Search Trees: Tree rotations, AVL tree and operations, Graphs: Basic terminologies, representation of graphs, traversals (DFS, BFS) with complexity analysis, path finding (Dijkstra's SSSP, Floyd's APSP), and spanning tree (Prim's and Kruskal's algorithms).

Text Books

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

2. Ellis Horowitz, SartajSahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.

3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.

4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013

Reference Books

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

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

3. Aditya Bhargava, Grokking Algorithms: An Illustrated Guide for Programmers andOther Curious People, First Edition, Manning Publications, 2016.

4. K. R. Venugopal and Sudeep R. Prasad, Mastering C, Second Edition, McGraw Hill,2015.

5. A. K. Sharma, Data Structures using C, Second Edition, Pearson Education, 2013.

Course Code	Course Title				Category
24ES03TP0203	Data Structure and Algorithms Lab				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	01	50	00	01
Course Objective					
Course outcome					

Course Code	Course Title				Category
24EE01TH0204	Digital Logic Design				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
02	00	01	50	50	02

Course Objective

Course Outcomes

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

CO1. Apply various optimization techniques to minimize digital circuits.
CO2. Design combinational logic circuits.
CO3. Analyze and design asynchronous and synchronous sequential circuits.
CO4. Discuss x 86 architecture

Module 1

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.

Module 2

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.

Module 3

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.

Module 4

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)

Module 5

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

Course Code	Course Title				Category
24EE01PR0204	Digital Logic Design Lab				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	01	01	50	50	01

Course Objective

Course Outcome

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.

Semester II

Course Code	Course Title				Category
24HS02TH0201	English for Professional Communication				AEC/ HSSM
Contact Hours per Week			CA	FE	Credits
L	P	S			
2	0	1	50	50	2

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 Code	Course Title				Category
24HS02PR0201	English for Professional Communication Lab				AEC/ HSSM
Contact Hours per Week			CA	FE	Credits
L	P	S			
2	0	1	50	50	2

Prerequisite:

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

Semester II

Course Code: 24ES03TP0202			Course: Fabrication Practices
L: 1	T: 0	P: 2	Total Credits: 2

CourseObjectives:
TheObjectiveofthecourseis:

1. Identifythedifferentmanufacturingprocessforvariousworkshoptradesincludingfitting,carpentry,smithy/foundryandwelding,etc.
2. Togetacquaintedwiththeknowledgeofvariousmachinetoolsandequipments.

CourseOutcomes:
Theexpectedlearningoutcomeisthatthestudentswillbeableto:

CO1. Understandcastingtechniquefortheproductionofcastedcomponents.

CO2. Identifyanappropriatemoldingpatternandvariouscarpentryjoints.

CO3. Understandthemachiningparametersandcuttingtoolforvariousmachiningoperations.

CO4. Distinguishwithhotandcoldworkingmethodforthemanufacturingofmetalcomponents.

CO5. Understandvariousfittingjointsandsheetmetaloperations.

CO6. Applytheknowledgeofsuitablejoiningprocessestocarryoutfabricationwork.
Introductiontofoundries,metalcasting,typesofsand,introductiontomouldingtools&differentcastingprocess.

Syllabus

Unit- I:
Introduction to foundries, metal casting, types of sand, introduction to moulding tools & different casting process.

Unit- II:
Introductiontopatternmakingformetalcasting,differenttypesofcarpentrytools,holdingdevices,differenttypesofcarpentry joints.

Unit- III:
Fundamentalsofmetalcutting,Lathemachinespecificationandoperations,metalcuttingparameters,singlepointcuttingtool.

Unit -IV
Smithyandforging,hotworkingandcoldworkingofmetals,forgingtoolslikechisels,hammers,typesoffurnaces.

Unit- V:
Fittingoperationsandassociatedmeasuringandmarkingtools,sheetmetaloperations.

Unit- VI:
MetaljoiningProcess,typesofwelding,mechanicsofwelding,solderingandbrazing.

Text Books

1. WorkshopTechnology,Volume-I&II-ByHajraChoudhary,MediaPromoters&PublishersPvt.Ltd.
2. ManufacturingTechnology,Volume-I&II-P.N.Rao,TataMcGrawHillPub.Company,NewDelhi.
3. ManufacturingScience -A.Ghosh&A.K.Malik -EastWestPressPvt.Ltd.NewDelhi.

ReferenceBooks

1. KalpakjianandSchimd,Manufacturingprocessesforengineeringmaterials,5thEdition-PearsonIndia,10034.
2. MikellP.Groover,FundamentalsofModernManufacturing:Materials,Processes,and System.
3. ProductionEngineering-P.C.Sharma,S.ChandandCompanyLtd.,NewDelhi.

LAB COURSE: Fabrication Practices

CourseObjectives:

TheObjectiveofthecourseis:

1. Tofamiliarizewithmajormanufacturingprocessandrequired MachineTools.
2. Togetacquaintedwithandhandsonexperienceonmachinetoolsandequipments.

CourseOutcomes:
Theexpectedlearningoutcomeisthatthestudentswillbeableto:

1. Prepareasandmouldforcastingandperformpatternmaking.
2. Performdifferentmachiningoperationsonlathemachineandpartsfittingjob.
3. Applytheknowledgeofjoiningprocessestocarryoutfabricationwork.

ListofExperiments:
Introductionoftools,equipments,material&processalongwithdemonstrationandpreparationof simplejobusingvarious workshop tradessuchas:

1) Metalcastingandmoldingpractice
2) Patternmakingpractice
3) Machiningpractices
4) Smithyandforgingpractice
5) Fittingjobpractice
6) Weldingpractice

*Casestudy:Topreparesimplemodel/projectusingvariousworkshopfacility(GroupActivity)

Text Books

1. Workshop Technology, Volume - I & II - By HajraChoudhary, Media Promoters &PublishersPvt.Ltd.
2. Manufacturing Technology, Volume - I & II - P.N. Rao, Tata McGraw Hill Pub.Company,New Delhi.
3. ManufacturingScience -A.Ghosh&A.K.Malik -EastWestPressPvt.Ltd.NewDelhi.

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.

Semester II

Liberal/Performing Art Courses

Course Code: 24HS02PR0106-01			Course: Bharatnatayam
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

The course aims to introduce the students to Bharatnatayam, an important element of Indian traditionalknowledgesystem.Thecoursewillnotonlyprovidethelearningandskilltoperformthisa rtbutwouldalsoenhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence,creativity,focus, coordination, etc.

Course Outcomes

On completion of thecourse,studentswillbeabletoachievethefollowing:

CO1. UnderstandtheimportanceofdanceandBharatnataymasanIndiandanceform.
CO2. Developskillstoperformthedanceform at its basic level.
CO3. Evaluate their strengths and interest to take bridge course to give *Pratham*(1st level formal exam ofBharatnatayam).

Syllabus

Practical-1: OrientationinBharatnatayam

Practical-2: TattuAdavutill8,NaattaAdavu4Steps,PakkaAdavu1step, MettaAdavu1Step,KudittaMettaAdavu 4 Steps,

Practical-3: Practicesessions

Practical-4: TattaKudittaAdavu (Metta), TattaKudittaAdavu (Metta) 2 Steps, TirmanamAdavu 3 Steps,KattuAdav-3 Steps, KattuAdav-3 Steps

Practical-5: Practicesessions

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

Practical-7: Practicesessions

Practical -8:finalpracticesessionsandperformances.

Recommended reading

1. IntroductiontoBharata'sNatyasastra,AdyaRangacharya,2011
2. TheNatyasastra and theBodyinPerformance:EssaysontheAncient Text, edited bySreenath Nair,2015
3. Bharatanatyam How to ...: A Step-by-step Approach to Learn the Classical Form, EshwarJayalakshmi,2011

Course Code: 24HS02PR0106-02			Course: Kathak
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

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

CourseOutcomes

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:Developskillsto perform thedanceformatits basic level.

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

Syllabus

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

Practical-2:practicesessionsofpractical1

Practical-3: Hastaks, HastaksandSteppings,RecitingasamyuktaMudrashloka,Hastakandsteppings

Practical-4:practicesessionsofpractical3

Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, GhanteKiTihai,

Practical-6:practicesessionsofpractical5

Practical -7:2 1ChakkardarToda and GinntiKiTihai, 2Todasand 1ChakkardarToda, practicesessions

Practical-8: Finalperformances.

Recommendedreading

1. Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book), MaramiMedhi&DebasishTalukdar,2022, AnshikaPublication (13 September 2022)

Course Code: 24HS02PR0106-03			Course: Introduction to Digital Photography
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

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

Course outcome:

Attheendofthecourse the studentswillbeabletoachievethefollowing:

Develop anunderstandingof the technicalaspectsandaestheticsofPhotography.
Applytherulesof digital photographyforcreatingphotographs.
Developskillstoenhancephotographsthroughpostprocessing.
Createaportfoliooftheirphotographsinselectedgenre.

Syllabus

Practical1: **Orientationindigitalphotography:**Genres, camerahandlingandsettings

Practical2:**RulesofComposition**

Practical3: **RulesofComposition**:Practicesessions

Practical4: **UnderstandingExposureandArtofPre-Visualization**

Practical 5: **Rules of Composition and Art of Pre-Visualization:** Practice sessions

Practical6:**PostProcessingPhotographsandPortfoliocreation**

Practical7:**PostProcessingPhotographs:**Practicesessions

Practical8:**Portfoliofinalizationandpresentationinselectedgenre.**

Referencematerial

1. Scott Kelby (2020) *The Digital Photography Book: The Step-by-Step Secrets for how to Make YourPhotosLookLikethe Pros*, RockyNook, USA
2. Larry Hall (2014) *Digital Photography Guide: From Beginner to Intermediate: A Compilation ofImportant Information in Digital Photography*,SpeedyPublishing LLC, Newark
3. J Miotke (2010) *Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro*,AMPHOTOBooks, Crown PublishingGroup, USA

Course Code: 24HS02PR0106-04			Course: Introduction to Basic Japanese Language
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

Thecourseaimstodevelopbasiccommunicationskillsin Japanese Language andhelpdevelopabasicunderstandingof Japaneseculturein cross-culturalcommunication.

Courseoutcome

CO1. GainabriefunderstandingaboutJapanasacountryandJapanese culture.
CO2. DevelopabilitytousevocabularyrequiredforbasiclevelcommunicationinJapaneselanguage.
CO3. Abletowriteand read thefirst script in Japaneselanguage.
CO4. Able to frame simple sentences in Japanese in order to handle everyday conversations
CO5. Able towritein basic Japaneseaboutthetopicscloselyrelated to thelearner.

Syllabus

Practical-1: OrientationaboutJapan,itslanguage,anditsculture

Practical-2: CommunicationSkills1: VocabularyforbasicJapaneselanguage

Practical-3: Practicesessions

Practical-4: WritingSkills 1:Readingand writingfirstscriptinJapanese

Practical-5: Practicesessions

Practical-6: CommunicationSkills2:framingsentences

Practical-7: Practicesessions

Practical-8: WritingSkills 2:WritebasicJapaneseandpractice

RecommendedReading

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

Course Code: 24HS02PR0106-05			Course: Art of Theatre
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjectives:

Thecourseaimstodevelopinthestudents,anactor'scraftthroughphysicalandmentaltraining.

CourseOutcomes:

On completion of thecourse,studentswillbeabletoachievethefollowing:

CO1. Understand and synthesize the working of the prominent genres of theatre across the world.
CO2. Applythe skill of voice and speech in theatreandpublicspeaking
CO3. Apply the art of acting and also develop generic skills such as confidence, communication skills, self-responsibility, motivation, commitment, interpersonal skills, problem solving, and self-discipline.
CO4. Apply skills acquired related to technical/production aspects of theatre and also develop problem solvingandinterpersonal skills.

Syllabus:

Practical1: **Orientationintheatre**

Practical2:**VoiceandSpeechtraining**

Practical3: **Voice and Speech training: practice sessions**

Practical4:**Art of acting**

Practical 5: **Art of acting: practice sessions Practical 6: Art of script writing**

Practical 7: **Art of script writing: practice sessions Practical 8: Final performances**

Referencebooks:

1. Boleslavsky,R.(2022). *Acting:TheFirstSixLessons*(1sted.,pp.1-92). DelhiOpenBooks.
2. Shakthi,C.(2017). *NoDramaJustTheatre*(1sted.,pp. 1-171).Partridge.
3. Bruder, M., Cohn, L. M., Olnek, M., Pollack, N., Previto, R., &Zigler, S. (1986). *A Practical HandbookfortheActor*(1st ed.). Vinatge Books New York.

Course Code: 24HS02PR0106-06			Course: Introduction to French Language
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective:

To help build a foundation and interest in French language so that the students can pursue the proficiencylevelsof the languageinhigher semesters.

Courseoutcomes:

On successfulcompletion of thecoursethestudentswillbeabletoachievethefollowing:

CO1. Demonstratebasicknowledgeabout France, theculture andsimilarities/differencesbetweenIndiaandFrance.
CO2. Learn to use simple language structures in everyday communication.
CO3. DevelopabilitytowriteinbasicFrenchaboutthemselvesandothers.
CO4. Develop abilitytounderstandbeginnerleveltextsinFrench

Syllabus

ListofPracticals:

Practical-1: OrientationaboutFrance,thelanguage, andculture

Practical-2: CommunicationSkills1: Vocabularybuildingforeverydayconversations

Practical-3: Practicesessions

Practical-4: ReadingandwritingSkills:ReadingandwritingsimpletextinFrench

Practical-5: Practicesessions

Practical-6: CommunicationSkills2:listeningcomprehension

Practical-7: Practicesessions

Practical-8: WritingSkills:WritebasicFrenchandpractice

Recommendedreading

1. 15-minuteFrenchbyCaroline Lemoine
2. CoursdeLangue etdeCivilisationFrançaisesbyG.MaugerVol.1.1
3. Cosmopolite IbyNatalieHirschsprung,TonyTricot

Course Code: 24HS02PR0106-07			Course: Introduction to Spanish Language
L: 0	T: 0	P: 2	Total Credits: 1

Course objective:

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 successful completion of the course the 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

List of Practicals

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

Recommended reading

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

Course Code: 24HS02PR0106-08			Course: Art of Painting
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

Paintingisfundamentallyaboutlearningtosee,andtotransportthatvisionontopaperthroughavariet yof mark making techniques. This course aims to develop basic skills of students in painting to lay afoundationforthemasahobby and/or aprofession.

Course outcome:

Attheendofthecoursethestudentswillbeabletoachievethefollowing:

CO1. Becomefamiliarwiththebasicmethods,techniques&toolsofpainting.
CO2. Traintheeyeandhandtodevelopsenseofbalance,proportionandrhythm.
CO3. Developtheabilitytoobserveandrendersimplenaturalforms.
CO4. Enjoythechallengingandnuancedprocessofpainting.

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: 24HS02PR0106-09			Course: Art of Drawing
L: 0	T: 0	P: 2	Total Credits: 1

Courseobjective

Drawingisfundamentallyaboutlearningtosee,andtotransportthatvisionontopaperthroughavariet yof mark making techniques. This course aims to develop basic skills of students in drawing to lay afoundationforthemasahobbyand/oraprofession.

Course outcome:

Attheendofthecoursethestudentswillbeabletoachievethefollowing:

CO1. Becomefamiliarwiththebasicmethods,techniques&toolsofdrawing.
CO2. Traintheeyeandhandtodevelopsenseofbalance,proportionandrhythm.
CO3. Developtheabilitytoobserveandrendersimplenaturalforms.
CO4. Enjoythechallengingandnuancedprocessofdrawing.

Syllabus

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

Practical2:**Theartofobservation**howtoseeshapesindrawing

Practical 3: **One/two-point basic linear perspective**

Practical 4: **Nature drawing and landscapes**

Practical5:**Gestaltprinciplesofvisualcomposition**

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

Practical7:**Gesturedrawing:**expressionandcompositionsofhumanfigures

Practical8: **Memorydrawing:**anexercisetocombinethetechniqueslearnt

Referencematerial

1. DrawingmadeeasybyNavneet Gala;2015th edition
2. PerspectiveMadeEasy(DoverArtInstruction)byErnestR.Norling

Course Code: 24HS02PR0106-10			Course: Nature Camp
L: 0	T: 0	P: 2	Total Credits: 1

Course Objective: To create an opportunity for the students to develop affinity with nature and thussubsequentlyimpacttheirabilitytocontributetowardssustainabilityofnature.

Courseoutcome:

Afterthecompletionofthecoursethestudentswillbeabletodothefollowing:

CO1. Develop an affinity with nature by observing and understanding it marvels with guidance fromexperts
CO2. Develop an understanding of the challenges and solutions associated with nature and itsconservation.

Coursecontent

In collaboration with the Forest Department and/or a local NGO working in the field of environmentconservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve inVidrabha region or Forest fringe villages or work with an NGO from Vidarbha region working on naturalresourcemanagement.Thecamps(for2days)willcoveranyoneofthefollowingtopicsasdecidedbythecourse coordinator:

1. Awarenessabouteachelementofbiodiversity(campsonmoths,butterflies,birds,otherwildlifeetc.)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing a tigerreserve, andotheraspectsofwaterandforest 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 ForestDepartment
5. Traditionalpracticesinenvironmentconservation–roleoflocalcommunitiesandlocalNGOs

Course Code: 24HS02PR0106-11			Course: Developing Self-awareness
L: 0	T: 0	P: 2	Total Credits: 1

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 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: **NeurolinguisticProgramming , 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: 24HS02PR0106-12			Course: Art of Poetry
L: 0	T: 0	P: 2	Total Credits: 1

CourseOutcomes:

Tofamiliarizethestudentswiththeartofpoetryanddevelopasenseofappreciationfortheart

Attheendofthecoursethestudentwillbeabletoachievethe following:

CO1. Understand the origin and development of poetry
CO2. Appreciatetheartofpoetryinlife
CO3. Developaestheticsense
CO4. Developholisticperspectivetotheirpersonality

Syllabus

Practical 1. Art of poetry – orientation
Practical 2. Formsofpoetry–orientation
Practical 3. Formsof poetry–recitation
Practical 4. Applicationofpoetry–orientation
Practical 5. Applicationofpoetry –practicalsession
Practical 6. Poetryandaesthetics
Practical 7. Writingpoetry–orientation
Practical 8. Writingpoetry–writingsessions

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.

Course Code: 24HS02PR0106-13	Course: Creative and content writing

L: 0	T: 0	P: 2	Total Credits: 1

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: 24HS02PR0106-14			Course: Science of life through Bhagwad Gita
L: 0	T: 0	P: 2	Total Credits: 1

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
24HS04PR0201	Sports-Yoga-Recreation		CCA

Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	01	50		1

Aim of the Course

The course aims at creating awareness about the fundamentals of Physical Education, Sports, Yoga, Recreation and its effectiveness to promote Health and wellness through Healthy Lifestyle.

Objectives of the Course

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 completion of the course, students will be able to:

1. Understand fundamental skills, basic principle and practices of sports and Yoga.
2. Practically learn the principles of implementing general and specific conditioning of physical exercises and yoga.
3. Develop Health-related fitness and Body-mind co-ordination through various fitness activities, sports, recreational games and yoga.
4. Practice Healthy & active living with reducing Sedentary Lifestyle

Unit1:-Theory:Introduction

- Meaning,DefinitionandImportanceofHealth&Wellness
- DimensionsofHealthandWellness
- FactorsinfluencingHealthandWellness
- PhysicalFitness,Nutrition,Habits,Age,Gender,Lifestyle,BodyTypes
- Health & Wellness through Physical Activities, Sports, Games, Yoga and Recreationactivities
- CausesofStress&StressreliefthroughExerciseandYoga
- SafetyinSports

Unit 2: - Practical- Exercises for Health and Wellness

- Warm-Up and Cool Down - General & Specific Exercises
- Physical Fitness Activities
- Stretching Exercises

- General & Specific Exercises for Strength, Speed, Agility, Flexibility, coordinative abilities
- Cardiovascular Exercises
- Assessment of BMI
- Relaxation techniques
- Physical Efficiency Tests

Unit 3: - Yoga

- ShukshmaVyayam
- Suryanamaskar
- Basic Set of Yogasanas – Sitting, standing, supine and prone position
- Basic Set of Pranayama & Meditation

References:

1. Russell, R.P. (1994). Health and Fitness Through Physical Education. USA:Human Kinetics.
2. Uppal, A.K. (1992). Physical Fitness. New Delhi: FriendsPublication.
3. AAPHERD "Health related Physical Fitness Test Manual."1980 Published by AssociationdriveRestonVirginia
4. Kumar,Ajith.(1984)YogaPravesha.Bengaluru:RashtrothannaPrakashana.
5. Dr.Devinder K. Kansal, A Textbook of Test Evaluation, Accreditation, Measurementsand Standards(TEAMS'Science)

Semester III

SEMESTER III					
Course Code	**Course Title**				**Category**
24HS03TH0303	**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
24ES03TH0301		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.

Course Code	Course Title				Category
24ES03TH0302	Design of Manipulator and End-effector				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
02	00	1	50	-	**02**

Prerequisites:

Students should have:

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

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. Analyse 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. Analyse 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: Introduction to Robotic Mechanical Design	**07 Hrs.**

Components of robotic systems (links, joints, actuators, sensors), Types of robots: industrial, mobile, humanoid, collaborative, Design requirements: payload, precision, stiffness, workspace. Design methodology and system-level approach, Structural requirements of robotic manipulators: rigidity, stability, and precision. Design criteria: stiffness, strength, weight optimization, natural frequency, payload capacity, 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, Case studies of robotic systems

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, Tolerance, fits, and surface finish considerations, Thermal effects on materials and

expansion issues.

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.

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, Types of grippers: Mechanical (parallel jaw, angular), Vacuum grippers, Magnetic grippers, Compliance and adaptability in gripper design, Sensor integration (force/torque sensors) in end effectors

Text Books:

1. R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Education (India) Pvt. Ltd.
2. Budynas, R.G. & Nisbett, J.K., *Shigley's Mechanical Engineering Design*, McGraw-Hill, 11th/12th Ed.
3. **Robert L. Norton, Machine Design: An Integrated Approach,** 6th Edition, Pearson Education
4. 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.

Course Code	Course Title	Category

24ES03PR0302	Design of Manipulator and End-effector Lab				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	1	50	-	**02**

Prerequisites:

Students should have:

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

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

1. **To impart** knowledge of engineering drawings, dimensioning standards, and their interpretation for CAD modeling.
2. **To develop** students' skills in designing and modeling robotic end-effector mechanisms using 3D CAD software.
3. **To familiarize** students with the principles and workflow of 3D printing for the fabrication of robotic components and prototypes.

Course Outcomes (COs): At the end of this course, students will be able to:

1. Interpret engineering drawings with respect to dimensions and CAD modeling requirements.
2. Develop a CAD model of the end-effector mechanism using appropriate 3D modeling software.
3. Understand the principles and workflow of the 3D printing process for fabricating the mechanism.

List of Experiments:

1. Study and review of various end-effector mechanisms used in robotic systems.
2. Development of a CAD model of an end-effector mechanism using 3D modeling software.
3. Fabrication of the end-effector model using 3D printing technology.

Course Code	Course Title				Category
24ES03TH0303	Microcontroller and Interfacing				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	00	02	50	50	03

Prerequisite: Basic Electronics

Course Objectives:

1. This course develops a strong foundation in 8051 microcontroller architecture, programming, and peripheral interfacing, along with skills in Embedded C and real-time control.
2. It focuses on sensor–actuator integration for robotics applications and introduces industrial and wireless communication protocols relevant to IIoT systems.
3. The course advances to ARM Cortex-M architecture, providing exposure to Free RTOS and Edge AI deployment for intelligent autonomous systems.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Describe the architecture, memory organization, and peripherals of the 8051 microcontroller.
CO2: Develop 8051 assembly and Embedded C programs using timers, interrupts, and serial communication.
CO3: Interface sensors and actuators with 8051 for basic motor control and obstacle detection applications.
CO4: Select suitable wired and wireless communication protocols for IIoT and robotics network requirements.
CO5: Design an ARM Cortex-M based embedded system integrating FreeRTOS for real-time robotics applications

UNIT I: Introduction to microcontrollers **07 Hrs.**

Micro-controller Vs Micro-processor, Embedded System, Criterion for selection of Microcontrollers, Other members of 8051 Family, 8051 architecture, Pin diagram, clock and oscillator, flags, PSW register, Internal Memory, External Memory, Idle mode, Power down mode, SFR's, counter, timer, I/O Port Pins and their functions, Assembling and running an 8051 Program.

UNIT II: Microcontroller Instruction Set and programming **08 Hrs.**

Register Banks, ROM Memory Map, RAM Memory Map, Program Counter, Stack in 8051, Overview of Assembly Language instruction set, Addressing modes of 8051, Advantages of 8051 Programming in Embedded C, Data types in Embedded C, Timer & Counter Programming, Serial Communication, Interrupts.

UNIT III: 8051 Interfacing 08

LCD and Keyboard Interfacing, Sensor Interfacing, Ultrasonic and IR distance sensor interfacing for obstacle detection, DC motor control via PWM and H-Bridge (L293D), Servo motor interfacing for robotic arm positioning, Interfacing external SRAM, EPROM/Flash memory to 8051 microcontroller, Interfacing external RAM and Flash, Timing diagrams and wait states in memory interfacing, 8051

Interfacing with 8255

UNIT IV: Communications and protocols

Buses and protocols, RS-232C, RS-485, I2C, SPI, Modbus, CAN, DeviceNet, EtherNet/IP Protocols, Wireless Protocols, Protocols for IIoT, IR sensors, Wireless Sensors & Actuators Network, MQTT protocol for robot telemetry and IIoT data pipelines, BLE (Bluetooth Low Energy) for short-range robot communication, Zigbee/Thread for mesh-based wireless sensor networks, LoRaWAN for long-range low-power field robots, OPC-UA for smart factory and collaborative robot integration.

UNIT V: ARM Microcontroller

Features, comparison & selection of ARM series as per application (Cortex-M0/M3/M4/M7/M33 selection for robotics workloads), ATMEL AVR architecture — MCU, Program and Data memory organization, Pin out diagram, Overview of instruction set, STM32 as practical ARM platform: HAL library, advanced PWM for BLDC/servo control, DMA for sensor pipelines, FreeRTOS task and queue model for real-time robot firmware, micro-ROS on FreeRTOS as bridge between embedded firmware and ROS2 ecosystem

TEXT BOOKS:

- Bolton, W. Mechatronics, Pearson Education.
- Alciatore, D.G., and Histand, M.B. Introduction to Mechatronics and Measurement Systems, McGraw Hill.

M. A. Mazidi, S. Naimi, and S. Mazidi, The AVR Microcontroller and Embedded Systems: Using Assembly and C, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2014.

REFERENCE BOOKS:

- J. W. Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, 5th ed. Austin, TX, USA: CreateSpace Independent Publishing, 2013.
- D. Ibrahim, ARM-Based Microcontroller Projects Using mbed, Burlington, MA, USA: Newnes, 2019.

F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction

- , New York, NY, USA: Wiley, 2001.
- A. R. Rajkamal, Embedded Systems: Architecture, Programming and Design, 3rd ed. New Delhi, India: McGraw Hill Education, 2019.

A. Kurniawan, Internet of Things Projects with ESP32, Birmingham, UK: Packt Publishing, 2019.

Course Code	Course Title				Category
24ES03PR0303	Microcontroller and Interfacing Lab				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	02	50		02

Prerequisite: Basic Electronics

Course Objectives:

1.

List of Experiments

1. Write and execute an Assembly language program for basic data transfer and arithmetic operations in 8051 microcontrollers
2. Write an Assembly language program to implement decision-making and array processing (largest/smallest number)
3. **Write a program to interface a 4×4 matrix keypad with microcontroller and display the pressed key on an LED/LCD.**
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.**
5. Interface a 16×2 LCD with microcontroller and display dynamic messages
6. Interface and control a DC/Stepper motor for direction and speed control
7. Implement a traffic light control system using LEDs with timing logic
8. Implement UART communication between microcontroller and PC/controllers

9. Interface wireless module (Bluetooth/ZigBee/Wi-Fi) for sensor data transmission

10. Develop an ARM-based application using ARM Cortex-M series for sensor-based decision making

Course Code	Course Title				Category
24ES03TH0304	Introduction to Python (IIIrd Semester)				PCC
Contact Hours per Week			CA	ESE	Credits
L	P	S			
02	00	00	50	00	02

Prerequisite:

Course Objectives:

1. To provide students with a solid foundation in the Python programming language which makes them to understand and apply fundamental programming concepts
2. To develop students' ability to implement control flow constructs, modular programming through the use of functions

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

CO1. Apply Python fundamentals, control structures, and basic programming constructs to develop logical solutions for computational problems.

CO2. Design and implement modular programs using functions and appropriate built-in data structures for efficient data manipulation.

CO3. Utilize file handling, exception management, and Python libraries to create robust and data-driven applications.

CO4. Integrate Python programming concepts to plan, develop, test, and document mini projects for real-world problem-solving.

UNIT I: Python Fundamentals and Control Structures	**08 Hrs.**

Python installation, IDEs (IDLE, VS Code), Python syntax, keywords, identifiers, variables, data types, type casting, input/output functions, arithmetic operators, logical operators, conditional statements (if, elif, else), loops (for, while), loop control statements (break, continue, pass)

UNIT II: Functions, Modular Programming, and Data Structures	**9 Hrs.**

Function definition, calling functions, parameters, return values, variable scope (local, global), user-defined functions, string operations and methods, list creation and manipulation, tuple operations, dictionary operations, set operations, Concept of OOPs using Python

UNIT III: File Handling, Exception Management, and Libraries	**9 Hrs.**
File operations (read, write, append), working with CSV files, structured data handling, exception handling (try, except, finally, raise), math library, random library, datetime library, introduction to numpy, introduction to pandas	
UNIT IV: Data Handling, Visualization, and Applications	**8 Hrs.**
Data processing tasks, data cleaning using Pandas, data analysis using NumPy and Pandas, data visualization using Matplotlib (plots, bar charts, histograms, customization), integration of Python concepts for problem-solving, project planning, coding and debugging, testing and documentation, mini project development and 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

24ES03PR0304	Introduction to Python Lab (IIIrd Semester)				PCC
Contact Hours per Week			CA	ESE	Credits
L	P	S			
00	01	00	50	00	01

Prerequisite:

Course Objectives:

1. To provide hands-on experience in implementing Python programs using fundamental programming concepts.
2. To develop problem-solving skills through Python programming and modular program design.
3. To familiarize students with Python libraries for data handling and visualization.
4. To enable students to develop simple real-world applications using Python.

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

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

CO1: Develop Python programs using variables, operators, input/output, and control structures.

CO2: Implement modular programs using functions and Python data structures.

CO3: Develop applications using file handling, exception handling, and standard Python libraries.

CO4: Perform data analysis, visualization, and mini-project development using NumPy, Pandas, and Matplotlib

List of Experiments	08 Hrs.

1. Write a Python program to perform basic arithmetic operations (addition, subtraction, multiplication, division) using user input. (CO1)
2. Develop a program to demonstrate the use of different data types and type casting. (CO1)
3. Write a program to check whether a number is even or odd using conditional statements. (CO1)
4. Write a Python program to perform basic arithmetic operations (addition, subtraction, multiplication, division) using user input. (CO2)
5. Develop a program to demonstrate the use of different data types and type casting. (CO2)
6. Write a program to check whether a number is even or odd using conditional

statements. (CO2)
7. Write a program to create, write, and read a text file. (CO2)
8. Develop a program to handle exceptions using try, except, and finally blocks. (CO3)
9. Write a program to demonstrate the use of the math, random, and datetime libraries. (CO3)
10. Develop a program to read and write CSV files. (CO3)
11. Write a program to clean a dataset using Pandas (handling missing values, duplicates). (CO3)
12. Develop a program to filter and analyze data using Pandas. (CO4)
13. Write a program to visualize data using Matplotlib (line plot, bar chart). (CO4)
14. Develop a program to plot a histogram and pie chart using Matplotlib. (CO4)
15. Write a program integrating NumPy and Pandas for data analysis. (CO4)

Course Code	Course Title				Category
24ES03TH0205	Design Thinking				AEC
Contact Hours per Week			CA	FE	Credits
L	P	S			
01	00	02	50		01

Course Objectives

1. To introduce to the students the concept of design thinking.
2. To make the students as sound designers by imparting creativity and problem-solving ability.
3. To conceive, conceptualize, design, and demonstrate innovative ideas using prototypes.

Course Outcomes

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

CO1. Examine critical theories of design, systems thinking, and design methodologies.
CO2. Produce great designs, be a more effective engineer, and communicate highly emotionally and intellectually.
CO3. Apply the diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices.
CO4. Conceive, organize, lead and implement projects in the interdisciplinary domain and address social concerns with innovative approaches.

Unit-1: Design process

Traditional design, design thinking, existing sample design projects, study on designs around us, compositions /structure of a design.

Unit 2: **Innovative design**

Breaking of patterns, reframe existing design problems, principles of creativity.

Unit 3: Empathy

Customer needs, insight-leaving from the lives of others/standing on the shoes of others, observation.

Unit 4: Conceptualization

Visual thinking, concept generation methodologies, Concept Selection, Concept Testing, Prototyping. Design projects for teams.

Text Books / References

Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation,
HarperCollins Publishers Ltd.
Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons Inc
Brenda Laurel Design Research methods and perspectives MIT press 2003
Terwiesch, C. & Ulrich, K.T., 2009. Innovation Tournaments: creating and identifying Exceptional

Opportunities,
Harvard business press.
Ulrich &Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004.
Stuart Pugh, Total Design: Integrated Methods for Successful Product Engineering,
BjarkiHallgrimsson, Prototyping and model making for product design, 2012, Laurence King Publishing Ltd
Kevin Henry, Drawing for Product designers, 2012, Laurence King Publishing Ltd.

Course Code	Course Title				Category
24ES03PR0205	**Design Thinking Lab**				AEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	02	02	50		01
Course Objectives					

Semester IV

<table>
<tr><th colspan="6">SEMESTER IV</th></tr>
<tr><th>Course Code</th><th colspan="4">Course Title</th><th>Category</th></tr>
<tr><td>24ES03TH0401</td><td colspan="4">Kinematics and Dynamics of Robot</td><td>PCC</td></tr>
<tr><th colspan="3">Contact Hours per Week</th><th rowspan="2">CA</th><th rowspan="2">ESE</th><th rowspan="2">Credits</th></tr>
<tr><th>L</th><th>P</th><th>S</th></tr>
<tr><td>03</td><td>00</td><td></td><td>50</td><td>50</td><td>03</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="5">UNIT I: Coordinate Frames, Mapping & Transforms</td><td>08 Hrs.</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="5">UNIT II: Forward Kinematics of Robot</td><td>08 Hrs.</td></tr>
</table>

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.

SEMESTER IV					
Course Code	**Course Title**				**Category**
26ES03PR0401	**Kinematics and Dynamics of Robot Lab**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
00	02		50		**01**

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
24ES03TH0405	Control Systems for Robotics				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	0	-	50	50	03

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.

Course Code	**Course Title**				**Category**
24ES03PR0405	**Control Systems for Robotics Lab**				**PCC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	**2**	**-**	**50**		**01**

Prerequisite:

Course Objectives:

Course Outcomes:

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)

Course Code	Course Title				Category
24ES03TH0402	Machine Learning				PCC
Contact Hours per Week			CA	ESE	Credits
L	T	D/P			
03	00	00	50	50	03

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,	
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), 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	
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: 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 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.	

Course Code	Course Title				Category
24ES03PR0402	Machine Learning Lab				PCC
Contact Hours per Week			CA	ESE	Credits
L	T	D/P			
00	00	02	25	25	01

Prerequisite: Introduction to Python.

Course Objectives:

1. To provide hands-on experience in implementing machine learning algorithms using Python and its scientific computing libraries.
2. To develop practical skills in data preprocessing, model development, evaluation, visualization, and deployment of machine learning solutions for robotics and AI applications.

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

CO1. Perform data acquisition, preprocessing, visualization, and exploratory data analysis using Python libraries such as NumPy, Pandas, and Matplotlib.

CO2. Implement supervised machine learning algorithms for regression and classification problems, and evaluate their performance using appropriate performance metrics.

CO3. Develop unsupervised learning models and dimensionality reduction techniques to discover hidden patterns and visualize high-dimensional datasets.

CO4. Apply ensemble learning methods, model selection techniques, and hyperparameter optimization to improve machine learning model performance.

CO5. Design, implement, and evaluate basic artificial neural network models and machine learning applications for real-world engineering problems using appropriate Python frameworks.

Course Code	Course Title			Category
26ES03TH0403	Mechatronics			PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
02	00	01	50	50	02

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.

Course Code	Course Title				Category
26ES03PR0403	Mechatronics Lab				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
00	02	01	50		01

Prerequisite: Basic Electronics

Course Objectives:

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

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
24ES03PR0404	Mini Project-1				CFP/MP
Contact Hours per Week			CA	ESE	Credits
L	P	S			
00	02	03	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
25ES04AECPR0408	**Basic Competitive coding**				AEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	00	02	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 :

CO1. Understand problem statements and implement basic algorithms.
CO2. Apply arrays and string manipulation techniques.
CO3. Solve problems using recursion and basic backtracking.
CO4. Implement searching and sorting techniques.
CO5. 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
24HS01TH0401	**Environmental Science**				VEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
01	00	00	50	-	**01**

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

Course Code	Course Title				Category
24HS01PR0401	**Environmental Science Lab**				VEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	02	00	50	-	**01**
Prerequisite:					
Course Objectives: 5.					

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

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.

Course Code	Industrial Hydraulics and Pneumatics				Category
24ES03TH0502					PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	0	3	50	50	3

Prerequisite: Students should have a basic understanding of Fluid properties, pressure and fundamental laws. Familiarity with mechanical systems and components is essential. Basic knowledge of electrical circuits, will also be beneficial.

Course Objectives:

1. To understand the fundamental principles of industrial hydraulics and pneumatics, including fluid properties, system components and working mechanisms.
2. To analyze hydraulic and pneumatic systems used in industrial applications.

Course Outcomes:

CO1: Understand the fundamentals of fluid power systems, including the basic principles and components of hydraulic systems.
CO2: Identify and classify hydraulic pumps, actuators and compressors for various industrial applications.
CO3: Analyse the operation and performance of hydraulic components and circuits.
CO4: Describe the fundamentals of pneumatic systems, including the construction, working and applications of pneumatic components.
CO5: Study the hydraulic and pneumatic circuits for industrial applications.

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 oils and compressed air. Properties of fluids: viscosity, density, compressibility, lubrication and contamination. Basic principles of hydraulics, Bernoulli's applications and Pascal's Law and its applications.

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

Sources of hydraulic power: Pumps and compressors. Types of pumps; construction, working principle, advantages, disadvantages, and industrial applications. Hydraulic actuators: hydraulic cylinders- types (single-acting, double-acting, etc.), construction, working and applications.

UNIT III: Hydraulic Valves and Circuits — **8Hrs.**

Control valves: Direction control valves (types and operation), flow control valves and pressure control valves. Hydraulic circuits: Basic and industrial circuits such as regenerative, pressure intensifier and speed control. Hydraulic accumulators and their applications. Pipes and hoses: types, materials and piping connections.

UNIT IV: Pneumatic Systems — **8Hrs.**

Properties of compressed air, perfect gas laws and their applications in pneumatics, air generation and distribution. Air compressors and air receivers, air preparation units: Filter, regulator and lubricator. Pneumatic control valves: Directional control valves, flow control valves and pressure control valves. Special valves: quick exhaust valve and shuttle valve, pneumatic actuators.

UNIT V: Industrial Applications — **8Hrs.**

Hydraulic and pneumatic circuits for industrial applications: Hydraulic press, drilling machine, surface grinding machine, fork-lift system, pick-and-place operations, tool handling in CNC machines and safety considerations in industrial fluid power systems.

TEXT BOOKS:

1. R. K. Bansal: Fluid mechanics and hydraulic machines
2. R. K. Rajput: Fluid mechanics and hydraulic machines
3. Pipenger J.J., Industrial Hydraulics, McGraw Hill Co.
4. Sahashtrabudhe N.V., Introduction to Fluid Power, Nirali Prakashan Pune.
5. 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.

Course Code	Industrial Hydraulics and Pneumatics lab				Category
24ES03PR0502					PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
0	2	2	50	50	1

Prerequisite: Students should have a basic understanding of Fluid properties, pressure and fundamental laws. Familiarity with mechanical systems and components is essential. Basic knowledge of electrical circuits, will also be beneficial.

Course Objectives:

1.To develop practical skills in identifying, assembling, operating, and testing hydraulic and pneumatic components and circuits used in industrial fluid power systems.

2.To provide knowledge of analyzing the performance of hydraulic and pneumatic systems, diagnosing basic faults, and understanding their integration with industrial automation systems.

Course Outcomes:

1.Identify and demonstrate the construction and working of hydraulic and pneumatic components such as pumps, valves, actuators, seals, accumulators, compressors, and air preparation units.

2.Operate basic hydraulic and pneumatic circuits using standard industrial components by following laboratory procedures.

3.Inspect hydraulic and pneumatic systems by evaluating component performance, leakage, contamination, and operational faults.

4.Demonstrate hydraulic and pneumatic automation systems integrated with CNC machines, PLC modules, VMCs, and other industrial equipment for specified applications.

LIST OF PRACTICALS : **Any 8**

1) Study of hydraulic fluid used in hydraulic system
2) Study of contamination of oil and its control in hydraulic system
3) Study of seals used in hydraulic system
4) Study of hydraulic pump, accumulator and intensifier
5) Study and demonstration of control valves used in hydraulic system

6) Study of air preparatory used in pneumatic system
7) Study and demonstration of control valves used in pneumatic system
8) Study and demonstration pneumatic circuit trainer
9) Demonstration of hydraulic circuits used in CNC Lathe
10) Demonstration of hydraulic and pneumatic circuits used in VMC
11) Demonstration of pneumatic circuit used in CNC Milling Machine
12) Study and demonstration of hydraulic system in power saw, tool cutting and grinding machine and pipe bending machine.
13) Demonstration based learning of hydraulic circuits used in EDM machine
14) Demonstration based learning of pneumatic circuits,valves used in CMM machine
15) Automation integration using PLC add-on modules (Pneumatic and Hydraulic) for linear actuation of sorting mechanism

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Mutli Disciplinary Minor (MDM-1- For other schools)

Course Code:			Course: Robotic Foundation
L: 2	T: 0	P: 2	Total Credits: 3

Unit 1: Introduction To Robotics: Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots.

Unit 2: Robot Anatomy and Motion Analysis: Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Work volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.

Unit 3: Robot Drives and End Effectors: Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1-DOF, 2-DOF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.

Unit 4: Path Planning: Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial-Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.

Unit 5: Robotics Applications: Material Handling: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots

Text Books:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.
2. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, “A textbook on Industrial Robotics”, University science press, 3rdedition,2017.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987. https://www.robots.com/applications.

Web links and Video Lectures (e-Resources):

1. https://roboticscasual.com/ros-tutorial-pick-and-place-task-with-the-moveit-c-interface/
2. https://roboticscasual.com/ros-tutorial-simulate-ur5-robot-in-gazebo-urdf-explained/
3. https://roboticscasual.com/the-best-degrees-to-work-in-robotics/
4. https://roboticscasual.com/robotics-tutorials/
5. https://www.ieee-ras.org/educational-resources-outreach/educational-material-in-robotics-and-automation
6. https://www.academia.edu/20361073/Web_Based_Control_and_Robotics_Education_pdf
7. https://github.com/Developer-Y/cs-video-courses
8. https://www.isa.org/
1. https://www.asme.org/engineering-topics/articles/bioengineering/top-6robotic-applications-in-medicine.

Mutli Disciplinary Minor ((MDM-2- For other schools)

Course Code:			Course: Mobile Robotics
L: 2	T: 0	P: 2	Total Credits: 3

Course Outcomes

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

CO1: Understand the concepts of mathematical models and motion control methods.
CO2: Apply various models of localization and navigation.
CO3: Analyze locomotion challenges and select motion-planning algorithms.
CO4: Design and develop autonomous mobile robots with obstacle avoidance.

Syllabus

Unit 1

Introduction to autonomous robotics, terrestrial and aerial locomotion, mobile robot kinematic models, maneuverability, workspace, and kinematic control. Perception – non-visual sensors and algorithms, computer vision, image processing, feature extraction – interest point detectors, range data.

Unit 2

Mobile robot localization, Noise and aliasing, belief representation, probabilistic map-based localization – Markoc and Kalman filter localization, Autonomous map building, SLAM paradigms - Extended Kalman filter, graph based and particle filter. Sensorial, geometric and topological maps, robot collectives – Sensing, communication, formation control, localization and mapping.

Unit 3

Planning and Navigation: Path planning. Graph search – Voronoi diagram, deterministic graph search, Dijkstra's algorithm, A*, D* algorithm, Randomized graph search, Potential field path planning. Obstacle avoidance – Bug algorithm, Techniques viz. bubble band, curvature velocity, dynamic window approach, Schlegel approach, gradient method, etc., Mobile robots in practice, delivery robots, intelligent vehicles, mining automation, space robotics, underwater inspection, etc. .

Text Books

1. *Roland Siegwart, Illah R. Nourbakhsh, and DavideScaramuzza. (2011). Introduction to Autonomous MobileRobots. 2nd edition, The MIT Press.*
2. *Gregory Dudek, and Michael Jenkin. (2010). Computational Principles of Mobile Robotics. Second edition, Cambridge University press*

Reference Books

1. *Ulrich Nehmzow, (2012). Mobile Robotics: A Practical Introduction Second Edition. Springer.*
2. *Peter Corke (2017). Robotics, Vision and Control Fundamental Algorithms in MATLAB®. Second Edition. Springer*
3. *Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian*

4. *Thrun (2005) Principles of Robot Motion Theory, Algorithms, and Implementation, MIT press.*
5. *Sebastian Thrun, Wolfram Burgard, Dieter Fox. (2002) Probabilistic Robotics. The MIT press.*
6. *Steven M. LaValle. (2006). Planning Algorithms, Cambridge University Press.*

Mutli Disciplinary Minor (MDM-3- For other schools)

Course Code:			Course: Modeling and Simulation of Robotic System
L: 2	T: 0	P: 2	Total Credits: 3

Course Objectives:

1. Understand the fundamental principles of robotic modeling.
2. Develop mathematical models of robotic systems.
3. Simulate robotic systems using various simulation tools.
4. Analyze the performance and behavior of robotic systems through simulations.
5. Apply the concepts of kinematics, dynamics, and control in robotic systems modeling.

Prerequisites:

1. Basic knowledge of robotics.
2. Proficiency in linear algebra, calculus, and differential equations.
3. Familiarity with programming languages such as MATLAB or Python.

Unit 1: Introduction to Robotic Systems

- Overview of robotics and its applications.
- Introduction to modeling and simulation.
- Tools and software used in robotic simulations (MATLAB, Simulink, ROS, Gazebo).
- Coordinate transformations and homogeneous transformations.
- Introduction to robot kinematics.
- Forward and Inverse Kinematics

Unit 2: Dynamics and Control of Robotic Systems

- Newton-Euler and Lagrangian dynamics.
- Deriving equations of motion for robotic systems.
- Introduction to control systems for robotics.
- PID control, state-space representation, and modern control methods.

Unit 3: Simulation Techniques and Tools

- Overview of simulation techniques.
- Detailed introduction to ROS (Robot Operating System) and Gazebo for robotic simulations.

Unit 4: Sensor Modeling and Integration

- Modeling and simulating sensors (e.g., cameras, LIDAR, IMUs).
- Sensor integration in robotic systems.

Unit 5: Path Planning and Navigation

- Algorithms for path planning (e.g., A*, RRT, Dijkstra's).

- Implementing path planning and navigation in simulations.

Textbooks:

- "Introduction to Robotics: Mechanics and Control" by John J. Craig.
- "Robot Modeling and Control" by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar.
- "Modelling and Control of Robot Manipulators" by Lorenzo Sciavicco and Bruno Siciliano.

Software:

- MATLAB/Simulink
- ROS (Robot Operating System)
- Gazebo

Mutli Disciplinary Minor (MDM-4- For other schools)

Course Code:			Course: Design of Robotic Systems
L: 2	T: 0	P: 2	Total Credits: 3

Course Objectives:

- Understand the principles of robotic system design.
- Learn the process of designing robotic systems for various applications.
- Gain practical experience in designing robotic hardware and control systems.
- Analyze and optimize robotic system performance through design iterations.
- Apply principles of engineering, mechanics, and electronics to robotic design challenges.

Prerequisites:

- Basic knowledge of robotics and mechanical engineering.
- Proficiency in CAD software (e.g., SolidWorks, AutoCAD).
- Familiarity with programming languages such as MATLAB or Python.

Unit 1: Introduction to Robotic System Design

- Overview of robotic system design process.
- Types of robotic systems and their applications.
- Design requirements and specifications.
- Mechanical components of robots (joints, actuators, linkages).
- Design principles for robot manipulators.
- Material selection and fabrication techniques.

Unit 2: Sensors and Actuators Integration and control

- Sensors for robotic systems (e.g., proximity sensors, encoders).
- Actuators and motors (DC motors, stepper motors, servos).
- Integration of sensors and actuators in robotic designs.
- Introduction to control theory for robotic systems.
- PID control, state-space representation.
- Designing control systems for robots.

Unit 3: Robot Prototyping and Testing

- Prototyping techniques and rapid prototyping tools.
- Testing methodologies and performance evaluation.
- Iterative design process and feedback loops.
- Safety considerations in robotic system design.

Unit 4: Design for Manufacturing and Assembly (DFMA)

- DFMA principles in robotic system design.
- Design optimization for manufacturing efficiency.
- Assembly techniques and considerations.

Project Development: Students work on a comprehensive robotic system design project which involves conceptual design, prototyping, and testing.

- **Textbooks:**

1. "Robot Modeling and Control" by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar.
2. "Introduction to Autonomous Robots" by Roland Siegwart, Illah R. Nourbakhsh, and DavideScaramuzza.
3. "Mechatronics: Principles and Applications" by Godfrey C. Onwubolu.

- **Software and Tools:**
  - CAD software (SolidWorks, AutoCAD)
  - MATLAB or Python for control system design
  - Simulation tools (ROS, Gazebo)

Mutli Disciplinary Minor

Course Code:			Course:
L: 2	T: 0	P: 2	Total Credits: 3

Mutli Disciplinary Minor

Course Code:			Course:
L: 2	T: 0	P: 2	Total Credits: 3

Honors-1 (Sem-III)

Course Code:			Course: Advanced Robotics and Analysis
L:	T: 0	P:	Total Credits:

Unit 1

Review of robot manipulator (Serial and Parallel), D-H convention, Forward and Inverse kinematics, Workspace,
Analytical and numerical solutions, vibration isolation.

Unit 2

Redundancy and resolution of redundancy in robots, minimizing joint rotations and cartesian motion, Tractrix based approach (resolution, planar and spatial). Experimental 8-link hyper-redundant manipulator, Dynamic equations of motion, derivation & simulation, Recursive inverse dynamics: Newton-Euler formulation, Articulated body algorithm, Chaos and non-linear dynamics, Pseudo-inverse approach, modal approach for straight and circular trajectory.

Unit 3

Simulation on linear control, motion planning, nonlinear position and force control of 6 DOF robot manipulator, partitioning of tasks. Numerical and analytical solutions, Over-constrained and deployable structures – modeling and analysis, Cable driven & pneumatically actuated flexible robots.

Text Book

Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.

Reference Books

R.K. Mittal and I.J. Nagrath, "Robotics and Control", Tata McGraw Hill.
John J Craig, "Introduction to Robotics: Mechanics and control", Printice Hall of India.
S. K. Saha, "Introduction to Robotics", Tata McGraw Hill.
K.S.Fu, R.C.Gonzalez and C.S.G.Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill.
M.W.Spong and M. Vidyasagar, "Robot Dynamics and Control", Wiley India.

Honors-2 (Sem-IV)

Course Code:			Course: Advanced Artificial Intelligence
L:	T: 0	P:	Total Credits:

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

- Explain in detail how the techniques in the perceive-inference-action loop work.
- Choose, compare, and apply suitable basic learning algorithms to simple applications.
- Ability to explain how deep neural networks are constructed and trained, and apply deep neural networks to work with large scale datasets.
- Understand and develop deep reinforcement learning algorithms for suitable applications.

Module 1:
Overview of Probability Theory, Bayes Networks, Independence, I-Maps, Undirected Graphical Models, Bayes Networks and Markov Networks, Local Models, Template Based Representations, Exact Inference: Variable Elimination; Clique Trees, Belief Propagation Tree Construction.

Module 2:
Intro to Optimization, Approximate Inference: Sampling, Markov Chains, MAP Inference, Inference in Temporal Models, Learning Graphical Models: Intro Parameter Estimation, Bayesian Networks and Shared Parameters.

Module 3:
Structure Learning, Structure Search Partially Observed Data, Gradient Descent, EM, Hidden Variables, Undirected Models, Undirected Structure Learning, Causality, Utility Functions, Decision Problems, Expected Utility, Value of Information, Decision- Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample application.

Suggested Text Books:
(i) Russell, Stuart and Norvig, Peter, Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.
(ii) Zhongzhi Shi, “Advanced Artificial Intelligence”, World Scientific Publishing Company, March 2011.
(iii) Luger " Artificial Intelligence", Edition 5, Pearson, 2008.

Suggested Reference Books:
(i) Daphne Koller and Nirfriedman, “Probabilistic Graphical Models”, MIT Press, 2009.
(ii) Russell and P. Norvig, “Artificial Intelligence”, Pearson Publication, 2020.
(iii) Cristopher Bishop: pattern Recognition and machine Learning, Springer, 2006.

Honors-3 (Sem-V)

Course Code:			Course: Human Machine Interface
L:	T: 0	P:	Total Credits:

Course Outcomes: At the end of the course, the students will be able to -

1. Identify User Interface (UI) design principles.
2. Analysis of effective user friendly interfaces.
3. Apply Interactive Design process in real world applications.
4. Evaluate UI design and justify.
5. Create application for social and technical task.

Unit 1: FOUNDATIONS OF HMI:

The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving . The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.

Unit 2: DESIGN & SOFTWARE PROCESS:

Mistakes performed while designing a computer system, Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds .Interactive Design basics, process, scenarios, navigation, Iteration and prototyping. HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process. Evaluation Techniques: Universal Design.

Unit 3: GRAPHICAL USER INTERFACE:

The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.

Unit 4: SCREEN DESIGNING:

Design goals , Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.

Unit 5: INTERFACE DESIGN FOR MOBILE DEVICES:

Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Unit 6: INTERACTION STYLES AND COMMUNICATION:

Windows: Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia and colors

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction‖, 3rdEdition,
Pearson Education, 2004.
2. Wilbert O. Galitz, ―The Essential Guide to User Interface Design‖, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, ―About Face3: Essentials of Interaction design‖,
Wiley publication.
4. Jeff Johnson, ―Designing with the mind in mind‖, Morgan Kaufmann Publication.
5. Donald A. Normann, ― Design of everyday things‖,Basic Books; Reprint edition 2002.
6. Brian Fling, ―Mobile Design and Development‖, First Edition , O'Reilly Media Inc., 2009.

Reference Books:

1. Rogers Sharp Preece,‖Interaction Design:Beyond Human Computer Interaction‖,,Wiley.
2. Guy A. Boy ―The Handbook of Human Machine Interaction‖, Ashgate publishing Ltd.
3. Kalbnde,Kanade,Iyer,‖Galitz's Human Machine Interaction‖, Wiley Publications.

Honors – 4 (Sem-VI)

Course Code:			Course: Advanced Drones Technology
L:	T: 0	P:	Total Credits:

Unit 1

Fixed Wing and Multirotor Micro Drones: Introduction – Drones – Kinematic and dynamics modelling formulation
of drones - Transformation and representations – Dynamics of a fixed-wing drones, Propeller theory – Thrust and
drag moment – Dynamics of a multi rotor micro drones (MMD) – Mathematical modelling of MMD

Unit 2

State Estimation: Physics and working of Navigational sensors – Inertial Sensors – Magnetometer – Pressure
sensors, GPS – Camera based navigation – Kalman filter – Position and velocity analysis, Inertial navigation
systems – Attitude estimation

Unit 3

Flight Controls and Motion Planning: PIC control – Lateral control of MMD, LQR – Design of servo LQR control,
Linear model predictive control – Design and implementation. Holonomic vehicle boundary value solver, Dubins
airplane model boundary value solver – collision free navigation, Structural inspection path planning

Text Books

R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012
R. C. Nelson, "Flight Stability and Automatic Control", McGraw Hill, New York, 1998.

Reference Books

L.R. Newcome, Unmanned Aviation, a Brief History of Unmanned Aerial Vehicles, American Institute of
Aeronautics and Astronautics, Reston, 2004.
Kuo, B. C., "Automatic Control Systems", Prentice Hall, 1991

Honors-5 (Sem-VII)

Course Code:			Course: Al in Natural Language Processing
L:	T: 0	P:	Total Credits:

Syllabus

Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems. Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Embedding: Word2vec, Glove and Fasttext. Language Model-n-gram, Sequences and sequential data: Part-of-Speech tagging-HMM and CRF, Named Entity recognition, Dependency parsing.

Evaluation metrics for NLP models and Visualization Machine learning and deep learning for NLP, Sequence to sequence modelling (Encoder decoder), Attention mechanism, Transformer Networks – BERT.

A brief introduction to Reinforcement learning for NLP. NLP application introduction-Sentiment Analysis, Machine translation, Question answering, Text summarization.

Text Books / References Books

'Foundations of Statistical Natural Language Processing', Christopher Manning and HinrichSchütze, MIT press,
1999
'Natural Language Processing with Python', Steven Bird, Ewan Klein and Edward Loper, O'Reilly Media,
Inc.", 2009.
'Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language
Problems (Ebook)', Jason Browlee, Machine Learning Mastery, 2017.
'Speech & language processing', Daniel Jurafsky, James H Martin, preparation [cited 2020 June 1] Available from:
https://web. stanford. edu/~ jurafsky/slp3 (2018).