Course Code	2312301						
Course Name	Robot Kinematics and Dynamics						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--				3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20			--	20	60	100

Prerequisites for the Course:

1. Computer Graphics for Robotics

2. Applied Mathematics III

The course aims to:

Course Objectives	Description
1	To understand the basic components and layout of linkages in the assembly of a system/ machine.
2	To understand robot work envelope geometries and motion control methods
3	To understand robot forward kinematics and inverse kinematics
4	To articulate robot forward dynamics and inverse dynamics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Select the type of mechanism for the robotic applications	2
CO2	Demonstrate robot work envelope geometries and motion control methods	2
CO3	Perform forward and inverse kinematic for a given application	3
CO4	Analyse manipulator forces and torques using forward and inverse robot dynamics	4

Course context, Relevance, Practical Significance:

Robot kinematics is the study of relationship between the dimensions and connectivity of kinematic chains and the position, velocity and acceleration of each of the links in the robotic system, in order to plan and control movement and to compute actuator forces and torques. The relationship between mass and inertia properties, motion, and the associated forces and torques is studied as part of robot dynamics. In practical robot programming, robot kinematics and dynamics plays an important role in motion planning, singularity avoidance, redundancy, collision avoidance etc.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Kinematics of mechanisms** Links, pairs, degree of freedom, Mechanisms, kinematics inversions of 4 bar and slider crank chain, kinematics analysis in simple mechanisms, velocity and acceleration polygons, Analytical methods, computer approach.	7	CO1

	Description of common mechanisms, applications of mechanisms.		
2	**Robotics manipulation** Robot classification, Robot configurations, work envelope geometries, motion control methods, Robot specifications: Number of axes, capacity and speed, reach and stroke, tool orientation, repeatability, precision, and accuracy, operating environment	7	CO2
3	**Robot Arm forward Kinematics** Types of grippers, Robot kinematics-Types- 2D, 3D transformation, Homogeneous co-ordinate frames, translations and rotations, composite homogeneous transformations, Denavit-Hartenberg (D-H) Representation, Forward kinematics analysis of manipulators. Simulation of forward kinematics.	7	CO3
4	**Robot Arm Inverse Kinematics** Inverse kinematics problem, inverse kinematics for open chains and closed chains, analytical approaches to solve inverse kinematics problems, numerical solutions for inverse kinematic problems, Inverse kinematics examples for articulated robots (ABB & KUKA) UR 5, KUKA IIWA, SCARA etc. Inverse kinematics of parallel robot. Simulation of Inverse kinematics.	7	CO3
5	**Robot Arm Dynamics** Robot dynamics–Rigid body dynamics, Lagrange Euler dynamic model, Recursive Newton-Euler formulation: Forward and backward Newton- Euler formulations. Forward and inverse dynamics. Case study on development of robot configuration for any given application considering the aspects of kinematics and dynamics of robot manipulator.	7	CO4

References Books

1. Yoram Koren, 'Robotics for Engineers', McGraw Hill Book Co. ISBN: 9780071005340
2. J. E. Shigley and J.J.Uicker Jr., 'Theory of Machines and Mechanism', McGraw Hill ISBN:019515598X

Text Books

1. S. R. Deb and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publications, New Delhi. ISBN: 9780071331296
2. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., 'Industrial Robotics: Technology Programming and Applications', McGraw Hill Book Co. ISBN 9780071004428
3. S. S. Ratan , 'Theory of Machines', Tata McGraw Hill, ISBN: ISBN0070591202
4. G K Grover', 'Mechanical Vibration', Nemchand and brothers. ISBN: 8185240752

e Resources

1. https://ecommons.cornell.edu/items/d0ec9495-2d37-4a17-888c-43fd7f8a8010 (e-Book on 'Kinematics and Synthesis of Linkages' by Hartenberg and Denavit, McGraw Hill Book Co.

Useful websites / Video

1. https://www.youtube.com/watch?v=unwUt3kkgvE
2. https://www.youtube.com/watch?v=B67ug1yx13E

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2											2	1
CO 2			3										2	1
CO 3			2	2	2								2	1
CO 4			3	2	2	1			1				2	1

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312302						
Course Name	Robot Path Planning						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course: Applied Mathematics I, Applied Mathematics II, Computational Thinking and C- programming.

The course aims to:

Course Objectives	Description
1	Understand the fundamental concepts of robot motion planning and configuration space.
2	Explore and apply sampling-based and roadmap-based motion planning algorithms.
3	Examine grid-based and cell decomposition techniques for path planning.
4	Understand and implement potential field methods for robot trajectory generation.
5	Analyze motion planning strategies for dynamic environments with multiple moving objects.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Describe the configuration space and apply sampling-based algorithms	2
CO2	Apply roadmap and grid-based search algorithms to solve static motion planning problems.	2
CO3	Use Cell decomposition for critical path planning	2
CO4	Utilize potential field techniques to generate feasible robot paths in known environments.	2
CO5	Analyze multiple moving objects	2

Course context, Relevance, Practical Significance: This course introduces key concepts and algorithms in robot motion planning, including sampling-based methods (PRM, RRT), grid and roadmap techniques (A*, Dijkstra), cell decomposition, and potential field methods. It also covers planning for multiple moving objects and robots. The course is highly relevant for applications in autonomous vehicles, drones, and industrial robots, providing practical skills for designing intelligent navigation systems in dynamic environments.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit 1: Fundamentals of Robot Motion Planning and Sampling-Based Methods:** Introduction to robot motion planning and configuration space, Representation of rigid body motion: Euclidean embedding, parameterization, quaternions, Obstacles and free space: obstacle configuration space, path connectivity **Sampling-based motion planning**: Probabilistic Roadmap (PRM), Rapidly-exploring Random Tree (RRT), RRT*	7	1
2	**Unit 2: Roadmap and Grid-based Search Methods:** **Roadmap Methods**: Visibility graph method, retraction approaches, freeway method, silhouette method, Voronoi graph. **Grid-based algorithms:** D* algorithm, A* algorithm, Dijkstra algorithm.	7	2
3	**Unit 3: Cell decomposition:** **Exact cell decomposition:** critical curves and non-critical regions, decomposition of free space, general approach to path planning, **Approximate cell decomposition:** Divide and label method, approximateand decompose, hierarchical graph searching.		3
4	**Unit 4: Potential field methods:** Potential field in translational case, potential guide path planning, depth first planning, best first planning, other potential functions.	7	4
5	**Unit 5: Multiple moving objects:** Planning with moving obstacles, planning with velocity bound, **Multiple robots systems**: centralized and decoupled planning.	7	5

References Books

1. Sebastian Thrun, Wolfram Burgard, and Dieter Fox Lynch, Probabilistic Robotics, MIT Press, 2005, ISBN: 9780262201629
2. Jean-Claude Latombe, Robot Motion Planning, Springer New York, NY, 2012, ISBN:978-0-7923-9206-4
3. Steven M. Lavalle, Planning Algorithms, Cambridge University Press.

Text Books

1. Steve LaValle, Planning Algorithms, Cambridge Univ. Press, New York, 2006, ISBN:978-0521862059

e Resources

1. https://www.roboticsbook.org/S55_diffdrive_planning.html

Useful websites / Video

1. https://archive.nptel.ac.in/courses/112/104/112104308/

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2	2	2	-	2	-	2	-	-	-	-	-	1	-	2
2	2	2	-	2	-	2	-	-	-	-	-	1	-	2
2	2	2	-	2	-	2	-	-	-	-	-	1	-	2
2	2	2	-	2	-	2	-	-	-	-	-	1	-	2
2	2	2	-	2	-	2	-	-	-	-	-	1	-	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312303						
Course Name	Microprocessors and Microcontrollers						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--				3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20			--	20	60	100

Prerequisites for the Course:

1. Basic Digital Electronics
2. Electrical Engineering

The course aims to:

Course Objectives	Description
1	**Introduce the fundamental architecture and working principles** of microprocessors and microcontrollers, with an emphasis on their role in robotics and industrial automation.
2	**Enable students to develop and analyze assembly language Programs** for performing control and automation tasks using microcontroller platforms.
3	**Impart knowledge of interfacing techniques** for integrating microcontrollers with external peripherals such as sensors, actuators, displays, and communication modules.
4	**Equip students with the ability to design, simulate, and implement embedded systems** relevant to real-time control in robotics and automation domains.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the architecture and working of microprocessors and microcontrollers.	Understand-2
CO2	Develop assembly and embedded C programs for basic computational tasks.	Apply-3
CO3	Interface microcontrollers with input/output devices for control applications.	Apply-3
CO4	Analyze and simulate timing, control, and communication operations using microcontrollers.	Analyze - 4

Course context, Relevance, Practical Significance:

This course introduces the architecture, programming, and interfacing techniques of microprocessors and microcontrollers, focusing on systems like the 8085, 8051, and modern embedded platforms. It is essential for understanding the core functioning of embedded systems used in robotics, automation, IoT, and consumer electronics. Students gain hands-on skills in writing assembly/C programs and interfacing peripherals, enabling them to design and implement real-time control and automation applications.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Advanced Microprocessors in Robotics and Automation:** Overview of microprocessors: architecture and operation, Introduction to x86/x64 and ARM Cortex-A series processors, Latest microprocessors in robotics, NVIDIA Jetson platform (e.g., Jetson Orin), Intel Atom & Core i-series in industrial automation, Raspberry Pi 5 (ARM-based SoC) in prototyping and automation, Integration with AI and edge computing, Real-time control and decision-making using microprocessors, Use cases: Autonomous robots, industrial arms, vision-based automation,Case study: Jetson Orin in autonomous mobile robots	7	CO1 CO2
2	**Introduction to Microcontrollers for Embedded Robotics** Architecture and features of modern microcontrollers, Introduction to ARM Cortex-M series (e.g., STM32, NXP LPC), Overview of Arduino, ESP32, and STM32 boards, Memory mapping, I/O ports, and peripheral interface, Differences between microcontrollers and microprocessors, Role of MCUs in closed-loop robotic control systems	7	CO1
3	**Advanced Microcontroller Programming and Peripherals** Timers, counters, watchdogs, UART, SPI, I2C protocols for robotic subsystems, Real-time interrupt handling and task scheduling, Motor control: stepper and servo interfacing, Sensor integration: ultrasonic, IR, IMU, encoders, Low power modes and battery optimization in mobile robots	7	CO4 CO5
4	**Advanced Microcontroller Programming and Peripherals** Wireless modules: Wi-Fi (ESP32), Bluetooth (BLE), Zigbee,CAN and RS485 in industrial automation, MQTT and HTTP protocols for robotic data exchange, Cloud connectivity using microcontrollers (e.g., Blynk, Firebase, AWS IoT), Remote monitoring and control of robots	7	CO2
5	**Application Development and Project Integration** Designing embedded systems for specific robotic tasks, Integration of microcontroller, sensors, and actuators, Power management, PCB design basics, Real-time operating systems (RTOS) in robotic applications, Debugging, testing, and deployment	7	CO3 CO4

References Books

1. Jonathan W. Valvano, "Embedded Systems: Introduction to the MSP432 Microcontroller" **Publisher:** Create Space Independent Publishing **Edition:** 1st Edition (2017) **ISBN:** 978-1512185676
2. Andrew N. Sloss, Dominic Symes, Chris Wright,"ARM System Developer's Guide: Designing and Optimizing System Software" **Publisher:** Morgan Kaufmann **Edition:** 1st Edition (2004)**ISBN:** 978-1558608740
3. Simon Monk,"Programming the Raspberry Pi: Getting Started with Python" **Publisher:** McGraw-Hill Education TAB **Edition:** 2nd Edition (2015) **ISBN:** 978-1259587405
4. Neil Kolban, "Internet of Things with ESP32"**Publisher:** Kolban Technical Books **Edition:** Latest edition (self-published, updated regularly) **ISBN:** 978-1717311656.
5. Peter Corke,"Robotics, Vision and Control: Fundamental Algorithms in MATLAB" **Publisher:** Springer **Edition:** 2nd Edition (2017) **ISBN:** 978-3319544120

Text Books

1. Krishna Kant,Microprocessors and "Microcontrollers: Architecture, Programming and System Design Using 8085, 8086 and 8051",**Publisher:** PHI Learning Pvt. Ltd. **Edition:** Revised 2nd Edition (2014) **ISBN:** 978-8120348530.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay,"The 8051 Microcontroller and Embedded Systems Using Assembly and C",**Publisher:** Pearson Education**Edition:** 2nd Edition (2006) **ISBN:** 978-8131709107.
3. Raj Kamal,"Embedded Systems: Architecture, Programming and Design",**Publisher:** McGraw Hill Education India **Edition:** 3rd Edition (2017) **ISBN:** 978-9352605170.
4. Rajkumar Buyya, Amir Vahid Dastjerdi, "*Internet of Things: Architecture and Design Principles",***Publisher:** Wiley India Pvt. Ltd. **Edition:** 1st Edition (2016) **ISBN:** 978-8126558926
5. Elecia White," Making Embedded Systems: Design Patterns for Great Software",**Publisher:** O'Reilly Media**Edition:** 1st Edition (2011)**ISBN:** 978-1449302146.

E Resources

https://www.engineeringbooks.in/books/eee-electrical-and-electronics/eee-sem-5-r2017/ee8551-microprocessors-and-microcontrollers?utm_source=chatgpt.com
("Microprocessor Architecture, Programming and Applications with the 8085" by R. S. Gaonkar A comprehensive guide to Intel 8085 architecture, instruction set, and interfacing Available as a full PDF scan via the Internet Archive)

Useful websites / Video

1. **NVIDIA Jetson Embedded Tutorials**
   NVIDIA's official resource for Jetson, including hands-on demos with Jetson Orin, DeepStream, and AI-on-edge application
2. **STM32 PWM Generation Tutorial**
   Step-by-step explanation of PWM using STM32 timers, including code and theory reddit.com+1reddit.com+1visualgdb.com+4deepbluembedded.com+4embetronicx.com+4
3. **DeepBlu Embedded – STM32 L293D DC Motor Control**
   Practical example using STM32 with L293D H-Bridge for bidirectional motor control via PWM deepbluembedded.com+1deepbluembedded.com+1.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low, 2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping

Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	-	-	-	-	-	-	-	-	2	3	2
CO 2	3	3	2	-	2	-	-	-	-	-	-	2	3	2
CO 3	3	3	3	2	2	-	-	-	2	-	-	2	3	3
CO 4	3	3	3	3	3	-	-	-	2	-	-	2	3	3
CO 5	3	3	3	3	3	2	2	-	3	2	2	3	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using Microcontrollers & Microprocessors	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312304						
Course Name	Robot Kinematics and Dynamics Lab						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		2		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	--	25	25	--	--	--	50

Prerequisites for the Course:
1. Computer Graphics for Robotics
2. Applied Mathematics III

The course aims to:

Course Objectives	Description
1	To understand the basic components and layout of linkages in the assembly of a system/ machine.
2	To understand robot work envelope geometries and motion control methods
3	To understand robot forward kinematics and inverse kinematics
4	To articulate robot forward dynamics and inverse dynamics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Select the type of mechanism for the robotic applications	2
CO2	Demonstrate robot work envelope geometries and motion control methods	2
CO3	Perform forward and inverse kinematic for a given application	3
CO4	Analyse manipulator forces and torques using forward and inverse robot dynamics	4

Course context, Relevance, Practical Significance:

Robot kinematics is the study of relationship between the dimensions and connectivity of kinematic chains and the position, velocity and acceleration of each of the links in the robotic system, in order to plan and control movement and to compute actuator forces and torques. The relationship between mass and inertia properties, motion, and the associated forces and torques is studied as part of robot dynamics. In practical robot programming, robot kinematics and dynamics plays an important role in motion planning, singularity avoidance, redundancy, collision avoidance etc.

Course Contents:

Experiment No.	Contents	Pr. Hours	Cos Mapped
1	Simulation of four bar and slider crank mechanism	2	CO1
2	Design of planetary mechanism for robot joint	2	CO2
3	Forward kinematics of articulated robot and simulation using Robo-analyser	2	CO3

4	Forward kinematics of SCARA robot and simulation using Robo-analyser	2	CO3
5	Inverse kinematics of articulated robot and simulation using Robo-analyser	2	CO3
6	Inverse kinematics of 4 DOF robot and simulation using Robo-analyser	2	CO3
7	Forward and inverse kinematics of parallel robot	2	CO3
8	Robot forward and inverse Dynamic using Matlab/Robo-analyser	2	CO4

References Books

1. Yoram Koren, 'Robotics for Engineers', McGraw Hill Book Co. ISBN: 9780071005340
2. J. E. Shigley and J.J.Uicker Jr., 'Theory of Machines and Mechanism', McGraw Hill ISBN:019515598X

Text Books

1. S. R. Deb and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publications, New Delhi. ISBN: 9780071331296
2. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., 'Industrial Robotics: Technology Programming and Applications', McGraw Hill Book Co. ISBN 9780071004428
3. S. S. Ratan , 'Theory of Machines', Tata McGraw Hill, ISBN: ISBN0070591202
4. G K Grover', 'Mechanical Vibration', Nemchand and brothers. ISBN: 8185240752

e Resources

1. https://ecommons.cornell.edu/items/d0ec9495-2d37-4a17-888c-43fd7f8a8010 (e-Book on 'Kinematics and Synthesis of Linkages' by Hartenberg and Denavit, McGraw Hill Book Co.

Useful websites / Video

1. https://www.youtube.com/watch?v=unwUt3kkgvE
2. https://www.youtube.com/watch?v=B67ug1yx13E

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2											2	1
CO 2			3										2	1
CO 3			2	2	2								2	1
CO 4			3	2	2	1			1				2	1

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312305						
Course Name	Microprocessors and Microcontrollers Lab						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		2		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	--	25	25	--	--	--	50

Prerequisites for the Course:

1. Basic Digital Electronics
2. Electrical Engineering

The course aims to:

Course Objectives	Description
1	**To develop hands-on skills in programming microprocessors and microcontrollers** using assembly and embedded C language for performing arithmetic, logical, and control operations.
2	**To demonstrate the ability to interface microcontrollers with peripheral devices** such as LEDs, switches, sensors, motors, displays, and communication modules.
3	**To apply microcontroller-based solutions in designing, testing, and implementing embedded control systems** for basic automation and robotic applications.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Develop and implement assembly and embedded C programs for performing basic arithmetic, logical, and control operations on microprocessor and microcontroller platforms.	Understand -2
CO2	Interface microcontrollers with various I/O devices (sensors, actuators, displays) to design and test embedded control applications relevant to robotics and automation.	Apply-3
CO3	Demonstrate the ability to simulate, debug, and validate microcontroller-based systems through practical experiments and mini-projects	Apply-3

Course context, Relevance, Practical Significance:

This lab helps students learn how microprocessors and microcontrollers work through programming and real-time applications. It is highly relevant in robotics and automation, where embedded systems control machines, sensors, and actuators.

Course Contents:

Experiment No.	Contents	Pr. Ho	Cos Mapp

		urs	ed
1	Write and execute an **assembly language program** on 8085/8051 to perform **8-bit addition and subtraction**	2	CO1
2	Develop an **embedded C program** to perform **logical operations** (AND, OR, XOR) on two 8-bit numbers using 8051/Arduino.	2	CO1
3	Write an embedded C program to **generate a square wave** on a microcontroller pin using **timer/counter**.	2	CO1
4	Interface **LEDs and switches** with a microcontroller and write a program to **control LEDs based on switch input**.	2	CO2
5	Interface a **16x2 LCD display** with a microcontroller and display a custom message (e.g., "Hell Robotics")	2	CO2
6	Write a program to **read analog input from a temperature sensor (e.g., LM35)** and display the result on an LCD or serial monitor.	2	CO2
7	Interface a **DC motor or servo motor** with a microcontroller and control its speed/direction using PWM.	2	CO3
8	Simulate and test a **basic traffic light control system** using microcontroller output ports.	2	CO3
9	Develop a program for **serial communication (UART)** between a microcontroller and PC (or between two MCUs).	2	CO3
10	**Mini-project**: Design and implement a small embedded system (e.g., **line follower, temperature-based fan control, obstacle detector**) integrating sensors and actuators.	2	CO3

References Books

1. "The 8051 Microcontroller and Embedded Systems: Using Assembly and C" Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay Pearson Education **ISBN-13:** 978-0131194021
2. Ajay V. Deshmukh "Microcontrollers and Applications" Tata McGraw Hill ISBN-13: 978-0070585959

Text Books

1. A. P. Godse, D. A. Godse "Microprocessor and Microcontroller Laboratory Manual" Technical Publications, ISBN-13: 978-8184311695
2. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay "The 8051 Microcontroller and Embedded Systems " Using Assembly and C – Mazidi et al. ISBN-13: 978-0131194021 (ISBN-10: 013119402X)

e Resources

"The 8051 Microcontroller" – I. Scott MacKenzie Classic textbook from Prentice Hall, rich in programming examples and control-system applications. Full PDF accessible via Internet Archive (print-disabled DRM)

Useful websites / Video

https://www.tutorialspoint.com/8051_microcontroller/index.htm

Covers architecture, instruction set, timers, interrupts, and serial communication, Includes simple code snippets in **assembly and embedded C**.

3. https://www.geeksforgeeks.org/introduction-of-8051-microcontroller/

Well-structured articles with diagrams and basic programming examples.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1	2	1	-	-	-	1					1	1
CO 2	1	1	1	1	-	-	-	1	1	1	1	1	1	1
CO 3	1	1	1	2	-	-	-	1					2	2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312306A						
Course Name	Elective 1 (A) Python Programming						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course: students are expected to have a good understanding of basic computer principles.

The course aims to:

Course Objectives	Description
1	To introduce the basic concepts and features of Python programming.
2	To help students understand how to write and execute Python programs using variables, data types, and expressions.
3	To explain how decision-making and looping structures work in Python.
4	To make students understand the use of functions, modules, and packages to organize Python programs.
5	To explain how to use strings, lists, tuples, and dictionaries effectively.
6	To introduce object-oriented programming concepts like classes, objects, and inheritance using Python.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the basic concepts of Python such as variables, data types, input/output, and operators.	2
CO2	Describe how decision-making and looping statements work in Python, along with basic data types.	2
CO3	Understand the purpose of functions, modules, and packages in Python and how they help organize code.	2
CO4	Explain string operations and dictionary handling using Python's built-in features.	2
CO5	Describe object-oriented programming concepts such as classes, objects, and inheritance in Python.	2

Course context, Relevance, Practical Significance: The Python programming course introduces students to the fundamentals of Python language, covering topics such as basic syntax, decision control statements, functions, modules, strings, dictionaries, and object-oriented programming (OOP). Through this course, students gain practical skills in writing and executing Python programs, making decisions using control statements, defining and using functions and modules, manipulating strings and dictionaries, and implementing OOP concepts like classes, objects, and inheritance. Python's simplicity, versatility, and extensive libraries make it a valuable tool across various domains such as software development, data science, web development, and automation, making this course highly relevant for students aiming to build a strong foundation in programming for real-world applications.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit 1: Basics of Python Programming:** Features of Python, History and Future of Python, Writing and executing Python program, Literal constants, variables and identifiers, Data Types, Input operation, Comments, Reserved words, Indentation, Operators and expressions, Expressions in Python.	7	1
2	**Unit 2 Decision Control Statements:** **Decision Control Statements:** Decision control statements, **Selection/conditional** branching Statements: if, if-else, nested if, if-elif-else statements. **Basic loop** Structures/Iterative statements: while loop, for loop, selecting appropriate loop. Nested loops, The break, continue, pass, else statement used with loops. Other data types- Tuples, Lists and Dictionary.	7	2
3	**Unit 3 Functions and Modules:** Need for functions, **Function:** definition, call, variable scope and lifetime, the return statement. Defining functions, Lambda or anonymous function, documentation string, good programming practices. Introduction to modules, Introduction to packages in Python, Introduction to standard library modules.	7	3
4	**Unit 4 Strings and Dictionaries:** **Strings and Operations**- concatenation, appending, multiplication and slicing. Strings are immutable, strings formatting operator, built in string methods and functions. Slice operation, ord() and chr() functions, in and not in operators, comparing strings, Iterating strings, the string module. **Dictionaries-** creating, assessing, adding and updating values.	7	
5	**Unit 5 Object Oriented Programming:** Programming Paradigms-monolithic, procedural, structured and object oriented, **Features of Object oriented programming**-classes, objects, methods and message passing, inheritance, polymorphism, containership, reusability, delegation, data abstraction and encapsulation. **Classes and Objects:** classes and objects, class method and self-object, class variables and object variables, public and private members, class methods.	7	5

References Books

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st edition, ISBN10: 8131705625, ISBN-13: 978-8131705629 Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th edition, ISBN-10: 9780132492645, ISBN-13: 978-0132492645

2. Romano Fabrizio, "Learning Python", Packt Publishing Limited, ISBN: 9781783551712,

1783551712
3. Paul Barry, "Head First Python- A Brain Friendly Guide", SPD O'Reilly, 2nd Edition, ISBN:978-93-5213-482-3

Text Books

1. Reema Thareja, "Python Programming Using Problem Solving Approach", Oxford University Press, ISBN 13: 978-0-19-948017-6
2. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Second edition ISBN10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL

e Resources

1. https://www.geeksforgeeks.org/python/python-programming-language-tutorial/

Useful websites / Video

1. https://nptel.ac.in/courses/106106145

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312315D						
Course Name	Design of Machine Elements						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3 hrs/week		---		---		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	---	---	---	20	60	100

Prerequisites for the Course:
1. Engineering Drawing
2. Engineering Mechanics

The course aims to:

Course Objectives	Description
1	Understand the basic procedure for machine design
2	Understand the theories of failures and Factor of safety to design mechanical component.
3	Understand design belt drives and selection of belt, rope and chain drives.
4	Understand the basic knowledge to analyse, design and select machine elements required in transmission systems

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Describe the various steps involved in the Design Process.	1,2,3
CO2	Study principles involved in evaluating the shape and dimensions of a component.	1,2,3
CO3	Articulate strength and functional requirement of machine elements.	1,2,3
CO4	Learn to use standard practices and standard data.	1,2,3
CO5	Learn to use catalogues and standard machine components.	1,2,3

Course Contents:

Unit	Contents	Lecture Hours	COs Mapped
1	**Design of Simple Machine Elements**: Introduction to the design process, Factors influencing machine design, Design Process- Traditional design methods, Basic procedure of Machine Design, Concept of stress and strain, Hooke's law, Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Working stress, Generalized Hooke's law, Factor of safety, Service factor, Design of simple machine elements, Design of components subjected to eccentric loading.	7	CO1, CO2

2	**Design of Belt, Rope and Chain Drive:** Materials and construction of flat and V belts, Geometric relationships for length of belt, Power rating of belts, Concept of slip & creep, Initial tension, Effect of centrifugal force, Maximum power condition, Selection of Flat and V- belts from manufacturer's catalogue, Belt tensioning methods, Relative advantages and limitations of Flat and V- belts, Construction and applications of timing belts, Construction of wire ropes, Stresses in wire rope, Selection of wire ropes, Rope drums construction and design, Types of chains and its Geometry, Selection criteria for chain drive, Polygon effect of chain, Modes of failure for chain, Lubrication of chains.	7	CO3, CO4
3	**Gear Design:** Gear fundamentals, Force analysis and bearing loads- spur, helical and worm gear, Spur Gears-Various design consideration, Beam Strength, tangential loading module calculations, Width calculations, Type of gear tooth failures, Estimation of dynamic load by velocity factors and Spott's equation, Types of Gear Trains, Analysis of epicyclic gear trains, Holding torque – Simple, compound and epicyclic gear trains, Torque on sun and planetary gear train, Compound epicyclic gear train, Bevel epicyclic gear train, Selection criteria of harmonic drives in robotics.	7	CO1, CO5
4	**Design of Shaft and Bearing:** Classification of shafts, Shafts-Design considerations in transmission shafts with spur gear and pulley, Splined Shafts, Shaft design on strength basis, Shaft design on torsional rigidity basis, Types of bearings, Comparison of bearing friction characteristics, Basics of hydrodynamic theory of lubrication, Design methods for journal bearings, Rolling Contact Bearings-Type, static and dynamic loading capacity, Stribeck's equation, Concept of equivalent load, Load life relationship, Selection of bearing from manufacturer's catalogue, Design for variable load and speeds.	7	CO1, CO6
5	**Design of Power screw:** Power Screws-Types of screw threads Forms of threads, Multiple start screws, Torque analysis and Design of power screws with square and trapezoidal threads, Self-locking screw, Collar friction torque, Stresses in power screws, Recirculating ball screw.	7	CO1, CO6

References Books

1. Orthewein and William C. Orthewein, "Machine Component Design", West Publishing Co. (23 May 1989), ISBN No. 0314242570.

2. Black paulH.and Adams O. Eugene, “Machine Design”, 3ed, McGraw-hill Book Company, 1999, ISBN 0–07-085037-2.
3. Hall Allens, Holowenko Alfred R., Laughlin Herman G., “Theory & Problems of Machine Design”, McGraw-hill Book Company, 2000, ISBN 48333-7

Text Books

1. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw- Hill publication Co. Ltd., 1989, ISBN 0-07-049462-2.
2. Spotts M. F. and Shoup T. E., “Design of Machine Elements”, 8ed., Pearson Education pvt. Ltd., 2008, ISBN 81 -7758- 4219.
3. Bhandari V.B., “Design of Machine Elements”, Tata Mcgraw-hill publishing, 2007, ISBN 978-00-70-681798.

e-Resources

https://nptel.ac.in/courses/112105124

Useful websites / Video

1. https://www.machinedesign.com
2. https://www.engineersedge.com

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	1	3	-	1	1	-	-	-	-	1	2	1
CO2	1	-	1	-	-	1	2	-	-	-	-	1	2	1
CO3	2	2	-	1	-	1	-	-	-	-	-	1	1	3
CO4	3	-	1	-	1	1	1	-	-	-	-	1	2	2
CO5	3	-	1	-	1	1	-	-	-	-	-	1	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	10
2	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312306C						
Course Name	Hybrid Vehicle						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course:
1. Mathematics, Physics, Chemistry
2. Systems in Mechanical Engineering, Basic Electrical Engineering
3. Electrical and Electronics Engineering, Computer Aided Engineering

The course aims to:

Course Objectives	Description
1	Introduce the concepts of electric vehicle and allied technologies.
2	Learn the concept and types of hybrid electric vehicle.
3	Identify and Judge application specific selection of Prime Movers, Energy Storage and Controllers required for e-vehicles.
4	Recognize the e-Vehicle Configurations and Understand the Mechanics of vehicle movement.
5	Design and Select the body frame with relevant suspension system and testing of e-Vehicle as per Regulation/Licensing/Approval Organizations.
6	Understand the Battery Charging techniques and management.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the basics related to Hybrid Vehicle.	2-Understand
CO2	Classify the different hybrid vehicles.	3-Apply
CO3	Identify and evaluate the prime movers, energy storage and controllers.	3-Apply
CO4	Discover and categorize the electric vehicle configuration with respect to propulsion, power distribution and drive-train topologies.	4-Analyze
CO5	classify and evaluate battery charging techniques and management.	4-Analyze

Course context, Relevance, Practical Significance:
The Hybrid Vehicle course focuses on the design, operation, and integration of hybrid powertrains, which combine internal combustion engines (ICEs) with electric motors to improve fuel efficiency and reduce emissions. The course is highly relevant today due to the global shift toward sustainable transportation and efforts to combat climate change. Understanding hybrid systems enables engineers to: Design more efficient vehicles, Optimize

energy management and battery usage.

Course Contents:

Unit	Contents	Lecture Hours	COs Mapped
1	**Introduction to Electric and Hybrid Vehicle:** History and evolution of Electric Vehicles, Comparison of Electric with Internal Combustion Engine Vehicles, Limitations of IC Engine Vehicles (ICEV), Exhaust Emission and Global warming, Environmental importance of Hybrid and Electric Vehicles, Overview of EV Challenges, Classification, Overview of EV Technologies, Advantages and Disadvantages	08	CO1
2	**Hybrid Electric Vehicle:** Classification of HEV: Architecture, Construction, Working, Advantages and Limitations of Conventional and Gridable HEV, Classification of Conventional HEV, Types of Gridable HEV, Tractive force, Power and Energy requirements for standard drive cycles of HEV Hybrid Electric Drive-Trains: Basic concept of Hybrid Traction, introduction to various hybrid Drive-Train Topologies	07	CO2
3	**Prime Movers, Energy Storage:** Brief introduction to Motors: Classification, Construction, Working, Control, Design criteria, Application and Design Examples, Selection of Motor, Structural Configuration of Motor Layout Brief introduction to Energy Storage Systems: Classification - Types and Packs, Construction, Working, Comparison and Selection, Principle of Operation, Units of Battery/Fuel Cell Energy Storage, Battery Performance Parameters Estimation, Battery/Cell Modeling	07	CO3
4	**Controllers:** Configuration based on power electronics, Torque/Speed Coupling, Speed and Torque Controllers, BCU, MCU, Speed Control for Constant Torque/Power Operation of all electric motors, Control Method	07	CO4
5	**EV Charging Infrastructure Management:** Battery Charging: Basic Requirements for Charging System, Charging Methods and Standards, Converters, Charger Architectures, Grid Voltages, Frequencies and Wiring, Charger Functions, Real Power, Apparent Power, and Power Factor, Boost Converter for Power Factor Correction, Examples, Vehicle to Grid operation of EV's Battery Management Systems: Necessity of Battery Management Systems, Typical Structure of BMSs, Hazard/Safety Management	08	CO5

	Safety Guidelines for EV: Charging Safety, Battery Safety, Emergency Response, Maintenance Safety, Driving in Wet Conditions		

References Books

1. Mehrdad Ehsani, Yimi Gao, Sefano Longo, Kambiz Ebrahimi, (2019), "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design," CRC Press, ISBN: 9780367137465
2. Tariq Muneer, Mohan Kolhe, Aisling Doyle, (2017), "Electric Vehicles: Prospects and Challenges", ISBN: 9780128030219
3. Sandeep Dhameja, (2001), "Electric Vehicle Battery Systems", Newnes, ISBN: 9780750699167
4. Bruno Scrosati, Jürgen Garche, Werner Tillmetz, (2015), "Advances in Battery Technologies for Electric Vehicles," Woodhead Publishing, ISBN: 9781782423775
5. Shunli Wang, Carlos Fernandez, Yu Chunmei, Yongcun Fan, Cao Wen, Daniel-Ioan Stroe, Zonghai Chen, (2021), "Battery System Modeling," Elsevier, ISBN: 9780323904728
6. Andrea, Davide, (2010), "Battery management systems for large lithium battery packs," Artech House Publishers, ISBN: 9781608071043

Text Books

1. Iqbal Hussein, (2021), "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press, ISBN: 9780367693930
2. Denton, Tom, (2020), "Electric and Hybrid Vehicles," 2nd Ed., Routledge, ISBN:9780367273248
3. John Lowry, James Larminie, (2012), "Electric Vehicle Technology Explained," Wiley, ISBN: 9781119942733
4. Knowles, Don, (2011), "Automotive Suspension & Steering Systems," Cengage learning, ISBN: 9781435481152
5. Malen, Donald E., (2011), "Fundamentals of Automobile Body Structure Design," SAE International, ISBN: 9780768021691
6. R. Krishnan, (2001), "Electric Motor Drives: Modeling, Analysis, and Control," Pearson, ISBN: 9780130910141
7. Mohammad Saad Alam, Reji Kumar Pillai, N. Murugesan, (2021), "Developing Charging Infrastructure and Technologies for Electric Vehicles," IGI Global/ Business Science Reference, ISBN: 9781799868583

e Resources

1. https://archive.nptel.ac.in/courses/108/103/108103009/

Useful websites / Video

1. https://www.youtube.com/watch?v=403xVzVHgEQ&t=1244s
2. https://www.youtube.com/watch?v=bHrWjMVOpag&t=134s

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping		
Strength	PO	PSO

of COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1														
CO 2														
CO 3														
CO 4														
CO 5														

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 10 M and total will be converted out of 5 M)	05
2	Quiz on each topic of having 3 marks and total marks is converted into 5 marks	05
3	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**2312306D**						
Course Name	**Strength of Materials**						
Type of Course	**PEC**						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03						03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20				20	60	100

Prerequisites for the Course: Engineering Mechanics

The course aims to:

Course Objectives	Description
1	Analyze stresses and strains in materials subjected to axial, bending, torsion, and combined loads.
2	Apply Mohr's circle to determine principal stresses and their orientations in robotic components.
3	Calculate stresses and strains in thin-walled pressure vessels used in automation systems.
4	Construct shear force and bending moment diagrams to design lightweight robotic beams and frames.
5	Understand the design principles of shafts and columns critical for power transmission and structural stability in robotics.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Analyze and design structural member subjected to tension, compression, torsion, bending, and combined stresses using the fundamental concepts of stress, strain, and elastic behavior of materials	1,2
CO2	Ability to draw the Mohr's circle and to determine the principal stresses and its directions	2,3
CO3	Calculate the stresses and strain associated with thin wall spherical & cylindrical pressure vessels	3,4
CO4	Present the concept of shear force, bending moment, slope and deflection and their use in machine design.	2,3
CO5	Understand the design aspects of power transmitting shafts.	2,3

Course context, Relevance, Practical Significance: This course equips robotics students with essential knowledge of material behavior and stress analysis to design safe, efficient, and reliable robotic components and systems.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped

1	**Simple stresses and strains** Stress at area, normal and shear stress in structural elements, bearing stress, axial load problems, Stress at inclined plane, stress at a point, Coordinate transformation, Principal stress and direction, Plane of maximum shear, Mohr's Circle, Mechanical and thermal strain, lateral strain, Generalized Hooke's Law, Stress-Strain curve, Poisson's ratio – Volumetric strain, Elastic constants, Stress in composite bars. Strain energy impact and suddenly applied loads, Yield criteria	7	CO1
2	**Shear Force and Bending Moment** Shear Force and Bending Moment in Determinate Beams due to Concentrated Loads, Uniformly Distributed Loads. Relation between SF and BM Diagrams for Cantilevers, Simple and Compound Beams, Bends Defining Critical and Maximum Values and Positions of Points of Contra Flexure-Construction of Loading Diagram and BMD from SFD and Construction of Loading Diagram and SFD from BMD.	7	CO2
3	**Thin and Thick cylindrical** Thin cylindrical and spherical shells subjected to internal pressure. Principal stresses and their planes. Plane of maximum shear – Mohr's circle of stresses. Thick cylinders – Lame's equation, shrink fit. Compound cylinders.	7	CO3
4	**Deflection** Deflection – elastic curve, moment area method, statically determinate beams, Deflection –Macaulay's method, Moment area method, superposition, Deflection of cantilever, simply supported beams, UDL, point load, varying load, leaf spring.	7	CO4
5	**Torsion** Torsion of solid and hollow circular shafts – Power transmission, strength, and stiffness of shafts, Polar moment of inertia, varying sections, composite shafts, strain energy due to torsion.	7	CO5

References Books

1. Beer F. P., Johnston E. R and Dewolf J. T., "Mechanics of Materials", McGraw Hill Higher Education, 5th edition, 2004, ISBN: 978-007 3529 387.
2. Gere J. M. and Timoshenko S. P., "Mechanics of Materials", 4th Edition, PWS Pub. Co, 2001, ISBN 978- 0534934293.
3. Popov E. P., "Engineering Mechanics of Solids", Prentice Hall of India LTD, New Delhi, 2008.ISBN-10 :0137261594
4. Singer and Pytel, "Strength of Materials", Addison Wesley Publishing Corporation, 1999, ISBN 0 321 045416.
5. Timoshenko S P. and Young D. N., "Strength of Materials", Affiliated East-West Press PVT. LTD. New Delhi, 2006, ISBN : 8176710199

Text Books

1. Ramamrutham S. and Narayanan R., “Strength of Materials”, Dhanapat Rai and Sons,1992, ISBN: 818743354X
2. Rao Prakash “Strength Of Materials- A Practical Approach”, Vol I, Universities Press India Limited, ISBN: 8173711259
3. Rattan S. S., “Strength of Materials”, Tata McGraw-Hill Education,2011, ISBN: 007107256X
4. Junnarkar and Shah H J., “Mechanics of Structures”, Charotar Press, 2002, ISBN: 81-85594-06-6.
5. Rajput R. K., “Strength of Materials”, S. Chand Publication. ISBN-10 : 8188458104

e Resources

1. **NPTEL – Strength of Materials for Mechanical Engineering by Prof. M.S. Sivakumar, IIT Madras** https://archive.nptel.ac.in/courses/112/106/112106141/
2. **NPTEL –** Strength of Materials for Mechanical Engineering by Dr. Satish C Sharma, IIT Roorkee, https://archive.nptel.ac.in/courses/112/107/112107146/

Useful websites / Video

1. NPTEL Video Course: Strength of Materials, http://www.digimat.in/nptel/courses/video/112107147/L10.html

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	2	-	-	-	-	-	-	-	-	-	-	2	2
CO 2	1	2	2	-	-	-	-	-	-	-	-	-	2	2
CO 3	2	2	3	3	-	-	-	-	-	-	-	-	2	2
CO 4	2	2	-	1	-	-	-	-	-	-	-	-	2	2
CO 5	3	3	3	3	-	-	-	-	-	-	-	-	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	10
2	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312307A						
Course Name	Elective 1 (A)Python Programming Lab						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	-		-		2		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	-	25	25	-	-	-	50

Prerequisites for the Course: students are expected to have a good understanding of basic computer principles.

The course aims to:

Course Objectives	Description
1	To introduce the basic concepts and features of Python programming.
2	To help students understand how to write and execute Python programs using variables, data types, and expressions.
3	To explain how decision-making and looping structures work in Python.
4	To make students understand the use of functions, modules, and packages to organize Python programs.
5	To explain how to use strings, lists, tuples, and dictionaries effectively.
6	To introduce object-oriented programming concepts like classes, objects, and inheritance using Python.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the basic concepts of Python such as variables, data types, input/output, and operators.	2
CO2	Describe how decision-making and looping statements work in Python, along with basic data types.	2
CO3	Understand the purpose of functions, modules, and packages in Python and how they help organize code.	2
CO4	Explain string operations and dictionary handling using Python's built-in features.	2
CO5	Describe object-oriented programming concepts such as classes, objects, and inheritance in Python.	2

Course context, Relevance, Practical Significance: The Python programming course introduces students to the fundamentals of Python language, covering topics such as basic syntax, decision control statements, functions, modules, strings, dictionaries, and object-oriented programming (OOP). Through this course, students gain practical skills in writing and executing Python programs, making decisions using control statements, defining and using functions and modules, manipulating strings and dictionaries, and implementing OOP concepts like classes, objects, and inheritance. Python's simplicity, versatility, and extensive libraries make it a valuable tool across various domains such as software development, data science, web development, and automation, making this course highly relevant for students aiming to build a strong foundation in programming for real-world applications.

Lab Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	Basics of Python Programming	2	1
2	Programs using Decision Control Statements	2	2
3	Programs using List, Tuples, Functions and Modules	2	3
4	Programs using Strings and Dictionaries	2	4
5	Programs using Object Oriented Programming	2	5
6	Mini project	4	1,2,3,4,5

References Books

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st edition, ISBN10: 8131705625, ISBN-13: 978-8131705629 Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th edition, ISBN-10: 9780132492645, ISBN-13: 978-0132492645
2. Romano Fabrizio, "Learning Python", Packt Publishing Limited, ISBN: 9781783551712, 1783551712
3. Paul Barry, "Head First Python- A Brain Friendly Guide", SPD O'Reilly, 2nd Edition, ISBN:978-93-5213-482-3

Text Books

1. Reema Thareja, "Python Programming Using Problem Solving Approach", Oxford University Press, ISBN 13: 978-0-19-948017-6
2. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Second edition ISBN10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL

e Resources

1. https://www.geeksforgeeks.org/python/python-programming-language-tutorial/

Useful websites / Video

1. https://nptel.ac.in/courses/106106145

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2

2	1	2	-	2	-	-	-	-	-	-	1	1	-	2
2	1	2	-	2	-	-	-	-	-	-	1	1	-	2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312316D						
Course Name	Design of Machine Elements Lab						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	---		---		2 hrs/week		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	---	25	---	25	---	---	50

Prerequisites for the Course:

1. Fundamentals of Strength of Materials
2. Engineering Mechanics (Statics and Dynamics)

The course aims to:

Course Objectives	Description
1	To impart hands-on skills in designing basic mechanical components using design standards.
2	To provide practice in selecting materials and dimensions based on strength and performance requirements.
3	To train students to use software tools for modelling and validating machine elements.
4	To develop the ability to interpret design data and communicate it through drawings and reports.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Apply design principles to analyse and design simple machine components.	2
CO2	Prepare detailed design calculations with appropriate safety factors.	2,3
CO3	Model mechanical parts using CAD software and validate them using standard tools.	3,4
CO4	Prepare professional design reports and interpret technical drawings.	3,4

Course Contents:

Sr.No.	Contents	COs Mapped
1	Design of Cotter Joint or Knuckle Joint	CO1, CO2
2	Design of Shaft and Key for Power Transmission	CO1,CO2,
3	Design and Assembly Modelling of Flange Coupling	CO2, CO3

4	Design of Welded and Riveted Joints	CO2, CO3
5	Design of a Journal Bearing	CO2, CO3
6	Design of Helical or Spur Gear Pair	CO3, CO4
7	Finite Element Analysis (FEA) of a Designed Component	CO3, CO4

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	3	1	3	-	1	1	-	-	-	-	1	2	1
CO 2	1	-	1	-	-	1	2	-	-	-	-	1	2	1
CO 3	2	2	-	1	-	1	-	-	-	-	-	1	1	3
CO 4	3	-	1	-	1	1	1	-	-	-	-	1	2	2
CO 5	3	-	1	-	1	1	-	-	-	-	-	1	2	2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312307C						
Course Name	Hybrid Vehicle Lab						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		02		01
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	--	25	25	--	--	--	50

Prerequisites for the Course:

1. Mathematics, Physics, Chemistry
2. Systems in Mechanical Engineering, Basic Electrical Engineering
3. Electrical and Electronics Engineering, Kinematics of Machinery
4. Computer Aided Engineering, Design of Transmission Systems

The course aims to:

Course Objectives	Description
1	Introduce the concepts of electric vehicle and allied technologies
2	Learn the concept and types of hybrid electric vehicle
3	Identify and Judge application specific selection of Prime Movers, Energy Storage and Controllers required for e-vehicles

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the basics related to Hybrid Vehicle	2
CO2	Classify the different hybrid vehicles	3
CO3	Identify and evaluate the prime movers, energy storage and controllers	3
CO4	Discover and categorize the electric vehicle configuration with respect to propulsion, power distribution and drive-train topologies	4
CO5	Classify and evaluate battery charging techniques and management	4

Course context, Relevance, Practical Significance:

In the context of robotic engineering, a course on hybrid vehicles would focus on understanding the integration of robotic systems within hybrid vehicle platforms. Robotic engineering principles are essential for integrating sensors within hybrid vehicles. Robotic engineering principles enable the development of hybrid vehicles with enhanced mobility features, such as robotic assistance for passengers with disabilities or elderly individuals.

Course Contents:

Experiment No.	Contents	Pr. Hours	COs Mapped
1	Study of basic components of e-vehicles	2	CO1, CO2
2	Study of basic components of hybrid vehicles	2	CO1, CO2
3	Battery capacity calculations for specific application	2	CO2
4	Study and verification active and passive cell balancing (using suitable simulation)	2	CO2, CO3
5	Battery connections for discharge system (using suitable simulation)	2	CO2, CO3
6	Experiment/Simulation for AC-DC Speed Control using electric motor	2	CO2
7	DC-DC, Speed Control using electric motor	2	CO2
8	Study of Battery Management System	2	CO4, CO5

References Books

1. Mehrdad Ehsani, Yimi Gao, Sefano Longo, Kambiz Ebrahimi, (2019), "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design," CRC Press, ISBN: 9780367137465
2. Tariq Muneer, Mohan Kolhe, Aisling Doyle, (2017), "Electric Vehicles: Prospects and Challenges", ISBN: 9780128030219
3. Sandeep Dhameja, (2001), "Electric Vehicle Battery Systems", Newnes, ISBN: 9780750699167
4. Bruno Scrosati, Jürgen Garche, Werner Tillmetz, (2015), "Advances in Battery Technologies for Electric Vehicles," Woodhead Publishing, ISBN: 9781782423775
5. Shunli Wang, Carlos Fernandez, Yu Chunmei, Yongcun Fan, Cao Wen, Daniel-Ioan Stroe, Zonghai Chen, (2021), "Battery System Modeling," Elsevier, ISBN: 9780323904728
6. Andrea, Davide, (2010), "Battery management systems for large lithium battery packs," Artech House Publishers, ISBN: 9781608071043

Text Books

1. Iqbal Hussein, (2021), "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press, ISBN: 9780367693930
2. Denton, Tom, (2020), "Electric and Hybrid Vehicles," 2nd Ed., Routledge, ISBN:9780367273248
3. John Lowry, James Larminie, (2012), "Electric Vehicle Technology Explained," Wiley, ISBN: 9781119942733
4. Knowles, Don, (2011), "Automotive Suspension & Steering Systems," Cengage learning, ISBN: 9781435481152
5. Malen, Donald E., (2011), "Fundamentals of Automobile Body Structure Design," SAE International, ISBN: 9780768021691
6. R. Krishnan, (2001), "Electric Motor Drives: Modeling, Analysis, and Control," Pearson, ISBN: 9780130910141
7. Mohammad Saad Alam, Reji Kumar Pillai, N. Murugesan, (2021), "Developing Charging Infrastructure and Technologies for Electric Vehicles," IGI Global/ Business Science Reference, ISBN: 9781799868583

e Resources

1. https://archive.nptel.ac.in/courses/108/103/108103009/

Useful websites / Video

1. https://www.youtube.com/watch?v=403xVzVHgEQ&t=1244s
2. https://www.youtube.com/watch?v=bHrWjMVOpag&t=134s

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1														
CO 2														
CO 3														
CO 4														
CO 5														

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**2312307D**						
Course Name	**Strength of Materials Lab**						
Type of Course	**PEC**						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs					02		01
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)		25	25				50

Prerequisites for the Course: NA

The course aims to:

Course Objectives	Description
1	To provide hands-on experience in testing mechanical properties of various engineering materials.
2	To help students relate theoretical concepts of stress, strain, and deformation with experimental observations.
3	To develop skills in operating material testing equipment and interpreting experimental data.
4	To foster analytical thinking through comparison of experimental results with theoretical predictions.
5	To inculcate good laboratory practices including accurate record-keeping, teamwork, and adherence to safety norms.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Determine mechanical properties of engineering materials using standard tests (tension, compression, hardness, etc.).	1,2
CO2	Analyze material behavior under different loading conditions using stress-strain relationships.	2,3
CO3	Examine failure patterns in structural elements subjected to bending, torsion, and buckling.	3
CO4	Validate theoretical models with experimental data and justify deviations.	4
CO5	Demonstrate correct use of lab equipment, follow safety protocols, and maint lab records.	3

Course context, Relevance, Practical Significance:

The Strength of Materials Lab provides foundational understanding and practical skills in evaluating material behavior under various loads, crucial for designing safe and efficient mechanical structures and components in real-world engineering applications.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped

1	TENSION TEST ON MILD STEEL	2	CO1, CO5
2	DOUBLE SHEAR TEST	2	CO1, CO2
3	TORSION TEST ON MILD STEEL BAR	2	CO1, CO4
4	COMPRESSIVE TEST ON Robot components	2	CO3, CO4
5	IZOD IMPACT TEST	4	CO2, CO4
6	CHARPY IMPACT TEST	2	CO2, CO3
7	ROCKWALL HARDNESS TEST	2	CO3
8	BRINELL HARDNESS TEST	2	CO3

References Books

1. **Timoshenko, S.P. and Gere, J.M.,** *Mechanics of Materials*, CBS Publishers & Distributors, ISBN-10: 8123908949
2. **Beer, F.P., Johnston, E.R., DeWolf, J.T., and Mazurek, D.F.,** *Mechanics of Materials*, McGraw-Hill Education, ISBN-10: 0073398233

Text Books

1. **Bedi, D.S.,** *Strength of Materials*, Khanna Book Publishing Co., ISBN-10: 9382609853
2. **R.K. Bansal,** *Strength of Materials*, Laxmi Publications, ISBN-10: 8131808147

e Resources

1. **NPTEL – Strength of Materials for Mechanical Engineering by Prof. M.S. Sivakumar, IIT Madras** https://archive.nptel.ac.in/courses/112/106/112106141/
2. **NPTEL –** Strength of Materials for Mechanical Engineering by Dr. Satish C Sharma, IIT Roorkee, https://archive.nptel.ac.in/courses/112/107/112107146/

Useful websites / Video

2. NPTEL Video Course: Strength of Materials, http://www.digimat.in/nptel/courses/video/112107147/L10.html

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	2	-	-	-	-	-	-	-	-	-	-	2	2
CO 2	1	2	2	-	-	-	-	-	-	-	-	-	2	2

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

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Timely completion of assignments	10
2	Understanding of assignments	10
3	Presentation/Clarity of journal writing	05
	Total	**25**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312308						
Course Name	Financial Management						
Type of Course	OE						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	02		--		---		02
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	50	--	--	--	---	---	50

-

The course aims to:

Course Objectives	Description
1	To provide thorough grounding of financial management concepts and preparation of Financial Statements with their analysis.
2	To gain expert knowledge of principles and concepts used in finance
3	To learn to manage short-term resources of a business firm
4	To be able to find out the best course of action among several financial options
5	To help understand costing and management accounting techniques that could be utilized for decision making and control.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Use Financial Statements to evaluate performance of a firm	1,2
CO2	Calculate time value of money and Cost of Capital.	1,2
CO3	Demonstrate how materials, labour and overhead costs are added to a product at each stage of the production cycle.	3,4
CO4	Apply cost accounting techniques and evaluate their limitations	3,4
CO5	Use and evaluate appropriate costing and decision making techniques to make short term decisions;	3,4
CO6	Use standard costing systems to undertake a performance review and interpret the results	3,4

Course context, Relevance, Practical Significance: Financial Management is a core subject in business, commerce, and management studies. It introduces students to the key principles and practices used in managing the financial resources of an organization. The course covers financial analysis, planning, control, investment decisions, capital structure, and working capital management. It blends theoretical concepts with real-world financial decision-making tools, helping learners to become effective financial managers or entrepreneurs.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Financial Management:** Financial function, Scope, goals and tools. Sources of finance, corporate planning and financial management. Financial Statements: Balance sheet, profit and loss account.	7Hrs	CO1
2	**Financial Statement Analysis:** Ratio Analysis: Classification, Ratio Analysis Advantages and its limitations. Operating, Financial and Combine Leverage, ROI, EPS.	7Hrs	CO1,CO2
3	**Capital Budgeting :** Control of Capital Expenditure, Evaluation Process-Payback approach, Accounting of Rate of Return, Present Value Method Vs Internal Rate of Return. Replacement cost and discounted cash flow.	7Hrs	CO3
4	**Working Capital Management :** Concept and design of Working Capital, types of working capital, sources of working capital, time value of money, cost and capital, cost of capital. Funds Flow Analysis: Concepts, Objectives, and Techniques of Funds Flow Statement. (Theory part)	7Hrs	CO4,CO5
5	**Cost Accounting and Functional Budgets :**Cost Unit, Cost Centre and Cost Object. Classification of costs, Cost allocation, Cost Apportionment, Cost Absorption, Preparation of Simple Cost sheet, Economic Order Quantity, Functional Budgets– Cash Budget and Flexible Budget.	7Hrs	CO5,CO6

References Books :

1. N. Ramachandran & Ram Kumar Kakani "Financial Accounting for Management"McGraw Hill
2. Prasanna Chandra "Financial Management: Theory and Practice"McGraw Hill Education
3. Ramachandran & Ram Kumar Kakani"Financial Accounting for management"McGraw Hill

Text Books :

1. M. Y. Khan, P. K. Jain, Financial Management, Tata McGraw Hill Publishing Ltd. ISBN: 933921305X
2. B. K. Bhar, Cost Accounting: Methods and Problems, 19th Edition, Academic Publishers, Calcutta, ISBN: 978-9380599618
3. P.C. Tulsian, Bharat Tulsian, Financial Management, S. Chand Publishing, ISBN: 978-9352531349
4. P.C. Tulsian, Bharat Tulsian, Cost Accounting, S. Chand Publishing, ISBN: 9788121929417

e Resources :

https://www.oreilly.com/library/view/financial-management/9788131774953/

Useful websites / Video :

1. https://youtu.be/itPxYGhf9Pw?si=3CB2-n1Y1PH1KCTC

2.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	1		1									2	
CO 2	1	2		1									2	
CO 3	1	2	2	1									1	
CO 4	1	2	2	1									2	
CO 5	2	1	2	1									1	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	20
2	Timely Assignment Submission	30
	Total	**50**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312309						
Course Name	Evolutionary Computation						
Type of Course	MDM						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--		--		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course:

1. Applied Mathematics
2. Numerical Methods
3. Artificial Neural Network and Fuzzy System

The course aims to:

Course Objectives	Description
1	Understand philosophy of various evolutionary computation algorithms
2	Study the algorithm specific parameters and their tuning
3	Learn Hybridization with other techniques and modification of existing techniques
4	Discover real life applications of evolutionary computation to engineering and robotics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Demonstrate the working principles of various evolutionary computation	
CO2	Tune algorithm specific parameters of evolutionary computation	
CO3	algorithms for given application	
CO4	Apply evolutionary computation algorithms for robotics applications	
CO5	Evaluate the performance of evolutionary computation algorithms	

Course context, Relevance, Practical Significance:

Evolutionary computation plays a significant and growing role in robotics and automation, particularly in solving complex, nonlinear, and high-dimensional problems that are difficult to address using traditional methods. Basic philosophy and working of evolutionary computing methods such as genetic algorithm, swarm intelligence, neural network and fuzzy system etc. will be discussed in this subject. Their applications in the field of robotics such as inverse kinematics and dynamics, path planning and navigation, task learning and adoption will be studied in detail in this subject

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Genetic Algorithms** Introduction to evolutionary computation, Traditional approach vs. evolutionary computation, Mechanism of working of genetic algorithm, variants of genetic algorithm	7	CO1, CO3, CO4, CO5

	: Differential evolution, genetic programming, real coded genetic algorithm, hybrid algorithms: Hybrid GA-SA algorithm, performance evaluation of the algorithm, Multi-objective optimization-NSGA, Real life applications,		
2	**Particle swarm optimization** Introduction, Mechanism of working of particle swarm optimization algorithm, parameter selection, convergence criteria, adaptive mechanisms, variants of PSO algorithm: Civilised swarm optimization, Shuffled from leaping algorithm hybridization: Hybrid GA-PSO algorithm, performance of algorithm - convergence rate and accuracy, termination criteria, Real life applications	7	CO1, CO2 CO3, CO4, CO5
3	**Artificial bee colony optimization** Artificial bee colony meta-heuristic: Initialization, employed bees, onlooker bees, scout bees, honey foraging behaviour, Global Guided ABC Algorithm, Hybrid Algorithm: Hybrid ABC-SA algorithm, ABC-PSO algorithm, Real life applications	7	CO1, CO2 CO3, CO4, CO5
4	**Ant colony optimization** Introduction, Mechanism of working of ant colony optimization algorithm, collective intelligence, parameter selection, convergence, elitist ant system, Rank based ant systems, recursive ant colony optimization, Applications to combinatorial optimization problems.	7	CO1, CO2 CO3, CO4, CO5
5	**Fuzzy logic and Artificial Neural Networks: Applications to Robotics** Review of concepts of fuzzy logic and artificial neural networks, Applications of fuzzy logic in robotics such as robot control system, automatic navigation of mobile robots, robot kinematics and dynamics, Applications of neural networks such as: Object recognition, trajectory planning, robot kinematics etc.	7	CO1, CO3, CO4

References Books

1. Dan Simon (2013), 'Evolutionary Optimization Algorithms', John Wiley & Sons, Inc. ISBN: 978-0-470-93741-9
2. Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga (2017), 'Meta-Heuristic and Evolutionary Algorithms for Engineering Optimization', John Wiley & Sons, Inc. ISBN: 978-11-19386-99-5.

Text Books

1. Pawar P. J. (2019), 'Evolutionary Computations for Manufacturing', Studium Press, ISBN: 978-93-85046-52-0
2. Eiben A. S., Smith J. E. (2015), 'Introduction to Evolutionary Computing', Springer, ISBN: 3662448742

e Resources

1. https://archive.nptel.ac.in/courses/112/103/112103301/

Useful websites / Video

1. https://www.youtube.com/watch?v=19s8THlAhB8
2. https://www.youtube.com/watch?app=desktop&v=HmDjfL3R39M&t=489s

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2												
CO 2		3	3											
CO 3	3	2	2		2	2			2	2	1	2	3	
CO 4				3	2									
CO 5		2	2	2	2	2			2	2	1	2	3	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312310						
Course Name	Seminar						
Type of Course	CEP						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	02		1		01		02
Assessment Scheme	CCE	TW	PR	TU	ISE	ESE	Total (Marks)
(Marks)	--	--	25	25	---	---	50

-

The course aims to:

Course Objectives	Description
1	Understand the importance of seminars in enhancing technical knowledge and communication skills within the engineering discipline.
2	Identify and select relevant and current topics for seminar presentation based on literature survey and research.
3	Develop research skills by collecting, analyzing, and synthesizing information from credible technical sources.
4	Prepare well-structured technical reports that clearly communicate complex engineering concepts and findings.
5	Enhance oral communication skills through effective presentation and interaction with peers and faculty.
6	Demonstrate professionalism by adhering to ethical standards in research and presentation.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Identify and select relevant and current technical topics in engineering through literature survey and analysis.	1,2
CO2	Conduct a comprehensive literature review and critically analyze existing research work on the chosen topic.	1,2
CO3	Develop technical writing skills by preparing well-structured seminar reports and documentation.	3,4
CO4	Enhance oral communication skills by preparing and delivering effective technical presentations.	3,4
CO5	Demonstrate the ability to engage in discussions, respond to queries, and defend their research findings confidently.	3,4
CO6	Apply ethical standards in research and presentation, ensuring originality and proper citation of sources.	3,4

Course context, Relevance, Practical Significance: The seminar course is an integral part of the engineering curriculum designed to complement theoretical knowledge with practical research and communication skills. It serves as a platform for students to independently explore specialized topics, develop a deeper understanding of emerging technologies, and stay updated with the latest trends in their discipline. The seminar encourages self-learning, critical analysis,

and effective dissemination of technical knowledge, bridging the gap between classroom learning and real-world applications.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	Introduction to Seminar and Topic Selection:· Overview of the Seminar Course- Importance of seminars in engineering education,How to choose a seminar topic: relevance, feasibility, and scope , Types of sources: journals, conferences, patents, white papers,Ethical research practices and avoiding plagiarism.	3Hrs	CO1
2	Research Methodology and Literature Review: Basics of technical research and scientific inquiry, Conducting literature review using databases (IEEE Xplore, ScienceDirect, Google Scholar),Referencing styles (APA/IEEE),Annotated bibliography and review writing	3Hrs	CO1,CO2
3	Technical Writing and Report Preparation:· Structure of a technical seminar report: abstract, introduction, body, conclusion, references, Tools for documentation: LaTeX, MS Word, Graphs, tables, figures – how to present data effectively,Proofreading and formatting.	3Hrs	CO3
4	Presentation Skills and Public Speaking:· lide preparation and visual design (PowerPoint/Google Slides) Oral presentation techniques: clarity, confidence, body language, Handling Q&A and feedback, Mock presentation sessions with peer review	3Hrs	CO4,CO5
5	Final Seminar Presentation and Evaluation:· inal seminar presentation (15–20 minutes), Question & answer session with faculty and peers , Submission of final seminar report, Evaluation criteria: content depth, delivery, report quality, interaction,	3Hrs	CO5,CO6

References Books :

1. C.R. Kothari,"Research Methodology: Methods and Techniques"
2. Ashraf Rizvi ""Technical Communication"
3. Robert A. Day and Barbara Gastel ""How to Write and Publish a Scientific Paper"

Text Books :

Sangeeta Sharma and Binod Mishra"Communication Skills for Engineers and Scientists"
Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery"

e Resources :

IEEE Xplore, ScienceDirect, Google Scholar for current research papers

Useful websites / Video :

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	1		1									2	
CO 2	2	2		2									2	
CO 3	2	2	2	1									1	
CO 4	2	2	2	1									2	
CO 5	2	1	2	1									1	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Seminar presentation in mid of the term	25
2	Seminar presentation in end of the term	25
	Total	**50**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312311						
Course Name	Sensor Technology						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course:

1.Basic Electronics Engineering
2. Basic Electrical Engineering

The course aims to:

Course Objectives	Description
1	Familiarity with sensor principles and Technologies
2	Master Sensor interfacing and signal conditioning
3	Explore Sensor Fusion and Integration
4	Examine Applications of Sensor Technology
5	Explore Emerging Trends and Future Directions

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the underlying principles of sensor operation in robotics and automation	2
CO2	Understand the role of sensors in various robotic applications such as industrial automation, autonomous navigation, and manipulation tasks.	2
CO3	Use sensor data to solve practical problems related to sensor integration, calibration, and troubleshooting in robotic systems	3,4
CO4	Analyze sensor data to evaluate the performance and reliability of sensors in specific robotic tasks and environments	3,4
CO5	Develop the ability to analyze and assess the suitability of sensors for specific robotic tasks and environments.	3,4

Course context, Relevance, Practical Significance:

Sensor Technology is a core course in the curriculum of Robotics and Automation Engineering. As modern robotic systems become increasingly autonomous, real-time environmental sensing and response are crucial. This course provides foundational knowledge of sensor types, characteristics, interfacing techniques, signal conditioning, and sensor fusion strategies, all of which are vital for building intelligent, responsive robotic systems.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Introduction to Sensors & Transducers:**Introduction to sensor Technologies in Robotics, Definition and classification of sensors, Role of sensors in robotics and automation, Role of Transducer in measurement Systems, Block Diagram Measurement system Basic principles of sensor operation, Types of sensors: contact and non-contact, Characteristics of sensors: accuracy, precision, resolution, sensitivity, etc., Overview of sensor selection criteria	7	1,2
2	**Sensor Principles & Technologies ;**Types of Sensors: Distance and proximity: Ultrasonic sensors, LiDAR, infrared sensors. Position and orientation: Encoders, gyroscopes, accelerometers, Force/torque sensors, Vision sensors (cameras, depth sensors), Inertial sensors (accelerometers, gyroscopes), Tactile sensors, Environmental sensors (temperature, humidity, gas)- Working principle & operation of each sensor, Basic Principle of working of Resistive, Capacitive and Inductive sensors, Optical sensors (photodiodes, phototransistors, etc.), Ultrasonic sensors, Hall effect sensors, Comparative analysis of different sensor technologies	7	1,2
3	**Sensor Interfacing & Signal Conditioning:**Analog and digital sensor interfaces, Signal conditioning techniques: Amplification, Filtering, Linearization, Analog-to-digital conversion (ADC) methods, Digital signal processing (DSP) for sensor data, Practical considerations in sensor interfacing and signal conditioning	7	3,4
4	**Sensor Fusion and Integration:**Sensor fusion concepts and importance in robotics and automation, Integration of multiple sensors for enhanced performance, Kalman filtering and other fusion algorithms, Applications of sensor fusion in: Localization and mapping,Object tracking and recognitionNavigation and path planning, Feedback control systems	7	3,4
5	**Application of Sensor Technology:**Role of sensors in robotics and automation systems, Case studies and practical applications:Position and motion sensing in robotic manipulators, Vision sensors for object detection and localization, Proximity sensors for obstacle avoidance, Force and torque sensors for robotic grippers, Environmental sensors for industrial automation (temperature, humidity, etc.), Feedback control systems utilizing sensor feedback, Emerging trends and future directions in sensor technology for robotics and automation	8	3,4

References Books

1] Sensors and Actuators in Mechatronics: Design and Applications" by Andrzej Pawlak

2] Fundamentals of Industrial Automation" by Ricardo Suárez Fernández

3] Sensor Technology Handbook" by Jon S. Wilson

4] B.C. Nakra, K.K. Chaudhary, “Instrumentation, Measurement and Analysis”, Tata McGraw Hill Education India Private Limited, 4th Edition

5]John G. Webster, "Instrumentation and Sensors Handbook", CRC Press, 1 st Edition, 1999.

Text Books:

1]Sawhney A. K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 4 th Edition, 1994

2] D. Patranabis, “Sensors and Transducers”, Prentice Hall India Learning Private Limited, 2nd Edition

e Resource:

1.https://www.dbooks.org/sensor-technologies-1430260149 2.

2.https://www.sciencedirect.com/book/9780750677295/sensor-technology-handbook

Useful websites / Video:

1. https://onlinecourses.nptel.ac.in/noc23_ee95/preview
2. https://youtu.be/sCTgZv33tuA?si=PZLUw7COFlX2E8KC

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1											1	
CO 2	1	1	1	1	1								1	
CO 3	1			2	1								1	1
CO 4	1			1	1								1	1
CO 5	1	2	1	1	1	1							1	1

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	AssignmentsAssignments (Total 3Assignment,Unit I and II 20marks, Unit III and IV20marksand Unit V10 marks & 50 marks will be converted to 10 Marks)	10
2	Tests on each unit using LMS (Each test for10 M and total will be converted out of 5M)	5
3	Quiz per lecture converted into 5	5
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	ROB223012						
Course Name	Robot Programming						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03hrs/week		---		---		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	---	---	---	20	60	100

Prerequisites for the Course:

1. Robot Kinematics and Dynamics

2. Basic knowledge of any Programming Language.

The course aims to:

Course Objectives	Description
1	Programming a robot is usually a key task in simulation not only for creating factory simulations but for testing robots.
2	With Visual Components, students can manually create statements that define the actions and logic of a robot program.
3	The robot routine and subroutines can easily be visualized and modified.

On completion of the course, learner will be able to -

Course Outcomes	Description	Bloom's Level
CO1	Explain different robot programming methods	2
CO2	Recognize the components of robot programming	2,3
CO3	Develop simple programs to simulate robot movements	3,4
CO4	Develop complex robot programs for specific application	3,4
CO5	Describe the safety rules in robot handling	3

Course Contents:

Unit	Contents	Lecture Hours	COs Mapped
1	**Introduction to Robot Programming:** Robot programming-Introduction-Types- Flex Pendant-Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications-Motion commands, end effectors and sensors commands.	7	CO1
2	**VAL-II and MELFA Programming Languages:** VAL II Language: VAL-II programming-basic commands, applications-Simple problem using conditional statements- Simple pick and place applications-Production rate calculations using robot. MELFA Language:	7	CO2,CO3

	MELFA Language overview, Basic Commands, Syntax rule, Variable declarations and data types, Use of motion and non-motion instructions. Programming for object pickup and placement.		
3	**RAPID Programming Language:** RAPID language basic commands- Motion Instructions- Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Move master command language- Introduction, syntax, industry problems.	7	CO3
4	**KAREL Programming Language:** KAREL language overview-controller, input output system. Language elements-character set, operators, reserved words, data types, arrays (multi-dimensional and variable sized). Use of operators, Program control, Routines, industry problems.	7	CO3
5	**Study of Virtual Robot:** Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems- Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input and output signals- Singularities-Collision detection-Repeatability measurement of robot-Robot economics. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing.	7	CO3, CO4

References Books

1. S. R. Deb, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994.
2. Mikell. P. Groover, "Industrial Robotics Technology, Programming and Applications", McGraw Hill Co., 1995.

Text Books

1. Danny Staple, "Learn Robotics Programming: Build and control AI-enabled autonomous robots using the Raspberry Pi and Python", Packt Publishing Ltd, 2021
2. Klafter. R.D, Chmielewski.T.A. And Noggin's., "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd., 1994.

e-Resources

https://nptel.ac.in/courses/112105249

Useful websites / Video

1. https://roboticscourseware.org
2. https://wiki.ros.org

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low, 2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	3	1	3	-	1	1	-	-	-	-	1	2	1
CO2	1	-	1	-	-	1	2	-	-	-	-	1	2	1
CO3	2	2	-	1	-	1	-	-	-	-	-	1	1	3
CO4	3	-	1	-	1	1	1	-	-	-	-	1	2	2
CO5	3	-	1	-	1	1	-	-	-	-	-	1	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	10
2	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312313						
Course Name	Lab work in Sensor Technology						
Type of Course	PCC						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	-		-		2		1
Assessment Scheme (Marks)	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	-	25	25	-			50

Prerequisites for the Course:

1.Basic Electronics Engineering
2. Basic Electrical Engineering

The course aims to:

Course Objectives	Description
1	Familiarity with sensor principles and Technologies
2	Master Sensor interfacing and signal conditioning
3	Explore Sensor Fusion and Integration
4	Examine Applications of Sensor Technology
5	Explore Emerging Trends and Future Directions

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the underlying principles of sensor operation in robotics and automation	2
CO2	Understand the role of sensors in various robotic applications such as industrial automation, autonomous navigation, and manipulation tasks.	2
CO3	Use sensor data to solve practical problems related to sensor integration, calibration, and troubleshooting in robotic systems	3,4
CO4	Analyze sensor data to evaluate the performance and reliability of sensors in specific robotic tasks and environments	3,4
CO5	Develop the ability to analyze and assess the suitability of sensors for specific robotic tasks and environments.	3,4

The **Sensor Technology Laboratory** is a core practical course that complements the theoretical understanding of sensors gained in classroom lectures. In the context of **Robotics and Automation Engineering**, sensors are the "eyes and ears" of robotic systems—providing the necessary data to perceive and interact with the environment. This lab offers students hands-on experience in working with various types of sensors, their interfacing methods, and data acquisition techniques that form the backbone of intelligent and autonomous systems.

Course Contents:

Pr.	Contents	Pr. Hours	Cos Mapped
1	Distance Measurement using Ultrasonic Sensor (	2	1,2
2	Object Detection using Infrared (IR) Sensor	2	1,2
3	Temperature Monitoring using Digital Temperature Sensor (e.g., DHT22, LM35)	2	3,4
4	Accelerometer & Gyroscope (IMU - MPU6050) Based Tilt and Motion Detection	2	3,4
5	Color Detection using Color Sensor	2	3,4
6	Force and Load Sensing using Load Cell and HX711	2	3,4
7	Touch and Pressure Sensing using Tactile Sensor	2	3,4

References Books

1] Sensors and Actuators in Mechatronics: Design and Applications" by Andrzej M. Pawlak

2] Fundamentals of Industrial Automation" by Ricardo Suárez Fernández

3] Sensor Technology Handbook" by Jon S. Wilson

4] B.C. Nakra, K.K. Chaudhary, “Instrumentation, Measurement and Analysis”, McGraw Hill Education India Private Limited, 4th Edition

5] John G. Webster, "Instrumentation and Sensors Handbook", CRC Press, 1 st Edition, 1999.

Text Books:

1.Sawhney A. K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 4 th Edition, 1994

2.D. Patranabis, “Sensors and Transducers”, Prentice Hall India Learning Private Limited, 2nd Edition

e Resource:

1.https://www.dbooks.org/sensor-technologies-14302601492.

2.https://www.sciencedirect.com/book/9780750677295/sensor-technology-handbook

Useful websites / Video:

1. https://onlinecourses.nptel.ac.in/noc23_ee95/preview
2. https://youtu.be/sCTgZv33tuA?si=PZLUw7COFlX2E8KC

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1											1	

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

Guidelines for Continuous Comprehensive Evaluation of Practical Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Practical Write up with proper observation and calculationand ora on each practical	25
	Total	**25**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312314A						
Course Name	Object Oriented Programming						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course: students are expected to have a good understanding of basic computer principles and Python Programming.

The course aims to:

Course Objectives	Description
1	To introduce the foundational principles of object-oriented programming using Python.
2	To enable students to apply the concepts of classes, objects, inheritance, and polymorphism in Python.
3	To make students proficient in designing, organizing, and implementing OOP-based Python programs.
4	To develop the ability to handle files, exceptions, and modularize code using advanced Python features.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Describe the core principles and features of object-oriented programming in Python.	2
CO2	Apply the concepts of classes, objects, and encapsulation to solve programming problems.	2
CO3	Explain and implement operator overloading and special methods using Python.	2
CO4	Demonstrate inheritance and polymorphism through class hierarchies in Python.	2
CO5	Develop robust Python programs using modules, exception handling, and file operations.	2

Course context, Relevance, Practical Significance:

This course introduces object-oriented programming , enabling students to design modular, reusable, and scalable programs. It builds essential skills for real-world applications in domains like automation, web development, and data science, preparing students for internships, projects, and industry roles.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit I: Introduction to Object-Oriented Programming:** Overview of programming paradigms: procedural, modular, OOP, Comparison of C++ and Python approaches to OOP, Core OOP concepts: class, object, method, message passing, encapsulation, abstraction, inheritance, and polymorphism, Object lifecycle, memory management, and garbage collection, Dynamic typing and dynamic binding in Python	7	1
2	**Unit II: Classes and Objects:** Defining classes and creating objects, Instance variables vs. class variables, The __init__() constructor and self, Class methods and static methods (@classmethod, @staticmethod), Access specifiers in Python: public, protected, private, Object as function argument, returning objects	7	2
3	**Unit III: Operator Overloading and Special Methods:** Introduction to operator overloading, Magic methods: __str__, __repr__, __add__, __sub__, etc., Overloading unary and binary operators, Comparison operators (__eq__, __lt__, etc.), Creating custom behaviors for user-defined types	7	2
4	**Unit IV: Inheritance and Polymorphism:** Types of inheritance: single, multilevel, multiple, Method overriding and use of super(), Polymorphism and duck typing, Abstract base classes and the abc module, Dynamic binding, containment, and composition, Real-world examples demonstrating class hierarchy	7	2
5	**Unit V: Modules, Exception Handling, and File Handling** Python modules and packages, Namespaces and scope (global, nonlocal), Exception handling: try, except, finally, raise, Creating user-defined exceptions, File operations: open, read, write, append, context manager (with), Formatted output using format() and f-strings	7	2

References Books

1. Irv Kalb , "Object-Oriented Python" No Starch Press, ISBN: 9781718502062
2. Dusty Phillips, "Python 3 Object Oriented Programming", Packt Pub Ltd, Packt Pub Ltd

Text Books

1. Matt Weisfeld, "The Object-Oriented Thought Process", Pearson Education.

e Resources

1. https://realpython.com/python3-object-oriented-programming/

Useful websites / Video

1. https://nptel.ac.in/courses/106107574

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	-	2	-	-	-	-	-	-	-	-	-	2	
1	2	-	2	-	-	-	-	-	-	-	-	-	2	
1	2	-	2	-	-	-	-	-	-	-	-	-	2	
1	2	-	2	-	-	-	-	-	-	-	-	-	2	
1	2	-	2	-	-	-	-	-	-	-	-	-	2	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312314B						
Course Name	Tool and die Design						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--		--		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course:
1. Manufacturing Technology
2. Design of Machines and Mechanisms

The course aims to:

Course Objectives	Description
1	Material Selection for Tools and Dies
2	Learn Die Components and their Functions
3	Design of various tool and dies and CAD/CAM applications
4	Cost estimation and process planning

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Select appropriate material for tools and dies	2
CO2	Demonstrate the functions of various components of tools and dies	2
CO3	Design of various tool and dies	3
CO4	Evaluate the performance of tools and dies considering various aspects such as cost, ergonomics, safety, maintenance etc.	4

Course context, Relevance, Practical Significance:
The subject Tool and Die Design is crucial in manufacturing engineering, particularly in the design and development of tooling for mass production processes. Learning objectives typically aim to provide students with a deep understanding of how tools and dies are conceptualized, designed, and manufactured.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Cutting Tool Design:** Fundamentals of Cutting tools design, cutting tools and their principal elements, Tool geometry, system of nomenclatures and their interrelations, setting for the grinding of various basic cutting tool (turning, drilling, milling)	7	CO1, CO2, CO3,
2	**Design of Jigs and Fixture:** Principles of jig and fixture design, Dual cylinder location, diamond pin analysis, V-block analysis, design principles of centralisers, various mechanisms and design of equalizers, analysis for optimum number of clamping forces required and calculation of their magnitudes, concept of modular fixtures, design of fixtures for NC/CNC machines,	7	CO1, CO2 CO3, CO4,

	computer applications in fixture design and analysis		
3	**Design of press tools:** Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops, Design procedure for progressive dies, compound dies and combination dies for press tool operation forging die design for drop and machine forging parts. Computer applications in press tool design.	7	CO1, CO2 CO3, CO4,
4	**Design of forging dies and die casting dies:** Forging dies: Grain flow considerations, parting line selection, draft, ribs, bosses and fillets. Flash and flash control, determination of number of impressions required and their sequence, cooling and ejection systems Die casting dies: Metals for die casting, specific details of die construction, casting ejectors, side cores, loose die pieces, slides, types of cores, directional solidification, types of feeders, die venting, water cooling, design aspects of die casting dies, defects.	7	CO1, CO2 CO3, CO4,
5	**Design of injection molds:** Principles of melt processing, product considerations, determination of economical number of cavities, temperature control of injection molds, calculation of mold opening force and ejection force. Detail design of cooling system, ejection system and gating system. Moldability features, mold flow analysis.	7	CO1, CO2, CO3 CO4,

References Books

1. Donaldson, C., LeCain, G. H., Goold, V. C., & Ghose, S. (2017), 'Tool Design' McGraw-Hill Education.
2. Nee, J. G. (Ed.). (2010), 'Fundamentals of Tool Design' Society of Manufacturing Engineers, ISBN: 0872638677
3. Venkataraman, K. (2022) 'Design of Jigs, Fixtures and Press Tools' Ane Books Pvt. Ltd. ISBN-9385462016

Text Books

1. Oberg, E., Jones, F. D., Horton, H. L., Ryffel, H. H., & McCauley, C. J. (Eds.). (2024). 'Machinery's Handbook (32nd Edition)' Industrial Press, Inc. ISBN: 978-0831138325
2. Jones, F. D., & Ryffel, H. H. (n.d.). Die Makers Handbook. Industrial Press Inc.

e Resources

1. https://bharatskills.gov.in/pdf/E_Books/CTS/41/English/TP/TDM%20(PTJ_F)%20-%201st%20Year%20-%20TP%20(NSQF%202022).pdf
2. https://students.aiu.edu/submissions/profiles/resources/onlineBook/G7b2w8_Fundamentals_of_Tool_Design-_6.pdf

Useful websites / Video

1. https://www.youtube.com/watch?v=7yzvno4AvKw
2. https://www.youtube.com/watch?v=rLq0XghhYxM

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3						2				2		1	
CO 2	3	1	1										1	
CO 3	3	2	2	2	3	1			2		2		1	
CO 4	3	2	2	2	3	1		1	2	1	3		1	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312314C						
Course Name	Advanced Processors						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--				3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20			--	20	60	100

Prerequisites for the Course:

1. Digital Electronics
2. Microprocessors and Microcontrollers
3. Computer Organization and Architecture

The course aims to:

Course Objectives	Description
1	To understand the evolution and architecture of advanced microprocessors.
2	To explore instruction sets, addressing modes, and programming techniques for advanced processors
3	To learn about ARM architecture and embedded system integration.
4	To analyze interfacing techniques and system-level integration using advanced processors
	To apply advanced processors in real-time, industrial, and automation applications

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the architecture, pipelining, and execution model of modern advanced processors	2
CO2	Develop assembly-level and embedded C programs for advanced processors (e.g., ARM Cortex).	2
CO3	Design and interface memory and peripheral devices with advanced processors	3
CO4	Analyze interrupt handling, communication protocols, and embedded system design using advanced processors.	4
CO5	Apply advanced processor-based solutions in robotics, IoT, and industrial automation.	

Course context, Relevance, Practical Significance:

Provides in-depth knowledge of advanced processors with practical applications in embedded systems, robotics, and automation.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped

1	**Introduction to Advanced Microprocessors** Evolution of microprocessors: 8086 to modern CPUs Architecture overview: Intel x86 (Pentium/Core series), AMD, ARM Cortex-A series Instruction sets: CISC vs. RISC Overview of cache memory, pipelining, and branch prediction, Real-mode vs. protected-mode operation	7	CO1
2	**UNIT II: ARM Architecture and Programming** ARM processor family overview,Architecture of ARM Cortex-M and Cortex-A,Register organization and instruction set, ARM assembly programming basics Thumb and Thumb-2 instruction set	7	CO2
3	**UNIT III: Interfacing and Peripheral Devices** Memory interfacing (SRAM, DRAM, Flash)Interfacing with I/O devices, Interrupts and exception handling, DMA (Direct Memory Access), Serial and parallel communication interfaces (UART, SPI, I2C)	7	CO3
4	**UNIT IV: Advanced Microcontroller Platforms** Introduction to microcontrollers with advanced features (e.g., STM32, MSP430, PIC32), Embedded C programming basics for ARM-based controllers, Real-time applications using timers, ADC, PWM, RTOS basics and scheduling in microcontrollers	7	CO3
5	**UNIT V: Applications and Case Studies** Case study: Signal processing using microprocessors Industrial control applicationsRobotics and automation using ARM microcontrollers IoT and wireless communication integrationPerformance benchmarking of processors	7	CO4

References Books

1. B. Brey, *The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, and Pentium 4 Architecture, Programming, and Interfacing*, 8th ed., Pearson Education, 2008. ISBN: 978-0135026458.

2. A. N. Sloss, D. Symes, and C. Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, 1st ed., Morgan Kaufmann, 2004. ISBN: 978-1558608740.

3. D. V. Hall and S. S. S. P. Rao, *Microprocessors and Interfacing: Programming and Hardware*, 3rd ed., McGraw-Hill Education, 2017. ISBN: 978-1259006151.

[1] R. Gaonkar, *Microprocessor Architecture, Programming and Applications with the 8085*, 6th ed., Penram International Publishing, 2013. ISBN: 978-8120348165.

e Resources

1. Intel Developer Zone – *Intel x86 Processor Documentation & Architecture*
   ⛓ https://www.intel.com/content/www/us/en/developer/tools/documentation.html
   Official technical manuals for x86 and modern Intel processors.
2. ARM Developer – *ARM Cortex Architecture and Tools*
   ⛓ https://developer.arm.com/documentation
   Resources on ARM Cortex-A/M processors, instruction sets, and development tools.

Useful websites / Video

1. Intel Developer Zone
⛓ https://www.intel.com/content/www/us/en/developer/tools/documentation.html
Official technical manuals and optimization guides for Intel x86 and modern processors.

2. ARM Developer Portal
⛓ https://developer.arm.com/architectures
Comprehensive documentation and resources on ARM Cortex-A, Cortex-M, and instruction sets.

1.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	1	2	1	-								1	2
CO2	1	2	1	1	-								1	2
CO3	1	2	2	1	-								2	1
CO4	1	2	2	1	-								1	1
CO5	1	2	1	1	-								2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312315A						
Course Name	Cloud Computing						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course: C Programming

The course aims to:

Course Objectives	Description
1	To understand the basic concepts of cloud computing and its service models.
2	To explore cloud architecture, deployment models, and virtualization techniques.
3	To provide knowledge of cloud storage, security, and resource management.
4	To implement cloud computing tools and platforms for real-time applications.
5	To introduce emerging trends and the role of cloud computing in automation and robotics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the concepts, architecture, and service models of cloud computing.	Understand
CO2	Analyse different cloud deployment models and virtualization technologies.	Analyse
CO3	Demonstrate cloud storage and resource management techniques.	Apply
CO4	Evaluate security mechanisms and challenges in cloud environments.	Evaluate
CO5	Apply cloud platforms and tools to design and implement cloud-based applications for robotics and automation.	Apply & Create

Course context, Relevance, Practical Significance:

Cloud computing is a transformative technology reshaping robotics and automation by enabling scalable, real-time, and collaborative systems. This course equips students with the essential skills to develop, deploy, and manage robotic systems integrated with cloud platforms. It builds a strong foundation for Industry 4.0 trends, including smart manufacturing, IoT, and cyber-physical systems.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit I: Introduction to Cloud Computing** Definition, characteristics, benefits Service models: IaaS, PaaS, SaaS ,Cloud deployment models: Public, Private, Hybrid, Community Comparison with traditional computing	7	CO1
2	**Unit II: Cloud Architecture and Virtualization** Cloud architecture components, Virtualization: Types, hypervisors, benefits, Virtual machine provisioning and management, Containers vs VMs	7	CO2
3	**Unit III: Cloud Storage and Resource Management** Cloud storage types: Object, Block, File storage, Storage services: AWS S3, Google Cloud Storage, Azure Blob, Resource allocation and load balancing, Elasticity and scalability.	7	CO3
4	**Unit IV: Cloud Security and Compliance** Security architecture and models, Threats and vulnerabilities, Authentication, authorization, encryption, Regulatory standards (GDPR, ISO, HIPAA)	7	CO4
5	**Unit V: Cloud Applications in Robotics and Automation** Role of cloud in IoT, AI, and robotics, Use cases in industry automation, Edge computing and fog computing, Case study: Cloud-based robotic control systems.	7	CO5

Course Mapping:

Unit	CO	Bloom's Taxonomy Level	PO Mapping	PSO Mapping
I	CO1	Understand (Level 2)	PO1, PO2	PSO1
II	CO2	Analyse (Level 4)	PO2, PO3, PO5, PO11	PSO1, PSO2
III	CO3	Apply (Level 3)	PO2, PO4, PO5, PO11	PSO1, PSO2
IV	CO4	Evaluate (Level 5)	PO6, PO7, PO8, PO9	PSO2
V	CO5	Apply & Create (Level 3 & 6)	PO5, PO9, PO10, PO11, PO12	PSO2

References Books

1. **Cloud Computing: Principles and Paradigms** – Raj Kumar Buyya, James Bromberg, Andrzej Goscinski. ISBN: 9781118002209
2. **Cloud Computing Bible** – Barrie Sosinsky. ISBN: 9780470903568

Text Books

1. **Cloud Computing: Concepts, Technology & Architecture** – Thomas Erl. ISBN: 9780133387520
2. **Mastering Cloud Computing** – Raj Kumar Buyya, Christian Vecchiola, Thamarai Selvi. ISBN: 9789380931913
3. **Cloud Computing** – Dan C. Marinescu. ISBN: 9780128128107

e Resources

1. NPTEL Cloud Computing: https://nptel.ac.in/courses/106105167
2. AWS Free Tier Labs: https://aws.amazon.com/training/self-paced-labs/
3. Google Cloud Tutorials: https://cloud.google.com/training
4. Microsoft Learn Cloud Fundamentals: https://learn.microsoft.com/en-us/training/azure/

Useful websites / Video

1. Simplilearn Cloud Computing Basics: https://www.youtube.com/watch?v=2LaAJq1lB1Q
2. Free Code Camp Full Cloud Course: https://www.youtube.com/watch?v=3hLmDS179YE
3. AWS Tutorial for Beginners: https://www.youtube.com/watch?v=ulprqHHWlng

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO 2	-	3	2	-	2	-	-	-	-	-	1	-	2	2
CO 3	-	2	-	2	2	-	-	-	-	-	2	-	2	2
CO 4	-	-	-	-	-	2	2	2	1	-	-	-	-	3
CO 5	-	-	-	-	3	-	-	-	2	2	2	2	-	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS	10
2	Timely Assignment Submission	10
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**2312315B**						
Course Name	**Flexible Manufacturing System**						
Type of Course	**PEC**						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03						03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20				20	60	100

Prerequisites for the Course: Manufacturing Technology

The course aims to:

Course Objectives	Description
1	Understand Flexible Manufacturing Systems (FMS) and their importance in modern industry.
2	Learn about Cellular Manufacturing for enhanced production flexibility.
3	Master Computer-Aided Manufacturing (CAM) techniques, including CNC programming.
4	Explore the integration of computers in manufacturing for efficiency.
5	Gain insight into Automated Material Handling Systems for streamlined operations.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain FMS and its applications	2
CO2	Demonstrate applications of group technology and tool management system	2
CO3	Perform CNC programming	3
CO4	Apply the concept of computer integrated manufacturing in FMS scenario	3

Course context, Relevance, Practical Significance: Flexible Manufacturing Systems enable automated, efficient, and adaptable production processes essential for meeting the dynamic demands of modern manufacturing industries.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**FMS Introduction and Description**	7	CO1

	Limitations with conventional manufacturing, Need for FMS Introduction, Definition, Basic Component of FMS, and Significance of FMS, General layout and configuration of FMS, Principle Objectives of FMS, Benefits and limitations of FMS, Areas of Application of a FMS in Industry, Various Hardware and Software required for an FMS, CIM Technology, Hierarchy of CIM, FMS Justification.		
2	**Cellular Manufacturing** Introduction, Description and Classifications of Cell, Unattended Machining, Cellular versus Flexible Manufacturing. Group Technology: Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT.	7	CO2
3	**Computer Aided Manufacturing** Concepts and features of NC, CNC & DNC - feedback devices ,Interpolators., Point-to-point and contouring systems –Interchangeable tooling system – preset & qualified tools – ISO specification – Machining center – Turning center, CNC Programming: -Machine Tool Co-ordinate System, Machine zero, Job zero, Cutter Programming, Tool Offsets, Manual part programming – steps involved – G-codes and M-codes, sample program in lathe & milling. CAM package – canned cycles - Programming.	7	CO3
4	**Computer Integrated Manufacturing** Computer application in manufacturing automation, Computer aided inspection and quality control. Computer integrated production management system, inventory, material requirement planning, manufacturing resource planning, enterprise resource planning. Rapid Product Development and Manufacture, Extended Enterprises.	7	CO4
5	**Automated Material Movement and Storage System** Introduction, Types of AGV and Their principle of working, Advantages, Limitation and General AGV Guide path, Robots, Benefits of using Industrial Robots, Basic components and benefits of Automated Storage and Retrieval Systems, Conveyors and Pallet Flotation System, Queuing Carrousels and Automatic Work Changers, Coolant and Chip Disposal and Recovery system	7	CO4

References Books

1. Nanua Singh, Approach to Computer Integrated Design and Manufacturing, , John Wiley and Sons, ISBN:9780471585176
2. Luggen, Flexible Manufacturing Cells and Systems, , PHI, ISBN: 9780133217384

Text Books

1. H. K. Shivanand, M. M. Benal, Flexible Manufacturing System, V. Koti, New Age Pub. ISBN:9386070227
2. Groover M.P, Automation, Production Systems and Computer Integrated Manufacturing,

Prentice Hall of India, ISBN: 9789332572492

e Resources

1. FLEXIBLE MANUFACTURING SYSTEM e-book http://ndl.ethernet.edu.et/bitstream/123456789/87815/6/Flexible%20Mnfg%20System-HK%20Shivanand.pdf

Useful websites / Video

1. Manufacturing Systems Management - Video course by Prof. G. Srinivasan, Department of Management Studies, IIT Madras, https://archive.nptel.ac.in/courses/110/106/110106044/

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	1	-	-	-	-	2	2	3	-	-	2	2
CO 2	2	2	2	-	-	-	-	2	2	3	-	-	2	2
CO 3	2	2	3	3	-	-	-	2	2	3	-	-	2	2
CO 4	2	2	3	1	-	-	-	2	2	3	-	-	2	2
CO 5	3	3	3	3	-	-	-	2	2	2	-	-	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	10
2	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code							
Course Name	Power Electronics and Drives						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3s		--		--		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course:

1. **Basic Electrical Engineering, Network Analysis**, **Analog/Digital Electronics**

The course aims to:

Course Objectives	Description
1	**To understand** the operation, characteristics, and selection criteria of modern power semiconductor devices such as MOSFETs, IGBTs, and wide band gap devices (SiC, GaN) used in robotic systems.
2	**To analyze** and design power electronic converters like AC-DC, DC-DC, and DC-AC circuits required for motion control and power regulation in robotics and automation.
3	**To study** various electric drive systems such as DC, Induction, BLDC, PMSM, and servo motors with suitable control methods for precise robotic actuation.
4	**To explore** embedded and digital control techniques, including PWM, sensor interfacing, and feedback systems for intelligent motor control in robotic applications.
5	**To apply** power electronics and drive knowledge in real-time robotic systems such as mobile robots, manipulators, AGVs, and collaborative robots through relevant case studies and design perspectives.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the characteristics, switching behaviour, and applications of modern power semiconductor devices used in robotic drive circuits.	2
CO2	Design and analyse AC-DC, DC-DC, and DC-AC converters suitable for robotic power management and actuation systems.	2
CO3	Evaluate the performance and control strategies of various electric motors such as DC, BLDC, PMSM, and stepper motors used in robotic platforms.	3
CO4	Implement PWM control and feedback mechanisms for intelligent motor control using microcontroller/embedded platforms.	4

Course context, Relevance, Practical Significance:

This course provides a foundational understanding of power electronic converters, motor drives, and control strategies essential for operating electromechanical systems used in robotics and automation. Power electronics and motor drives are at the heart of robotic actuators, manipulators, mobile platforms, and automated systems.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Power Semiconductor Devices** Characteristics of SCR, MOSFET, IGBT, GTO, SiC and GaN Devices**,** Static and Dynamic Characteristics**,** Gate Drive Circuits and Protection**,** Losses in Power Semiconductors**,** Selection of Devices for Robotics Applications	7	CO1, CO2, CO3,
2	**AC-DC and DC-DC Converters in Robotic Systems:** Controlled Rectifiers (1φ and 3φ), Buck, Boost, Buck-Boost, Cuk, and SEPIC Converters, Multi-output SMPS and Isolated Converters, Power Supply Design for Microcontrollers, Sensors, Actuators, Application in Battery Charging for Mobile Robots	7	CO1, CO2 CO3, CO4,
3	**Inverters and AC-AC Converters:** 1φ and 3φ Voltage Source and Current Source Inverters**,** PWM Techniques (Sine PWM, Space Vector PWM)**,** Cycloconverters, Matrix Converters**,** Harmonics, Filters, and EMI/EMC in Robotic Drives**,** Regenerative Braking using Inverters	7	CO1, CO2 CO3, CO4,
4	**Electric Drives for Robotic Applications:** DC Drives (Separately Excited, PMDC), Induction Motor Drives (V/f Control, Vector Control), BLDC and PMSM Drives – Control and Feedback Techniques, Servo Drives and Stepper Motors for Precision Motion, Motor Selection for Robotic Arm, Mobile Robot, AGVs	7	CO1, CO2 CO3, CO4,
5	**Embedded Motion Control and Recent Trends** Motion Controllers and DSP/FPGA-Based Motor Control, Integration with PLC, ROS, and SCADA for Automation, Industrial Communication Protocols (CAN, RS485, Ether CAT), Smart Drives, IoT-Enabled Drives, Energy Efficiency Standards Case Studies: Autonomous Robots, Cobots, and Electric Vehicles	7	CO1, CO2, CO3 CO4,

References Books

1. B. K. Bose, *Power Electronics and Motor Drives: Advances and Trends*, 1st ed., Burlington, MA, USA: Academic Press, 2006.
2. N. Mohan, T. M. Undeland, and W. P. Robbins, *Power Electronics: Converters, Applications, and Design*, 3rd ed., Hoboken, NJ, USA: Wiley, 2003.
3. R. Krishnan, *Electric Motor Drives: Modeling, Analysis, and Control*, 1st ed., Upper Saddle River, NJ, USA: Prentice Hall, 2001.

Text Books

1. M. H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th ed., Pearson Education, 2014. ISBN: 978-9332542609

e Resources

NPTEL Online Courses (IITs)

Power Electronics by Prof. Krishna Vasudevan (IIT Madras)
https://nptel.ac.in/courses/108/106/108106084

Advanced Power Electronics and Drives
https://nptel.ac.in/courses/108/105/108105067

Useful websites / Video

1. NPTEL (IIT Online Lectures)

Free structured lectures by IIT professors
Power Electronics – Prof. K. Vasudevan, IIT Madras
https://nptel.ac.in/courses/108/106/108106084

2. **Texas Instruments – Motor Control Resources- Industry-grade tutorials, application notes, and videos**
https://training.ti.com/motor-control

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	2	1	1	-	-	-	-	-	-	-	1	2	2
CO 2	2	2	1	2	-	-	-	-	-	-	-	1	1	2
CO 3	1	2	2	2	-	-	--	-	-	-	-	2	2	1
CO 4	1	1	1	1		--	--	-	-	-	1	1	1	1

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**2312306B**						
Course Name	**Hydraulics and Pneumatics**						
Type of Course	**PEC**						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	03						03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20				20	60	100

Prerequisites for the Course: NA

The course aims to:

Course Objectives	Description
1	To study governing laws in hydraulic and pneumatic systems.
2	To study working principles of various components used in hydraulic and pneumatic systems.
3	To understand the selection of different components used in hydraulic and pneumatic systems.
4	To design hydraulic and pneumatic systems.
5	To understand Industrial applications of hydraulic and pneumatic systems.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Ability to understand working principle of components used in hydraulic & pneumatic systems.	1,2
CO2	Ability to identify various components of hydraulic & pneumatic systems.	2,3
CO3	Ability to select appropriate components required for hydraulic and pneumatic systems.	3,4
CO4	Ability to design hydraulic and pneumatic system for industrial applications.	2,3
CO5	Ability to understand industrial applications of hydraulic and pneumatic system	3,4

Course context, Relevance, Practical Significance: The Hydraulics and Pneumatics Lab offers hands-on experience in operating and troubleshooting fluid power systems. It is crucial for applying theoretical knowledge to real-world industrial automation and machinery control.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped

1	**Introduction to Hydraulics and Pneumatics** Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Distribution of fluid power, ISO symbols, energy losses in hydraulic systems. Pumps: Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission.	7	CO1
2	**Hydraulic system Components** Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors). Control Components: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation	7	CO2
3	**Hydraulic Circuit Design and Analysis** Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Speed Control of Hydraulic Cylinder and motors, Safety circuit, Accumulators, types, construction and applications with circuits, Intensifier circuits and their applications, Proportional control valves and servo valves.	7	CO3
4	**Pneumatic system** Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder - Types, Cascade design of Pneumatic circuit, Use of Logic gates - OR and AND gates in pneumatic applications.	7	CO4
5	**Electro-hydraulics and Electro-pneumatic systems** PLC based electro-hydraulic systems, PLC programming using ladder logic for automation and robotics applications,	7	CO5

	Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple applications. Troubleshooting of fluid power systems Identifying root cause, suggest remedies, steps to be followed in troubleshooting.		

References Books

1. Peter Rohner, Industrial hydraulic control, Wiley Edition, 1995, ISBN: 0471334987
2. Mujumdar S.R., Pneumatic Systems, Tata McGraw Hill, 2002 Edition. ISBN: 9780074602317
3. Esposito, Fluid Power with Applications, Pearson Education India, 2003, ISBN: 9788177585803
4. Bolton W., Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, Pearson, Education (Singapore) Pvt Ltd., ISBN 81-7808-339-6.
5. Industrial hydraulics manual by Vickers, Inc.

Text Books

1. . Pinches, M.J., Ashby, J.G., *Power Hydraulics*, Prentice-Hall, ISBN: 13. 978-0136874430

e Resources

1. **NPTEL – Hydraulics and Pneumatics by PROF. SOMASHEKHAR S, Department of Mechanical Engineering, IIT Madras**
   https://archive.nptel.ac.in/courses/112/106/112106300/

Useful websites / Video

1. Bosch Rexroth – Industrial Hydraulics Training Videos

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	2	1	-	-	-	-	-	-	-	-	-	2	2
CO 2	1	2	2	-	-	-	-	-	-	-	-	-	2	2
CO 3	2	2	3	3	-	-	-	-	2	1	-	-	2	3
CO 4	2	2	2	1	3	-	-	-	3	1	-	1	2	3
CO 5	3	3	3	3	-	-	-	-	2	1	-	2	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	10
2	Timely Assignment Submission	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**2312316A**						
Course Name	**Cloud Computing Lab**						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		2Hrs		01
Assessment Scheme (Marks)	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	--	25	25	--	--	--	50

Prerequisites for the Course: C Programming

The course aims to:

Course Objectives	Description
1	To understand the basic concepts of cloud computing and its service models.
2	To explore cloud architecture, deployment models, and virtualization techniques.
3	To provide knowledge of cloud storage, security, and resource management.
4	To implement cloud computing tools and platforms for real-time applications.
5	To introduce emerging trends and the role of cloud computing in automation and robotics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Explain the concepts, architecture, and service models of cloud computing.	Understand
CO2	Analyse different cloud deployment models and virtualization technologies.	Analyse
CO3	Demonstrate cloud storage and resource management techniques.	Apply
CO4	Evaluate security mechanisms and challenges in cloud environments.	Evaluate
CO5	Apply cloud platforms and tools to design and implement cloud-based applications for robotics and automation.	Apply & Create

Course context, Relevance, Practical Significance:

Cloud computing is a transformative technology reshaping robotics and automation by enabling scalable, real-time, and collaborative systems. This course equips students with the essential skills to develop, deploy, and manage robotic systems integrated with cloud platforms. It builds a strong foundation for Industry 4.0 trends, including smart manufacturing, IoT, and cyber-physical systems.

Course Contents:

Sr. No.	Contents	Pr. Hrs.
1	Create and Launch a Virtual Machine Instance on the Cloud (AWS EC2 / Google Cloud / Azure)	2
2	Deploy a Web Application Using Platform as a Service (PaaS) (Heroku / Azure App Services)	2
3	Configure and Use Object Storage Service (Create and access AWS S3 bucket or Google Cloud Storage)	2
4	Containerize a Sample Application Using Docker (Run, build, and deploy using Docker Desktop)	2
5	Simulate Private Cloud with OpenStack Dashboard (Horizon) (Manage virtual machines and volumes)	2
6	Set Up Identity and Access Management (IAM) Roles and Policies (Use AWS IAM to create users, groups, and permissions)	2
7	Develop a Simple Cloud-Connected Robot Control App (Using Firebase Real-time Database or MQTT protocol)	2

Course Mapping

Practical No.	Title	Mapped CO(s)	POs	PSOs
1	Create and Launch a Virtual Machine on the Cloud	CO1, CO2	PO1, PO2, PO3, PO11	PSO1
2	Deploy a Web App using PaaS	CO1, CO3	PO1, PO2, PO5, PO12	PSO1
3	Configure and Use Object Storage (S3, GCS)	CO3	PO2, PO4, PO5	PSO1, PSO2
4	Containerize an Application using Docker	CO2, CO3	PO2, PO3, PO5	PSO1
5	Simulate Private Cloud with OpenStack	CO2, CO3	PO2, PO3, PO4, PO11	PSO1, PSO2
6	Set Up IAM Roles and Policies	CO4	PO6, PO7, PO8	PSO2
7	Cloud-Connected Robot Control with Firebase/MQTT	CO5	PO5, PO9, PO10, PO12	PSO2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	2312316C						
Course Name	Elective 2- Power Electronics and Drives Lab						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	-		-		1		01
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	-	25	25	-	-	-	50

Prerequisites for the Course: Mathematics, Fundamentals of Electronics Engineering, Fundamentals of Electrical Engineering

The course aims to:

Course Objectives	Description
1	Understand Fundamentals of power electronic devices and characteristics
2	Understand The concepts and operating principles of power electronics circuits.
3	Electrical Drives for Robotics

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Examine the characteristics of various devices and application of firing circuits used in power electronics.	1,2
CO2	Analyse the performance characteristics of AC voltage regulators, choppers, inverters, rectifiers	2,3
CO3	Analyse the operation and performance of different chopper configurations, including voltage and current-fed choppers, in both continuous and discontinuous conduction modes.	3,4
CO4	Analyse the operating principles and characteristics of various electric motors to determine their suitability for robotics applications.	2,3
CO5	Implement control techniques for electric drives to achieve desired motion control in robots	3,4

Course context, Relevance, Practical Significance:
The Power Electronics and Drives Lab provides hands-on experience in controlling electrical machines using power electronic converters, essential for modern automation and electric drive systems.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	Study of Single phase Half Wave Half Controlled Rectifier with R & RL Load	2	CO1, CO2
2	Study of Single phase Wave Half Controlled bridge Rectifier with R & RL Load	2	CO1, CO2
3	Study of 3- phase AC to DC full controlled converter.	2	CO2

4	Study of DC –DC Buck Converter	2	CO2, CO3
5	Study of DC-DC Boost Converter	2	CO2, CO3
6	Single phase A.C. voltage regulator with R and RL load using Diac & Triac	2	CO2
7	Single phase A.C. voltage regulator with R and RL load using Thyristor	2	CO2
8	Study of VSI fed 3-Phase Induction motor(using v/f control PWM Inverter) Speed control characteristics	2	CO4, CO5
9	Study of a Thyristor based DC-drive with closed loop speed control.	2	CO4, CO5
10	Study of speed control of PMSM Drive	2	CO4, CO5
11	Study of speed control of BLDC (Hardware)	2	CO4, CO5

References Books

1. **M.H. Rashid**, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, 2013. ISBN: 978-0273769088.
2. **Bimal K. Bose**, *Modern Power Electronics and AC Drives*, Pearson Education, 2002. ISBN: 978-0130167439.
3. **M.D. Singh and K.B. Khanchandani**, *Power Electronics*, 2nd Edition, Tata McGraw-Hill Education, 2008. ISBN: 978-0070583894.

Text Books

1. **M.H. Rashid**
   Power Electronics Handbook: Devices, Circuits, and Applications, 4th Edition, Academic Press (Elsevier), 2017 ISBN: 978-0128114070.
2. **Bimal K. Bose**
   Power Electronics and Motor Drives: Advances and Trends, 1st Edition, Academic Press, 2006 ISBN: 978-0120884056.
3. **S.N. Singh**
   Electrical Machines and Power Electronics: Theory and Practice, PHI Learning, 2006 ISBN: 978-8120333480

e Resources

NPTEL – Power Electronics & Drives

https://nptel.ac.in/courses/108/105/108105066/

(Lecture series by Prof. G. Bhuvaneshwari, IIT Delhi)

Useful websites / Video

NPTEL Power Electronics

https://nptel.ac.in/courses/108/105/108105066/

– Comprehensive video lectures and notes on power electronics by IIT professors.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping

Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 3	1	1	-	1	-	-	-	-	-	-	-	-	1	-
CO 4	1	1	1	1	1	1	-	-	-	-	-	-	1	1
CO 5	1	1	1	1	1	1	-	-	-	-	-	-	1	1

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Timely completion of assignments	10
2	Understanding of assignments	10
3	Presentation/Clarity of journal writing	05
	Total	**25**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312307B						
Course Name	Hydraulics and Pneumatics Lab						
Type of Course	PEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs					02		01
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)		25	25				50

Prerequisites for the Course: NA

The course aims to:

Course Objectives	Description
1	To study governing laws in hydraulic and pneumatic systems.
2	To study working principles of various components used in hydraulic and pneumatic systems.
3	To understand the selection of different components used in hydraulic and pneumatic systems.
4	To design hydraulic and pneumatic systems.
5	To understand Industrial applications of hydraulic and pneumatic systems.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understanding the principle of industrial fluid power	1,2
CO2	Classification & identification of components for Hydraulics & Pneumatics	2,3
CO3	Perform the PLC programme on electro hydraulic kit	3,4
CO4	Organize hydraulic and pneumatic circuits for given application	2,3
CO5	Evaluate the hydraulic and pneumatic systems based on various evaluation criteria	3,4

Course context, Relevance, Practical Significance:
The Hydraulic and Pneumatics Lab offers hands-on experience in designing and analyzing fluid power systems, essential for automation, machine control, and industrial process efficiency in modern engineering applications.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	Experiment on measurement of hydraulic pump efficiency.	2	CO1, CO5
2	Experiment on design of speed control hydraulic circuits.	2	CO1, CO2
3	Experiment on design of regenerative circuits	2	CO1, CO4

4	Experiment on design of electro-hydraulic sequencing circuits	2	CO3, CO5
5	Experiment on pneumatic circuits by demonstrating logic gates.	2	CO2, CO4
6	Experiment on electro-pneumatic circuits	2	CO2, CO3
7	Experiment on programmable logic controllers: Ladder logic programming.	2	CO3
8	Microprocessor programming for basic operations	2	CO3

References Books

1. Center Training Vickers, Industrial Hydraulics Manual, Eaton Hydraulics Training, ISBN-10 0963416200
2. 2. Mujumdar S.R., Pneumatic Systems, Tata McGraw Hill, 2002 Edition. ISBN: 9780074602317

Text Books

1. Pinches, M.J., Ashby, J.G., *Power Hydraulics*, Prentice-Hall, ISBN: 13. 978-0136874430

e Resources

1. **NPTEL – Hydraulics and Pneumatics by PROF. SOMASHEKHAR S, Department of Mechanical Engineering, IIT Madras** https://archive.nptel.ac.in/courses/112/106/112106300/

Useful websites / Video

2. Bosch Rexroth – Industrial Hydraulics Training Videos

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	2	1	-	-	-	-	-	-	-	-	-	2	2
CO 2	1	2	2	-	-	-	-	-	-	-	-	-	2	2
CO 3	2	2	3	3	-	-	-	-	2	1	-	-	2	3
CO 4	2	2	2	1	3	-	-	-	3	1	-	1	2	3
CO 5	3	3	3	3	-	-	-	-	2	1	-	2	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Timely completion of assignments	10
2	Understanding of assignments	10
3	Presentation/Clarity of journal writing	05
	Total	**25**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312317						
Course Name	Machine Vision						
Type of Course	MDM						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	20	--	--	--	20	60	100

Prerequisites for the Course: Fundamentals of Electronics Engineering, C Programming**, Python** Programming.

The course aims to:

Course Objectives	Description
1	Introduce the fundamentals of image acquisition, processing, and analysis for automated inspection and control.
2	Familiarize students with key components of machine vision systems, including cameras, lighting, lenses, and image sensors.
3	Develop skills in digital image processing techniques such as filtering, edge detection, segmentation, and feature extraction.
4	Equip students with the knowledge to integrate machine vision with robotics and automation systems for industrial applications.
5	Expose students to machine learning and AI-based approaches used in vision-based recognition and decision-making.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Describe the stages of digital image processing
CO2	Demonstrate the role of image processing in different fields such as robotics, medical, engineering, agriculture, food industry, etc.
CO3	Apply various machine learning algorithms for image processing and analysis
CO4	Develop algorithms for machine vision in robotic applications

Course context, Relevance, Practical Significance:

The **"Machine Vision"** course is a vital interdisciplinary subject integrating **optics, electronics, signal processing, computer vision, and artificial intelligence**. It serves as a bridge between theoretical image processing and real-world vision systems used in automation, robotics, and quality inspection systems.

This course provides foundational and advanced knowledge in:

- Image acquisition and enhancement
- Image segmentation, restoration, and compression
- Motion analysis
- Machine learning and deep learning applications in vision

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Introduction to machine vision** Machine vision components - Lighting system, optical system, sensors, steps of vision processing, communications. Machine vision functions – measurement, counting, decoding, and location. Applications of machine vision in automotive industry, manufacturing, electronics, semiconductors, robotics. Benefits of vision system.	7
2	**Image Acquisition and enhancement** Image acquisition: Image acquisition concept, quantum detectors, Image acquisition models, Charged coupled device (CCD), Complementary metal oxide semi-conductors (CMOS). Image Enhancement in spatial domain: Point operator, Spatial filter, Linear and non-linear filtering, bilateral filtering, histogram equalization Image enhancement in frequency domain: 2D Fourier transforms, smoothing frequency domain filters – ideal, butter worth, Gaussian low pass filters.	7
3	**Image restoration and image compression** Image restoration: Noise reduction by frequency domain filtering, Arithmetic mean filters, geometric mean filters, adaptive filters, Band pass and band reject filters. Image compression: Steps involved in image compression, Lossless compression techniques – Run length encoding, Huffman encoding, area coding. Lossy compression: Predictive coding, transform coding, wavelet coding. Performance measures of compression – Compression ratio, S/N ratio, speed.	7
4	**Image segmentation and representation** Image segmentation: Approach based classification – Region based, boundary based. Technique based classification – structural, stochastic, hybrid. Techniques of image segmentation – Thresholding, edge based, watershed, clustering, Image representations: Color based image representations, Texture based image representations, Shape based image representation	7
5	**Motion estimation and Deep learning algorithms in image processing** Hierarchical motion estimation, Fourier based alignment, incremental refinement, parametric motion, layered motion, Optical flow, Block matching algorithm. Supervised learning algorithms: Bayesian classification, logistic regression, support vector machines. Unsupervised learning algorithms: Clustering, Principal Component Analysis. Deep Neural networks. Convolutional Neural Networks.	7

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Remember, Understand	1,2	PO1, PO2, PO5, PO10	1,2
2	Apply, Analyse	1	PO1, PO2, PO3, PO4, PO5, PO12	1,2
3	Analyse, Evaluate	1,3	PO1, PO2, PO3, PO4, PO5, PO12	1,2
4	Analyse, Evaluate	3,4	PO1, PO2, PO3, PO4, PO5, PO11, PO12	1,2
5	Apply, Create	3,4	PO1, PO2, PO3, PO4, PO5, PO10, PO11, PO12	1,2

References Books

1) Richard Szeliski, Computer Vision: Algorithms and Applications, Springer Nature, ISBN: 9783030343729
2) Refael C. Gonzalez and Richard E, Woods Digital Image Processing, Addison-Wesley ISBN: 9780133356724

Text Books

1) Refael C. Gonzalez and Richard E. Woods, Digital Image Processing Using MATLAB, Addison Wesley, ISBN: 9780070702622
2) Scott E Umbaugh, Computer Vision and Image Processing Prentice-Hall International, ISBN: 9781439802052
3) 5) Jain A.K., Fundamentals of Digital Image Processing, Prentice-Hall of India, ISBN-100133361659

e Resources

NPTEL Courses:

- NPTEL – Digital Image Processing by Prof. P.K. Biswas
- Computer Vision by Prof. J. Sivaram (IIT Madras)

Free Toolkits for Practice:

- Google Colab – Run Python image processing code online
- MATLAB Online – MATLAB without installation (limited access)
- OpenCV-Python Tutorials

Useful websites / Video

1) https://www.youtube.com/playlist?list=PL4C939ED22F991970
2) https://www.youtube.com/@PyImageSearch
3) https://www.youtube.com/watch?v=YRhxdVk_sIs
4) https://www.youtube.com/c/MurtazasWorkshopRoboticsandAI/playlists
5) https://www.youtube.com/playlist?list=PLm_MSClsnwm-0Z_G1fQkNYN9ArsJFDC0f

Strength of CO - PO/PSO Mapping (Sample):

Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	--	--	--	2	--	-	--	--	--	--	2	2	2
CO 2	2	2	--	--	2	2	1	1	--	2	--	2	2	2
CO 3	3	3	2	2	3	--	--	1	--	2	2	3	3	2
CO 4	3	3	3	2	3	1	1	1	2	2	2	3	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for CCE	Marks Allotted
1	Tests on each unit using LMS	10
2	Timely Assignment Submission	10
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	2312318						
Course Name	Nutrition and Weight Management						
Type of Course	OE						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	02		-		-		02
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	50	-	-	-	-	-	50

Prerequisites for the Course:

1. Basic Biology, Anatomy and Physiology

The course aims to:

Course Objectives	Description
1	Understand the principles of nutrition and their role in maintaining health and managing weight.
2	Analyze dietary patterns and assess nutritional needs of individuals based on various factors such as age, gender, activity level, and health status.
3	Evaluate the impact of nutrition on weight management, including factors such as energy balance, metabolism, and dietary composition.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the fundamental principles of nutrition and their implications for maintaining overall health.	Understand
CO2	Comprehend the relationship between dietary intake, energy balance, and weight management strategies.	Understand
CO3	Interpret nutritional information from various sources to make informed decisions about dietary choices.	Understand
CO4	Demonstrate knowledge of factors influencing food behaviors and dietary patterns within different populations or cultural contexts.	Understand
CO5	Apply evidence-based nutrition principles to create personalized dietary plans for individuals to achieve specific health and weight objectives.	Apply

Course context, Relevance, Practical Significance:

The course Nutrition and Weight Management is designed to provide a comprehensive understanding of the principles of nutrition, metabolism, and energy balance, and their critical role in maintaining a healthy body weight. In the current global context, where obesity and diet-related chronic diseases are escalating public health challenges, understanding nutrition and weight management is essential. Ultimately, the course fosters the ability to promote sustainable lifestyle changes that contribute to long-term health outcomes for individuals and communities.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Obesity epidemic** Causes of obesity epidemic, eating habits, lack of exercise, managing obesity crisis, nutrition transition, international strategies.	07	CO2, CO4
2	**Body Mass Index** Meaning of body mass index (BMI), BMI chart, BMI for age percentiles, proportion of body fats, weight statistics, BMI, Waist Circumference and disease Risk.	07	CO1, CO3
3	**Heath risk analysis** Health risk analysis due to high or low body fat, its effect on Heart disease, Diabetes, cancer, Gallbladder Disease, Breathing Problems, Reproductive Problems, Psychological and Social Impact of Being Overweight, causes of underweight and its Health consequences.	07	CO2, CO4
4	**Balancing energy and weight** Food Nutrition and body weight, Importance of nutrition for energy, structure, body process regulations, six classes of nutrient: carbohydrates, lipid, proteins, water, vitamins, minerals, dietary reference intakes, tools for choosing healthy diet, Amount of calories required, energy to stay alive, energy to keep moving, energy to process food, calculating energy need, biology of body weight.	07	CO1, CO5

References Books

1. Lori A. Smolin, Mary B. Grosvenor, "Nutrition and Weight Management", Infobase Publishing, ISBN: 1438102208, 9781438102207, 2009
2. Gerard E. Mullin, Lawrence J. Cheskin, Laura E. Matarese, "Integrative weight management", Springer, ISBN: 9781493905478, 2014

Text Books

1. Dr. A. K. Uppal, Dr. P. P. Ranganathan, "Fitness, Wellness and Nutrition", Friends Publications India, ISBN: 9388457676, 2020

e Resources

1. https://nptel.ac.in/courses/127105236
2. https://onlinecourses.swayam2.ac.in/nce19_sc04/preview

Useful websites / Video

1. https://onlinecourses.swayam2.ac.in/cec19_ag02/preview
3. www.youtube.com/watch?v=If4SNX4y03k&t=2s

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low, 2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	1	1	1	1	1	-	-	-	-	-	-	-	-	-

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

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 30 M)	30
2	Timely Assignments Submission on each unit (5 M for each unit)	20
	Total	**50**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312319							
Course Name	Design thinking and problem solving (Mini Project)							
Type of Course	VSEC							
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits	
Weekly Working Hrs	-		1		2		2	
Assessment Scheme (Marks)	CCE	TW	PR	OR	TU	ISE	ESE	Total (Marks)
	-	-	25	-	25	-	-	50

Prerequisites for the Course: --

The course aims to:

Course Objectives	Description
1	To learn design thinking concepts and principles
2	To learn the different phases of design thinking

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand(identify) the fundamentals of Design Thinking concepts, process and Principles	Understand
CO2	Identify the methods to empathize and define the problem	Understand
CO3	Apply the ideation techniques for problem solving	Apply
CO4	Construct the prototype to evaluate a design	Apply
CO5	Identify various techniques for testing to improve the performance.	Apply
CO6	Apply the Design Thinking approach and model to real world situations	Apply

Course context, Relevance, Practical Significance:

This course introduces students to the structured methodology of design thinking, focusing on user-centric problem solving through empathy, ideation, prototyping, and testing. It emphasizes the application of creative and analytical skills to real-world challenges by identifying user needs, defining problems, and developing meaningful solutions. The relevance of this course lies in its interdisciplinary approach, making it valuable across engineering, business, healthcare, and social innovation domains. Practically, students gain hands-on experience in using ideation techniques, building prototypes, evaluating designs, and applying design thinking models to real-life scenarios. The course fosters critical thinking, teamwork, and innovation—skills essential for addressing complex, dynamic problems in both academic and professional settings.

Course Contents:

Unit	Contents	Tutorial Hours	Cos Mapped
1	**Introduction to design thinking, empathize and define :** **Introduction to Design Thinking:** Design Thinking as a problem solving tool, Principles of Design Thinking, Process of Design Thinking, Tools and techniques for Design Thinking process, Planning a Design Thinking project. **Empathize and define:** Search field determination, Problem clarification, Understanding of the problem, Problem analysis, Reformulation of the problem, Observation Phase, Empathetic design, Tips for observing, Methods for Empathetic Design, Artifact Analysis, Behavioral Mapping and Tracking, Empathy Map, Cognitive Walkthrough, Heuristic Evaluation, Point-of-View Phase, Characterization of the target group, Description of customer needs, Persona, Define- Analysis and Drawing Inferences from Research	03	CO1, CO2, CO6
2	**Idea Generation :** Idea generation Basic design directions, Themes of thinking, Inspiration and references, Brainstorming, Value, Inclusion, Sketching, presenting ideas Refinement Thinking in images, thinking in signs, Appropriation, Humour, Personification, Visual metaphors, Modification, thinking in words, Words and language, Type 'faces', thinking in shapes, thinking in proportions, Thinking in colours, Ideation tools & exercises. Storytelling and Tools for Innovation Evaluation of ideas	03	CO3, CO6
3	**Prototype:** Prototype Phase - Lean Startup Method for Prototype Development, Visualization and presentation techniques, Ideas to presentable concepts, Storyboards, Developing mock-ups, models and prototypes, Quick and Dirty Prototyping	03	CO4, CO6
4	**Testing and Implementation :** Test Phase – Technique for interviews and surveys, Kano Model, Desirability Testing, Presenting Prototypes ,testing prototypes, Obtaining feedback to refine product Usability and Ergonomic testing	03	CO5, CO6
5	**Design Thinking and Innovation:** Design and Innovation as an Organizational Strategy : Design Thinking meets the corporation, Design Thinking a systematic approach to innovation, using design thinking to manage an innovation portfolio	03	CO6

References Books

1. "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", Idris Mootee, Wiley.
2. "Designing for Growth: a design thinking tool kit for managers", Jeanne Liedtka and Tim Ogilvie

Text Books

1. ” Design Thinking”, Gavin Ambrose, Paul Harris, AVA Publishing.
2. “Handbook of Design Thinking - Tips & Tools for how to design thinking”, Christian Mueller-Rotenberg.
3. “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation” by Tim Brown

e Resources

1. https://onlinecourses.nptel.ac.in/noc22_mg32/preview

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	1	1	-	-	-	-	-	-	1	-	2	2	2
CO 2	2	2	2	-	-	2	-	2	2	2	-	2	2	2
CO 3	2	3	3	2	2	-	-	-	2	2	2	2	2	2
CO 4	2	2	3	3	3	-	-	-	2	2	2	2	2	2
CO 5	2	2	2	3	3	-	-	-	-	2	2	2	2	2
CO6	3	3	3	2	2	2	1	2	3	3	3	3	2	2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	2312320						
Course Name	Research Methodology						
Type of Course	RM						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	-		-		2		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	-	25	25	-	-	-	50

Prerequisites for the Course: -----

The course aims to:

Course Objectives	Description
1	To orient students towards research-related activities and developing skills in literature review, data collection, and critical analysis
2	To develop the students with the skills to design, execute, and evaluate research studies.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the formulation research problem formulation effectively, considering feasibility, relevance, and significance.	Understand
CO2	Analyse research related information like existing research, literature, and data.	Analyze
CO3	Prepare the research proposal report consisting of literature survey, research gap identified and research significance.	Create

Course context, Relevance, Practical Significance:

This course component is designed to build foundational research skills essential for Robotics and Automation. It guides students through identifying research gaps via literature review, formulating research proposals, understanding funding mechanisms and applying academic integrity through proper citation and plagiarism checks. By engaging in proposal writing, case study analysis of intellectual property, and seminar presentations, students gain practical exposure to real-world research processes. This experience not only enhances their analytical and communication skills but also prepares them for future academic, industrial, or funded research projects in emerging areas of robotics.

Course Contents:

	Contents	Cos Mapped
1	Literature review: Collect the existing literatures on any research idea in Robotics and Automation and identify the research gap.	CO1, CO2, CO3

2	Report and seminar presentation: Prepare the research proposal based on the earlier identified research gap (report should be checked for plagiarism) and present the idea. (Introduction, Objectives, Scope of work, Methodology)	CO1, CO2, CO3
3	Collection of standard format and guidelines of research proposal: Identify the national and international funding agencies and prepare research proposal for any one of the funding agencies (in a group of students of not more than five).	CO1, CO2, CO3
4	Prepare a report on different citation styles and referencing styles adopted by different publishers and prepare the list of references as per any standard style.	CO1, CO2, CO3
5	Write a report on case study of any existing patent/copy right/trademark on the selected topic for literature review.	CO1, CO2, CO3

Guidelines for Conduction:
Subject faculty will conduct the sessions on course content. Faculty will form small groups of students. Each group has to select one problem in the field of Robotics and Automation Engineering and decide the topic for literature review. Topics will be based on study, identification of problems and improvement in existing systems in Robotics and Automation Engineering.

Guidelines for Termwork Assessment:
A continuous assessment will be done by Subject Faculty/Mentor/Guide. Assessment will be based on the Assignments mentioned in the course content.

References Books

1. Research Methodology Methods & Techniques, C. K. Kothari, 2nd edition, New Age International, New Delhi.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3	3	2	2	2	2	2	3	3	2	3	3	2
CO 2	3	3	3	2	2	2	2	2	3	3	2	3	3	2
CO 3	3	3	3	2	2	2	2	2	3	3	2	3	3	2

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**