PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To create a high qualified mechatronics engineer, who have ability to design, develop and analyze the mechatronic system and provide optimal solutions with basic and advanced technology for industrial and societal problems.

II. To develop innovative and sustainable products with multidisciplinary expertise.

III. To develop a successful entrepreneur in their field with strong communication and high ethics.

IV. To develop industry readiness engineer with complex solving capability and lifelong learning.

V. To develop high employability in industry and academia.

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 over the area as per the specialization of the program.</td>
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<td>4</td>
<td>Post Graduates able to acquaint the knowledge in key concepts, methods, core elements, design, modern tools and techniques for unified mechatronic systems and their intelligence.</td>
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<td>Post Graduates will apply to develop the solution for various engineering system needs using a mechatronics-based approach.</td>
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<td>Post Graduates able to build the real-time/virtual mechatronics system within realistic constraints such as industrial, economic, environmental, ethical, social, health and safety aspects.</td>
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PEO & PO Mapping

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ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. MECHATRONICS
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI

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#### SEMESTER II, ELECTIVE - II

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#### SEMESTER III, ELECTIVE - III & IV

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### Employability Enhancement Courses (EEC)

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### Research Methodology and IPR Courses (RMC)

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### Audit Courses (AC)

Registration for any of these courses is optional to students.

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COURSE OBJECTIVES:
1. Mathematical foundations of numerical techniques for solving linear systems, eigenvalue problems and generalized inverse.
2. To expose the students to variational formulation and numerical integration techniques and demonstrate solution methodology for the variational problems.
3. To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
4. To make the students appreciate the purpose of using Laplace transforms to solve the partial differential equation.
5. To introduce the Fourier transforms and its properties.

UNIT – I  MATRIX THEORY  12

UNIT – II  CALCULUS OF VARIATIONS  12

UNIT – III  PROBABILITY AND RANDOM VARIABLES  12

UNIT – IV  LAPLACE TRANSFORM TECHNIQUES FOR PDE  12

UNIT – V  FOURIER TRANSFORM TECHNIQUES FOR PDE  12

COURSE OUTCOMES:
At the end of the course, students will be able to
1. apply various methods in matrix theory to solve system of linear equations.
2. maximizing and minimizing the functional that occur in various branches of Engineering disciplines.
3. computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
4. application of Laplace transforms to initial value, initial- boundary value and boundary value problems in Partial Differential Equations.
5. obtain Fourier transforms for the functions which are needed for solving application problems.

TOTAL: 60 PERIODS
REFERENCES:

MR4101 CONCEPTS IN ELECTRONICS ENGINEERING L T P C 2 0 2 3

COURSE OBJECTIVES
1. To understand the functionality of fundamental electronic components.
2. To understand the functions of the operational amplifier and its applications.
3. To review and use the logic gates for various digital circuit development.
4. To understand the functions and uses in measurement.
5. To learn the power management of various electronic units.

UNIT I ELECTRONIC COMPONENTS AND DEVICES 6
Resistors, capacitors, inductors, transformers – types and properties - junction diodes, Zener diodes, transistors and thyristors - types-operating mechanism-characteristics and applications.
LED – characteristics and applications

UNIT II OPERATIONAL AMPLIFIERS AND APPLICATIONS 6
Operational amplifiers – principles, specifications, characteristics and applications- arithmetic operations, integrator, differentiator, comparator, Schmitt trigger, instrumentation amplifiers, active filters, linear rectifiers, waveform generators, A/D converters, feedback and power amplifiers, sine wave oscillators

UNIT III DIGITAL ELECTRONICS 6

UNIT IV SIGNAL PROCESSING AND MEASURING DEVICES 6
UNIT V  POWER MANAGEMENT
Pulse width modulation and pulse position modulation – batteries–SMPS - sensors, actuators and controllers’ energy consumption -power optimization of integrated system.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Apply the fundamental electronic components in various circuits.
CO2: Create the basic electronic circuits using op-amp for various applications.
CO3: Create the digital electronic circuits using logic gate ICs’.
CO4: Apply the power supply and measurement system appropriately for various applications.
CO5: Measure, estimate and monitor the power for various applications to use battery or electrical power sources.

CO-PO MAPPING:

<table>
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<tr>
<th>Course Outcomes</th>
<th>PO1</th>
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</table>

REFERENCES

LABORATORY

LIST OF EXPERIMENTS
2. Experimentation with CRO.
3. Design of DC power supplies
4. Design of inverting amplifier and non-inverting amplifiers
5. Design of Instrumentation amplifier.
7. Design of combinational circuits and sequential circuits.
9. RC Servo motor driver circuit.
10. Design of stepper motor driver circuit.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:
1. CRO-1
2. DSO-1
3. DC Power supply
   5V – 5 No's

TOTAL: 30 PERIODS
12V, 10A - 1 No
24V, 10A or higher - 1 No
4. Function generator-1
5. OP-Amp trainer kit (inverting and non-inverting amplifier module)
6. Analog filters trainer kit
7. Sequential circuit trainer kit
8. Combination circuit trainer kit
9. A/D Converter trainer kit -1 No
10. D/A Converter Trainer kit-1 No
11. Driver Circuit Module for servomotor-1 No
12. Driver Circuit module for stepper motor-1 No
13. Multi-Meter, bread board, and solder machine.
14. Electronic components for power supply (transformer, regulator, diode, capacitors) -5
No’s.

MR4102 CONCEPTS OF MACHINES AND MECHANISMS 

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.
3. To identify the nomenclature of gear and to understand the functions and typical uses of various types of gears and Cams.
4. To understand the behaviours of the vibration in various machines.
   To make use of various conventional machine tools for component development.

UNIT I MECHANISMS

UNIT II FRICTION

UNIT III GEARING AND CAMS
Gear profile and geometry-nomenclature of spur and helical gears – law of gearing – interference requirement of minimum number of teeth in gears-gear trains-simple and compound gear trains determination of speed and torque in epicyclic gear trains-Cam profile-different types of followers.

UNIT IV VIBRATION
UNIT V  MACHINE TOOLS
Machine tool construction-features – operations of lathe, milling machine, drilling machine –
Drive system for machine tools – mechanical, hydraulic and electric stepped and variable
speeds – spindle speeds and feed drives-linear and reciprocation motion generation.

TOTAL :  30 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Apply the fundamental mechanism in machinery development.
CO2: Consider the functions of friction in joints and select of appropriate belt drives for the
typical applications.
CO3: Select and use of appropriate gears and cams for system development.
CO4: Evaluate the possibility of vibration generation in the system design.
CO5: Demonstrate the various conventional machine tools and CNC Machines.

CO-PO MAPPING:

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REFERENCES
   2009.

LABORATORY

LIST OF EXPERIMENTS
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. 2D modeling and 3D modeling of Structures and frames
6. Modeling and simulation of mechanism of 4 Bar chain
7. Modeling and simulation of mechanism of Slider crank,
8. Modeling and simulation of mechanism of Ball and screw and Rack and pinion.
10. Modeling and simulation of mechanism of Quick return and elliptical trammel.

TOTAL: 30 PERIODS

LIST OF SOFTWARES
Solid Works/ OpenCAD /CREO /CATIA/ NX CAD/MSC-Adams – 15 No’s
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 motion, proximity and ranging sensors.
3. To understand and analyse the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyse the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.

UNIT I INTRODUCTION TO SENSORS

UNIT II MOTION, OPTICAL AND RANGING SENSORS

UNIT III FORCE, MAGNETIC, AND HEADING SENSORS

UNIT IV FLUID POWER ACTUATORS

UNIT V ELECTRICAL DRIVES AND ACTUATORS

TOTAL : 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyse the sensor response.
2. Analyze and select suitable sensor for motion, proximity and range measurement.
3. Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
4. Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
5. Understand the working principles of various actuators and their applications.

REFERENCES

CO-PO MAPPING:

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MR4104 CONTROL SYSTEM DESIGN

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, analyse and design a control system of servomotors for motion control.
UNIT I  
**SYSTEM REPRESENTATION AND MODELLING**  
9

UNIT II  
**DESIGN OF FEEDBACK CONTROL SYSTEM**  
9

UNIT III  
**TIME AND FREQUENCY DOMAIN ANALYSIS**  
9

UNIT IV  
**CONTROL SYSTEM DESIGN**  
9
Root locus approach to control system design – lead, lag, lag-lead compensation using time domain analysis. Control system design using frequency domain analysis - lead, lag, lag-lead compensation using frequency domain analysis– P, PI, and PID controllers – tuning methods and rule.

UNIT V  
**CONTROL AND ANALYSIS OF SERVO MOTOR**  
9

TOTAL : 45 PERIODS

**COURSE OUTCOMES:**

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

**CO1:** Develop the mathematical model of physical systems.

**CO2:** Characterize the responses and evaluate the range of stability for the physical systems using time domain techniques.

**CO3:** Describe and assess the range of stability for the physical systems using frequency domain technique.

**CO4:** Design an appropriate control system and compensator for system dynamics.

**CO5:** Evaluate and demonstrate the motion control of motors.
CO-PO MAPPING:

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REFERENCES

LABORATORY

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.

TOTAL: 30 PERIODS

LIST OF SOFTWARE FOR A BATCH OF 30 STUDENTS:
1. MATLAB/SCI-LAB – Control System Tool Box - 15 No’s
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 9
Introduction and need for automation- Instrumentation system for measurement of process parameters – overview on flow, level, pressure, temperature, speed, current and voltage measurements – proximity and vision based inspection systems – process control systems – continuous and batch process – feedback control system overview.

UNIT II PROGRAMMABLE LOGIC CONTROLLER 9

UNIT III DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS 9

UNIT IV FACTORY AUTOMATION 9
Factory layout - Tools and software based factory modeling - case study on automated manufacturing units, assembly unit, inspection systems and PLC based automated systems- Introduction to factory automation monitoring software

UNIT V BUILDING AUTOMATION 9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
CO1: Understand the need of process parameter measurement and control.
CO2: Select, configure and program the PLC by interfacing the sensors and actuators and other input and output devices for automation.
CO3: Understand and compare various data communication protocols. Able to compare centralized, decentralized and smart control system.
CO4: Select and apply suitable sensor, control and actuation for factory automation. Also, they can simulate the same using software.
CO5: Select appropriate sensor, controller and actuation

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REFERENCES


RM4151 RESEARCH METHODOLOGY AND IPR

UNIT I RESEARCH DESIGN
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS
UNIT V PATENTS


TOTAL :30 PERIODS

REFERENCES

MR4111 SENSORS AND ACTUATORS LABORATORY

COURSE OBJECTIVES
1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors.
3. To learn about various displacement and speed measuring sensors.

LIST OF EXPERIMENTS

SENSORS AND TRANSDUCERS
2. Determine the characteristics of Pressure Sensor and Piezoelectric Force Sensor.
3. Displacement Measurement using LVDT.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
7. Determine angular velocity using gyroscope, Vibration measurement using Accelerometer and Direction measurement using Magnetometer.

ACTUATORS
1. Experiments on control of Speed and Direction Control of DC Motor.
2. Experiments on control of Position, Speed and Direction Control of Stepper Motor.
3. Experiments on control of Position, Speed and Direction Control of AC Servo Motors.
4. Experiment on control of Position, Speed and Direction Control of DC Servo Motors.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
1. Understand and demonstrate various contact and non-contact sensors.
2. Analyze and Identify appropriate sensors for given applications.
3. Create a sensor system for given requirements.
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**MR4112 INDUSTRIAL AUTOMATION LABORATORY**

**COURSE OBJECTIVES**
1. To learn the basic operations in PLC.
2. To learn to integrate various sensors and actuators to PLC.
3. To apply the PLC controller to various systems through real-time applications.

**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. Experiments on Sensor and Actuator Interfacing and PLC to PLC Communication.
5. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
6. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
7. Experimental Verification of Pneumatic Sequencing Circuits.
8. Experiments on Control of PLC Based Electro Pneumatic Sequencing Circuits.
10. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
11. Develop Ladder Diagram Program in PLC For Material Filling and Object Shorting.
12. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Pick and Place Operation.

Note: Any of the 10 experiments to be conducted

**TOTAL: 30 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

- PLC Software - 2 Users
- PLC Station with Communication Protocol, Sensors and Actuators – 2 No’s
- Electro Pneumatic Sequencing - 1 Unit
- Electro Hydraulic Sequencing Circuits – 1 Unit
- PLC station with Pressure and Level in a Bottle Filling System – 1 Unit
- PLC station with Material Handling, Delaying Conveyor, Pick and Place Operation – 1 Unit.
COURSE OUTCOMES:
Upon completing this course Students able to
1. Understand and demonstrate PLC controller programming.
2. Analyse and Identify appropriate sensors and its integration with PLC for given applications.
3. Create a PLC controller system for given requirements

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MR4201 MECHATRONICS SYSTEM DESIGN

COURSE OBJECTIVES:
1. To enlist the various elements required to design and integrate the mechatronic systems.
2. To acquire the Modelling skills to capture the system dynamics of hybrid systems and to familiar the system identification techniques and to practice the design and assembly of mechanical system in software environment for integrating various system sub-elements.
3. To familiar the standard simulation procedure for algorithm and controller development and to practice simulate and verify interactions and functions of integrated systems and its elements for fine tuning the design and control for real time system development.
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 12

UNIT II MODELLING & SYSTEM IDENTIFICATION 12
UNIT III SIMULATION 12

UNIT IV DESIGN OPTIMIZATION 12

UNIT V CASE STUDIES ON MODELING OF MECHATRONIC SYSTEMS 12

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to
CO1. Understand the list of elements required integrate the entire mechatronic systems developments.
CO2. Create the system dynamics of hybrid systems and to trial the system identification techniques and to practice the design, integration and simulation in virtual systems that are closer to the real time systems’ functionalities and its parameters.
CO4. Apply the optimization concepts mechatronics elements selection and process parameter optimization.
CO5. Integrate and analyze the mechatronics system design 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

UNIT II ROBOT ARM KINEMATICS

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING
Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

UNIT IV NONLINEAR CONTROL OF MANIPULATORS
Introduction - nonlinear and time - varying systems - multi-input, multi-output control systems - the control problem for manipulators - practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian - based control systems - adaptive control

UNIT V ROBOT PROGRAMMING AND APPLICATIONS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to
CO1. Understand the basics of Industrial Robotics and Control.
CO2. Create the kinematic solutions for the serial manipulators.
CO3. Analyze linear control of manipulators
CO4. Analyze non-linear control of manipulators
CO5. Create robotic program for specific applications.

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MR4203 MACHINE VISION SYSTEMS

COURSE OBJECTIVES:
1. To understand the basics concepts of optics and machine vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on stereo vision and structure from motion.
4. To understand the design factors in machine vision system design.
5. To demonstrate the various applications of machine vision system.

UNIT I INTRODUCTION
Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation

UNIT II IMAGE PROCESSING FUNDAMENTALS
UNIT III  COMPUTATIONAL STEREO AND MOTION

UNIT IV  SMART VISION SYSTEM DESIGN
Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.

UNIT V  APPLICATIONS AND CASE STUDIES

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to
CO1. Understand the difference between the vision systems and were able to remember the functions of vision system.
CO2. Understand various image processing techniques and develop algorithms.
CO3. Create the visual serving for mechatronics applications
CO4. Evaluate and select appropriate lighting source, lighting technique, lens, sensor and interfacing.
CO5. Apply various machine vision techniques in various engineering fields.

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TOTAL: 45 PERIODS
COURSE OBJECTIVES:
1. To understand the basic concepts of artificial intelligence available in systems.
2. To learn and understand the basic concepts of artificial neural networks
3. To impart knowledge genetic algorithm.
4. To understand the components and concepts in fuzzy systems
5. To demonstrate the various applications of Artificial intelligence in systems

UNIT I INTRODUCTION
Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems

UNIT II ARTIFICIAL NEURAL NETWORKS

UNIT III GENETIC ALGORITHM
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT IV FUZZY LOGIC SYSTEM

UNIT V ADVANCED LEARNING

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to
CO1. Understand the various intelligence concepts available in the mechatronics system.
CO2. Demonstrate and design any mechatronics system with artificial neural networks
CO3. Select and implement appropriate techniques and genetic algorithm
CO4. Design and implement the real time application with fuzzy logic.
CO5. Familiar with advanced learning techniques

TOTAL: 45 PERIODS
REFERENCES:
   Ltd., 1993.

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MR4205 SMART EMBEDDED SYSTEMS L T P C
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COURSE OBJECTIVES:
1. To understand the inclusion of embedded system in smart system design
2. To learn and understand the basic concepts in ARM 7 Core processor
3. To learn and understand the basic concepts in ARM 9 Core processor
4. To impart knowledge on real time models, language and operating systems
5. To demonstrate the embedded processors and various applications of embedded systems

UNIT I MICROCONTROLLER

UNIT II 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 III INTRODUCTION TO ARM PROCESSOR

UNIT IV  REAL TIME MODELS, LANGUAGE AND OPERATING SYSTEMS  9
Models and languages – State Machine and state tables in embedded design – High level language descriptions - Java based embedded system design – Petrinet models-Real time languages – The real time Kernel - OS tasks - Task Scheduling - kernel services – Real time languages and their features.

UNIT V  OTHER PROCESSORS AND APPLICATIONS  9

TOTAL: 45 PERIODS

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

CO1. Understand and implement embedded technologies in the field of smart system design.
CO2. Understand and interface the peripherals with 8051.
CO3. Design, program and implement ARM 7 and ARM 9 based system
CO4. Familiarize and select real time models, language and operating system in their system design
CO5. Demonstrate various applications of embedded systems in various fields.

REFERENCES:
6. Tim Wilmshurst, An Introduction to the design of small – scale Embedded Systems.

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COURSE OBJECTIVES:
1. To introduce different types of robotics and demonstrate them to identify different parts and components.
2. To write programming for simple operations.
3. To write program for identification and recognition of object parameters.

LIST OF EXPERIMENTS
1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place.
5. Robot programming and simulation for Color identification.
6. Robot programming and simulation for Shape identification.
7. Robot programming and simulation for machining (cutting, welding).
8. Robot programming and simulation for writing practice.
9. Robot programming and simulation for any industrial process (Packaging, Assembly).
10. Robot programming and simulation for multi process.
11. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
12. Program to construct a Bayesian network. Use this model to implement any application using standard Data Set. You can use Java/Python ML library classes/API.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS
1. ROS (Robotic Operating System)
2. 18 Systems with server
3. Verification of direct kinematics equations and inverse kinematics equations of 1DOF “R-configuration” robot.
4. Verification of direct kinematics equations and inverse kinematics equations of 2DOF “R-R-configuration” robot.

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to:
CO1. Apply any robotic simulation software to model the different types of robots and calculate work volume for different robots.
CO2. Analyse and estimate the various robotic specifications.
CO3. Create program for object identification and recognition, machining operation and simulate the same in any robotic simulation software.
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MR4212 MACHINE VISION AND INTELLIGENCE LABORATORY

COURSE OBJECTIVES:
1. To gather the practical exposure on machine vision elements, lighting technique, processing software and algorithms.
2. To learn and practice various image processing techniques.
3. To learn various application of machine vision and programming

LIST OF EXPERIMENTS
1. Study on different kinds of vision sensors.
2. Study on lighting techniques for machine vision
4. Experimentation on image acquisition towards the computation platform.
5. Pre-processing techniques in image processing
6. Edge detection and region of interest extraction.
7. Experimentation with image processing algorithm for feature extraction.
8. Experimentation with pattern recognition.
10. Vision based Gear parameter measurement.
12. Implement the SIFT blob detector and tracker.
13. Object recognition by SIFT, SURF

LIST OF EQUIPMENT FOR A BATCH OF 18 STUDENTS
1. CMOS Camera (USB/Ethernet) - 1 No
2. CCD Camera (USB/Ethernet) - 1 No
3. Standard Boom Stand (Bench top setup) - 2 No's
4. Extension Tube (5mm to 50mm) - 2 No's
5. Lenses (between 3mm to 50mm focal length) - 2 No's
6. Tele-centric lens - 1 No
7. Lighting (Coaxial, ring lighting, Diffused, backlighting) - 1 No Each.
8. Machine vision software - 2 No's
9. PC-2 No's

TOTAL: 60 PERIODS
COURSE OUTCOMES:
Upon the completion of this course, the students will be able to:
CO1. To select a vision sensor for any kind of application.
CO2. To understand and implement various image processing techniques.
CO3. To understand and implement industrial applications.

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MR4311
PROJECT WORK - I

COURSE OBJECTIVES:
1. To enable students to select and define a problem/need for analysis in the field of mechatronic 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.
4. To design, model and experiment/develop optimal solution for problem being investigated.
5. To analysis and interpretation of system and its performance, data, and synthesis of the information to provide valid conclusions and submit dissertation.

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 the 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 Phase–I.
2. The progress of the project is evaluated based on a minimum of three reviews and 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 anna university 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 Obtain Fourier transforms for the functions which are needed for solving application problems.

TOTAL: 180 PERIODS
COURSE OUTCOMES:

CO1 - The students would apply the knowledge gained from theoretical and practical courses in solving problems.

CO2 - The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.

CO3 – The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

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MR4411 PROJECT WORK - II

COURSE OBJECTIVES:

1. The students will be able to propose and define a problem/need for development and analysis in the field of mechatronic and its interdisciplinary area and it may be a continuation phase - I or newly formulated problem for phase - 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, modelling, simulation, developing algorithms, fabrication and integration of system elements for automation for development of sustainable and economical solution for problem being investigated.

4. To analyse and interpretation of system and its performance, data, and synthesize of the factual information's to arrive at valid conclusions

5. To enable students to communicate technical information in form of oral presentation and technical report in form of dissertation

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 anna university 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: 180 PERIODS
COURSE OUTCOMES:
CO1 - The students would apply the knowledge gained from theoretical and practical courses in solving problems.
CO2 - The students would be able to create a novel mechatronics-based solution for an engineering problem and get trained in planning, organizing and executing the method.
CO3 – The students would be able to analyse and evaluate the result and can be able to record and write a technical document in form of thesis.

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COURSE OBJECTIVES:
1. To familiarize the measurement standards and to know the instruments used and various errors in measurements.
2. To recognize the use of basic and advanced instruments for measurements.
3. To learn the applications of opto-electronics device 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
Standards of measurement – Analog and digital measuring instruments-comparators – Limits, Fits and Tolerances – Gauge design – Angular measurements – Surface Roughness – Form errors and measurements.

UNIT II INSPECTION AND GENERAL MEASUREMENTS 9

UNIT III OPTO ELECTRONICS IN ENGINEERING INSPECTION 9
Use of opto electronics in Tool wear measurement – Micro hole measurement and surface Roughness – Applications in In-Process measurement and on line Inspection.

UNIT IV MACHINE VISION 9

UNIT V COORDINATE METROLOGY AND QUALITY CONTROL 9
Co-ordinate measuring machines – Applications and case-studies of CMM in Inspection – Use of Computers in quality control – Control charts – Reliability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
Upon completion of this course, the students will be able to:
CO1: Evaluate the standards in measurements and to avoid the various forms of errors in measurements.
CO2: Apply of basic and advanced metrology instruments for measurements.
CO3: Acquire the knowledge on non-contact opto-electronics device for measurements.
CO4: Apply machine vision-based inspections.
CO5: Create the measurement strategies in inspection using CMM

REFERENCES
MR4002  DIGITAL MANUFACTURING  L T P C  3 0 0 3

COURSE OBJECTIVES

1. To learn the concept of NC and CNC technologies on practical problems with feedback and adaptive control.
2. To learn the configuration of CNC system, PLC programming for CNC and also case studies on machine structure elements.
3. To learn the mechatronics elements in CNC measuring system and tooling system, EEPROM tools, automatic tool changing system, tool magazine and sensors in CNC.
4. To learn about the CNC programming tools with computer assisted programming using APT, generation and execution of APT programs.
5. To learn the methods for verification, testing and Maintenance of CNC machines during idle running and machine tooling.

UNIT I  INTRODUCTION OF NC, CNC, DNC AND ADAPTIVE CONTROL  9
Classification of machine tools – types, functions and processes - fundamentals of NC and CNC technologies Adaptive control - types, application and benefits - general configuration of adaptive control and function – reasons for process change - practical problems with adaptive control - example for feedback and adaptive control.

UNIT II  MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS  9
CNC systems - configuration of the CNC system – interfacing – monitoring – diagnostics - machine data - compensations for machine accuracies - PLC in CNC – PLC programming for CNC, steps in programming and case studies - machine structure -types of loads on CNC machine - guide ways and types - mechanical transmission elements - elements for rotary motion to linear motion - ball screw and types - roller screw and types - rack and pinion - various torque transmission elements - requirements of feed drives and spindle drive.

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CO - Course Outcomes
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UNIT III  MECHATRONICS ELEMENT IN CNC MEASURING SYSTEM AND 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: Get the knowledge of the differences of NC, CNC and DNC.
CO2: Analyse architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.
CO3: Realize the functions of instrumentation systems
CO4: Write the part programming in CNC machine.
CO5: Perform the testing and maintenance of various sub systems of CNC

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MR4003 COMPUTER AIDED PRODUCTION AND AUTOMATION OF PLANTS

COURSE OBJECTIVES
1. To learn various production planning processes, capacity planning, and shop floor planning processes.
2. To learn about the fundamentals of Automated assembly and part transferring systems.
3. To learn about Group Technology and Flexible manufacturing systems.
4. To learn about automation systems and advanced manufacturing techniques.
5. To familiarize computer-aided production and automation of plants through various case studies.

UNIT I COMPUTER AIDED PRODUCTION PLANNING


UNIT II AUTOMATED MATERIAL TRANSFER AND STORAGE SYSTEM


UNIT III GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS

UNIT IV AUTOMATION SYSTEMS AND ADVANCED MANUFACTURING
TECHNIQUES

UNIT V CASE STUDIES

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
1. Understand various production planning processes, capacity planning, and shop floor planning processes
2. Understand the fundamentals of Automated assembly and part transferring systems.
3. Understand the concepts of Group Technology and Flexible manufacturing systems.
4. Understand about automation systems and advanced manufacturing techniques.
5. Apply the concepts of “computer aided production and automation” in various manufacturing industries.

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REFERENCES
COURSE OBJECTIVES
1. To introduce the students about basic concepts, practices, standard data, terminology and symbols for designing.
2. To learn the design procedures of shafts and couplings to withstand various loads.
3. To learn the design procedures of transmission components to transfer power and to withstand various loads.
4. To introduce the students about basic concepts of product development.
5. To learn the basic formulation of finite element analysis for various components.

UNIT I INTRODUCTION
Introduction to national and international symbols- Engineering materials and their physical properties and applied to design- Selection of materials- selection for new design and material considerations-Factors of safety in design- Dimensioning and detailing- Fitness and tolerance- Surface finish and machining symbols –Product development- Elementary concept of functional, aesthetic and form design- Principles of design optimization- Future trends- CAD.

UNIT II STATIC AND VARIABLE STRESSES
Static and variable loading in machine elements- Stress concentration- Goodmen and soderberg method of design- Design of power transmission shafts- Subjected to torsion, bending and axial loads- Design of close coiled helical spring -Design of couplings- Muff, Flange, Bushed and pin types.

UNIT III DESIGN OF TRANSMISSION ELEMENTS

UNIT IV PRODUCT DESIGN AND DEVELOPMENT
Quality function development (QFD) - product design and specification, design for manufacturability (DFM), design for assembly and disassembly, human factors in design ergonomics, creativity in design, TRIZ- axiomatic design.

UNIT V FINITE ELEMENT ANALYSIS
Basic Concept of FEA - finite element analysis of one dimensional and two dimensional problems- variational formulation of B.V.P. – Ritz Method-Examples related to one-dimensional and two-dimensional problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students can able to
1. Understand the basic concepts, practices, standard data, terminology and symbols for designing.
2. Create the shafts and couplings for given various types of loads.
3. Create the transmission components to transfer given power and to withstand various types of loads.
4. Understand the basics concepts of product development.
5. Analyze and formulate finite element equations for some general machine components.
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MR4005
MULTI-BODY DYNAMICS
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COURSE OBJECTIVES
1. To understand the important concepts of multi-body dynamics.
2. To familiar the various computational methods multi-body dynamics.
3. To characterize the nonlinear concepts of multi-body dynamics.
4. To recognize the need of control in nonlinear dynamics multi body interactions.
5. To interpret the nonlinear dynamics of multi body systems and its realization of control.

UNIT I  INTRODUCTION TO DYNAMICS

UNIT II  COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS
UNIT III  NONLINEAR SYSTEMS AND CONCEPTS

UNIT IV  SYSTEM CHARACTERIZATION

UNIT V  CONTROL OF NONLINEAR MECHANICAL SYSTEMS

TOTAL: 45 PERIODS

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

CO1: Apply the important concepts in multi-body dynamics.
CO2: Create mathematical model for capturing the dynamics of multi-body interactions.
CO3: Understand the nonlinear behaviour of multi-body dynamics.
CO4: Evaluate the control in nonlinear dynamics of multi body interactions.
CO5: Apply control for the nonlinear behaviour of multi body systems.

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COURSE OBJECTIVES
1. To understand the basics of single board computers.
2. To learn about real-time operating system.
3. To get knowledge on python programming basics.
4. To learn to embed python in various hardware.
5. To learn various case studies of python and onboard computers.

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to:
1. Understand the basics of single board computers.
2. Understand about real-time operating system.
3. Understand basics of python programming.
4. Apply python programming concepts in various hardware.
5. Apply python programming and onboard computer concepts in various systems.

REFERENCES
4. NInad Sathaye, Learning python application development, Packt publishing, 2016
MR4007 MICRO AND NANO SYSTEMS  

COURSE OBJECTIVES:  
1. To introduce to microsystem of MEMS, material and fabrication technique  
2. To provide overview of characterization tools for MEMS  
3. To create awareness about principles and applications of various sensors  
4. To impart knowledge on different kind of Micro-Nano actuators  
5. To introduce Bio MEMS, Microfluidic and Nano position system  

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

Requirement for Micro Actuators - Nano Positioners, Micro Mechanical Testing Apparatus -
Classification of Micro Actuator - Electrostatic Distributed Actuator- Force Distance various Actuators--
Inch Worm, Zipper and Scratch Drive. Thermal Actuation-Bimorph-Buckle Beam -Frequency and Force
Characteristics and Advantages -Electro thermal Actuator - Electro Thermal Relay with Mechanical
Latch – Force vs Displacement Curve - Piezoelectric Actuation Advantages - MEMS Switch -Thin Film
Bulk Acoustic Resonator (FBAR) - Magnetic Actuation - External Magnetic Field Actuators & Issues -
Variable Reluctance Actuators - Shape Memory Actuators - Micro Pump and Micro Fluidics.

UNIT V  MICRO AND NANO SYSTEM

Micro Fluidic Systems - Micro Engine Driven by Electrostatically Actuated Comb Drive – Micro Robots
and Nano position Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1. Understand material and fabrication involved in Microsystems.
CO2. Explain techniques to visualize and measure geometrical features of MEMS system and
chemical composition.
CO3. Select a type of sensors based on application with working knowledge and principles.
CO4. Select a type of factor based on application with knowledge of working principle.
CO5. Discuss on Micro fluidic, Bio MEMS and Nano position systems.

REFERENCES:

Delhi, 2007.

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COURSE OBJECTIVES

- To recall the fundamentals of PID control and familiar various performance measures used in control systems.
- To interpret the single loop control and its tuning.
- To model, analyse the system in state space and its observer design in detail.
- To familiar the nonlinear control system and its concepts.
- To learn the functions and used of various control methodology.

UNIT - I  CONTROLLER AND PERFORMANCE MEASURES  9

UNIT- II  ENHANCEMENT TO SINGLE LOOP CONTROL  8

UNIT - III  STATE SPACE ANALYSIS  10

UNIT – IV  NONLINEAR SYSTEMS AND CONTROL  10

UNIT - V  OTHER CONTROL METHODS  8

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Develop the PID control and capable to analyze performances of the control systems.
CO2: Know the functions of various types of single loop control and its tuning.
CO3: Examine the system in state space and its observer design in detail.
CO4: Approach the nonlinear control system and its concepts.
CO5: Recognize the uses of various control methodology.

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REFERENCES:

MR4009 BIOMECHATRONICS

COURSE OBJECTIVES
- To familiarize the fundamentals of biomechanics.
- To characterize and relate the behaviours of skeletal and muscular systems for engineering solutions.
- To understand the servomechanism of biological systems.
- To design artificial structural elements for replacements.
- To simulate and develop the applications of bio-mechatronics.

UNIT- I  BIOMECHANICS  9

UNIT- II  MECHANICS IN SKELETAL AND MUSCULAR SYSTEM  9

UNIT- III  CONTROL MECHANISM OF BIOLOGICAL SYSTEMS  9
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 BIOMECHANTRONICS


TOTAL: 45 PERIODS

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

CO1: Know the fundamentals of biomechanics.
CO2: Describe and relate the behaviours of skeletal and muscular systems
CO3: Realize the servomechanism of biological systems for bio mechatronics development.
CO4: Design the artificial bio Mehatronics systems.
CO5: Establish and develop the applications of bio mechatronics.

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REFERENCES
COURSE OBJECTIVES:
1. To understand electrical actuator steady state operation and transient dynamics of a motor load system.
2. To learn the operation and construction of solid-state switching devices.
3. To study the operation of various D.C Motor drives and to select appropriate drive for speed and position control.
4. To study the operation of various A.C Motor drives and to select appropriate drive for speed control.
5. To study the operation of various Special Motor drives.

UNIT I  ELECTRICAL ACUATORS AND DRIVE CHARACTERISTICS

UNIT II  SOLID STATE SWITCHING DEVICES
Solid State Relay - Switching Characteristics - Bipolar Junction Transistor (BJT), Metal Oxide Semiconductor - Field Effect Transistor Silicon Controlled Rectifier (SCR) - DIAC- TRIAC- Gate Turn-Off Thyristor (GTO) – Insulated Gate Bipolar Transistor (IGBT) - Classification of PWM Techniques.

UNIT III  D.C. MOTOR DRIVES

UNIT IV  A.C. MOTOR DRIVES

UNIT V  SPECIAL ELECTRICAL MOTOR DRIVES

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of this course, the students will be able to:
 CO1. Understand electrical actuator steady state operation and transient dynamics of a motor load system.
 CO2. Select suitable solid-state switching devices.
 CO3. Identify and apply appropriate drive for speed and position control for various D.C Motors.
 CO4. Identify and apply appropriate drive for speed control for various A.C Motors.
 CO5. Select suitable drives for special motors
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MR4011 AUTOMOTIVE ELECTRONICS  L T P C
3 0 0 3

OBJECTIVES:
- To impart knowledge to the students in the principles of operation and constructional details of various Automotive Electrical and Electronic Systems
- To understand the need for starter batteries, starter motor and alternator in the vehicle.
- To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols
- To list common types of sensor and actuators used in vehicles.
- To understand dash – Board Instruments, various sensors and networking in vehicles.

UNIT I  FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS  9
Components for an electronic engine management system, open and closed-loop control strategies, PID control, Lookup tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

UNIT II  ELECTRONIC SENSORS IN AUTOMOBILE  9
Throttle position, mass air flow, crankshaft position, cam position, engine speed sensor, exhaust oxygen level (two step, linear lambda and wideband), knock, manifold temperature, and pressure sensors. Solenoid, relay (four and five pins), stepper motor

UNIT III  ELECTRONIC COMPONENTS FOR ENGINE CONTROL  9
Cold start and warm-up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop and closed-loop control – Integrated engine control system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dashboard instruments – Onboard diagnosis system.
UNIT IV  ELECTRONIC COMPONENTS FOR IGNITION AND INJECTION SYSTEMS

UNIT V  MICROPROCESSOR IN AUTOMOBILES
Microprocessor and Microcomputer controlled devices in automobiles such as instrument clusters, Voice warning systems, Travel information systems, and Keyless entry system. Environmental requirements (vibration, Temperature, and EMI).

OUTCOMES:
At the end of this course the student should be able to
- Explain the fundamentals, operation, function of various sensors and actuators in engine management systems.
- Define the glossary related to vehicle electrical and electronic system
- Understand the need for starter batteries, starter motor, and alternator in the vehicle.
- Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control units using different communication protocols
- List common types of sensors and actuators used in vehicles.
- Understand networking in vehicles.

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REFERENCES:
MR4012 UNMANNED AERIAL VEHICLE

COURSE OBJECTIVES:
1. To understand the basic concepts of UAVs.
2. To learn and understand the various components of UAVs.
3. To familiarize the basic concepts of flights.
4. To impart knowledge on maintenance of drone equipment.
5. To understand the various regulatories and regulations.

UNIT I INTRODUCTION TO UNMANNED AERIAL VEHICLES (UAV) 9
Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas. Operational considerations like liability / legal issues, ethical implications LOS / BLOS

UNIT II UNMANNED AERIAL SYSTEM (UAS) COMPONENTS 9

UNIT III BASIC CONCEPTS OF FLIGHT 9

UNIT IV DRONE EQUIPMENT MAINTENANCE 9
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.

UNIT V REGULATORY AND REGULATIONS 9
Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of this course, the students will be able to:
CO1. Understand and familiarize the basic concepts on UAVs
CO2. Select and choose the components of UAV
CO3. Understand the basic concepts of flight
CO4. To maintain the drone equipment.
CO5. To understand various regulatories and regulations.

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REFERENCES:

MR4013 INTELLIGENT PRODUCT DESIGN L T P C

COURSE OBJECTIVES:
1. To understand the basics of intelligent design and manufacturing.
2. To learn and understand the knowledge representation techniques.
3. To learn and understand the intelligent product modelling techniques.
4. To demonstrate the applications of neural networks.
5. To study the applications of internet based collaborative CAD/CAM.

UNIT – I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING 9
Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

UNIT – II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9

UNIT – III INTELLIGENT PRODUCT MODELING TECHNIQUES 9
Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

UNIT – IV APPLICATION OF NEURAL NETWORKS 9
Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

UNIT – V INTERNET BASED COLLABORATIVE CAD/CAM 9
Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Identify and understand the intelligent design and manufacturing.
2. Familiarize the knowledge representation techniques.
3. Understand the various techniques in intelligent product modeling.
4. Demonstrate the applications of neural networks
5. Apply internet on collaborative CAD/CAM
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REFERENCES:

IL4073 HUMAN INDUSTRIAL SAFETY AND HYGIENE

OBJECTIVES:
- Identify and prevent operational hazard
- Categorize, analyze and interpret the accidents data based on various safety techniques.
- Use proper safety techniques on safety engineering and management.
- Design the system with environmental consciousness by implementing safety regulation
- Use safety management practices in Industries.

UNIT I OPERATIONAL SAFETY

UNIT II SAFETY APPRAISAL AND ANALYSIS
UNIT III  OCCUPATIONAL HEALTH

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV  SAFETY AND HEALTH REGULATIONS


UNIT V  SAFETY MANAGEMENT


TOTAL: 45 PERIODS

OUTCOMES:
CO1: Ability to Identify and prevent operational hazard
CO2: Ability to collect, analyze and interpret the accidents data based on various safety techniques.
CO3: Ability to apply proper safety techniques on safety engineering and management.
CO4: Ability to design the system with environmental consciousness by implementing safety regulation
CO5: Ability to apply safety management practices in Industries.

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MR4071 INTERNET OF THINGS FOR MANUFACTURING L T P C 3 0 0 3

COURSE OBJECTIVES:
1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT prototype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

UNIT I INTRODUCTION

UNIT II DESIGN OF IoT
Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT

UNIT IV PREREQUISITES FOR IoT
IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V APPLICATION IN MANUFACTURING
Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL: 45 PERIODS

COURSE OUTCOME:
On completion of the course, the students will be able to
CO1: Identify the Opportunities and challenges in IoT
CO2: Propose a suitable IoT design
CO3: Develop an optimized IoT prototype
CO4: Understand the various protocols used in IoT and Localization
CO5: Understand the applications of IoT in Manufacturing

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MR4014 COMMUNICATION PROTOCOLS

COURSE OBJECTIVES
1. To study the various types wired protocols for electronic system.
2. To know the various types wireless protocols for electronic system.
3. To aware the various industrial wired protocols in automation.
4. To study the various types wireless protocols for industrial automation.
5. To develop the wired and wireless functions of various protocols

UNIT – I WIRED BUSES AND PROTOCOLS

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
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Design wired protocols for electronic system.
2. Use wireless protocols for electronic system.
3. Practice industrial wired protocols in automation.
4. Select wireless protocols for industrial automation.
5. Demonstrate the wired and wireless functions of various protocols in application development.

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REFERENCES:

UNIT – I  BASIC CONCEPTS FOR COMPUTER VISION  9
UNIT – II  IMAGE FORMATION AND CAMERA CALIBRATION  9
Projective Geometry - Imaging through lenses and pin-hole – Basic Photometry – Basic model of imaging geometry – Ideal Camera – Camera with intrinsic parameters – Approximate camera models – Camera Calibration – Methods and Procedure

UNIT – III  SURFACE RECONSTRUCTION TECHNIQUES  9
Depth Perception in Humans, Cues – Shape from Texture, Shading, Focus, Defocus, Structured Light Reconstruction – Time of Flight Methods

UNIT – IV  COMPUTATIONAL STEREO AND MOTION  9

UNIT – V  ROBOT VISION  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Understand the basic concepts behind computer vision algorithms.
CO2: Understand various image formation and camera calibration techniques.
CO3: Understand various 3D surface reconstruction algorithms.
CO4: Understand stereo vision and structure from motion.
CO5: Apply the computer vision techniques to robots

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REFERENCES:

MR4016 MECHATRONICS IN AERO SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES
1. To learn about the aircraft system and its automation requirements.
2. To learn about various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. To learn various actuators and other mechanisms related to aircraft.
4. To understand the stability and control of an aircraft.
5. To learn about GPS and other navigation techniques used in aircraft.

UNIT – I OVERVIEW OF AIRCRAFT ENGINEERING

UNIT – II SENSORS AND MEASUREMENTS

UNIT – III MECHANISMS AND ACTUATORS

UNIT – IV STABILITY AND CONTROL
UNIT – V NAVIGATION

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
1. Understand the aircraft system and its automation requirements.
2. Understand various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
3. Understand various actuators and other mechanisms related to aircraft.
4. Understand the stability and control of an aircraft.
5. Understand GPS and other navigation techniques used in aircraft.

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REFERENCES:

MR4017 MEDICAL MECHATRONICS

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COURSE OBJECTIVES
1. To know the various types of human functional system and basic human functional measurement instrumentations.
2. To understand the mechatronic elements in various assisting and therapeutics equipment.
3. To realize the integrations of in cardiac and regulatory functions assist systems.
4. To acquire the architecture and functions of medical imaging equipment.
5. To introduce the sensory assist devices and automated analysed in medical field.
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 Non-invasive 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 – Anaesthesia 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 Haemodialysis, Membrane, Dialysate, Different Types of Haemodialysis,
Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT – IV  MEDICAL IMAGING 9
Radio Graphic and Fluoroscopic Techniques – XRAY Machine - Computer Tomography – MRI
– FMRI- Ultrasonography – Endoscopy – Colonoscopy -Thermography – Different Types of

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: 42 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Understand the uses of human functional measurement instrumentations.
CO2: Evaluate the mechatronic elements in various assisting and therapeutics equipment.
CO3: Apply the integrations of in cardiac and regulatory functions assist systems.
CO4: Understand the elements and functions of medical imaging equipment.
CO5: Evaluate the appropriate sensory assist devices and automated analysed in medical
field.

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REFERENCES:

MR4018 MOBILE ROBOTICS
L T P C
3 0 0 3

COURSE OBJECTIVES
1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT – I INTRODUCTION TO MOBILE ROBOTICS

UNIT – II KINEMATICS

UNIT – III PERCEPTION

UNIT – IV LOCALIZATION

TOTAL: 45 PERIODS

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

CO1: Evaluate the appropriate mobile robots for the desired application.

CO2: Create the kinematics for given wheeled and legged robot.

CO3: Analyse the sensors for the intelligence of mobile robotics.

CO4: Create the localization strategies and mapping technique for mobile robot.

CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

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COURSE OBJECTIVES
1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy.
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT – I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT
Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT – II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM

UNIT – III ENERGY SAVING MACHINERY AND COMPONENTS

UNIT – IV HAZARDOUS AND SOLID WASTE MANAGEMENT

UNIT – V GREEN CO-RATING

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Understand the Concepts of environmental sustainability and environmental impact assessment objectives
CO2: Apply suitable schemes towards design of green manufacturing requirements.
CO3: Analyze manufacturing processes towards conservation of energy.
CO4: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.
CO5: Acquire Knowledge of green co-rating and its benefits are well known to the students.
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REFERENCES:
5. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015

MR4019 HAPTICS AND AUGMENTED REALITY L T P C
3 0 0 3

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. Recognize the haptic technology and its concepts in various haptic systems.
CO2. Classify the elements of haptics system and tele-operation in detail.
CO3. Design and use the devices in human haptic applications.
CO4. Combine and build the virtual and augmented reality-based models.
CO5. Develop the design and model the hardware of mixed reality.

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REFERENCES:

MR4020 INDUSTRIAL INSTRUMENTATION AND CONTROL L T P C

3 0 0 3

COURSE OBJECTIVES
1. To understand the overview of the industrial automation and control.
2. To familiarize with data communication and supervisory control systems.
3. To learn and understand the basic concepts of factory automation.
4. To understand various control elements in industry.
5. To understand and select final control element for process control.

UNIT – I INDUSTRIAL INSTRUMENTATION

UNIT – II DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS

UNIT – III 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.

UNIT – IV CONTROL ELEMENTS

UNIT – V FINAL CONTROL ELEMENTS
I/P converter - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of ControlValves:- Inherent and Installed characteristics – Modeling of pneumatic control valve – Valve body:-Commercial valve bodies – Control valve sizing – Cavitation and flashing – Selection criteria.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Understand the concepts of industrial instrumentation.
2. Select and design a system with data communication and supervisory control.
3. Understand the concepts and layout of automation in factory.
4. Understand the various control elements in industry.
5. Evaluate and select control elements for the system design.

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REFERENCES:

MR4021 MODELING AND ANALYSIS OF ELECTRO-MECHANICAL SYSTEMS

COURSE OBJECTIVES
1. To equip students with fundamentals of finite element principles.
2. To enable them to understand the behavior of various finite elements and to be able to select appropriate elements to solve physical and engineering problems to emphasis on structural, thermal, Electrical and fluid engineering applications.
3. To make them to understand to shape functions and higher order formulation.
4. To learn various quantities in engineering problems and also make them to work on preprocessing, meshing, boundary condition assigning and post processing.
5. To make them to work on real time problem by giving various case studies and explore them to the FEM software available in the market.
UNIT – I  
FINITE ELEMENT MODELLING  

UNIT – II  
ONE DIMENSIONAL ANALYSIS  

UNIT – III  
SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS  

UNIT – IV  
ELECTROMECHANICAL SYSTEMS AND IMPLEMENTATION  

UNIT – V  
CASE STUDIES  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

**CO1:** Understand the fundamentals of finite element principles.

**CO2:** Evaluate and select appropriate elements to solve Physical and Engineering problem in structural, thermal, Electrical and fluid engineering applications.

**CO3:** Understand shape functions and higher order formulation.

**CO4:** Evaluate and select appropriate element, boundary condition, meshing and Post processing for any engineering problem.

**CO5:** create FEM model on various software packages used for FEM analysis tool to analyse a production process through FEA and control its parameters.

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REFERENCES:

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES
• Teach how to improve writing skills and level of readability
• Tell about what to write in each section
• Summarize the skills needed when writing a Title
• Infer the skills needed when writing the Conclusion
• Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

UNIT III TITLE WRITING SKILLS
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS
COURSE OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

AX4092 DISASTER MANAGEMENT L T P C 2 0 0 0

COURSE OBJECTIVES
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.
UNIT V RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

AX4093 CONSTITUTION OF INDIA

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional Role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950(Bare Act), Government Publication.

AX4094 சங்கித்திய லேச்சிக்கேம் 2000

UNIT I சங்கித்திய லேச்சிக்கேம்
1. சங்கித்திய லேச்சிக்கேம் - செய்தியுடைய செய்தி பார்வை
2. அகத்தாயின் (82)
3. செய்தியுடைய செய்தி பார்வை
4. பச்சுதோம் (95, 195)
UNIT II
அறநநறிக் கதை
1. அரங்கில் மத்திய சிற்றிருந்து
   - அமர் மாறிப்படுத்திய, அச்சு புகுவது, தண்டு அந்தல், நல்லது, புறம்
2. பெயர் அமர்ந்த தெளிவு
   - தந்தை, சிற்றரசமானது, சிற்றரசமானது, அனைத்துகளும் (அப்பாமல் தண்டுப்பக்கியது வந்த)

UNIT III
இரட்டக் காப்பனைகள்
1. காந்தரசின்பில் புரிந்த
   - கிளிம்பின் புருக்கு காலந்த
2. ருந்தவிகள் சிற்றிருப்பு பரவலாக
   - கிளி போன்ற அடிகரும்பமில்லாவாக

UNIT IV
அறநநறிக் கதை
1. சிற்றிருப்பு புரோந்தல்
   - பத்ரி புருந்துகைகள் பேர் வருவது, பொறு மறுகைகளின் போது வருவது
   - கூம்பிக்கேறிய, அம்பையான சல்லுவது தந்தைகளை வருவது
   - நல்லது பரவலாக
2. கோள் கோள்
   - அலங்கரிக்கிற புரிய திறப்ப
3. சிற்றிருப்பு (617, 618)
   - போர் போர் விளக்கம்
4. காப்பனைகளும் சிற்றிருப்பு கலங்கள்
5. புறநூறு
   - சிற்றிருப்பு வோர்பனைகள்
6. அகநூறு (4)
   - சிற்றிருப்பு
   - காப்பனை (11)
   - கோள் (11)
   - பெயர், புறம்
   - கோள் (50, 27)
   - மரக்
   - காப்பனை புரிந்து தந்தைகள்

UNIT V
இன்றான கதை சிற்றிருப்பு
1. இன்றான கதை
   - காப்பனை பேர் புரிந்த
   - காப்பனை பேர் சிற்றிருப்பு
   - காப்பனை பேர் கோள்
   - காப்பனை பேர் கோள்
   - பொருகு சிற்றிருப்பு
1. தமிழ் விங்கு விஷயம் கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia)
   - https://ta.wikipedia.org
3. தர்மபுர ஆதின தவளியீடு
4. வொழ்வியல் களஞ்சியம் - தமிழ் பல்கலைக்கழகம், தீவு என்னை
5. தமிழ்களஞ்சியம் - தமிழ் வளர்ச்சிசுற்றுக்கள் (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ் பல்கலைக்கழகம், தீவு என்னை

TOTAL: 30 PERIODS