VISION
To develop educational avenues for the students to emerge as disciplined researchers, technocrats and entrepreneurs making transformative impact on establishing a world class society in the domain of Production Engineering and Automation.

MISSION
1. To impart students with knowledge on modern manufacturing and automated systems by incorporating critical thinking, leadership qualities, communication with interpersonal skills.
2. To create a conducive environment for exchange of multidisciplinary ideas towards research, creativity, innovation and entrepreneurship to meet the societal needs with optimal solutions.
3. To follow the values of integrity and honesty through curricular, co-curricular and extracurricular activities.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)
I. Secure gainful employment in industry, academia and research avenues by showcasing their competence and adaptability.
II. Outshine in scientific, managerial, and entrepreneurial roles, applying a versatile and multidisciplinary approach with capacity to address complex challenges.
III. Graduates will possess the skills and knowledge to excel as technocrats, specializing in the design, development, and analysis of mechatronic systems to provide sustainable solutions for industrial and societal issues.
IV. Graduates will embody ethical responsibility, committing to lifelong learning and exhibit effective communication as individual professional and collaborative team member.

PROGRAMME OUTCOMES (POs):

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<tr>
<td>1</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems.</td>
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<td>An ability to write and present a substantial technical report/document.</td>
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<td>Students should be able to demonstrate a degree of mastery in the area of mechatronics.</td>
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<td>Graduates will have a solid understanding of key concepts, methodologies, core components, and contemporary tools and techniques essential for unified mechatronics systems with intelligence.</td>
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<td>Students will develop, analyze and optimize the solution for diverse engineering challenges using a mechatronics-based approach.</td>
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<td>Graduates will be capable of constructing real-time or virtual mechatronic systems with considerations for industrial standards, environmental impact, ethical principles, and socio-economic factors.</td>
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PEO & PO Mapping

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*Attested*

**Director**

Centre for Academic Courses
Anna University, Chennai-600 025
ANNA UNIVERSITY: CHENNAI 600 025  
UNIVERSITY DEPARTMENTS  
M.E. MECHATRONICS (FT)  
REGULATIONS – 2023  
CHOICE BASED CREDIT SYSTEM  
CURRICULUM AND SYLLABI FOR SEMESTER I TO IV

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**TOTAL** | **16** | **1** | **16** | **33** | **25**

Note: 1. * - is bridge course for circuit and non-circuit stream of students. Students with multi-disciplinary background (i.e. Mechatronics, Robotics and Automation may opt anyone of this based on the undergraduate curriculum exposure).
2. # - Mini project internal evaluation
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Note: 1# - Mini project internal evaluation

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TOTAL CREDITS -25+25+13+12= 75 CREDITS
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**TOTAL** 21 0 22 43 32

# MINI PROJECTS

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# PROFESSIONAL ELECTIVE COURSES (PEC)

(ALL COURSES COMMON TO PROFESSIONAL ELECTIVE I- V)

# ROBOTICS

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[Director, Centre for Academic Courses, Anna University, Chennai-600 025]
## MOBILITY SYSTEMS

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## INTELLIGENCE SYSTEMS

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### INDUSTRIAL MANAGEMENT

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### M.E MECHATRONICS (FULL TIME)

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<td>1. To recall the functionality of fundamental electronic components.</td>
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<td>2. To understand the functions of operational amplifier and its applications.</td>
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<td>3. To review and use the logic gates for various digital circuit development.</td>
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<td>4. To understand the functions and uses in measurement.</td>
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<td>5. To learn the power management on various electronic units.</td>
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| TOTAL | 30 PERIODS |

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<td>2. Experimentation with CRO.</td>
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<td>3. Design of DC power supplies</td>
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<td>4. Design of Inverting Amplifier and Non-Inverting Amplifiers</td>
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<td>5. Design of Instrumentation amplifier.</td>
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<td>7. Design of combinational circuits and sequential circuits.</td>
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<td>9. RC Servo motor driver circuit.</td>
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<td>10. Design of stepper motor driver circuit</td>
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(Any 7 Experiments)
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

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<td>State the fundamentals of electronic, circuits and measurement instruments.</td>
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<tr>
<td>CO2</td>
<td>Recognize the components, circuits and measurement instruments operation.</td>
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<tr>
<td>CO3</td>
<td>Design and develop the circuits using electronics components and measure using instruments.</td>
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<tr>
<td>CO4</td>
<td>Analyse the circuit by measuring parameters using measurement instruments.</td>
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<td>CO5</td>
<td>Create circuit to perform the signal conditioning, power management and logic operations.</td>
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REFERENCES:

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COURSE OBJECTIVES:
1. To understand the functionality of basic mechanisms and to determine the position, velocity, and acceleration profiles of these mechanisms.
2. To recognize the effect of friction in joints and to know the various types of mechanical power transmission using belt drives and cams.
3. To understand the behaviors of the vibration in various machines.
4. To design machine components.
5. To design transmission elements.

UNIT I MECHANISMS

UNIT II FRICTION AND CAMS
Types of Friction – Friction in Screw and Nut – Screw Jack- Belt (Flat And V) Drives. Cam-Terminology-Different Types of Cams and Followers – Cam Design for Different Follower Motion Curves, Graphical Construction of Cam Profiles for Different Types of Follower

UNIT III VIBRATIONS

UNIT IV DESIGN OF MACHINE COMPONENTS
Design of Closed Coiled Helical Spring - Design of Couplings – Design of Shaft

UNIT V DESIGN OF TRANSMISSION ELEMENTS

LIST OF EXPERIMENTS:
1. Law of Polygon of Forces Apparatus
2. Parallel Force System Apparatus
3. Rolling Friction Apparatus
4. Square Threaded Screw Jack
5. Bell Crank Lever
6. Equilibrium Forces Apparatus
7. Sliding Friction Apparatus
(Any 7 Experiments)

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Reproduce the fundamental of mechanism in machinery development
CO2 Describe the working and usage of mechanism and mechanical parts in a system development
CO3 Design and develop the various mechanisms and mechanical parts for a system
CO4 Analyze by determining the mechanical parameters to the mechanical components and Mechanisms
CO5 Evaluate the mechanical component and mechanism by graphical representation and by doing experiments.
REFERENCES
7. Design Data: Data Book of Engineers by PSG College-Kalaikathir Achchagam – Coimbatore, 2020

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**COURSE OBJECTIVES:**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I | SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES**


**UNIT II | DISPLACEMENT, PROXIMITY AND RANGING SENSORS**


**UNIT III | FORCE, MAGNETIC AND HEADING SENSORS**


**UNIT IV | OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS**


**UNIT V | DATA ACQUISITION SYSTEM**


**LIST OF EXPERIMENTS:**

1. Experiments Using Strain Gauge Sensor: Load Measurement, Torque
2. Determine the characteristics of Pressure Sensor.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
7. Determine angular velocity using gyroscope.
8. Experiment on accelerometer to determine amplitude and frequency of Vibration.
10. Experiment on acquisition of analog signal using DAQ.
11. Experiment on acquisition of digital signal using DAQ.
12. Design and realize circuit to convert change in resistance, inductance and capacitance to voltage.

45 PERIODS

60 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

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<td>State the principles of various sensor, sensor characteristics, signal types, calibration methods.</td>
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<td>CO2</td>
<td>Determine the transfer function and empirical relation of sensors through sensor response study.</td>
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<td>CO3</td>
<td>Describe the operation of sensors, circuits and data acquisition system.</td>
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<td>Analyze and select the suitable sensor for the given applications.</td>
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<td>Select and design suitable signal conditioning circuit for data acquisition.</td>
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**COURSE OBJECTIVES:**

1. To represent and simplify the mathematical models for various types of physical systems.
2. To recognize the time domain specifications and to analyze of various types of system and its characteristics in time domain.
3. To know the frequency domain specifications and to analyze of various types of system and its characteristics in frequency domain methods.
4. To design compensator and controller using time and frequency domain.
5. To evaluate, analyze and design a control system of servomotors for motion control.

**UNIT I | SYSTEM REPRESENTATION AND MODELLING**


**UNIT II | TIME DOMAIN ANALYSIS**


**UNIT III | FREQUENCY DOMAIN ANALYSIS**


**UNIT IV | DESIGN OF COMPENSATORS AND CONTROLLERS**


**UNIT V | MOTION CONTROL**


**TOTAL | 45 PERIODS**

**COURSE OUTCOMES:**

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

- **CO1** Describe the terminologies, definitions and performance measures of control system.
- **CO2** Identify the parameters of mathematical modelling of a system method in time and frequency analysis.
- **CO3** Design the signal flow graph, block diagram, transfer function, state space models, stability analysis methods, compensators and control methods.
- **CO4** Evaluate the system modelling as well as system stability.
- **CO5** Suggest the modelling and analytical methods, control technique and controller for the given applications.
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COURSE OBJECTIVES:
1. To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2. To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3. To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4. To understand the typical functions and selections of various types electrical actuators and to provide the hands-on training to the use of various electrical motors for automatic control.
5. To apprehend the utilities of mechanical and power electronic drives for various functional requirements of actuators and control valves.

UNIT I | FLUID POWER SYSTEM GENERATION AND ACTUATORS

UNIT II | CONTROL AND REGULATING ELEMENTS

UNIT III | CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS
Typical Design Methods – Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method – KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters, Programmable Logic Control of Hydraulics - Pneumatics Circuits - PLC Ladder Programming

UNIT IV | ELECTRICAL ACTUATORS

UNIT V | ELECTRICAL DRIVE CIRCUITS

45 PERIODS
LIST OF EXPERIMENTS:

FLUID POWER DRIVES
1. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
2. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
3. Experimental Verification of Electro-Pneumatic Circuits.
4. Experimental Verification of Pneumatic Sequencing Circuits.
5. Experimental Verification of Logic, Meter-in and Meter-out Pneumatic Circuits.
7. Control of PLC Based Electro Pneumatic Sequencing Circuits.
8. Control of PLC Based Electro Hydraulic Sequencing Circuits

Any 5 experiments

ELECTRICAL DRIVES

1. Control the Position, Speed and Direction of DC Servo Motors
2. Control the Position, Speed and Direction of AC Servo Motors
3. Control the Position, Speed and Direction Stepper Motor.
4. Control the Position, Speed and Direction Control of Linear mechanical drive with DC Servo/ stepper Motor.

| TOTAL | 60 PERIODS | 105 PERIODS |

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 State the operation of pneumatic, hydraulic and electrical actuators and its circuit components.
CO2 Describe the working of pneumatic, hydraulic and electrical actuators and its circuit components in a circuit.
CO3 Design the circuit using pneumatic, hydraulic and electrical actuators to perform sequential operation.
CO4 Select appropriate pneumatic, hydraulic and electrical actuators, and corresponding drives to perform automation for a given application.
CO5 Develop and analyze the circuit of pneumatic, hydraulic and electrical actuators for a required application.

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[Signature of Director]
Centre for Academic Courses
Anna University, Chennai-600 025
OBJECTIVES:
To impart knowledge on
- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I - RESEARCH PROBLEM FORMULATION
9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II - RESEARCH DESIGN AND DATA COLLECTION
9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III - DATA ANALYSIS, INTERPRETATION AND REPORTING
9
Sampling, sampling error, measures of central tendency and variation; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV - INTELLECTUAL PROPERTY RIGHTS
9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V - PATENTS
9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filing, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
COURSE OBJECTIVES:
1. To familiarize the Modelling of system and control.
2. To design controller using time and frequency domain.
3. To evaluate, analyze and design a control system of servomotors for motion control.

LIST OF EXPERIMENTS
2. Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
3. Plot the pole-zero configuration in s-plane for the given Transfer Function.
4. Simulation and Analysis of First and Second Order System Equations in Time and frequency Domain.
5. Simulation and Analysis of Root-Locus and Bode Plot.
7. Simulation of Motor velocity, position and torque control.
8. Realization of control in ball balancing system using PID controller.
10. Realization of control in inverted pendulum using PID controller.

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recognize the fundamentals of control system parameters.
CO2 Modelling and Analysis of control system and motion parameters.
CO3 Evaluate and analyse the performance of control system and motion parameters.

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COURSE OBJECTIVES:
1. To understand the method/Concepts in Design and the use of software.
2. To design and assembly involved in various automated systems.
3. To demonstrate the computer-based modelling in the software for selected application.

MINI PROJECT

(EVALUATION - INTERNAL EXAMINATION SIMILAR TO MINI PROJECTS ONLY)
Students has to practice the following modelling task for the first 20 Periods duration
1. 2D modeling and 3D modeling of Bearing, and Couplings.
2. 2D modeling and 3D modeling of Gears and Ball screw.
3. 2D modeling and 3D modeling of Sheet metal components.
4. 2D modeling and 3D modeling of Jigs, fixtures and die.
5. Modeling and simulation of mechanism of 4 Bar chain
6. Modeling and simulation of mechanism of Slider crank,
7. Modeling and simulation of mechanism of Ball and screw and Rack and pinion.
8. Modeling and simulation of mechanism of Belt and chain drives.

After completion, Students has to do the Modelling, Assembly and simulation of the any of the following projects for the remaining 25 Periods.
1. 3D Modeling and assembly of serial manipulators – Gantry/ Articulated/ SCARA/Delta/ Drone
2. 3D Modeling and assembly of Automotive subsystems.

Finally, student has to present project along with report.

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Design and draw 2D and 3D models for part design and model developments for the selected project.

CO2 Assemble the parts and simulate motion functionality of the model virtually.

CO3 Demonstrate the knowledge of computer aided modeling in multibody system development.

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## COURSE OBJECTIVES:

1. To enlist the various elements required to design and integrate the mechatronic systems.
2. To acquire the Modelling skill to capture the system dynamics of hybrid systems.
3. To familiar the system identification techniques and to practice the design and assembly of mechatronics system and fine tuning the design and control for real time system development in software environment.
4. To apply the optimization procedure for the appropriate selection of mechatronic system elements and process parameter optimization.
5. To understand, apply, analyze and evaluate the functions of systems models for integrating the virtual elements of mechatronics.

### UNIT I  
**ELEMENTS OF MECHATRONICS**

### UNIT II  
**SYSTEM MODELLING**

### UNIT III  
**SYSTEM IDENTIFICATION**

### UNIT IV  
**SIMULATION AND DESIGN OPTIMIZATION**
- Optimization – Problem Formulation - Constraints – Overview of Linear and Nonlinear Programming Techniques – Advanced Optimization Techniques – Genetic algorithm - Particle Swarm Optimization

### UNIT V  
**CASE STUDIES ON MODELING OF MECHATRONIC SYSTEMS**

**TOTAL 45 PERIODS**

## COURSE OUTCOMES:

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

- **CO1**: State various elements of mechanical, electrical, thermal and fluid system and the parameters to model the system.
- **CO2**: Describe the parameter selection and different types of system modelling, identification and optimization.
- **CO3**: Develop the model, identify and optimize by selecting the input and output variables of a system.
- **CO4**: Design and analyze the developed model numerically and by simulation.
- **CO5**: Integrate and analyze the mechatronics system virtually and able to fine tune the system design and control algorithms in the software-in-loops before real time development.
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**COURSE OBJECTIVES:**

1. To know the basic terminologies, classification, configurations and components of serial manipulator.
2. To understand the mechanical design and robot arm kinematics
3. To learn and understand the various linear control techniques on manipulators
4. To learn and understand the various non-linear control techniques on manipulators
5. To learn the robot programming and demonstrate the robot in various applications

**UNIT I | INTRODUCTION TO SERIAL MANIPULATORS | 9**


**UNIT II | MECHANICAL DESIGN OF ROBOT SYSTEM | 9**


**UNIT III | ROBOT DYNAMICS AND TRAJECTORY PLANNING | 9**

Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning-control overview, Dynamic equations-control - Types of Programming – Teach Pendant Programming –Robotic Cell Layouts – Inter Locks-control overview

**UNIT IV | MOBILE ROBOTICS | 9**


**UNIT V | APPLICATIONS OF ROBOTS | 9**


**COURSE OUTCOMES:**

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

CO1 State about fundamental concepts of manipulators and mobile robots.

CO2 Describe the robot types, robot elements, numerical computation methods and the applications

CO3 Solve the robot kinematics, dynamics, trajectory and path planning problems.

CO4 Analyze robot kinematics, dynamics, trajectory and path planning problems.

CO5 Create robot architecture, kinematic and dynamic solutions, program the robot for the given application in the environment.
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COURSE OBJECTIVES:
1. To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
2. To learn PLC hardware, and practice the PLC programming and simulation in real systems.
3. To get knowledge on industrial standard data communication protocols, SCADA, centralized and decentralized control.
4. To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
5. To get exposure on building automation using sensors, controllers and actuators

UNIT I | INDUSTRIAL INSTRUMENTATION AND CONTROL

UNIT II | PROGRAMMABLE LOGIC CONTROLLER

UNIT III | DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS

UNIT IV | FACTORY AUTOMATION
Factory Layout - Tools and Software Based Factory Modelling -Case Study on Automated Manufacturing Units, Assembly Unit, Inspection Systems and PLC Based Automated Systems - Introduction to Factory Automation Monitoring Software- Building Automation System-Software

UNIT V | SMART TECHNOLOGIES FOR INDUSTRIAL 4.0

LIST OF EXPERIMENTS:
1. Experiments on Ladder Logic Program for Various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
2. Implement Various Mathematical Functions in PLC Using Ladder Diagram Programming Language.
3. Develop Ladder Diagram Programming to set Timer and Counter in PLC.
4. Develop PLC Program to Control Traffic Light.
5. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
6. Develop Ladder Diagram Program in PLC for Material Filling and Material Handling
7. Develop Ladder Diagram Program in PLC for Object Shorting, Orientation Check and Material Property Check.
8. Develop the Ladder Diagram Program in PLC for Material Handling and Conveyor Control
9. Develop the Ladder Diagram Program in PLC for Feeding, Pick and Place Operation.
10. Experiments on Sensor and Actuator Interfacing and PLC to PLC Communication.

45 PERIODS

60 PERIODS
TOTAL 105 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 State the need of identifying the control parameters, sensors, controllers, communication and role of advanced technologies in automating the industry.

CO2 Describe the operation of sensors, instrumentation, Logic controller, communication protocol, factory setup and smart technologies.

CO3 Design and simulate system layout develop logic program

CO4 Implement the selected sensor, protocol and logic in controller to automate an application.

CO5 Create industry model and simulate by varying the parameters to do analysis on statistical and management data of the plant.

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<td>2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.</td>
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<td>3. To design the interface circuit and programming of I/O devices, sensors and actuators.</td>
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<td>4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.</td>
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<td>5. To acquaint the knowledge of real time embedded operating system for advanced system developments.</td>
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**UNIT I | MICROCONTROLLER**


**UNIT II | PROGRAMMING AND COMMUNICATION**


**UNIT III | PERIPHERAL INTERFACING**

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Overview of Advanced Microcontrollers.

**UNIT IV | ARM 7 PROCESSOR**


**UNIT V | REAL TIME MODELS, LANGUAGES AND OPERATING SYSTEMS**


**TOTAL | 45 PERIODS**

**LIST OF EXPERIMENTS:**

1. Assembly Language Programming and Simulation of 8051.
   a) Data Transfer
   b) Arithmetic Instructions
   c) Counters
   d) Boolean and logical Instructions
   e) Code Conversion
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC &RTC Interfacing with 8051.
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. I2C Programming of 8051.
8. Interfacing and Programming of Bluetooth and Wi-Fi with 8051.
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

**CO1** Define the fundamentals of Microcontroller, Processor and Single board computers

**CO2** Recognize the architecture, functions and features of Microcontroller, Processor and SBC

**CO3** Develop the skills in programming and communication with 8051 Microcontrollers, Processor and SBC

**CO4** Apply the skills in interfacing with 8051 microcontroller, Processor and SBC to develop a system to a simulation model.

**CO5** Create software to realize in controller to perform the task.

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DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVES:
1. To Model, Simulate and verify the forward and inverse kinematics of serial manipulators for trajectory generation and to attain the exposure on robot programming.
2. To realize the integrated operation of mechatronics system thorough CNC Programming methods for part manufacturing.
3. To observe, practice and analyze the function of automated quality inspection and classifications system for dimensional and non-dimensional features.

LIST OF EXPERIMENTS

SIMULATION AND PROGRAMMING OF ROBOTS
1. Simulation of Forward and Inverse Kinematics of Planar Manipulators.
2. Simulation of Forward and Inverse Kinematics of Spatial Manipulators.
3. Trajectory Planning of Planer Manipulators.
4. Trajectory Planning of Spatial Manipulators.
5. Programming of Serial Manipulators.
   - Articulated Robot.
   - Cartesian Robot.
   - SCARA

PROGRAMMING OF CNC MACHINES
1. NC Programming on CNC Routers, Vertical Machining Centre and Turning Centre.

AUTOMATED MEASUREMENT AND INSPECTION
1. Conveyor Based Object Sorting using Sensors.
2. Conveyor with Vision Based Object Classification.

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recognize the fundamentals of Kinematics, CNC Programming and Automation Systems.

CO2 Develop model, create program and perform the simulation, machining and measurement operation.

CO3 Analyse output and identify optimum parameter/machining process/measurement technique for given application.

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COURSE OBJECTIVES:
1. To learn fundamentals related to system modelling.
2. To learn selection of appropriate control parameters to perform simulation.
3. To learn software to perform simulation of the developed model.

MINI PROJECT

EVALUATION - INTERNAL EXAMINATION SIMILAR TO MINI PROJECTS ONLY

Students have to model, simulate and analyze the following topics (not limited to).
- 6 DOF Serial Manipulators with virtual sensors and actuators
- Parallel Manipulator
- Aerial Robot
- Mobile Robot
- Vehicle and its Automotive Sub System.

Finally, student has to present the project along with a report.

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Develop the physical model and control parameters of the system.
CO2 Analyse the model by considering different variables.
CO3 Apply the real system parameters to analyse the developed model in the software.

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DIRECTOR
COURSE OBJECTIVES:

1. To enable students to select and define a problem/need for analysis in the field of mechatronics and its interdisciplinary area based on the complexity of the problem.
2. To review and analyse literature/data of selected problem for study and propose objective and scope of dissertation work.
3. To develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the proposed field of dissertation work.

EVALUATION:

1. A project topic may be selected based on the literature survey and the creative ideas of the students themselves in consultation with their project supervisor. The topic should be so chosen that it will improve and develop skills in design, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation and research. Literature survey and a part of the project work be carried out in dissertation-I.
2. The progress of the project is evaluated based on a minimum of three reviews and a review committee may be constituted by the Head of the Department.
3. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
4. A project report for dissertation-I is to be submitted at the end.
5. Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University.

TOTAL 180 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the knowledge gained from theoretical and practical courses, and the problem identified through the literature survey.

CO2 Design, model and experiment/develop optimal solution for problem being investigated.

CO3 Analysis and interpretate the system and its performance, data, and synthesis of the information to provide valid conclusions and submit report.

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COURSE OBJECTIVES:
1. To assess defined problems in the industry and to provide the feasible solutions based on the skills of the graduate through internship
2. To assess and acquire the training by observing and analyzing the functioning of various machineries and its elements in the industrial training.
3. To acquire certified training on various design and automation systems and their technologies offered by state / central approved institution.

INTERNSHIPS
To assess defined problems in the industry for at least two weeks and to provide the feasible solutions based on the skills of the graduate through internship

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recognize the problem in the existing system.
CO2 Give feasible solutions to the industrial problem using a systematic approach and implement the learned technologies on the platform.
CO3 Enable students to communicate technical information in form of oral presentation and technical report in form of dissertation

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COURSE OBJECTIVES:

1. To define a problem/need for development and analysis in the field of mechatronics and its interdisciplinary area and it may be a continuation of dissertation-I or newly formulated problem for dissertation-I.

2. To comprehensively review and analyse literature/data to develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the field of problem.

3. To design, model, simulate, develop algorithms, fabricate, integrate and system elements for automating the system for sustainable development and economical consideration.

EVALUATION:

1. The progress of the project is evaluated based on a minimum of three reviews.

2. The review committee may be constituted by the Head of the Department.

3. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

4. Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University.

TOTAL 360 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the knowledge gained from the theoretical and practical courses in identifying and solving problems.

CO2 Analyse and interpret system and its performance, data, and synthesize of the factual information’s to arrive at valid conclusions.

CO3 Enable students to communicate technical information in form of oral presentation and technical report in form of dissertation.

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MR3051  MULTI-BODY DYNAMICS AND CONTROL  L  T  P  C

1. To understand the importance of dynamics in analyzing the behavior of mechanical systems.

2. To develop proficiency in using computational methods for dynamic analysis of multibody systems.

3. To apply stability analysis techniques to assess the stability of nonlinear systems.

4. To characterize the behavior of nonlinear systems using phase plane analysis and describing function.

5. To design control strategies to achieve desired performance in nonlinear mechanical systems.

UNIT I  INTRODUCTION TO DYNAMICS
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| TOTAL | 45 PERIODS |

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### COURSE OBJECTIVES:

1. To know the fundamental concepts and principles of mobile robotics.
2. Gain proficiency in programming and implementing mobile robot systems using ROS.
3. Develop skills in sensor integration, perception, and localization for mobile robots.
4. Learn planning and navigation techniques for mobile robot autonomy.
5. Apply knowledge and skills to design and build functional mobile robot prototypes.

### UNIT I | INTRODUCTION TO MOBILE ROBOTICS (9)

- Introduction – Locomotion of the Robots
- Key Issues on Locomotion – Legged Mobile Robots
- Configurations and Stability – Wheeled Mobile Robots
- Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles
- Teleportation and Control.

### UNIT II | KINEMATICS (9)

- Kinematic Models – Representation of Robot
- Forward Kinematics – Wheel and Robot Constraints
- Degree of Mobility and Steerability – Maneuverability – Workspace
- Degrees of Freedom – Path and Trajectory Considerations
- Motion Controls – Holonomic Robots
- Open Loop and Feedback Motion Control – Humanoid Robot
- Kinematics Overview.

### UNIT III | PERCEPTION (9)

- Sensor for Mobile Robots – Classification and Performance Characterization
- Wheel/Motor Sensors – Heading Sensors – Ground-Based Beacons
- Active Ranging – Motion/Speed Sensors – Vision Based Sensors
- Uncertainty – Statistical Representation – Error Propagation
- Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging)
- Visual Appearance based Feature Extraction.

### UNIT IV | LOCALIZATION (9)

- The Challenge of Localization – Sensor Noise and Aliasing
- Effector Noise – Localization Based Navigation Versus Programmed Solutions
- Belief Representation – Single-Hypothesis Belief And Multiple-Hypothesis Belief
- Map Representation – Continuous Representations – Decomposition Strategies
- Current Challenges In Map Representation
- Probabilistic Map-Based Localization – Markov Localization
- Kalman Filter Localization
- Landmark-Based Navigation – Globally Unique Localization
- Positioning Beacon Systems – Route-Based Localization
- Autonomous Map Building – Stochastic Map Technique
- Other Mapping Techniques.

### UNIT V | PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS (9)

- Introduction – Competences for Navigation: Planning and Reacting
- Path Planning – Obstacle Avoidance – Navigation Architectures
- Modularity for Code Reuse and Sharing
- Control Localization – Techniques for Decomposition
- Case Studies – Collaborative Robots
- Swarm Robots.

### TOTAL | 45 PERIODS

### COURSE OUTCOMES:

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

- **CO1**: Recall the key issues, configurations, and types of mobile robots, as well as kinematic models and sensor classifications.
- **CO2**: Understand the concepts of locomotion, perception, localization, and planning/navigation in mobile robotics.
- **CO3**: Apply kinematic models, sensor data processing techniques, and localization methods to analyze and solve mobile robot problems.
- **CO4**: Analyze and evaluate different approaches for perception, localization, and planning/navigation in mobile robotics.
- **CO5**: Design and develop solutions for mobile robot locomotion, perception, localization, and planning/navigation using appropriate techniques and algorithms.
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MR3003 ROBOT OPERATING SYSTEMS

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COURSE OBJECTIVES:

1. To develop proficiency in programming and utilizing the ROS framework for robot applications.
2. To gain hands-on experience in creating and modeling robots using CAD tools and URDF.
3. To acquire skills in simulating and controlling robots in Gazebo and V-REP.
4. To understand mapping, navigation, and motion planning techniques using ROS MoveIt.
5. To apply theoretical knowledge to design and implement advanced robotic behaviors and interactions.

UNIT I  ROS ESSENTIALS  9
Introduction to ROS - Advantages and Disadvantages of ROS - ROS Framework - ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community - Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT II  BUILD YOUR OWN ROBOT ENVIRONMENT  9

UNIT III  SIMULATION ROBOTS IN ROS WITH GAZEBO  9

UNIT IV  ROS WITH VREP  9
V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, adding a laser sensor, 3D vision sensor

UNIT V  MAPPING, NAVIGATION AND MOTION PLANNING ROS WITH MOVEIT  9
Move it Instatation - Generating the Self-Collision matrix, virtual joints, planning groups, robot poses, robot end effector - Movelt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit – ROS with MATLAB - ROS with Industrial

TOTAL  45 PERIODS

COURSE OUTCOMES:

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

CO1 Recall advantages/disadvantages of ROS, understand ROS framework, and basic programming syntax.

CO2 Explain ROS computation graph, URDF modeling, and kinematics/dynamics library.

CO3 Apply ROS programming to create an environment, build robot models, and interact with simulation.

CO4 Analyze integration of ROS with simulation platforms, evaluate mapping/navigation/motion planning techniques.

CO5 Synthesize knowledge of ROS, CAD tools, and simulation platforms to design and implement complex robot behaviors.
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COURSE OBJECTIVES:
1. To apply research and investigative techniques to solve practical problems in mechatronics.
2. To demonstrate effective technical communication skills through technical report writing and presentations.
3. To develop a comprehensive understanding of key concepts, methods, and core elements of mechatronics.
4. To utilize modern tools and techniques to design intelligent mechatronic systems.
5. To analyze and optimize engineering solutions using a mechatronics-based approach.

UNIT I  INTRODUCTION

UNIT II  KINEMATICS
Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations- Gait Analysis

UNIT III  ZMP AND DYNAMICS
ZMP Overview, 2D Analysis, 3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force, Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot’s Center of Mass, Link Speed and Angular Velocity, Calculation of Robot’s Momentum and Angular Momentum

UNIT IV  BIPED WALKING

UNIT V  WALKING PATTERN GENERATION
ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Describe the historical development, characteristics, and design trade-offs of humanoid robots.
CO2 Interpret and summarize the concepts of kinematics, ZMP, and dynamics in humanoid robot systems.
CO3 Apply kinematic principles to solve forward and inverse kinematic problems and generate walking patterns for humanoid robots.
CO4 Analyze the dynamics of humanoid robots, including motion, ground reaction forces, momentum, and stability during bipedal locomotion.
CO5 Design and develop advanced stabilizing control strategies for humanoid robots to enhance their stability and performance during walking

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COs: Common Objectives; POs: Performance Objectives; Avg: Average
COURSE OBJECTIVES:
1. To understand principles of collaborative and swarm robotics.
2. To explore modular robot design and kinematics.
3. To study naturally inspired collaboration and decision-making in robotics.
4. To analyze reconfigurable robot control mechanisms.
5. To apply knowledge to design and optimize robotic systems.

UNIT I  INTRODUCTION TO COBOTICS  9
Collaborative Robotics - Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators - Current Challenges

UNIT II  SWARM ROBOTICS  9
Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT III  MODULAR ROBOTICS  9
Module Designs - Modular Robot Representation - Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots - Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics

UNIT IV  NATURALLY INSPIRED COLLABORATION  9

UNIT V  RECONFIGURABLE ROBOTS  9
V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self-Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

TOTAL  45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recall the properties and challenges associated with collaborative robotics, swarm robotics, modular robotics, and naturally inspired collaboration.

CO2 Understand the concepts and principles of swarm robotics, modular robotics, and naturally inspired collaboration in robotic systems.

CO3 Apply the knowledge of swarm robotics to analyze and design collective decision-making methodologies and scenarios for swarm robot applications.

CO4 Analyze the kinematics, dynamics, and configuration options of modular robotics systems for various applications.

CO5 Evaluate the control mechanisms and emerging swarm dynamics of reconfigurable robots, considering their formation control and self-assembly capabilities.

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COURSE OBJECTIVES:

1. To understand the construction and layout of different types of automobile vehicles, including chassis, frame, and body structures.

2. To explain the principles of vehicle aerodynamics and the various resistances and moments involved in vehicle motion.

3. To analyze the components, functions, and materials used in internal combustion engines (IC engines) and the concept of variable valve timing (VVT).

4. To evaluate and compare electronically controlled fuel injection systems for gasoline and diesel engines, including common rail direct injection and unit injector systems.

5. To examine the transmission systems in vehicles, including manual and automatic gearboxes, clutch types, and torque converters.

UNIT I  VEHICLE STRUCTURE AND ENGINES

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines—components-functions and materials, variable valve timing (VVT).

UNIT II  ENGINE AUXILIARY SYSTEMS

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Emission norms (Euro and BS).

UNIT III  TRANSMISSION SYSTEMS

Clutch-types and construction, gear boxes—manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV  STEERING, BRAKES AND SUSPENSION SYSTEMS

Steering geometry and types of steering gear box—Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT V  ALTERNATIVE ENERGY SOURCES


TOTAL 45 PERIODS

COURSE OUTCOMES:

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

CO1 Recall the different types of steering gearboxes, suspension systems, and braking systems used in automobiles.

CO2 Understand the principles of vehicle aerodynamics and their impact on vehicle performance and efficiency.

CO3 Apply the knowledge of engine auxiliary systems to analyze and diagnose engine performance issues and propose appropriate solutions.

CO4 Analyze the functioning and performance of alternative energy sources in automobiles, such as natural gas, biofuels, and electric/hybrid systems.

CO5 Evaluate the impact of different transmission systems on vehicle performance, including their efficiency, gear shifting mechanisms, and power transfer capabilities.
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Course Objectives:

1. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
2. Understand about vehicle dynamics.
3. Design the required energy storage devices.
4. Select the suitable electric propulsion systems and
5. Understand of hybrid electric vehicles.

Unit I: Need for Alternative System

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

Unit II: Design Considerations for Electric Vehicles

Design requirement for electric vehicles - Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance - Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems

Unit III: Energy Storage Devices and Sources


Unit IV: Motors and Controllers

Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking, Rectifiers, Inverters, DC/DC converters.

Unit V: Subsystems of Hybrid and Electric Vehicles


Course Outcomes:

CO1 Understand need and working of different configurations of hybrid and electric vehicles
CO2 Design and develop basic systems of electric vehicles and hybrid electric vehicles.
CO3 Choose proper energy storage systems for EV applications
CO4 Choose a suitable drive system for developing an electric and hybrid vehicle depending on resources
CO5 Understand basic operation of power-split device and control Strategies for hybrid and electric vehicle.

Text Books:

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COURSE OBJECTIVES:

1. To introduce the architecture, sub-systems of car and engines types and its functions of automobile.
2. To familiar the elements and functions of manual and automatic transmission, suspension and steering systems.
3. To understand functions of safety and diagnostic system and to familiar the role of ECU, communication protocols and modern automotive.
4. To understand integration of various subsystem in aerial vehicles.
5. To appreciate the integration of various subsystems in aerial vehicles.

UNIT I INTRODUCTION TO AUTOMOTIVE AND ENGINE CONTROL

UNIT II TRANSMISSION, SUSPENSION, STEERING SYSTEMS

UNIT III SAFETY SYSTEMS AND ECU

UNIT IV AIRCRAFT MECHATRONICS

UNIT V MARINE MECHATRONIC SYSTEMS

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Describe the key components and integration of subsystems in automobiles, aircraft, and marine systems.
CO2 Apply principles of transmission, suspension, and steering systems to analyze and optimize vehicle performance and control.
CO3 Evaluate and assess safety systems and ECUs to ensure efficient and reliable operation in automotive applications.
CO4 Analyze and interpret the functioning of aircraft mechatronic systems for navigation, stability, and control.
CO5 Exhibit the understanding of automobiles, aircraft, and marine engineering principles and the application of mechatronics systems in vehicles.
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COURSE OBJECTIVES:

1. To understand the concept of automated, connected, and intelligent vehicles and their significance in the automotive industry.
2. To gain knowledge about various sensor technologies used in smart mobility and their applications in vehicle systems.
3. To explore the principles and theories behind connected autonomous vehicles and their control systems.
4. To study wireless technology and networking concepts relevant to vehicle communication and autonomy.
5. To examine the technology and applications of connected cars and autonomous vehicles, including the associated ethical, legal, technical, and security considerations.

UNIT I  INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles

UNIT II  SENSOR TECHNOLOGY FOR SMART MOBILITY


UNIT III  CONNECTED AUTONOMOUS VEHICLE

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT IV  VEHICLE WIRELESS TECHNOLOGY & NETWORKING


UNIT V  CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY


TOTAL 45 PERIODS

COURSE OUTCOMES:

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

CO1 Recall and explain the key concepts and components of automated, connected, and intelligent vehicles.

CO2 Apply sensor technology to analyze and interpret data for smart mobility applications.

CO3 Evaluate and integrate sensor data to enhance the performance and autonomy of vehicles.

CO4 Design and implement wireless networking solutions for connected and autonomous vehicles.

CO5 Assess the challenges and ethical considerations associated with connected and autonomous vehicle technology.
REFERENCES
1. “Intelligent Transportation Systems and Connected and Automated Vehicles”, 2016, Transportation Research Board

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COURSE OBJECTIVES:
1. To Understand automotive systems, components, and safety protocols.
2. To Analyze and interpret data from various automotive sensors.
3. To Integrate ADAS technology into vehicle electronics.
4. To Evaluate and apply advanced driver assistance systems.
5. To Design innovative automotive display and warning technologies.

UNIT I | AUTOMOTIVE FUNDAMENTALS 9

UNIT II | AUTOMOTIVE SENSORS 9
Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications. Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera

UNIT III | OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY 9

UNIT IV | ADVANCED DRIVER ASSISTANCE SYSTEMS 9
Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic

UNIT V | ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY 9

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Recall and explain automotive systems and components.
CO2 Apply sensor technology to analyze and interpret data for automotive applications.
CO3 Evaluate and integrate ADAS technology into vehicle electronics.
CO4 Design and implement advanced driver assistance systems.
CO5 Develop innovative automotive display and warning technologies.

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**COURSE OBJECTIVES:**

1. To understand and apply fundamental problem-solving strategies and algorithms.
2. To develop proficiency in a programming language and its syntax for problem-solving tasks.
3. To analyze and evaluate different control flow structures and functions for efficient program execution.
4. To demonstrate proficiency in working with various data types and manipulating data in programming.
5. To apply advanced techniques and concepts to solve complex problems and develop efficient algorithms.

**UNIT I  | PROBLEM SOLVING**


**UNIT II | DATA TYPES, EXPRESSIONS, STATEMENTS**

Python interpreter and interactive mode, debugging; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III | CONTROL FLOW, FUNCTIONS, STRINGS**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV | LISTS, TUPLES, DICTIONARIES**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V | FILES, MODULES, PACKAGES**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: Programming Exercise

**TOTAL**  | 45 PERIODS

**COURSE OUTCOMES:**

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

**CO1** Recall and explain the key concepts and components of problem solving, including algorithms, computational problems, and strategies for developing algorithms.

**CO2** Apply problem-solving techniques and algorithmic thinking to analyze and solve a variety of computational problems, demonstrating proficiency in using different strategies and approaches.

**CO3** Design and implement efficient and effective algorithms to solve complex problems, utilizing appropriate control flow structures, functions, and data structures.

**CO4** Evaluate and critique algorithms and code solutions, identifying areas for improvement, optimizing performance, and demonstrating an understanding of good programming practices.

**CO5** Synthesize and integrate problem-solving skills and computational thinking into real-world scenarios, demonstrating the ability to apply problem-solving techniques to solve practical problems in various domains.
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### COURSE OBJECTIVES:

1. **To recall and explain the fundamental principles and components of machine vision and computer vision systems, including the role of vision in human perception and the benefits of machine vision.**

2. **To apply knowledge of lighting parameters, techniques, and sources to design effective lighting setups for machine vision applications, considering scene constraints and specific requirements.**

3. **To understand the physics of light and its interactions, such as refraction and thin lens equation, and apply this knowledge to explain image formation in machine vision systems.**

4. **To analyze and evaluate different image acquisition techniques, including machine vision lenses, optical filters, and imaging sensors, and make appropriate selections based on specifications and application requirements.**

5. **To apply image processing techniques, including spatial and frequency domain operations, edge detection, morphology, and feature extraction, to enhance and analyze digital images in the context of machine vision applications.**

### UNIT I  INTRODUCTION TO VISION AND LIGHTING  9


### UNIT II  IMAGE ACQUISITION  9


### UNIT III  IMAGE PROCESSING AND IMAGE ANALYSIS  9


### UNIT IV  3-D IMAGE RECONSTRUCTION  9


### UNIT V  VISION APPLICATIONS  9


**TOTAL 45 PERIODS**

### COURSE OUTCOMES:

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

- **CO1** Recall and explain the key principles, components, and functions of machine vision and computer vision systems.

- **CO2** Apply image acquisition techniques, including lenses, sensors, and interfaces, for machine vision systems.
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<th>CO3</th>
<th>Implement image processing algorithms and techniques to enhance and analyze digital images.</th>
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<td>CO4</td>
<td>Recognize and utilize 2D and 3D machine vision techniques for reconstruction and analysis.</td>
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<td>CO5</td>
<td>Develop machine vision applications for various fields, considering the requirements and constraints of each domain</td>
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COURSE OBJECTIVES:
1. To understand the fundamental concepts and principles of machine learning, deep learning, and neural networks.
2. To apply various supervised, unsupervised, and semi-supervised learning techniques to solve real-world problems.
3. To implement and evaluate reinforcement learning algorithms for sequential decision-making tasks.
4. To design, train, and optimize neural networks and deep learning models for different applications.
5. To analyze and interpret the performance of machine learning and deep learning models and make informed decisions for improvement.

UNIT I  
SUPERVISED LEARNING METHODS AND REGRESSION  
Introduction to Machine Learning - Platforms for ML- Classifiers - LDA, Naive Bayes Classifier and KNN and SVM, Decision Tree, Regression methods.

UNIT II  
SEMI-SUPERVISED LEARNING AND UNSUPERVISED LEARNING  

UNIT III  
REINFORCEMENT LEARNING, FUZZY AND GENETIC ALGORITHMS  
Reinforcement Learning Methods- Markov Decision Processes (MDPs)-Q-learning-SARSA, Basic Concepts in Fuzzy Set Theory - Fuzzy Classification, Genetic Algorithms- Initialization, Selection, Mutation and termination, Swarm Intelligence (PSO) - Ant Colony Optimization (ACO).

UNIT IV  
NEURAL NETWORKS AND DEEP LEARNING FUNDAMENTALS  
Introduction to Neural Networks, Perceptron, Multi-Layer Perceptron (MLP), Back Propagation (BPN), Tuning Neural Networks and Best Practices-Training Neural Networks and Update Rules- Neural Networks vs Conventional Neural Networks vs Deep Learning - Convolutional Neural Networks (CNN)-Convolution, Pooling, Activation Functions - Initialization, Dropout, Batch Normalization, Deep Learning Hardware (CPU, GPU, TPU).

UNIT V  
CONVOLUTIONAL NEURAL NETWORKS AND DEEP LEARNING APPLICATIONS  

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recall and explain the key principles and algorithms of machine learning, deep learning, and neural networks.

CO2 Apply different supervised, semi-supervised, and unsupervised learning methods to analyze and interpret data.

CO3 Implement reinforcement learning algorithms, fuzzy logic, and genetic algorithms for solving complex problems.

CO4 Design, train, and evaluate neural networks and deep learning models for various applications.

CO5 Develop program for neural network and advanced deep learning models for image classification, object detection, and semantic/instance segmentation.
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PROGRESS THROUGH KNOWLEDGE

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVES:

1. To identify the terminologies of haptic devices.
2. To understand the structure of haptic system and to aware the tele-operation for various applications.
3. To acquire the knowledge on modelling for haptic system development relevant to the human.
4. To emphasize the significance of knowledge in virtual and augmented reality.
5. To know the concepts and hardware of mixed reality.

UNIT I | INTRODUCTION TO HAPTICS
---|---
Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices - Types of Kinesthetic Devices

UNIT II | KINESTHETIC HAPTIC DEVICES AND TELEOPERATION
---|---

UNIT III | HUMAN HAPTICS ITS PLATFORM
---|---

UNIT IV | VIRTUAL AND AUGMENTED REALITY
---|---

UNIT V | MIXED REALITY
---|---

TOTAL | 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire a comprehensive understanding of haptics, including its definition, components, and applications.

CO2 Describe the principles and theories underlying haptics, kinesthetic devices, and teleoperation.

CO3 Apply the knowledge of haptics and kinesthetic devices to design and control haptic systems, ensuring stability and rendering accuracy.
CO4 | Analyze haptic parameters, sensor measurements, and psychophysical laws to evaluate and optimize haptic systems.

CO5 | Integrate haptic technologies into virtual, augmented and mixed reality environments, considering interaction techniques, user experience, and system performance.

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COURSE OBJECTIVES:

1. To understand the generation and characteristics of various types of signals, including speech, seismic, radar, vibration, ultrasonic, pressure, strain, temperature, and bio signals.
2. To learn the pre-processing techniques for signals, including noise reduction, filtering, and denoising concepts.
3. To study digital signal processing techniques, such as time series analysis, time-frequency representation, signal modeling, and power spectral density estimation.
4. To explore feature extraction methods for signals, including short-time Fourier transform (STFT), discrete Fourier transform (DFFT), wavelet transform, empirical mode decomposition (EMD), and time-frequency representation.
5. To analyze and apply signal processing techniques in various applications, such as speech analysis, bio signals analysis, radar signal processing, affective state computation, brain-computer interface, and fusion techniques.

UNIT I SOURCES OF SIGNALS


UNIT II PRE-PROCESSING OF SIGNALS


UNIT III DIGITAL SIGNAL PROCESSING


UNIT IV FEATURE EXTRACTION METHODS


UNIT V ANALYSIS AND APPLICATION OF SIGNAL PROCESSING


TOTAL 45 PERIODS

COURSE OUTCOMES:

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

**CO1** Acquire knowledge of signal generation, characteristics, and various types of signals, as well as noise sources and filtering techniques.

**CO2** Demonstrate an understanding of pre-processing techniques for signals, including filter design and denoising concepts.

**CO3** Apply digital signal processing techniques, such as time series analysis, spectral analysis, and signal modeling, to analyze and process signals.

**CO4** Analyze and interpret different time-frequency representations and feature extraction methods for signals, evaluating their effectiveness for specific applications.

**CO5** Evaluate the application of signal processing techniques in diverse areas, such as speech analysis, bio signals analysis, radar signal processing, affective state computation, and brain-computer interface, and assess the potential of fusion techniques for signal processing tasks.
REFERENCES

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COURSE OBJECTIVES:

1. To understand the architecture and features of single-board computers, including on-board system components, communication protocols (SPI, I2C, UART, USB, Ethernet, CAN), and input devices (GPIO, memory, camera).
2. To explore real-time operating systems, including their architecture, file systems, resource management, process scheduling, and applications in embedded systems.
3. To learn Python programming language, including data types, functions, file handling, object model, iterative and conditional statements, operators, arrays, and GUI development.
4. To develop skills in embedded Python programming, including GPIO programming, numerical and communication libraries, image processing, and machine learning.
5. To explore applications of single-board computers in automotive, mobile robotics, IoT, factory automation, and home automation.

UNIT I  | INTRODUCTION TO SINGLE BOARD COMPUTERS
--- | ---

UNIT II  | REAL TIME OPERATING SYSTEM
--- | ---

UNIT III  | PYTHON PROGRAMMING
--- | ---

UNIT IV  | EMBEDDED PYTHON PROGRAMMING
--- | ---

UNIT V  | APPLICATIONS
--- | ---
Automotive – Mobile Robotics - IoT- Factory Automation - Home Automation

TOTAL | 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1  Acquire knowledge of the architecture, features, and communication protocols of single-board computers, as well as real-time operating system concepts and Python programming language.

CO2  Describe the underlying principles and functioning of single-board computers, real-time operating systems, and Python programming constructs.

CO3  Apply Python programming skills to develop programs for embedded systems, including GPIO programming, numerical operations, communication, and image processing.

CO4  Analyze the requirements and constraints of different applications in automotive, robotics, IoT, and automation, and select appropriate single-board computer solutions.

CO5  Design and implement projects utilizing single-board computers, real-time operating systems, and Python programming, addressing specific application domains such as automotive, mobile robotics, IoT, factory automation, and home automation.
REFERENCES
1. David Beazley and Brian K. Jones, “Python Cookbook”, O'Reilly Media, 2013

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### COURSE OBJECTIVES:

1. To understand wired communication buses and protocols, including serial communication protocols, parallel communication, and wired network comparisons.

2. To explore wireless protocols and technologies, including antenna technology, network topologies, and wireless communication standards like Wi-Fi, Bluetooth, Zigbee, and Wimax.

3. To gain knowledge of wired networks used in industrial and autonomous systems, such as Modbus, HART, EtherCAT, CAN, PROFINET, and DeviceNet.

4. To learn about industrial wireless networks, including IWLAN, ISA100, Wireless HART, and remote network technologies.

5. To apply communication protocols in various industrial and automation applications, considering wired and wireless machine networking, communication network design, and integration with cloud computing and IoT.

### UNIT I  
**WIRED BUSES AND PROTOCOLS**

- SPI - I2C - UNI/O Bus - 1 Wire - Camara Link - Parallel Communication - PPI - Wishbone Bus - AMBA - JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485

### UNIT II  
**WIRELESS PROTOCOLS**


### UNIT III  
**INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS**


### UNIT IV  
**INDUSTRIAL WIRELESS NETWORKS**

- Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

### UNIT V  
**APPLICATION OF COMMUNICATION PROTOCOLS**


### TOTAL  
45 PERIODS

### COURSE OUTCOMES:

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

- **CO1**: Acquire knowledge of wired and wireless communication protocols, network topologies, and standards used in industrial and autonomous systems.

- **CO2**: Describe the differences between wired and wireless networks, as well as the advantages and limitations of various communication protocols.

- **CO3**: Apply wired and wireless protocols in practical scenarios, such as designing communication network layouts for machines and industrial systems.

- **CO4**: Analyze the requirements and constraints of different communication protocols in industrial settings, considering factors like reliability, scalability, and interoperability.

- **CO5**: Design and implement communication networks for specific automation applications, integrating wired and wireless protocols effectively and considering emerging technologies like cloud computing and IoT.
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COURSE OBJECTIVES:

1. To understand the architecture of FPGA, EPLD, and CPLD, including Xilinx FPGA families and TMS320C54x/C6x architecture.
2. To learn the design principles of synchronous and asynchronous sequential circuits, including FPGA programming technologies, logic cell structures, programmable interconnect, and I/O ports.
3. To gain proficiency in programming FPGA devices, including the design of arithmetic circuits, SDRAM, FIR filters, A/D converters, and using hardware description languages like Verilog and VHDL.
4. To explore fault diagnosis and testability algorithms for FPGA-based systems, including fault table method, path sensitization method, Boolean difference method, tolerance techniques, and built-in self-test.
5. To develop FPGA-based hardware systems, such as data acquisition devices, controllers for high-speed drives, and applications in automation and automotive industries.

UNIT I  ARCHITECTURE OVERVIEW OF FPGA  9

UNIT II  SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN  9

UNIT III  PROGRAMMING OF FPGA  9

UNIT IV  FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS  9
Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques-Built-in Self-Test

UNIT V  DEVELOPMENT OF FPGA BASED HARDWARE  9
Design of Data Acquisition Device – 4 Channel, 8 Channel, Variable Sampling Rate and Design of FPGA Based Controller - Design of Controller for High-Speed Drives - Applications in Automation Automotive.

TOTAL  45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge of FPGA architecture, EPLD, CPLD, Xilinx FPGA families, TMS320C54x/C6x architecture, and programming technologies for FPGA.

CO2 Demonstrate an understanding of synchronous and asynchronous sequential circuit design principles, FPGA logic cell structures, and timing issues in synchronous circuits.
CO3 Apply programming techniques to implement various FPGA circuits, including arithmetic circuits, SDRAM, FIR filters, and A/D converters.

CO4 Analyze and evaluate fault diagnosis and testability algorithms for FPGA-based systems, identifying and addressing potential issues in the design.

CO5 Design and develop FPGA-based hardware systems, such as data acquisition devices and high-speed drive controllers, utilizing the concepts learned in the course and applying them to real-world applications in automation and automotive industries.

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COURSE OBJECTIVES:

1. To understand the fundamentals of GPU computing and its role in heterogeneous parallel computing.
2. To gain knowledge of the architecture of modern GPUs and their evolution from fixed-function graphics pipelines to unified graphics and computing processors.
3. To learn parallel programming languages and models, with a focus on CUDA C and OpenCL.
4. To explore data parallelism and CUDA programming, including program structure, memory management, and thread organization.
5. To introduce OpenCL and OpenACC as alternative parallel programming frameworks and understand their execution and memory models.

UNIT I | INTRODUCTION TO GPU COMPUTING
---|---

UNIT II | INTRODUCTION TO DATA PARALLELISM AND CUDA C
---|---
Data Parallelism, CUDA Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading.

UNIT III | DATA-PARALLEL EXECUTION MODEL AND CUDA MEMORIES
---|---

UNIT IV | AN INTRODUCTION TO OPENCL
---|---
Data Parallelism Model, Device Architecture, Kernel Functions, Device Management and Kernel Launch, Electrostatic Potential Map in OpenCL.

UNIT V | PARALLEL PROGRAMMING WITH OPENACC
---|---
OpenACC Versus CUDA C, Execution Model, Memory Model, Basic OpenACC Programs, Parallel Construct, Loop Construct, Kernels Construct, Data Management, Asynchronous Computation and Data Transfer.

TOTAL | 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge of GPU computing, including the architecture of modern GPUs, the evolution of graphics pipelines, and parallel programming languages and models.

CO2 Demonstrate an understanding of the concepts and principles of data parallelism, CUDA C programming, and the execution models of CUDA and OpenCL.

CO3 Apply the CUDA programming model to develop parallel programs for real applications, such as vector addition and matrix multiplication.

CO4 Analyze the performance and efficiency of GPU programs, including memory access efficiency and resource allocation strategies.

CO5 Propose and implement parallel solutions using CUDA C, OpenCL, and OpenACC for complex computational problems, demonstrating an understanding of device management, kernel launch, data management, and asynchronous computation.
REFERENCES

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COURSE OBJECTIVES:
1. To provide an overview of Industry 4.0 and its significance in the digitalization and networked economy.
2. To understand the concepts and components of the Internet of Things (IoT) and its applications in industrial settings.
3. To explore the protocols and standards used in IoT and their role in enabling seamless communication and interoperability.
4. To examine the role of cloud computing in supporting IoT systems and leveraging big data for predictive analytics and smart business.
5. To analyze and discuss the challenges, opportunities, and emerging trends in the implementation of Industry 4.0 and IoT in different industries.

UNIT I | INDUSTRY 4.0
---|---
Digitalization and the Networked Economy - Introduction to Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Smart Devices and Products - Smart Logistics - Support System for Industry 4.0 - Cyber-physical Systems Requirements - Data as a New Resource for Organizations - Cloud Computing - Trends of Industrial Big Data and Predictive Analytics for Smart Business - Architecture of Industry 4.0.

UNIT II | IOT AND ITS PROTOCOLS
---|---

UNIT III | CLOUD COMPUTING
---|---

UNIT IV | INTEGRATED IOT
---|---

UNIT V | APPLICATIONS
---|---

TOTAL | 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Acquire knowledge of Industry 4.0, IoT, cloud computing, and their architectures, standards, and protocols.

CO2 Demonstrate comprehension of the concepts, pillars, and requirements of Industry 4.0 and IoT, including their impact on the networked economy and collaborative production environments.
<table>
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<th>CO3</th>
<th>Apply IoT protocols, middleware, and information security measures in designing and implementing IoT solutions for industrial and ubiquitous applications</th>
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<td>CO4</td>
<td>Analyze the role of cloud computing, data analytics, and unified architectures in IoT and Industry 4.0, and evaluate the business models and network dynamics associated with IoT.</td>
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<td>CO5</td>
<td>Propose innovative IoT-based solutions and strategies for resource management, automation, and increased autonomy in various domains, such as car manufacturing, electronics manufacturing, building automation, and agricultural automation.</td>
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**REFERENCES**


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COURSE OBJECTIVES:

1. To provide an introduction to Human Machine Interface (HMI) and its applications.
2. To familiarize students with the elements and considerations of HMI design and implementation.
3. To explore perception, memory, and cognition principles relevant to HMI.
4. To introduce an integrated modeling framework for supervisory control and human-machine cooperation.
5. To discuss Brain-Computer Interface (BCI) technologies and their applications.

UNIT I INTRODUCTION TO HMI


UNIT II ELEMENTS OF HMI


UNIT III PERCEPTION, MEMORY, COGNITION


UNIT IV INTEGRATED MODELLING FRAMEWORK


UNIT V BRAIN COMPUTER INTERFACE

Introduction to BCI – Brain Regions and Responsibilities - Active Methods for Measuring Brain Activity – Invasive and Non-Invasive Procedures - EEG – P300 - VEP- ERD- NIRS – Application in Prosthetic Control - Neurorehabilitation – Neurotraining – Brain Controlled Wheel Chairs

TOTAL 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge of HCI principles, HMI types, perception, memory, cognition, and BCI for effective design and operation of human-machine interfaces.

CO2 Demonstrate comprehension of HCI principles, HMI interfacing considerations, and the impact of perception, memory, and cognition on HMI design and user experience.

CO3 Apply HCI principles, usability engineering techniques, integrated modeling frameworks, and control loops to design and develop effective HMIIs with user-friendly interfaces and system communications.

CO4 Analyze the role of HCI in security, accessibility, and social computing, and evaluate the impact of perception, memory, cognition, and different BCI methods on HMI design and applications.
Synthesize knowledge of HCI principles, perception, memory, cognition, and BCI to propose innovative HMI designs, advancements, and solutions addressing complex human-machine interaction challenges and incorporating emerging trends and technologies.

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### COURSE OBJECTIVES:

1. To understand the principles and design of PID controllers and various tuning methods.
2. To explore and apply advanced control techniques such as feed-forward, cascade, inferential, and sliding mode control.
3. To gain proficiency in state space analysis and design control systems using state observers.
4. To analyze and handle nonlinear systems by linearization, stability analysis, and phase portrait analysis.
5. To familiarize with other control methods including LQR, adaptive control, optimal control, robust control, and model predictive control.

### UNIT I  | CONTROLLER AND PERFORMANCE MEASURES  | 9
---|---|---|---|---

### UNIT II  | ENHANCEMENT TO SINGLE LOOP CONTROL  | 9
---|---|---|---|---
Feed-Forward– Ratio Control – Cascade Control – Inferential Control – Split-Range – Override Control – Selective Control – Sliding Mode Control - Auto Tuning

### UNIT III  | STATE SPACE ANALYSIS  | 9
---|---|---|---|---

### UNIT IV  | NONLINEAR SYSTEMS AND CONTROL  | 9
---|---|---|---|---

### UNIT V  | OTHER CONTROL METHODS  | 9
---|---|---|---|---

### TOTAL  | 45 PERIODS

### COURSE OUTCOMES:

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

**CO1** Understand feedback systems, PID controllers, Tuning and different control methods.

**CO2** Interpret performance measures and evaluate PID controller effectiveness.

**CO3** Apply tuning methods to optimize PID controller performance and implement advanced control techniques in practical scenarios.

**CO4** Analyze state space models and perform stability analysis.

**CO5** Design control systems with observers, develop control strategies for nonlinear systems and integrate multiple control techniques for multivariable control systems.
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<td>Introduction to Motion Control System - Dynamic System Modeling - Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems -Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control</td>
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<tr>
<td>Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication protocols – features – Software - Programming – current, position and speed loops – Application in robots and portable systems</td>
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COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

**CO1** Recall and explain the fundamental concepts, principles, and components of motion control systems.

**CO2** Summarize and interpret the architecture and features of motion control systems, including programmable automation controllers, I/Os, and intelligent motors with integrated drives.

**CO3** Apply the acquired knowledge to design and configure motion control systems for specific industrial applications.

**CO4** Analyze and evaluate the performance of motion control systems, identify potential issues or limitations, and propose solutions for improvement.

**CO5** Develop and implement advanced motion control strategies, such as motion profiling, CAM profiling, and multi-axis control, to achieve precise and optimized motion control in complex applications.
REFERENCES
5. Operating instructions Compax3 T30 Programmable motion control according to IEC61131-3, Parker Hannifin Corporation, 2008.

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**COURSE OBJECTIVES:**

1. To understand the fundamental principles and concepts of digital twin technology.
2. To apply digital twin techniques to analyze and optimize complex systems.
3. To develop skills in designing and implementing digital twin models for real-world applications.
4. To evaluate the benefits and limitations of digital twin technology in various industries.
5. To critically analyze and interpret data obtained from digital twin simulations.

**UNIT I | INTRODUCTION**


**UNIT II | DIGITAL TWIN IN A DISCRETE INDUSTRY**


**UNIT III | DIGITAL TWIN IN A PROCESS INDUSTRY**

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise

**UNIT IV | INDUSTRY 5.0**

Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0

**UNIT V | ADVANTAGES OF DIGITAL TWIN**

Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.

**TOTAL | 45 PERIODS**

**COURSE OUTCOMES:**

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

- **CO1** Recall and explain the key principles and concepts of digital twin technology.
- **CO2** Apply digital twin techniques to model and simulate complex systems.
- **CO3** Design and implement digital twin models for specific applications.
- **CO4** Evaluate the effectiveness of digital twin technology in improving system performance and efficiency.
- **CO5** Analyze and interpret data generated from digital twin simulations to make informed decisions.

**REFERENCES**


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MR3022  MECHATRONICS IN MANUFACTURING SYSTEMS  L  T  P  C
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COURSE OBJECTIVES:

1. To understand the principles and functioning of unconventional machining processes and additive manufacturing.
2. To apply knowledge of mechatronics to analyze and operate additive manufacturing equipment and processes.
3. To create CAD models and utilize reverse engineering techniques for rapid prototyping and additive manufacturing.
4. To analyze the different liquid-based and solid-based additive manufacturing processes, their strengths, weaknesses, and applications.
5. To evaluate the powder-based and other additive manufacturing techniques, their capabilities, and material systems.

UNIT I  UNCONVENTIONAL MACHINING PROCESSES  9

UNIT II  INTRODUCTION TO ADDITIVE MANUFACTURING  9

UNIT III  REVERSE ENGINEERING AND CAD MODELLING  9

UNIT IV  LIQUID AND SOLID BASED ADDITIVE MANUFACTURING  9

UNIT V  POWDER BASED AND OTHER ADDITIVE MANUFACTURING  9

COURSE OUTCOMES:

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

CO1 Demonstrate an understanding of the principles and key elements of unconventional machining processes and additive manufacturing.

CO2 Apply mechatronics principles to operate and control additive manufacturing equipment.

CO3 Create CAD models and utilize reverse engineering techniques for additive manufacturing processes.
CO4 | Analyze and evaluate different additive manufacturing processes and their suitability for specific applications.
CO5 | Evaluate the capabilities and limitations of powder-based and other additive manufacturing techniques for different materials and applications.

REFERENCES
COURSE OBJECTIVES:
1. To understand the role of mechatronics in the field of medical applications.
2. To recall the functioning of human systems and their measurement techniques.
3. To apply knowledge of mechatronics principles to analyze and operate assisting and therapeutic medical equipment.
4. To analyze the functioning and principles of cardiac and regulatory assist systems.
5. To evaluate the different imaging techniques and their applications in medical diagnostics.

UNIT I  INTRODUCTION TO MEDICAL MECHATRONICS 9
Role of Mechatronics in Medical – Overview of Human Functional System – Cell and Origin
Bioelectric Potential - Measurement of Blood Pressure - Invasive and Noninvasive Methods-
Transducers Role in Measurement – Heart Rate – Pressure - Temperature- Heart Sound –
Pulmonary Function Measurements, ECG, EEG and EMG Systems.

UNIT II ASSISTING AND THERAPEUTIC EQUIPMENTS 9
Diathermy – Heart Lung Machine — Dialyzers – Centrifuge- Coagulators- Aspirator –
Oximeter – Spirometer - Nebulizer – Anesthesia Machine - Operating Table – Examination
Couches - Infusion Systems – Surgical Robots.

UNIT III CARDIAC AND REGULATORY ASSIST SYSTEM 9
Pacemakers – Defibrillators – Ventilators – Nerve and Muscle Stimulators - Location for
Stimulation - Synchronous Counter Pulsation, assisted through Respiration Right
Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and Closed Chest
Type, Intra-Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves,
Principle and Problem, Biomaterials for Implantable Purposes, its Characteristics and
Testing. Lithotripsy - Indication and Principle of Hemodialysis, Membrane, Dialysate,
Different Types of Hemodialysis, Monitoring Systems, Wearable Artificial Kidney, Implanting
Type.

UNIT IV MEDICAL IMAGING 9
Radio Graphic and Fluoroscopic Techniques – XRAY Machine - Computer Tomography –
MRI – FMRI- Ultrasoundography – Endoscopy – Colonoscopy -Thermography – Different
Types of Biotelemetry Systems and Patient Monitoring – PET- Introduction to Biometric
Systems.

UNIT V SENSORY ASSIST DEVICES AND AUTOMATED ANALYZER 9
Types of Deafness, Hearing Aids, Application of DSP in Hearing Aids - Ear Irrigator- Voice
Synthesizer, Speech Trainer, Ultra Sonic and Laser Canes, Intra Ocular Lens, Braille
Reader - Tactile Devices for Visually Challenged - Ophthalmoscopy - Text Voice Converter
- Screen Readers and Automated Analyzer

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Demonstrate an understanding of the role and significance of mechatronics in
medical applications.

CO2 Recall and describe the functioning of various medical measurement techniques and
equipment.

CO3 Apply mechatronics principles to operate and troubleshoot assisting and therapeutic
medical equipment.

CO4 Analyze the functioning and principles of cardiac and regulatory assist systems and
their applications.

CO5 Evaluate the effectiveness and limitations of different medical imaging techniques
and sensory assist devices.
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COURSE OBJECTIVES:

1. To recall the fundamental principles and vocabulary of biomechanics and bio-mechatronics.
2. To understand the relationship between mechanics and medicine in the context of biomechanics.
3. To apply the principles of mechanics to analyze and evaluate the mechanical properties of biological tissues and fluids.
4. To analyze the kinematics and kinetics relationship of the skeletal and muscular systems.
5. To design and manufacture biomechatronic products by integrating mechanical and electronic components.

UNIT I  
BIOMECHANICS  
9

UNIT II  
MECHANICS IN SKELETAL AND MUSCULAR SYSTEM  
9

UNIT III  
CONTROL MECHANISM OF BIOLOGICAL SYSTEMS  
9
Design and manufacturing of Biomechatronic products; Skeletal Muscles Servo Mechanism, Cardio Vascular Control Mechanism, Respiratory Control Mechanism – Interfacing Techniques with Natural Servo Mechanism.

UNIT IV  
PROSTHETIC AND ORTHOTIC DEVICES  
9

UNIT V  
SIMULATION AND MODELLING OF BIOMECHATRONICS  
9

TOTAL  
45 PERIODS

COURSE OUTCOMES:

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

CO1  Recall and explain the concepts, vocabulary, and principles of biomechanics and bio-mechatronics.

CO2  Demonstrate an understanding of the relationship between mechanics and medicine in the field of biomechanics.

CO3  Apply the principles of mechanics to analyze and evaluate the mechanical properties of soft biological tissues and biofluids.

CO4  Analyze the kinematics and kinetics relationship of the skeletal and muscular systems.

CO5  Design and fabricate biomechatronic products by integrating mechanical and electronic components to solve practical problems.
REFERENCES

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Centre for Academic Courses
Anna University, Chennai-600 025
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<td>1. To understand the concept, vocabulary, and history of drone technology, and its impact on businesses.</td>
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<tr>
<td>2. To learn the design, fabrication, and programming of drones, including the classification of UAVs, assembling drone parts, and programming methods.</td>
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<td>3. To gain practical skills in drone flying and operation, including flight modes, drone controls, sensor usage, and mobile device integration.</td>
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<td>4. To explore the commercial applications of drones in various industries such as insurance, logistics, agriculture, inspection, and filmmaking.</td>
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<td>5. To discuss the future trends in drone technology, safety risks, aviation regulations, miniaturization, autonomy, and the use of drones in swarms.</td>
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**UNIT I  | INTRODUCTION TO DRONE TECHNOLOGY  9**
Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses - Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT II  | DRONE DESIGN, FABRICATION AND PROGRAMMING  9**
Classifications of the UAV - Overview of the main drone parts- Technical characteristics of the parts- Function of the component parts - Assembling a drone- The energy sources- Level of autonomy- Drones configurations - The methods of programming drone- Download program - Install program on computer - Running Programs- Multi rotor stabilization- Flight modes - Wi-Fi connection

**UNIT III  | DRONE FLYING AND OPERATION  9**
Concept of operation for drone- Flight modes- Operate a small drone in a controlled environment- Drone controls- Flight operations- Management tool- Sensors- Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

**UNIT IV  | DRONE COMMERCIAL APPLICATIONS  9**
Choosing a drone based on the application- Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution- Drones in filming and panoramic picturing

**UNIT V  | FUTURE DRONES AND SAFETY  9**
The safety risks- Guidelines to fly safely - Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones- The use of drones in swarms

**TOTAL  | 45 PERIODS**

**COURSE OUTCOMES:**
Upon completion of this course, the students will be able to:

- **CO1** Recall and explain the concepts, vocabulary, and historical development of drone technology.
- **CO2** Analyze and evaluate the design, fabrication, and programming aspects of drones, demonstrating technical knowledge of drone components and their functions.
- **CO3** Demonstrate practical skills in flying and operating drones, including understanding flight modes, controlling drones, utilizing sensors, and integrating mobile devices.
- **CO4** Apply knowledge of drone technology to identify and discuss the commercial applications of drones in various industries, evaluating their benefits and limitations.
- **CO5** Evaluate and discuss the future trends and safety considerations in drone technology, demonstrating an understanding of aviation regulations, miniaturization, autonomy, and swarm usage.
REFERENCES


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COURSE OBJECTIVES:
1. To understand the different types of marine vehicles, including their functions and applications.
2. To analyze the design and construction principles of submersibles, ROVs, AUVs, and manned submersibles.
3. To evaluate the control systems and simulation techniques used in remotely operated and autonomous underwater vehicles.
4. To examine the operational considerations, safety measures, and certification requirements for manned submersibles.
5. To apply knowledge of marine vehicle design and technologies to real-world applications in the marine industry.

UNIT I MARINE VEHICLES 9
Types – general – by function – commercial marine vehicles- submersibles types - applications

UNIT II SUBMERSIBLES 9
Manned and unmanned submersibles – towed vehicles – gliders – crawler – Design and construction

UNIT III REMOTELY OPERABLE VEHICLE (ROV) 9

UNIT IV AUTONOMOUS UNDERWATER VEHICLE (AUV) 9

UNIT V MANNED SUBMERSIBLE 9
Introduction – Design and operational consideration – pressure hull exostructure – ballasting and trim – maneuvering and control – Life support and habitability – emergency devices and equipment’s – certification and classification

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Recognize and describe the various types of marine vehicles and their applications.

CO2 Explain the design and construction principles of submersibles, ROVs, AUVs, and manned submersibles.

CO3 Apply control systems and simulation techniques to design and operate remotely operated and autonomous underwater vehicles.

CO4 Analyze the operational considerations, safety measures, and certification requirements for manned submersibles.

CO5 Integrate knowledge of marine vehicle design and technologies to propose innovative solutions for real-world marine industry applications.

REFERENCES
4. R. Frank Busby, Manned Submersibles, Office of the oceanographer of the Navy, 1976
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COURSE OBJECTIVES:
1. To understand the fundamental concepts and principles of nanotechnology and MEMS.
2. To gain knowledge of various methods and techniques used for nano structuring and synthesis of nano materials.
3. To develop an understanding of the properties and characteristics of nano materials and their applications in micro and nano technology.
4. To acquire skills in different lithography and micromachining processes used in micro and nano fabrication.
5. To familiarize with the materials used in MEMS and their suitability for specific applications.

UNIT I | INTRODUCTION TO MICRO AND NANO TECHNOLOGY

UNIT II | CHARACTERIZATION OF MATERIALS

UNIT III | MICRO AND NANO SENSORS

UNIT IV | MICRO AND NANO ACTUATORS

UNIT V | MICRO AND NANO SYSTEM

TOTAL 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Apply the principles and theories of nanotechnology and MEMS to independently carry out research and development work in the field of Micro and Nano technology.

CO2 Demonstrate the ability to critically analyze and evaluate the performance of materials, sensors, actuators, and systems in Micro and Nano technology.
CO3 Generate and present substantial technical reports and documents that effectively communicate research findings and innovative solutions in the field of Micro and Nano technology.

CO4 Exhibit mastery and deep understanding of key concepts, methods, and core elements in Micro and Nano technology, showcasing expertise in design, fabrication, and characterization.

CO5 Develop and optimize solutions for complex engineering problems in Micro and Nano technology, integrating knowledge from multiple disciplines and employing advanced tools and techniques.

REFERENCES

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<td>1. To comprehend the fundamental principles of finite element analysis.</td>
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<td>2. To apply appropriate selection and utilization of finite elements in solving physical and engineering problems across different applications.</td>
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<td>3. To analyze and evaluate the effectiveness of shape functions and higher-order formulation in finite element analysis.</td>
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<td>4. To demonstrate proficiency in executing preprocessing tasks, including meshing, assigning boundary conditions, and post-processing of engineering problems.</td>
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<td>5. To evaluate and assess the capabilities of FEM software through real-time problem-solving and case studies.</td>
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| TOTAL | 45 PERIODS |

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<td>Upon completion of this course, the students will be able to:</td>
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| CO1 | State the fundamental principles of finite element analysis and their application in engineering problems. |
| CO2 | Apply appropriate finite element elements and techniques to solve physical and engineering problems in various domains. |
| CO3 | Analyze and evaluate the performance of one-dimensional and two-dimensional finite element elements in different engineering applications. |
| CO4 | Select and implement appropriate pre-processing techniques, including element selection, boundary condition specification, and meshing strategies, for efficient finite element analysis. |
| CO5 | Evaluate and interpret the results of finite element analysis using post-processing techniques to make informed engineering decisions. |
REFERENCES

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COs: Course Outcomes; POs: Performance Objectives
COURSE OBJECTIVES:
The main objective of this course is to prepare the students to:
1. Apply concurrent engineering principles in structuring work and deploying teams effectively in product development projects.
2. Analyse the role of customer involvement throughout the stages of the Product Life Cycle (PLC).
3. Utilize analysis tools such as Failure Mode and Effects Analysis (FMEA) to identify and mitigate potential risks in product design.
4. Assess the significance of intellectual property rights (IPR) in protecting new product innovations and conducting patent searches to ensure compliance.
5. Conduct quantitative and qualitative analysis to estimate future cash inflows and outflows in product development projects.

UNIT I PRODUCT DEVELOPMENT PROCESS & METHODOLOGIES

UNIT II INTRODUCTION TO PRODUCT LIFE CYCLE ENVIRONMENT

UNIT III PRODUCT MODELLING AND ANALYSIS TOOLS

UNIT IV PROJECT SELECTION, EVALUATION AND IPR

UNIT V PRODUCT DEVELOPMENT ECONOMICS
Elements of Economics analysis - Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows
analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis- Influence of qualitative factors on project success.

COURSE OUTCOMES
Upon successful completion if the course, students should be able to
1. Apply problem-solving strategies and methodologies to address challenges encountered during the product development process.
2. Evaluate the impact of customer involvement at different stages of the product life cycle and propose strategies for effective customer engagement.
3. Apply various product modelling techniques, such as CAD software and simulation tools, to create and optimize product designs.
4. Apply intellectual property rights (IPR) principles and conduct patent searches to protect and manage new product innovations.
5. Analyse and interpret quantitative and qualitative data to assess the economic viability of product development projects.

References
4. Karl T. Ulrich and Steven D. Eppinger "Product Design and Development"
5. John Stark "Product Lifecycle Management: Volume 1 - 21st Century Paradigm for Product Realisation"
7. Michael N. Kennedy "Product Development for the Lean Enterprise: Why Toyota’s System is Four Times More Productive and How You Can Implement It"
11. Marc Annacchino "New Product Development: Successful Innovation in the Marketplace"

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</table>
COURSE OBJECTIVES:

1. To interpret the classification of conventional machine tools and differences of NC, CNC and DNC.
2. To understand the architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.
3. To know the function various instrumentation system for parameter measurement and interface.
4. To understand standards and programming techniques in CNC machine.
5. To learn the testing and maintenance of various sub systems of CNC.

UNIT I  |  NC, CNC, AND DNC  

UNIT II  |  MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS  

UNIT III  |  INSTRUMENTATION SYSTEM AND AUTO TOOLING  

UNIT IV  |  CNC PROGRAMMING  

UNIT V  |  TESTING AND MAINTENANCE OF CNC MACHINES  

TOTAL  |  45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1  State and compare the differences between Numerical Control (NC), Computer Numerical Control (CNC), and Direct Numerical Control (DNC) systems.

CO2  Evaluate the architecture of CNC machines and assess the functions of mechatronic elements for ensuring reliable performance.

CO3  Apply CNC programming techniques in machine tools to accurately control and automate machining operations.
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<th>Implement testing and maintenance procedures for various subsystems of CNC machines to ensure their proper functioning.</th>
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<td>CO5</td>
<td>Create diverse products by utilizing NC and CNC programming skills, demonstrating the ability to apply programming concepts to practical applications.</td>
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*PROGRESS THROUGH KNOWLEDGE*

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Centre for Academic Courses
Anna University, Chennai-600 025
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COURSE OBJECTIVES:
1. To learn the standards, instrumentation and errors in measurement.
2. To learn the measurement principle and methods used in basic and advanced instruments.
3. To learn the applications of opto-electronics devices for measurements.
4. To observe the machine vision-based inspections.
5. To acquire the measurement strategies in inspection using CMM.

UNIT I  FUNDAMENTALS AND CONCEPTS IN METROLOGY  9

UNIT II  INSPECTION AND GENERAL MEASUREMENTS  9

UNIT III  OPTOELECTRONICS IN ENGINEERING INSPECTION  9

UNIT IV  MACHINE VISION  9

UNIT V  COORDINATE METROLOGY AND QUALITY CONTROL  9

TOTAL  45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1  Apply measurement standards and protocols to ensure accurate and error-free measurements.

CO2  Utilize both basic and advanced metrology instruments effectively for precise measurements.

CO3  Acquire knowledge and understanding of non-contact opto-electronics devices for measurement applications.

CO4  Apply machine vision-based inspection techniques to enhance quality control processes.

CO5  Plan and develop measurement strategies using Coordinate Measuring Machines (CMM) for inspection and implement quality control measures.
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COURSE OBJECTIVES:
1. To familiarize the concepts of Single Factor Experiment and Post hoc tests
2. To illustrate understanding of Factorial experiments
3. To enable students with the extensions of Factorial experiments and Response Surface Methods
4. To provide students with an understanding of Taguchi method for parameter optimization
5. To provide students with understanding of Shainin DOE

UNIT I  SINGLE FACTOR EXPERIMENTS  9
Introduction to Hypothesis testing – Experimentation – Need, Conventional test strategies, terminology, basic principles of design – steps in experimentation – Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods – Duncan’s multiple range test, Newman-Keuel’s test, Fisher’s LSD test, Tukey’s test- Testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications

UNIT II  FACTORIAL DESIGNS  9
Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model – Rule for sum of squares and Expected Mean Squares - 2^K Design with two and three factors– Yate’s Algorithm – Fitting regression model– Randomized Block Factorial Design- Introduction to MANOVA&ANCOVA.

UNIT III  SPECIAL FACTORIAL DESIGNS & RESPONSE SURFACE METHODS  9

UNIT IV  TAGUCHI DESIGN OF EXPERIMENTS  9
Taguchi’s Quality Loss Function- Philosophy- Design of Experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments - Response Graph Method- ANOVA- Attribute data analysis- Robust design- noise factors, Signal to Noise ratios, Inner/outer OA design- case studies.

UNIT V  SHAININ DESIGN OF EXPERIMENTS  9
Basics of Shainin DOE - Comparison between Taguchi DOE Vs Shainin DOE methods - Problem Solving Algorithm - Problem Identification Tools- Shainin Design of Experiments Tools - Case studies

TOTAL  45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Understand the fundamental principles of Classical Design of Experiments
CO2 Apply single factor experiment for process parameter understanding and optimization.
CO3 Apply Factorial Design principles for understanding of process parameters and its optimization
CO4 Gain knowledge on Taguchi’s approach to experimental design for attaining robustness.
CO5 Apply Response Surface Method and Shainin DOE to evaluate quality

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COURSE OBJECTIVES:
1. To describe different operations management strategies for competitive advantage.
2. To know various techniques in forecasting the future demand with accuracy.
3. To learn planning of production schedule and apply techniques like Aggregate plan, MRP, MRP II, DRP and ERP.
4. To learn how to determine the lot size and EOQ using the inventory systems. Also to learn how to classify the inventories for a better control.
5. To calculate the plant capacity and exercise control on production. Also to learn JIT implementation and control procedures.

UNIT I UNDERSTANDING OPERATIONS AND ITS DESIGN

UNIT II DEMAND FORECASTING
Forecasting as a planning tool, need for forecast, forecasting time horizon, Design of forecasting system, Developing the forecasting logic, Sources of data, Models for forecasting, Explorative Methods using Time Series - Moving averages, The exponential smoothing method, Extracting the components of time series, Estimating the trend using linear regression and Extracting the seasonal component; Causal Methods of forecasting, Accuracy of Forecasts and the Forecasting System.

UNIT III PRODUCTION PLANNING
Aggregate Production Planning and Master Production Scheduling; Resources Planning – Dependent demand attributes, the basic building blocks of a planning frame work, MRP logic, Using the MRP system, Capacity Requirements (CRP), Distribution Requirement Planning (DRP), and Resources Planning; Manufacturing Resources Planning (MRP II), Enterprise Resource Planning (ERP) and Resources Planning in Services.

UNIT IV INVENTORY PLANNING AND CONTROL
Inventory planning for independent Demand items, Types of inventory, Inventory Costs, Inventory Control for Deterministic Demand items, Handling Uncertainty in Demand, Inventory Control Systems, Selective Control of Inventory, Inventory Planning for Single - Period Demand and other issues in Inventory Planning and Control.

UNIT V CAPACITY ANALYSIS AND OPERATIONAL CONTROL
Defining capacity, Measures of capacity, The time horizon in capacity planning, The capacity planning framework, Alternatives for capacity augmentation, Decision tree for capacity planning; Operational control – Input - Output Control, Operational Control issues in mass production systems and Operations planning and control based on the theory of constraints; Elements of JIT Manufacturing and Production planning and Control in JIT.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to
CO1. Identify different operations management strategies for competitive advantage.
CO2. Apply various techniques in forecasting the future Demand with accuracy.
CO3. Plan the production schedule and apply techniques like Aggregate plan, MRP, MRP II, DRP and ERP.
CO4. Determine the lot size and EOQ using the inventory systems. Also will be able to classify the inventories for a better control.
CO5. Plan the capacity and exercise control on production. Also understand JIT implementation and control.

REFERENCES:
4. SeetharamaL.Narasimhan, Dennis W.McLeavey, Peter J.Billington,”Production Planning and Inventory Control”, PHI, 2002

CO’s - PO’s & PSO’s MAPPING

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COURSE OBJECTIVES:

1. To study the approaches and techniques to assess quality by statistical process control.
2. To study the methodology to assess and sampling of parameters.
3. To impart knowledge in reliability concepts and assess the various configurations.
4. To impart knowledge in reliability monitoring methods.
5. To analyze effectively various techniques to improve reliability of the system.

UNIT – I QUALITY AND STATISTICAL PROCESS CONTROL


UNIT – II ACCEPTANCE SAMPLING


UNIT – III RELIABILITY CONCEPTS AND ASSESSMENT


UNIT – IV RELIABILITY MONITORING


UNIT – V RELIABILITY IMPROVEMENT


TOTAL 45 PERIODS

COURSE OUTCOMES

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

CO1 Apply quality principles, process variation, and control charts for effective quality management.

CO2 Discuss different sampling plans.

CO3 Explain reliability concepts and assess the various configurations.

CO4 Build knowledge in reliability monitoring methods.

CO5 Examine effectively various techniques to improve reliability of the system.

REFERENCES:


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DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
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COURSE OBJECTIVES

1. To understand Lean production principles, eliminate waste, and improve efficiency through case studies.
2. To learn steps for Value Stream Mapping, apply Lean metrics, and implement improvements in value streams.
3. To explore Six Sigma's relationship with Lean Manufacturing, cultural changes, quality assessment, and cost implications.
4. To gain knowledge of various Six Sigma tools and techniques for problem-solving and project management.
5. To evaluate Six Sigma quality economics, focus on continuous improvement using Lean principles, Kaizen, and 5S methodologies.

UNIT I   LEAN MANUFACTURING  9

UNIT II   VALUE STREAM MAPPING  9
Need for Value Stream mapping; Steps involved in Value stream mapping – Choose value stream – PQ and PR analysis, Current State map, Lean Metrics, Future State Map, Kaizen plans; Lean implementation - Cultural change, Hoshin planning; Lean in the Supply chain.

UNIT III   SIX SIGMA  9
Six sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ)

UNIT IV   SIX SIGMA SCOPE OF TOOLS AND TECHNIQUES  9

UNIT V   EVALUATION AND CONTINUOUS IMPROVEMENT METHODS  9
Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to

CO1. Demonstrate understanding of Lean production principles, waste identification, and efficiency improvement.

CO2. Apply Value Stream Mapping steps and Lean metrics to enhance organizational performance.

CO3. Analyze the relationship between Six Sigma and Lean Manufacturing, evaluate cultural changes, quality levels, and cost implications.

CO4. Acquire knowledge of Six Sigma tools and techniques for effective problem-solving and project management.

CO5. Evaluate Six Sigma quality economics and demonstrate commitment to continuous improvement through Lean principles, Kaizen, 5S methodologies, and customer focus.

REFERENCES:
3. Fred Soleimannejed, Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004

CO’s- PO’s & PSO’s MAPPING

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COURSE OBJECTIVES:
1. To describe the role and drivers of supply chain management in achieving competitiveness.
2. To explain about Supply Chain Network Design.
3. To illustrate about the issues related to inventory in Supply Chain.
4. To appraise about transportation and sourcing in Supply Chain.
5. To application of Information Technology and Emerging Concepts in Supply Chain.

UNIT I  INTRODUCTION TO SUPPLY CHAIN MANAGEMENT  9

UNIT II  DISTRIBUTION NETWORK DESIGN IN SUPPLY CHAIN  9

UNIT III  INVENTORY IN SUPPLY CHAIN  9
The Role of Cycle inventory in a Supply Chain, Economies of Scale to Exploit Fixed costs, Managing Multi-echelon Cycle Inventory. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, Managing Safety Inventory in a Multi-echelon Supply Chain, The Role of IT in inventory management.

UNIT IV  TRANSPORTATION AND SOURCING IN SUPPLY CHAIN  9
The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation, Problems. Sourcing Decisions In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Total cost of Ownership, Supplier selection, Auctions and Negotiations, Sharing Risk and Reward in the supply chain.

UNIT V  INFORMATION TECHNOLOGY IN SUPPLY CHAIN  9
The role of IT in a supply chain, The supply chain IT framework, The supply chain macro processes, Lack of Supply Chain co-ordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories, collaborative planning, forecasting and replenishment (CPFR).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1. Understand supply chain concepts, systemic and strategic role of SCM in global competitive environment.
CO2. Evaluate alternative supply and distribution network structures using optimization models.
CO3. Develop optimal inventory policies in the supply chain context.
CO4. Develop optimal sourcing and Transportation decisions in the supply chain.
CO5. Select appropriate information technology frameworks for managing supply chain processes.

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