# Gurugram University Gurugram

# Curriculum for UG Degree Course

# in

# ROBOTICS AND AUTOMATION

# (Engineering & Technology)

**Semester V**

| S. No. | Course Code | | Course Title | Hours per week | | | Credits | Marks for Sessional | Marks for End Term Examination | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1. | PCC | | Introduction to Robotics | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 2. | PCC | | Sensors And Instrumentation | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 3. | PCC | | CNC Machine and Metrology | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 4. | ESC | | Introduction of AI & Ml | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 5. | PCC | | Linear Integrated Circuits and Applications | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 6. | PE | | Professional Elective-I | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 7. | OE | | Open Elective -1 | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| 8. | LC | | Robotics Engineering _Lab (P) | **0** | **0** | **2** | **1** | **50** | **50** | **100** |
| 9. | LC | | PLC SCADA LAB | **0** | **0** | **2** | **1** | **50** | **50** | **100** |
| 10. | LC | | CNC Machine and Metrology LAB | **0** | **0** | **2** | **1** | **50** | **50** | **100** |
| 11. | PT | | Practical Training -I | 0 | 0 | 2 | 1 | 30 | 70 | 100* |
| **Total** | | | | **27** | | | **25** | **1000** | | |

**NOTE**:
1. The evaluation of Practical Training - I will be based on the seminar, viva voice, and report submitted by the students. According to performance, the students are awarded grades A, B, C, F. A student who is awarded an 'F' grade is required to repeat Practical Training. A Excellent ,B Good ,C Satisfactory ,F Not Satisfactory
2. Choose any one from Professional Elective Course -I and Choose any one from Open Elective Course-I

**Open Elective-I**

| Sr. No. | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Intellectual Property Rights | 3 |
| 2 | | Disaster Management | 3 |
| 3 | | English for Professionals | 3 |
| 4 | | Managing Innovation & Entrepreneurship | 3 |

**Professional Elective-I**

| Sr. No. | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Industrial Automation | 3 |
| 2 | | Maintenance and Safety Engineering | 3 |
| 3 | | Augmented Reality and Virtual Reality | 3 |
| 4 | | Mechatronics | 3 |

| Category | Professional Core Course | | | | |
|---|---|---|---|---|---|
| Course Title | Introduction to Robotics | | | | |
| Semester and Credits | L | T | P | Credits | Semester - V |
| | 3 | 0 | 0 | 0 | |
| Class Work | 50 Marks | | | | |
| Examination | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exams | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**OBJECTIVES**:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control

**UNIT I**

**Basics of Robotics**

Types and components of a robot, Classification of robots, closed-loop and open loop control systems.
Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

**Robot Kinematics and Dynamics**:

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics
Dynamic Modelling: Equations of motion: Euler-Lagrange formulation

**UNIT II**

**Sensors and Vision System:**

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Camera: camera Calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations
Vision applications in robotics

**UNIT III**

**Robotics Controls**

Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID – Non-linear and advanced controls

**UNIT IV**

**Interfacing and Integration**

Control Hardware and Interfacing Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

**COURSE OUTCOMES:**

CO1: Ability to understand basic concept of robotics.
CO2: To Integrate mechanical and electrical hardware for a real prototype of robotic device.
CO3:To know about the differential motion add statics in robotics
CO4:To know about the various types of Sensors.
CO5 : Design control laws for a robot
C06 : Develop the ability to mathematically model robotic systems

**TEXT BOOKS /REFERENCES:**

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

2. Ghosal, A., “Robotics”, Oxford, New Delhi, 2006.
3. Niku Saeed B., “Introduction to Robotics: Analysis, Systems, Applications”, PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., “Robotics and Control”, Tata McGraw Hill.
5. Mukherjee S., “Robotics and Automation”, Khanna Publishing House, Delhi.
6. Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson, New Delhi, 2009
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modelling and Control”, John Wiley and Sons Inc, 2005
8. Steve Heath, “Embedded System Design”, 2nd Edition, Newnes, Burlington, 2003
9. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, “Intelligent Mechatronic System: Modeling, Control and Diagnosis”,

**Sensors and Instrumentation**

| | | | | | |
|---|---|---|---|---|---|
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | **Sensors and Instrumentation** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester - V |
| | 3 | 0 | 0 | 0 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives**:

• To understand the concepts of measurement technology.
• To learn the various sensors used to measure various physical parameters.
• To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

**UNIT I**

**Basics of Measurement** ,Classification of errors, Error analysis ,Static and dynamic characteristics of transducers ,Performance measures of sensors , Classification of sensors , Sensor calibration techniques, Sensor Output Signal Types.

UNIT II

**Motion, Proximity And Ranging Sensors** : Motion Sensors Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT ,RVDT ,Synchro ,Microsyn, Accelerometer ,GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

**UNIT II**

**Force, Magnetic and Heading Sensors** :Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

**UNIT III**

**Optical, Pressure And Temperature Sensors:** Photo conductive cell, photo voltaic, Photo resistive, LDR ,Fiber optic sensors ,Pressure ,Diaphragm, Bellows, Piezoelectric ,Tactile sensors, Temperature IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors – Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

**Outcomes:**

CO 1:Upon Completion of the course the students will be able to
CO 2:Familiar with various calibration techniques and signal types for sensors.
CO 3:Apply the various sensors in the Automotive and Mechatronics applications
CO 4:Describe the working principle and characteristics of force, magnetic and heading sensors.
CO 5 :Understand the basic principles of various pressure and temperature, smart sensors.

**Text Books:**

1.Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009
2.Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES

1.C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2.Hans Kurt T.nshoff (Editor), Ichiro , "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3.John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4.Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.

**TEXT BOOKS:**


- .Ernest O Doebelin, "Measurement Systems–Applications and Design", Tata McGraw-Hill, 2009
- Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12thedition, Dhanpat Rai & Co, New Delhi, 2013.


**REFERENCES**


- C.Sujatha... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
- Hans Kurt Tönshoff (Editor), Ichiro , "Sensors in Manufacturing"Volume 1,Wiley-VCHApril 2001.
- John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
- Patranabis D, "Sensors and Transducers", 2ndEdition, PHI, New Delhi,

| | | | | | |
|---|---|---|---|---|---|
| **Code** | | | | | |
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | **CNC Machine and Metrology** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – V |
| | 3 | 0 | 0 | 0 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

***OBJECTIVES:***

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

UNIT I

INTRODUCTION TO CNC MACHINE TOOLS :Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways

UNIT II

DRIVES AND WORK HOLDING DEVICES :Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives – stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moire fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines

UNIT III

CNC PROGRAMMING Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc,generation of CNC codes from CAM packages.

UNIT IV

ADVANCES IN METROLOGY Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM –Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications

**Course Outcomes:**

Upon completion of this course the students can able to understand

CO1:Ability to know about the basic in CNC machineries

CO2:Evolution and principle of CNC machine tools and different measurement technologies

CO3:Able to write simple programs for CNC machinery

CO4:To impart knowledge about linear and angular measurements in metrology

CO5:Capable of manufacturing components according to given drawings using various machine tools

CO6:Ability to know about the advancement in metrology

**Text Books**:

1. "Mechatronics", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.
3. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.

4. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
REFERENCES:
1. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
2. Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.
3.Peter Smid, “CNC Programming Hand book”, Industrial Press Inc., 2000
4. Berry Leathan – Jones, “Introduction to Computer Numerical Control”, Pitman, London, 1987.

| | | | | | |
|---|---|---|---|---|---|
| **Code** | | | | | |
| **Category** | **Engineering Science Course** | | | | |
| **Course Title** | **INTRODUCTION OF AI & ML** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – V |
| | 3 | 0 | 0 | 0 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**COURSE OBJECTIVE:**

1. Understand the very basics and Uses of Artificial Intelligence (AI)
2. Understand the basics and uses of Machine Learning (ML)
3. To provide the most fundamental knowledge to the students so that they become familiar with basic principles of AI towards problem solving, inference, knowledge representation and learning
4. Understand the logic-building methods and inferences for the knowledge representation.
5. Explore application of AI techniques in Expert systems, Neural Networks.

**UNIT - I**

**Introduction to AI:** What is AI, Turing test, History of AI, Artificial Intelligence Techniques, advantages, and limitations of AI, Impact and Examples of AI

**Applications of AI by domain:** Transportation, home/service robots, healthcare, education, low-resource communities, public safety and security, employment and workplace, entertainment, finance, banking and insurance.

**Introduction to Machine Learning:** What is Machine Learning, History of Machine Learning, Machine Learning and Statistics, Types of Machine Learning – Supervised, Unsupervised, Semi-supervised, Reinforcement Learning,

**UNIT - II**

**Intelligent agent**, Nature of Agents, Rationality and Rational agent with performance measures Flexibility and Intelligent agents, Task environment and its properties, Types of agents, other aspects of agents;

**Multi-Agent Systems:** Agents and Objects; Agents and Expert Systems; Generic Structure of Multiagent System, Semantic Web, Agent Communication, Knowledge Sharing using Ontologies, Agent Development Tools.

**UNIT - III**

**Knowledge Representation schemes and reasoning:** Approaches and issues, procedural vs declarative knowledge, Matching, conflict resolution.

**Logic:** Propositional logic, predicate logic, Resolution, Resolution in proportional logic and predicate logic, Clause form, unification algorithm.

**Uncertain Knowledge and reasoning:** Methods, Bayesian probability and belief network, Probabilistic reasoning, Forward and backward reasoning, Other uncertain techniques-Data mining , Fuzzy logic, Dempster -shafer theory

**UNIT – IV**

**Planning:** The Planning problem, planning with state space search, partial order planning, planning graphs, planning with propositional logic, Analysis of planning approaches, Hierarchical planning, conditional planning, Continuous and Multi Agent planning.

**Learning:** Introduction to Learning, Types of Learning: Learning by Induction, Rote Learning, Symbol Based Learning, Identification Trees, Explanation Based Learning, Transformational Analogy, Introduction to Neural Networks, Expert Systems.

**Course Outcome**

CO1: Formulate a problem and build intelligent agents
CO2: Apply basic principles of AI in solutions that require problem solving, inference, knowledge representation and learning
CO3: Analyze the problem and infer new knowledge using suitable knowledge representation schemes
CO4: Develop planning and apply learning algorithms on real world problems
CO5: Design an expert system and implement advance techniques in Artificial Intelligence.
CO6: Create a real life and industrial problems related mini project.

**TEXT AND REFERENCE BOOKS:**


1. Artificial Intelligence 3e: A Modern Approach Paperback – By Stuart J Russell & Peter Norvig; Publisher – Pearson
2. Artificial Intelligence Third Edition by Kevin Knight, Elaine Rich, B. Nair – Mc Graw Hill
3. Artificial Intelligence Third Edition by Patrick Henry Winston – Addison-Wesley Publishing Company
4. Machine Learning using Pythons, U Dinesh Kumar, Manaranjan Pradhan, John Wiley & Sons.
5. A Classical Approach to Artificial Intelligence, M. C. Trivedi, Khanna Publishing House.
6. Machine Learning, V. K. Jain, Khanna Publishing House.
7. Advanced Data Analytics Using Python: With Machine Learning, Deep Learning, Sayan Mukhopadhyay, Apress.
8. Introduction to Machine Learning, Jeeva Jose, Khanna Publishing House.

**Linear Integrated Circuits and Applications**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | | | | | |
| Category | **Professional Core Courses** | | | | |
| Course title | **Linear Integrated Circuits and Applications** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester : V** |
| | **3** | **1** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 03Hrs | | | | |

**NOTE:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:
1. To understand the functioning of OP-AMP and design OP-AMP based circuits
2. To design and analyze waveform Generators.
3. To design sinusoidal and non-sinusoidal oscillators
4. To understand the concept of filters and regulators.

**UNIT I**

IC OP-AMP applications: OP-AMP Fundamentals (brief review of differential amplifier, current mirror, active load, level shifter, output stage; ac and dc characteristics) Basic building blocks using OP-AMPS. Inverting/Non-inverting VCVS, Integrators, Differentiators, CCVS and VCCS, Instrumentation Amplifiers- Applications of OPAMPS

**UNIT II**

Waveform Generator: Square wave generators: 555Timer, Crystal controlled Oscillator Ramp Generator: Triangle generator, Saw tooth generator Sine wave generator: Requirement for sinusoidal oscillations, Wien-bridge and twin-T oscillators. Function Generators: Multi op-amp function generators, IC function generators Digitally controlled frequency synthesizer: PLL Fundamentals, PLL synthesizer, Totally digital synthesizer- Applications of

**UNIT III**

Active Filters: Introduction to filtering: Frequency response, Characteristics and terminology, Active versus passive filters Low pass filter: First order low pass active filter, second order active filter model, second order low pass filter characteristics, Sallen-Key unity gain filter, Sallen-Key equal component filter, Higher order filters. High pass active filter. Band pass filter: single op-amp band pass filter, multistage band pass filter State variable filter- - Applications of filters

**UNIT IV**

Non-linear Circuits: Logarithmic Amplifiers, Log/Antilog Modules, Precision Rectifier, Peak Detector, Sample and Hold Circuits. OP-AMP as Comparator,Schmitt Trigger, Square and Triangular Wave Generator, Monostable Multivibrator. IC Analog Multiplier applications OTA

Voltage Regulators: OP-AMP Regulators, IC Regulators, Fixed Voltage Regulators (78/79, XX), SMPS.- - Applications of Amplifiers and Regulators

**Course Outcomes:** At the end of this course, students will demonstrate the ability to:
1. Design, analysis, simulations, and testing of analog circuits,
2. Analog electronics, with focus on integrated circuit design
3. DC biasing, op-amp Cadence for Simulation Labs and Homework problems.
4. Understand filters and related terminology.
5. Concept of voltage regulators, SMPS
6.Different form of waves and how they generated.

**Text Book:**

1. Sedra and Smith, Microelectronic Circuits", Oxford University press, 5th Edition, 2005.
2. J. Michael Jacob, Applications and design with Analog Integrated Circuits", PHI, 2nd Edition, 2004.

**Reference Book :**

B.P. Singh and Rekha Singh, Electronic Devices an Integrated Circuits; Pearson Education, 1st Edition 2006.

| Category | Professional Core Course | | | | |
|---|---|---|---|---|---|
| Course Title | Robotics Engineering Laboratory | | | | |
| Semester and Credits | L | T | P | Credits | Semester – V |
| | 0 | 0 | 2 | 1 | |
| Class Work | 50 Marks | | | | |
| Examination | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exams | 03 Hours | | | | |

**Notes:**

(i) At least 10 experiments are to be performed by students in the semester.

(ii) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus

**Course Objective:**

- Introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations.

**LIST OF EXPERIMENTS**

1.Study components of a real robot and its DH parameters.

2.Forward kinematics and validate using a software (Robo Analyser or any other free software tool).

3.Inverse kinematics of the real robot and validation using any software3.Estimation of accuracy, repeatability and resolution.

4.Robot programming and simulation for pick and place

5.Robot programming and simulation for Colour identification

6.Robot programming and simulation for Shape identification

7.Positioning and orientation of robot arm

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.

**Course Outcome**: Upon Completion of the course, the students will be able to:

CO1:Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots

CO2 : Understand the concept of maximum and minimum positions of links in a robotic system and the factors that determine them.

CO3:Analyze joint limits and workspace to identify the extreme positions of each link.

CO4 : Estimate accuracy, repeatability, and resolution of a robot.

CO5 : Evaluate and quantify the precision and performance of a robot in executing tasks, considering factors such as sensor accuracy and mechanical tolerances.

CO6: simulate robots for pick and place operations

| | | | | | |
|---|---|---|---|---|---|
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | CNC AND METROLOGY LABORATORY | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – V |
| | 0 | 0 | 2 | 1 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Notes:**

(i) At least 10 experiments are to be performed by students in the semester.

(ii) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as COUper the scope of the syllabus

**Course Objectives**:

To impart knowledge in CNC programming for turning and milling operations

To use measuring systems for the geometrical measurements of gears and threads.

To know the measurement of Taper Angle using Sine Bar

**List Of Experiments**:

1. Study of the CNC machine
2. Programming and simulation of a lathe using any CAM package
3. Programming and simulation of a machining centre using any CAM package
4. Programming and operation of a CNC Lathe
5. Programming and operation of a CNC machining centre
6. Measurement of Taper Angle using Sine Bar
7. Optical profile projector–study of profile of gear tooth, screw threads.
8. Tool maker's microscope–to study cutting tool geometry, screw threads.
9. Tool wear and surface finish measurement.
10. Dimensional measurement of machined components using, bore gauge, air gauge and Height master

**Course Outcome**

- Ability to understand the features and operation of CNC machines.
- Ability to prepare CNC program from the component drawings
- Understanding the usage of profile projectors and tool makers microscopes
- Able to write simple programs for CNC machinery
- To impart knowledge about linear and angular measurements in metrology
- Capable of manufacturing components according to given drawings using various machine tools

| | | | | | |
|---|---|---|---|---|---|
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | **PLC SCADA LAB (P)** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – V |
| | 0 | 0 | 2 | 1 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Course Objectives:**

- To know about the basics of PLC and Automation
- To understand the importance of Automation
- To get practical knowledge of industrial automation PLCs.
- To learn about type of programming languages of PLC and some exercise few programs

**List of Experiments:**

1. Study of various logic Execution in ladder diagram.
2. Interfacing of Lamp & button with PLC for ON&OFF Operation. Verify all logic gates.
3. PLC based thermal ON/OFF Controller.
4. Develop ladder logic to develop MUX and DE-MUX
5. Combination of counter &timer for lamp ON/OFF Operation.
6. Study& implement ON delay timer in PLC
7. Study& implement OFF delay timer in PLC
8. To study & implement of counter in PLC programming. counter-up
9. To study& implement of counter in PLC programming. counter-down
10. PLC based temperature sensing using RTD
11. Parameter reading of PLC in SCADA
12. Temperature sensing using SCADA

**Course Outcomes:**

Students will be able to understand:

- CO1: Develop the logical instructions involved in Development of programmable logic controller for various operations
- CO2: Construct the Ladder Logic for various operation using PLC and SCADA for industrial Environment.
- CO3: Design the SCADA System for industrial Environment.

**Note:**

1. At least Ten experiments are to be performed in the semester.

PROGRAM ELECTIVE - 1

## INDUSTRIAL AUTOMATION

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | | | | | |
| **Category** | **Professional Elective Course** | | | | |
| **Course title** | INDUSTRIAL AUTOMATION | | | | |
| **Scheme and Credits** | **L** | **T** | **P** | **Credits** | **Semester: V** |
| | **3** | **0** | **0** | **3** | |
| **Classwork** | **30 Marks** | | | | |
| **Exam** | **70 Marks** | | | | |
| **Total** | **100 Marks** | | | | |
| **Duration of Exam** | **03 Hours** | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

OBJECTIVES:

- To understand the construction, operation and installation of PLCs.
- To provide the knowledge on interfacing the PLCs and field devices with communication protocols.
- To understand the concepts of DCS and SCADA systems

UNIT I

**Industrial Automation**

Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture – IEC61131-3 programming standard and types - Basics of PLC Programming – Ladder Logic Diagrams – Communication in PLC – Programming Timers and Counters – Data Handling - PLC modules – Advanced motion controlled Multi Axis PLC

UNIT II

**Applications of PLC**

Timer instructions – On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Motor start and stop, Simple materials handling applications, Automatic water level controller, Automatic lubrication of supplier Conveyor belt, Automatic car washing machine, Bottle label detection and process control application

UNIT III

**Scada System and Architecture**

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries – SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA/HMI Systems Various SCADA architectures, advantages and disadvantages of each system

UNIT IV

**Industrial Process Control**

Study of Advanced Process control blocks: Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control, PID Control.

Course Outcome.

- CO1 Choose appropriate PLC and explain the architecture, installation procedures and trouble shooting.
- CO2 Develop PLC programs using various functions of PLCs for a given application.
- CO3 Explain the application development procedures in SCADA and manage data, alarm and storage.
- CO4 Distinguish DCS, SCADA and PLC and explain the architecture of DCS
- CO5 Describe the controller elements and program methods

.

**TEXT BOOKS:**

- Gary Dunning, Introduction to Programmable Logic Controllers,3rd India edition, Cengage Learning, 2007
- John Webb, Programmable Logic Controllers: Principles and Applications,5th edition Prentice Hall of India, 2012.
- Krishna Kant Computer Based Process Control, Prentice Hall of India, 2004.
- Michael P. Lukas, Distributed Control Systems: Their Evaluation and Design, Van Nostrand Reinhold Co., 1986

**REFERENCES:**


1. B. G. Liptak Instrument Engineers Handbook – Process Software and Digital Network, 3rd edition, CRC Press,2002.
2. Jose A. Romagnoli, Ahmet Palazoglu, Introduction to Process control, CRC Taylor and Francisgroup, 2005.
3. Richard Cox, Programmable Controllers, Delmer Thomson learning, 2001.
4. Richard Zurawski, Industrial Communication Technology Handbook 2nd edition, CRC Press, 2015.
5. William T. Shaw, Cybersecurity for SCADA systems, Penn Well Books, 2006


| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Course title | **Maintenance and Safety Engineering** | | | | |
| Category | **Professional Elective - I** | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester V |
| | 3 | 0 | 0 | 3 | |
| **Marks for Sessional** | 30 Marks | | | | |
| Marks for End term Examination | 70 Marks | | | | |
| Total | 100 Marks | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. To impart knowledge in maintenance
2. To know about the fundamentals of maintenance and to implement it.
3. To study about safety engineering practices.
4. To analyze the hazards in protection.
5. To know about the safety in machine operation.

**UNIT-I**

**Maintenance:** Types – breakdown, preventive, predictive, TPM; elements of preventive maintenance – checklist, schedule, procedure

**Total Productive Maintenance:**

Principles; preparatory stages of implementation – TPM organization structure, creation; basic TPM policies and aids, master plan.

**UNIT-II**

**Safety Systems Analysis**:

Definitions, safety systems; safety information system: basic concept, safety cost / benefit analysis; industrial safety engineering, OSHA regulations.

**UNIT-III**

**Hazard analysis:**

General hazard analysis: electrical, physical and chemical hazard, detailed hazard analysis. Cost effectiveness in hazard elimination. Logical analysis: map method, tabular method, fault tree analysis and hazop studies.

**Fire Protection System**: Chemistry of fire, water sprinkler, fire hydrant, alarm and detection system. Suppression system: CO2 system, foam system, Dry Chemical Powder (DCP) system, halon system, portable extinguisher.

**UNIT-IV**

**Safety in Machine Operation**: Design for safety, lock out system, work permit system, safety in use of power press, cranes. Safety in foundry, forging, welding, hot working and cold working, electroplating and boiler operation.

**Safety And Law**: Provisions in factory act for safety, explosive act, workmen compensation act, compensation calculation. Boiler act and pollution control act.

**Course Outcomes**:

**CO1:** Maintain the industry without any risk in its operation
**CO2:** Improve the production
**CO3**: Analyze the hazards in maintenance and to solve it.
**CO4**: Identify and prevent chemical, environmental mechanical, fire hazard through analysis
**CO5:** Apply proper safety techniques on safety engineering and managemen.

**Text Books**:

1. John Ridley, "Safety at Work", Butter Worth Publisher, Oxford, 1997.
2. Robinson C J and Ginder A P, "Implementing TPM", Productivity Press, USA, 1995

**REFERENCES:**

1. Dhillon B S, "Maintainability, Maintenance and Reliability for Engineers", CRC Press, 2006.
2. Heinrich H W, "Industrial Accident Prevention", National Safety Council, Chicago, 1998.
3. National Safety Council, "Personal Protective Equipment", Bombay, 1998.
4. National Safety Council, "Accident Prevention Manual for Industrial Operations", Chicago, 1995.
5. Patrick A Michaud, "Accident Prevention and OSHA Compliance", CRC Press, 1995.
6. Derek James, "Fire Prevention Handbook", Butter Worth & Co., Oxford, 1991.

7. Dan Peterson, “Techniques of Safety Management”, 1990.

## AUGMENTED REALITY AND VIRTUAL REALITY

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | | | | | |
| **Category** | **Professional Elective Course** | | | | |
| **Course title** | AUGMENTED REALITY ***AND VIRTUAL REALITY*** | | | | |
| **Scheme and Credits** | **L** | **T** | **P** | **Credits** | **Semester: V** |
| | **3** | **0** | **0** | **3** | |
| **Classwork** | **30 Marks** | | | | |
| **Exam** | **70 Marks** | | | | |
| **Total** | **100 Marks** | | | | |
| **Duration of Exam** | **03 Hours** | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Objective**

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and Augmented Reality and its applications

UNIT I

**Introduction to Augmented Reality**

Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality. Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

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UNIT II

**Augmented Reality hardware**

**Displays –** Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model.

**Processors** – Role of Processors, Processor System Architecture, Processor Specifications.

**Tracking & Sensors** - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion

UNIT III

**Introduction to Virtual Reality**

Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark ,3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, The perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image. Realism-Stereographic image

UNIT IV

**Geometric Modelling**

Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation
Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection
Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems

COURSE OUTCOME

CO1: Description of AR system working and its applications
CO2: Understand and analyse the hardware requirement of AR
CO3: Develop Virtual Reality applications
CO4: Understand geometric modelling and Virtual environment
CO5:. Design and development of VR applications

*LIST OF SUGGESTED TEXT BOOKS*


*1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.*
*2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.*
*3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.*
*4. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.*
*5. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.*
*6. www.vresources.org*
*7. www.vrac.iastate.edu*
*8. www.w3.org/MarkUp/VRM*
9. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
10. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

| | | | | | |
|---|---|---|---|---|---|
| Code | | | | | |
| Course title | Mechatronics | | | | |
| Category | **PEC** | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester V |
| | 3 | 1 | 0 | 3 | |
| **Marks for Sessional** | 30 Marks | | | | |
| Marks for End term Examination | 70 Marks | | | | |
| Total | 100 Marks | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

To Introduce the basics of microprocessors and microcontrollers technology and related applications. Study of the architectural details and programming of 16 bit 8085 microprocessor and its interfacing with various peripheral ICs; Study of architecture and programming of 8051 processor.

**UNIT-I**

Mechatronics system design: Introduction, integrated design issues in mechatronics, key elements, the mechatronics design process, advanced approaches in mechatronics Modelling and simulation of physical systems: simulation and block diagrams, analogies and impedance diagrams, electrical systems, mechanical translational systems, mechanical rotational systems, electro mechanical coupling, fluid systems

**UNIT-II**

Sensors and transducers: An introduction to sensors and transducers, sensors for motion and position measurement, force, torque and tactile sensors, flow sensors, temperature-sensing devices Actuating devices: DC and AC drives – servo motors and stepper motor – hydraulic and pneumatic drives – piezoelectric and magnetostrictive actuators – micro actuators.

**UNIT-III**

Microcontroller programming: Microcontrollers, The PIC16F84 microcontroller, programming PIC, PicBasic programming fundamentals, examples, Use of Interrupts

**UNIT-IV**

Signals, systems and controls: Introduction to signals, systems and controls, system representation, linearization of nonlinear systems, time delays Real time interfacing: Introduction, elements of a data acquisition and control system, overview of the I/O process, installation of the I/O card and software.

**UNIT-V**

Advanced applications in mechatronics: Sensors for condition monitoring, mechatronic control in automated manufacturing, artificial intelligence in mechatronics, micro sensors in mechatronics.

**Course Outcomes:**

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

CO1: Develop a simulation model for simple physical systems and explain mechatronics design process

CO2: Outline appropriate sensors and actuators for an engineering application

CO3: Write simple microcontroller programs.

CO4: Explain linearization of nonlinear systems and elements of data acquisition.

CO5: Explain various applications of design of mechatronic systems.

CO6: Analyze and evaluate the integration of mechanical, electrical, and software components in mechatronic system design

**TEXT BOOK:**

1. Bolton W., "*Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering*", 3e, Pearson Education Press, 2005.

**REFERENCES:**

1. Histand B.H. and Alciatore D.G., "*Introduction to Mechatronics and Measurement Systems*", 3rd edition ,Tata McGraw Hill Publishing Company Ltd, 2007.
2. R.K. Rajput, "*A text book of Mechatronics*", 1st edition, S. Chand and Company Ltd., 2007.

## PRACTICAL TRAINING - I

| | | | | | |
|---|---|---|---|---|---|
| Semester | V | | | | |
| Course code | | | | | |
| Category | Professional Core Courses | | | | |
| Course title | Practical Training - I | | | | |
| Scheme and Credits | L | T | P | Credits | |
| | 0 | 0 | 2 | 1 | |
| Classwork | 50 Marks | | | | |
| Exam | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 02 Hours | | | | |

**The evaluation of Practical Training - I will be based on the seminar, viva voice, and report submitted by the students. According to performance, the students are awarded grades A, B, C, F. A student who is awarded an 'F' grade is required to repeat Practical Training.**

| | |
|---|---|
| **A** | **Excellent** |
| **B** | **Good** |
| **C** | **Satisfactory** |
| **F** | **Not Satisfactory** |

**Semester VI**

| S. No. | Course Code | Course Title | Hours per week | | | Credits | Marks for Sessional | Marks for End Term Examination | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | | | |
| 1 | | Microprocessors and Microcontrollers | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 2 | | Automation System Design | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 3 | | Hydraulic & Pneumatics | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 4 | | Professional Elective -II | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 5 | | Professional Elective -III | 3 | 1 | 0 | 3 | 30 | 70 | 100 |
| 6 | | Open Elective - II | 3 | 0 | 0 | 2 | 30 | 70 | 100 |
| 7 | | Microprocessors And Microcontrollers Lab | 0 | 0 | 2 | 1 | 50 | 50 | 100 |
| 8 | | Hydraulic and Pneumatics_ Lab | 0 | 0 | 2 | 1 | 50 | 50 | 100 |
| 9 | | Project-I | 0 | 0 | 4 | 2 | 25 | 25 | 50 |
| 12 | | Economics for Engineers* | 0 | 0 | 2 | 0 | 30 | 70 | 100* |
| **TOTAL** | | | 26 | | | 21 | 900 | | |

**NOTE**:

**Economics for Engineers*: Non-credit mandatory course, students have to attain pass marks (40%)**
The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will be shown in the detailed marks certificate of the students.

**Choose any one from Professional Elective Course –II, Professional Elective -III and Choose any one from Open Elective Course-II**

**Open Elective-II**

| Sr. No | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Computer Network & Internet of Things | 3 |
| 2 | | Operations Research | 3 |
| 3 | | Biosensors | 3 |
| 4 | | Image Processing | 3 |
| 5 | | Information Theory and Coding | 3 |

**Professional Elective-II**

| Sr. No. | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Lean Manufacturing | 3 |
| 2 | | Software Engineering | 3 |
| 3 | | Solar Energy Engineering | 3 |
| 4 | | **Wireless sensor networks** | 3 |

**Professional Elective-III**

| Sr. No. | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Additive Manufacturing | 3 |
| 2 | | Neural Network and fuzzy system | 3 |
| 3 | | System Modelling And Simulation | 3 |
| 4 | | Industrial Robotics | 3 |

## MICROPROCESSORS AND MICROCONTROLLERS

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Professional Core Courses** | | | | |
| Course title | **Microprocessors and Microcontrollers** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **1** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:**
The objectives of this course.

1. To develop an in-depth understanding of the operation of microprocessors & microcontroller.
2. To master the assembly language programming using concepts like assembler directives, procedures, macros, software interrupts etc.
3. To create an exposure to basic peripherals, its programming and interfacing techniques.
4. To understand the concept of Interrupts and interfacing details of 8086 & microcontroller.

### Unit-I

THE 8086 MICROPROCESSOR
Introduction to 8086 — Microprocessor architecture — Addressing modes — Instruction set and assembler directives — Assembly language programming — Modular Programming — Linking and Relocation — Stacks — Procedures — Macros — Interrupts and interrupt service routines — Byte and String Manipulation.

### Unit-II

8086 SYSTEM BUS STRUCTURE
8086 signals — Basic configurations — System bus timing –System design using 8086 — I/O programming — Introduction to Multiprogramming — System Bus Structure — Multiprocessor configurations — Coprocessor, closely coupled and loosely Coupled configurations — Introduction to advanced processors.

### Unit-III

I/O INTERFACING
Memory Interfacing and I/O interfacing — Parallel communication interface — Serial communication interface — D/A and A/D Interface — Timer — Keyboard /display controller — Interrupt controller — DMA controller — Programming and applications Case studies: Traffic Light control, LED display, LCD display, Keyboard display interface and Alarm Controller.

### Unit-IV

MICROCONTROLLER

Architecture of 8051 — Special Function Registers (SFRs) — I/O Pins Ports and Circuits — Instruction set — Addressing modes — Assembly language programming.
INTERFACING MICROCONTROLLER
Programming 8051 Timers — Serial Port Programming — Interrupts Programming — LCD & Keyboard Interfacing — ADC, DAC & Sensor Interfacing — External Memory Interface- Stepper Motor and Waveform generation — Comparison of Microprocessor, Microcontroller, PIC and ARM processors

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

1. Understand the fundamentals of Microprocessors.
2. Understand the internal design of 8051 microcontroller along with the features and their programming.
3. Competent with the on-chip peripherals of microcontrollers.
4. Design different interfacing applications using microcontrollers and peripherals.
5. Demonstrate the limitations and strengths of different types of microcontrollers and their comparison.
6. Build systems using microcontrollers for real time applications.

**List of References:**


1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International, 2009.
2. Douglas Hall, "Microprocessor & Interfacing", 2nd Edition, TMH, 2006.
3. Muhammad A. Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly and C", 2nd Edition., PHI, 2012.
4. Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition., Cengage Learning Publication, 2007.
5. Ajit Pal, "Microcontrollers: Principals and Applications", 2nd Edition, PHI, 2011. 6. Datasheet of P89V51RD2

**Automation System Design**

| | | | | | |
|---|---|---|---|---|---|
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | **AUTOMATION SYSTEM DESIGN** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – VI |
| | 3 | 0 | 0 | 3 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective**

To know about the basic concepts in industrial automation
To design automated systems.
To know about transfer lines and automated assembly

**UNIT I**

**FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION**

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation

**UNIT II**

**TRANSFER LINES AND AUTOMATED ASSEMBLY**

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

**UNIT III**

**DESIGN OF MECHATRONIC SYSTEMS**

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

**UNIT IV**

**PROGRAMMABLE AUTOMATION**

Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.

**Course Outcome**

CO1:Knowledge of industrial automation by transfer lines and automated assembly lines.
CO2:Ability to design automated system Understanding of automated controls using pneumatic and hydraulic

systems
CO3:Ability to understand the electronic control systems in metal machining and other manufacturing processes.
CO4:To understand advancement in hydraulics and pneumatics systems.
CO5: Knowledge of Electrical and Electronic systems in automation of mechanical operations.
CO6: Understand design features of CNC systems.

**TEXT BOOKS:**

1.Mikell P Groover, "Automation Production Systems and Computer-Integrated Manufacturing" Pearson Education, New Delhi, 2001.
2.Bolton W, "Mechatronics", Pearson Education, 1999.

**REFERENCES:**

1.Mikell P Groover, "Industrial Robots–Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000
2.Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3.Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011

**Hydraulic & Pneumatics**

| | | | | | |
|---|---|---|---|---|---|
| **Category** | **Professional Core Course** | | | | |
| **Course Title** | **Hydraulic & Pneumatics** | | | | |
| **Semester and Credits** | L | T | P | Credits | Semester – VI |
| | 3 | 0 | 0 | 3 | |
| **Class Work** | 50 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exams** | 03 Hours | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective**

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Unit-I

**Fluid Power Principles and Fundamentals and Hydraulic motors**

Introduction to fluid power, Advantages and applications, Fluid power systems, Types and Properties of Hydraulic fluids, Basics of hydraulics, Principles of flow, Work, Power and Torque, Reynolds number, Influence of temperature on viscosity, High water based fluid, Fluid preparation, Common fire resistant fluid, Biodegradable oils. Vane Motor, Gear Motor, Piston motor, Selection of hydro motor, Hydraulic or electrical motor, Hydraulic motor in circuits, Types of hydraulic transmission, Pump motor combination, Open loop and close loop system, Application of hydrostatic transmission

Unit II

**Hydraulic Linear Actuators**

Hydraulic cylinder, Construction of cylinders, Seals in cylinders, Cylinder reliability, Cylinder force, Acceleration and losses, Calculation of cylinder forces, Flow velocity, Cylinder efficiency, Sizing of cylinder tubes, Piston rod design, Mounting style of cylinders, Cushioning of hydraulic cylinder, Hydraulic cylinder and their characteristic application.

Unit III

**Hydraulic Circuits**

Hydraulic circuits, Manual or Automatic Hydraulic systems, Regenerative circuits, Use of check Valve in hydraulic circuits, Standards in circuit diagram representation, Speed variation in cylinder motion, Some basic circuits, Functional diagram, Application of functional diagram, Electrical control of hydraulic system.

UNIT IV

**Hydro Pneumatic**

Compressibility, Solution, Types of hydro Pneumatic systems, Hydraulic check unit, Hydro pneumatic cylinder, Parallel check unit, Integral air oil cylinder, Types of feed, Intensifier, Comparison of Hydro pneumatic, Hydraulic and pneumatic system. Maintenance need of Pneumatic systems, Common problems in Pneumatic system,

Maintenance schedule of Pneumatic system

OUTCOMES: Upon the completion of this course the students will be able to
CO1 Explain the Fluid power and operation of different types of pumps.
CO2 Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CO3 Explain the different types of Hydraulic circuits and systems
CO4 Explain the working of different pneumatic circuits and systems
CO5 Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems
.

**Suggested Books:**


1. S.R. Majumdar, **Oil Hydraulic Systems-Principles and Maintenance**, Tata McGraw Hill.
2. S.R. Majumdar, **Pneumatic Systems-Principles and Maintenance**, Tata McGraw Hill.
3. Farel Bradbury, **Hydraulic Systems and Maintenance,** Butterworth & Co (Publishers) Ltd.
4. R. Srinivasan, **Hydraulic and Pneumatic Controls**, Vijay Nicole.
5. Anthony Esposito, **Fluid Power with Applications**, PHI/Pearson Education.

## MICROPROCESSORS & MICROCONTROLLERS LABORATORY

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Professional Core Courses** | | | | |
| Course title | **Microprocessors & Microcontrollers Laboratory** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **0** | **0** | **2** | **1** | |
| Class Work | 50 Marks | | | | |
| Exam | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3Hrs | | | | |

Notes:

(i) At least 10 experiments are to be performed by students in the semester.

(ii) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus.

(iii) Group of students for practical should be 15 to 20 in number.

List of Experiments:

1. Write a program using 8085 and verify for:
   a) Addition of two 8-bit numbers.
   b) Addition of two 8-bit numbers (with carry).
2. Write a program using 8085 and verify for:
   a) 8-bit subtraction (display borrow)
   b) 16-bit subtraction (display borrow)
3. Write a program using 8085 for multiplication of two 8- bit numbers by repeated addition method. Check for minimum number of additions and test for typical data.
4. Write a program using 8085 for multiplication of two 8- bit numbers by bit rotation method and verify.
5. Write a program using 8086 for finding the square root of a given number and verify.
6. Write a program using 8086 for copying 12 bytes of data from source to destination and verify.
7. Write a program using 8086 and verify for:
   a) Finding the largest number from an array.
   b) Finding the smallest number from an array.
8. Write a program using 8086 for arranging an array of numbers in descending order and verify.
9. Write a program using 8086 for arranging an array of numbers in ascending order and verify.
10. Write a program to interface a two-digit number using seven-segment LEDs. Use 8085/8086 microprocessor and 8255 PPI.
11. Write a program to control the operation of stepper motor using 8085/8086 microprocessor and 8255 PPI.
12. To study implementation & interfacing of Display devices Like LCD, LED Bar graph & seven segment display with Microcontroller 8051/AT89C51
13. To study implementation & interfacing of Different motors like stepper motor, DC motor & servo Motors.
14. Write an ALP for temperature & pressure measurement
15. Write a program to interface a graphical LCD with 89C51

Note:

1. Each laboratory group shall not be more than about 20 students.
2. To allow fair opportunity of practical hands-on experience to each student, each experiment may either done by each student individually or in group of not more than 3-4 students. Larger groups be strictly discouraged/disallowed.

Lab Outcomes:

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

1. Understand the fundamentals of Microprocessors.
2. Understand the internal design of 8051 microcontroller along with the features and their programming.
3. Competent with the on-chip peripherals of microcontrollers.
4. Design different interfacing applications using microcontrollers and peripherals.
5. Demonstrate the limitations and strengths of different types of microcontrollers and their comparison.

Build systems using microcontrollers for real time applications.

## Hydraulic & Pneumatics Lab

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | | | | | |
| Category | **Professional Core Courses** | | | | |
| Course title | Hydraulic & Pneumatic Lab | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **0** | **0** | **2** | **1** | |
| Class Work | 50 Marks | | | | |
| Exam | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

Notes:

(i) At least 7 experiments are to be performed by students in the semester.

(ii) At least 5 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus.

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**List of Experiments**

1. Design and testing of hydraulic circuits using-
   i. Pressure control
   ii. Flow control
   iii. Direction control
2. Design of circuit with programmed logic sequence, using an optional PLC in hydraulic Electro hydraulic Trainer.
3. Design and testing of pneumatic circuits using-
   i. Pressure control
   ii. Flow control
   iii. Direction control
   iv. Circuits with logic controls
   v. Circuits with timers
   vi. Circuits with multiple cylinder sequences in pneumatic electro pneumatic trainer.
4. Design of circuits using mechanical feedback systems.
5. Velocity control of single and double acting hydraulic and pneumatic cylinders.
6. Design of Pneumatic system using any commercially available simulation software.
7. Design of Hydraulic system using any commercially available simulation

**Course outcome**

CO1:Identify the components of hydraulic and pneumatic system
CO2: Classify the applications of hydraulic and pneumatic system
CO3: DESIGN hydraulic and pneumatic circuits for various application
CO4:Conduct the troubleshooting of hydraulic and pneumatic system

## PROJECT-I

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Project** | | | | |
| Course title | **Project-I** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **0** | **0** | **4** | **2** | |
| Class Work | 50 Marks | | | | |
| Exam | 50 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Course objectives:**

1. To allow students to demonstrate skills learned during their course of study by asking them to deliver a product that has passed through the design, analysis, testing and evaluation
2. To encourage research through the integration learned in a number of courses.
3. To allow students to develop problem solving skills.
4. To encourage teamwork.
5. To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation and prepare a technical report.

The students are required to undertake institutional project work.

The final Viva voice of the institutional project work will be conducted by an external examiner and one external examiner appointed by the institute. External examiner will be from the panel of examiners submitted by the concerned institute approved by the board of studies in engineering and technology. Assessment of institutional project work will be based on seminar, viva-voice and report of institutional project work obtained by the student from the industry or institute.

The internal marks distribution for the students consists of 50 marks internally and 50 marks by an external examiner.

**Course outcomes**

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification and formulation.
3. Design engineering formula to complex problems utilising a systems approach.
4. Research and engineering project.
5. Communicate with engineers and the community at large in written and oral form.
6. Demonstrate the knowledge, skills and attitudes of a professional engineer.

## ECONOMICS FOR ENGINEERS

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Non-Credit** | | | | |
| Course title | **Economics for Engineers** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **0** | **0** | **2** | **0** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

Note: The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree.

**Course Objectives:**

1. Acquaint the students to basic concepts of economics and their operational significance.
2. Acquaint students with market and its operation.
3. To stimulate the students to think systematically and objectively about contemporary economic problems.

### Unit-I

Definition of Economics- Various definitions, types of economics- Micro and Macro Economics, nature of economic problem, Production Possibility Curve, Economic laws and their nature, Relationship between Science, Engineering, Technology and Economic Development.

Demand- Meaning of Demand, Law of Demand, Elasticity of Demand- meaning, factors effecting it, its practical application and importance.

### Unit-II

Production- Meaning of Production and factors of production, Law of variable proportions, Returns to scale, Internal and external economies and diseconomies of scale.

Various concepts of cost of production- Fixed cost, Variable cost, Money cost, Real cost, accounting cost, Marginal cost, Opportunity cost. Shape of Average cost, Marginal cost, Total cost etc. in short run and long run.

### Unit-III

Market- Meaning of Market, Types of Market- Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly (main features).

Supply- Supply and law of supply, Role of demand & supply in price determination and effect of changes in demand and supply on prices.

### Unit-IV

Indian Economy- Nature and characteristics of Indian economy as under developed, developing and mixed economy (brief and elementary introduction), Privatization - meaning, merits and demerits. Globalization of Indian economy - merits and demerits.

Banking- Concept of a Bank, Commercial Bank- functions, Central Bank- functions, Difference between Commercial & Central Bank.

**Course outcomes:**

1. The students will able to understand the basic concept of economics.
2. The students will able to understand the basic concept of demand.
3. The student will able to understand the concept of production and cost.
4. The student will able to understand the concept of market.
5. The students will able to understand the basic concept of supply.
6. The student will able to understand the concept of privatization, globalization and banks.

**References:**

1. Jain T.R., Economics for Engineers, VK Publication.
2. Chopra P. N., Principle of Economics, Kalyani Publishers.
3. Dewett K. K., Modern economic theory, S. Chand.
4. H. L. Ahuja., Modern economic theory, S. Chand.
5. Dutt Rudar & Sundhram K. P. M., Indian Economy.
6. Mishra S. K., Modern Micro Economics, Pragati Publications.
7. Singh Jaswinder, Managerial Economics, dreamtech press.
8. A Text Book of Economic Theory Stonier and Hague (Longman's Landon).
9. Micro Economic Theory – M.L. Jhingan (S.Chand).
10. Micro Economic Theory - H.L. Ahuja (S.Chand).
11. Modern Micro Economics: S.K. Mishra (Pragati Publications).

**Open Elective- II**

## COMPUTER NETWORK AND INTERNET OF THINGS

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Open Elective Courses** | | | | |
| Course title | **Computer Network and Internet of Things** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:

1. To understand working principles of various communication protocols.
2. Analyse structure and formats of TCP/IP layer protocols using network tools.
3. Implementing various network algorithms such as error control, error detection, routing, and security related algorithms.
4. To understand Sensors & Actuators.

### Unit-I

Computer Networks and The Internet What is the Internet; network edge; network core; Delay, Loss and throughput in Packet-Switched Networks; Protocol Layers and their Service Models.
Application Layer Principles of Network Applications; The Web and HTTP; File Transfer: FTP; Electronic Mail in the Internet; DNS - The Internet's Directory Service; Peer-to-Peer applications; Socket Programming.

### Unit-II

Creating network applications: Transport Layer Introduction and Transport-Layer Services; Multiplexing and Demultiplexing; Connectionless Transport: UDP; Principles of Reliable of Data Transfer; Connection-Oriented Transport: TCP; Principles of Congestion Control, TCP Congestion Control.

### Unit-III

Network Layer Introduction; Virtual circuit and datagram networks; What is inside a router; Internet Protocol (IP): Forwarding and Addressing in the Internet; Routing Algorithms; Routing in the Internet; Broadcast and Multicast Routing. Module 5: Data Link Layer Introduction to the link layer; Error Detection and Correction Techniques; Multiple Access links and Protocols; Switched local area networks.

### Unit-IV

Introduction to Internet of Things, Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, Domain, Specific IoTs Home, City, Environment, Energy, Agriculture and Industry.

**Course Outcomes:**
At the end of this course students will demonstrate the ability to

1. Understand data communication and the functions of each layer of ISO-OSI protocols.
2. Analyse structure and formats of TCP/IP layer protocols using network tools.
3. Perform computations and solve networking and routing problems.
4. Implement various network algorithms.

5. Understand sensors and actuators and their applications.
6. Implement small connections between two or more processes running in single or different computing systems.

**Text Books**


1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547 R22 B.Tech. CSE (IOT) Syllabus JNTU Hyderabad
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

## OPERATIONS RESEARCH

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Open Elective Courses** | | | | |
| Course title | **Operations Research** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:

1. Solving operational questions, solving questions related to resources‟ operations, and solving decision-making questions.
2. Operational research has a relation with different areas of study and it has several applications.
3. Operation research is considered as a tool of productivity.
4. In comparison to traditional approaches, operation research provides more extensive, quantitative, and detailed information about different issues and managers can implement their decisions based on quantitative analyses.
5. Operation research will be a good assistance for managers in different areas.

### Unit-I

Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods.

Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss Jordan reduction process in simplex methods, BIG-M methods computational, problems.

### Unit-II

Deterministic Model: Transportation model-balanced & unbalanced, north-west rule, Vogel‟s Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

Advanced Topic Of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

### Unit-III

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems.

Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

### Unit-IV

Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems.

Decision Theory: Decision process, SIMON model types of decision-making environment certainty, risk, uncertainty, decision making with utilities, problems.

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Discuss the role of operations research in decision-making, and its applications in industry.
2. formulate and design real-world problems through models & experiments.
3. Knowledge of various types of deterministic models like linear programming, transportation model etc.

4. Explore various types of stochastic models like waiting line model, project line model, simulation etc.
5. Deduce the relationship between a linear program and its dual and perform sensitivity analysis.
6. Describe different decision-making environments and apply decision making process in the real world situations

**Text Books:**


1. Operation Research – TAHA, PHI, New Delhi.
2. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.
3. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
4. Quantitative Techniques- Vohra, TMH, New Delhi 8. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice Hall of India, New Delhi.
5. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
6. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

## BIOSENSORS

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Open Elective Courses** | | | | |
| Course title | **Biosensors** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:

1. To understand the basic principles and classification of sensors and measurands.
2. To know the hardware and software of DAQ system and Electronic Interface systems
3. To understand how to measure various parameters and helps to design simple biomedical sensors.
4. To study about the sensor measurements for biological applications.

### Unit-I

Overview of biosensors and their electrochemistry: Molecular reorganization: Enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity, Fundamentals of surfaces and interfaces

### Unit-II

Bioinstrumentation and bioelectronics devices: Principles of potentiometry and potentiometric biosensors, Principles of amperometry and amperometric biosensors, Optical Biosensors based on Fiber optics, Introduction to Chemometrics, Biosensor arrays; Electronic nose and electronic tongue.

### Unit-III

Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET). Fabrication and miniaturization techniques.

### Unit-IV

Sensor-to-Frequency Conversion Data-Acquisition Systems: Hardware and Software of Data Acquisition System (DAS), Electronic Interface, Integrated Sensors, Wireless integration. Smart sensor, Nano sensor.

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Understand the basic principles and classification of sensors and measurands.
2. Understand the hardware and software of DAQ system and Electronic Interface systems.
3. Understand how to measure various parameters and helps to design simple biomedical sensors.
4. Explain the concept of molecular reorganization, fundamentals of surfaces and interfaces.
5. Elucidate the principles of different types of biosensors
6. Understand sensor measurements for biological applications.

**Text Books**


1. Gardner, J.W., Microsensors, Principles and Applications, John Wiley and Sons (1994).
2. Kovacs, G.T.A., Micromachined Transducer Sourcebook, McGraw Hill (2001).
3. Turner, A.P.F., Karube, I., and Wilson G.S., Biosensors Fundamentals and Applications, Oxford University Press (2008)
4. Jon Cooper, Biosensors A Practical Approach, Bellwether Books
5. Manoj Kumar Ram, Venkat R, Bhethanabolta, Sensors for chemical and biological applications, CRC Press

## IMAGE PROCESSING

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Open Elective Courses** | | | | |
| Course title | **Image Processing** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:

1. To understand need for image transforms different types of image transforms and their properties.
2. Analyse image processing application and Machine vision.
3. Implementing image compression and spatial and frequency domain techniques of image compression.
4. To understand different feature extraction techniques.

### Unit-I

**INTRODUCTION**: Image Processing Fourier Transform and Z-Transform Causality and stability Toeplit and Circulate Metrics orthogonal and unitary Matrices and Kronecker product, Markov Processes KI Transform Mean square Estimates and Orthogonal Principles.

IMAGE SAMPLING QUANTIZATION: Band Limited Image Sampling Versus Replication, Reconstruction of Image from samples Sampling Theorem, Sampling Theorem for Random Fields, Optimal Sampling, Nonrectangular Grid Sampling, Sampling Aperture, Display Aperture/ Interpolation Functions, Lagrange Interpolation Moire Effect. Image Quantization Uniform Optimal Quantizer, Properties of Mean Square Quantizer, Commander Design Visual Quantization

### *Unit-II*

*IMAGE* TRANSFORMS: Two Dimensional Orthogonal and Unitary Transforms and their properties. One Dimensional and Two Dimensional DFT Cosine and Sine Transforms. Hadamard, Slant, Harr and KL, Transforms and their properties, Approximation to KI Transforms.

IMAGE REPRESENTATION BY STOCHASTIC MODELS: One Dimensional Causal Models, AR and ARMA models, Non Causal Representation Spectral factorization, Image Decomposition.

### Unit-III

**IMAGE ENHANCEMENT AND RESTORATION**: Point Operation, Histogram Modeling, Spatial Operations, Transform Operations, Multispectral Image Enhancement. Image Observation Models, Inverse and Wiener filtering; FIR Wiener Filters, Filtering using Image Transform Causal Models and recursive filtering Maximum entropy restoration. Extrapolation of band limited signal.

### Unit-IV

**IMAGE ANALYSIS AND IMAGE COMPRESSION**: Spatial feature extraction, Edge detection and boundary extraction Boundary, region and moment representations structures, Texture, Image Segmentation, Reconstruction from Projections, Pixel Coding, Productive Techniques, Transform Coding Theory, Coding of Image, Coding of two-tone image.

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Understand the need for image transforms different types of image transforms and their properties.

2. Develop any image processing application and understand the rapid advances in Machine vision.
3. Learn different techniques employed for the enhancement of images.
4. Learn different causes for image degradation and overview of image restoration techniques.
5. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.
6. Learn different feature extraction techniques for image analysis and recognition.

**Text Books:**


1. Anil Jain, Digital Image Processing, PHI.
2. Gonzalez and Woods, Image Processing, Addison Wesley & Sons.
3. Digital Image Enhancement, Restoration and Compression, 4th Edition, SE Umbaugh, Taylor & Francis/CRC Press, 2023
4. Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication",1st edition, PHI

## INFORMATION THEORY AND CODING

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Open Elective Courses** | | | | |
| Course title | **Information theory and coding** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objective:** The objectives of this course are as under:

1. To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.
2. To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.
3. To encourage and train to design coding schemes for data compression and error correction.
4. they will also get an overall perspective of how this impacts the design of an optimum communication receiver.

### Unit-I

Information Theory: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model for Information Sources, Entropy and Information rate of Mark off Sources
Source Coding: Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon Fano Encoding Algorithm.
Source coding theorem, Prefix Codes, Kraft McMillan Inequality property- KMI, Huffinan codes

### Unit-II

Information Channels: Communication Channels, Discrete Communication channels Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies. Mutual Information, Channel Capacity, Channel Capacity of Binary Symmetric Channel, Binary Erasure Channel, Muroga's Theorem

### Unit-III

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities of Linear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.
Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register, Syndrome Calculation, Error Detection and Correction

### Unit-IV

Convolution Codes: Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram, The Viterbi Algorithm)

**Course Outcomes:**
At the end of this course students will demonstrate the ability to

1. Overview of Probability Theory, significance of "Information" with respect to Information Theory.
2. Implement the various types of source coding algorithms and analyse their performance.
3. Explain various methods of generating and detecting different types of error correcting codes
4. Understand the fundamentals of Field Theory and polynomial arithmetic
5. Design linear block codes and cyclic codes (encoding and decoding).
6. Implement and decode a sequence at the receiver using Trellis decoder and Viterbi decoder.

**Text Books**


1. Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw Hill, 2nd edition.
2. P.S. Satyanarayana, "Concepts of Information Theory and Coding", Dynaram Publication, 2005
3. Richard B. Wells, "Applied Coding and Information Theory for Engineers" Pearson Education, LPE 2004.
4. Shu Lin and Daniel Castello, "Error Control Coding – Fundamentals and Applications", second edition 2004
5. Thomas M Cover, Joy Thomas, "Elements of Information Theory", MGH 2006.

**Professional Elective-II**

**LEAN MANUFACTURING**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | | | | | |
| Category | **Professional Elective** | | | | |
| Course title | **LEAN MANUFACTURING** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **1** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3 Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives**

- Understand Lean manufacturing principles and tools
- Inculcate the concepts of value stream mapping
- Familiarize lean implementation practices

Unit I

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods The 7 Wastes, their causes and the effects - An overview of Lean Principles concepts / tools - Stockless Production.

Unit II

The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems. Ford production systems – FPS gear model

Unit III

Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit IV

Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation Implementation of lean practices

Course Outcome

CO1: Identify key requirements and concepts in lean manufacturing.
CO2: Initiate a continuous improvement change program in a manufacturing organization
CO3: Analyze and improve a manufacturing system by applying lean manufacturing tools
CO4: Build value stream map for improving the productivity
CO5: Improve productivity through lean practices

**Text Book and References**

Text Books Womack, J.P., Jones, D.T., and Roos, D.,'The Machine that Changed the World', Simon & Schuster, New York, 2007. Liker, J.K., '
Becoming Lean', Industrial Engineering and Management Press, 1997. References Books Womack, J.P. and Jones, D.T.,'Lean thinking', Simon & Schuster, USA, 2003. Rother, M. and Shook, J., 'Learning to see', The Lean Enterprise Institute, Brookline, USA, 2003.

## Software Engineering

| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Course title | Software Engineering | | | | |
| Category | **Profession Elective -II** | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester V |
| | 3 | 0 | 0 | 1 | |
| **Marks for Sessional** | 50 Marks | | | | |
| Marks for End term Examination | 50 Marks | | | | |
| Total | `100 Marks | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives**

1. To provide the idea of decomposing the given problem into Analysis, Desing, Implementation, Testing and Maintenance phases.
2. To provide an idea of using various process models in the software industry according to given circumstances.
3. To gain the knowledge of how Analysis, Design, Implementation, Testing and Maintenance processes are conducted in a software project.

### UNIT-I

Introduction to Software Engineering: The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, specialized process models, The Unified process.

### UNIT- II

Software Requirements: Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. System models: Context Models, Behavioral models, Data models, Object models, structured methods.

### UNIT- III

Design Engineering: Design process and Design quality, Design concepts, the design model, pattern based software design. Creating an architectural design: software architecture, Data design, Architectural styles and patterns, Architectural Design, assessing alternative architectural designs, mapping data flow into software architecture. Modeling component-level design: Designing class-based components, conducting component-level design, object constraint language, designing conventional components. Performing User interface design: Golden rules, User interface analysis, and design, interface analysis, interface design steps, Design evaluation.

### UNIT- IV

Testing Strategies: A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing, the art of Debugging. Product metrics: Software Quality, Frame work for Product metrics, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance. Metrics for Process and Products: Software Measurement, Metrics for software quality.

### UNIT- V

Risk management: Reactive vs Proactive Risk strategies, software risks, Risk identification, Risk projection, Risk refinement,

RMMM, RMMM Plan. Quality Management: Quality concepts, Software quality assurance, Software Reviews, Formal technical reviews, Statistical Software quality Assurance, Software reliability, The ISO 9000 quality standards.

**Course Outcomes:**

CO1: Students will be able to decompose the given project in various phases of a lifecycle.
CO2: Students will be able to choose appropriate process model depending on the user requirements.
CO3: Students will be able perform various life cycle activities like Analysis, Design, Implementation, Testing and Maintenance.
CO4: Students will be able to know various processes used in all the phases of the product.
CO5: Students can apply the knowledge, techniques, and skills in the development of a software product.
CO6: Collaborate in multidisciplinary teams to develop and deliver software systems, applying effective communication and teamwork skills.

**Text Books:**

1. Software engineering A practitioner's Approach, Roger S Pressman, sixth edition McGraw Hill International Edition.
2. Software Engineering, Ian Sommerville, seventh edition, Pearson education.

**Reference Books**:

1. Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India, 2010.
2. Software Engineering: A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008
3. Fundamentals of Software Engineering, Rajib Mall, PHI, 2005
4. Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.
5. Software Engineering1: Abstraction and modeling, Diner Bjorner, Springer International edition, 2006.

## Solar Energy Engineering

| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Category | **Professional Elective Course-II** | | | | |
| Course title | Solar Energy Engineering | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester VI |
| | 3 | 0 | 0 | 3 | |
| Classwork | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. To provide a fundamental understanding of solar energy principles and technologies for effective engineering and design.
2. To develop the skills necessary to assess, analyze, and optimize solar energy systems for maximum efficiency and sustainability.
3. To equip students with the knowledge and tools to design and manage solar energy projects, considering site-specific factors and integration into existing energy systems.
4. To explore and stay updated with the latest advancements and emerging trends in solar energy engineering, fostering innovation and problem-solving in the field.

**UNIT-I**

Solar Radiation: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles, estimation of solar radiation (direct and diffuse), measurement systems – pyrheliometers and other devices. Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces, shading of surfaces, periodic heat transfer through walls and roofs.

**UNIT-II**

Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings, heliostats. Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar bonds, solar pumps, solar lighting systems, solar cookers, solar drying of grains.

**UNIT-III**

Cooling Applications of Solar Systems: Continuous and Intermittent vapour absorption systems for cooling applications, absorbent – refrigerant combination, passive cooling systems.

**UNIT-IV**

Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems. Effects on Environment, economic scenario, ozone layer depletion, greenhouse effect, global warming, Remedial measures by international bodies.

**Course Outcomes:**

CO 1: Understand the principles of solar energy and its conversion into usable forms of power, including photovoltaic (PV) systems and solar thermal technologies.
CO 2: Analyze the design, installation, and operation of solar energy systems, including PV arrays, solar collectors, energy storage, and grid integration.
CO 3: Develop skills in assessing site suitability, solar resource estimation, and system sizing for efficient utilization of solar energy.
CO 4: Demonstrate proficiency in modeling and simulating solar energy systems using software tools and techniques.
CO 5: Apply knowledge of electrical and electronic engineering principles to optimize the performance and reliability of solar

energy systems.
CO 6: Evaluate the economic viability and environmental impact of solar energy projects, considering factors such as cost analysis, life cycle assessment, and policy frameworks.

**Text Books:**
1. Solar Energy – S P Sukhatme, Tata McGraw Hill
2. Solar Energy Process – Duffie and Bechman, John Wiley

**References Books:**
1. Applied Solar Energy – Maniel and Maniel, Addison Wiley
2. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

## WIRELESS SENSOR NETWORKS

| **Course Code** | | | | | |
|---|---|---|---|---|---|
| Category | **Professional Elective Courses** | | | | |
| Course title | **Wireless sensor networks** | | | | |
| Scheme | **L** | **T** | **P** | **Credits** | **Semester: VI** |
| | **3** | **0** | **0** | **3** | |
| Class Work | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| **Duration of Exam** | 3Hrs | | | | |

**Note:** The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. Understand the working principles of the Sensors.
2. Understand the protocols used in sensor networks.
3. Understand design principles of WSN.
4. Understand engineering sensor networks.

### Unit-I

Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks, Mobile Adhoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks.

### Unit-II

Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, BMAC protocol, IEEE 802.15.4 standard and ZigBee

### Unit-III

Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols. Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication

### Unit-IV

Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC

**Course Outcomes (COs):** After studying this course, students will be able:

1. Design wireless sensor networks for a given application
2. Understand emerging research areas in the field of sensor networks
3. Understand MAC protocols used for different communication standards used in WSN
4. Understand large sensor network.
5. Understand architecture and hardware components.
6. Explore new protocols for WSN

**Text Books:**


1. Waltenegus Dargie , Christian Poellabauer, " Fundamentals Of Wireless Sensor Networks
2. Theory And Practice", By John Wiley & Sons Publications ,2011
3. Sabrie Soloman, "Sensors Handbook" by McGraw Hill publication. 2009
4. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Elsevier Publications,2004
5. Kazem Sohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Inter

science

5. Philip Levis, And David Gay "TinyOS Programming" by Cambridge University Press 2009

**Professional Elective Course-III**

| S. No | Code | Subject | Credit |
|---|---|---|---|
| 1 | | Additive Manufacturing | 3 |
| 2 | | Finite Element Method | 3 |
| 3 | | System Modelling and Simulation | 3 |
| 4 | | Industrial Robotics | 3 |

## Additive Manufacturing

| | | | | | |
|---|---|---|---|---|---|
| Category | **Professional Elective Course-III** | | | | |
| Course title | Additive Manufacturing | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester VI |
| | 3 | 0 | 0 | 3 | |
| Classwork | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**
To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications

### Unit I
Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Vat Photo polymerization AM Processes: Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, Material Jetting and Binder Jetting AM Processes.

### Unit II
Extrusion - Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, BioExtrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes. Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

### Unit III
Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process 11 Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

### Unit IV
Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structureproperties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of nonequilibrium structure, microstructural studies, Structure property relationship.

### Unit V
Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

**Course Outcomes:**
CO1: Understand the working principle and process parameters of AM processes
CO2: Explore the applications of AM processes in various fields
CO3: Select the suitable material and process for fabricating a given product
CO4: Apply the knowledge in Material science in Additive Manufacturing Components.
CO5: Design and develop a product for AM Process.
CO6: Expertise in the field of 3D modelling and printing.

**Text Books:**
1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
2. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.

**Reference Books:**
1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

**Finite Element Method**

| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Category | **Professional Elective Course-III** | | | | |
| Course title | Finite Element Method | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester VI |
| | 3 | 0 | 0 | 3 | |
| Classwork | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. To provide a solid foundation in the principles and concepts of the finite element method (FEM) for numerical analysis and simulation of engineering problems.
2. To develop the skills necessary to discretize and model complex engineering systems using FEM, allowing for accurate prediction of structural behavior and performance.
3. To equip students with the knowledge and tools to analyze and optimize engineering designs through FEM, considering factors such as stress distribution, deformation, and heat transfer.
4. To explore advanced applications of FEM, such as nonlinear analysis, dynamic response, and multiphysics simulations, enabling students to tackle real-world engineering challenges.

**Unit I**

Basic concepts- The standard discrete system, Finite elements of an elastic continuum displacement approach, Generalization of the finite element concepts- weighted residual and variational approaches.

**Unit II**

Element Types- Triangular, rectangular, quadrilateral, sector, curved, iso-parametric elements and numerical integration. Automatic mesh generation schemes.

**Unit III**

Application to structural mechanics problems- Plane stress and plane strains, Axisymmetric stress analysis, three dimensional stress analyses, bending of plates.

**Unit IV**

FEM in Steady State Field Problems- Introduction, heat conduction, fluid flow and nonlinear material problems, plasticity, creep etc. Computer procedures for Finite element analysis.

**Course Outcomes:**

CO1: Understand the theoretical foundations and mathematical principles of the finite element method (FEM) for solving engineering problems.
CO2: Develop skills in constructing finite element models and discretizing complex geometries for structural and thermal analysis.
CO3: Demonstrate proficiency in using FEM software tools to solve linear and nonlinear problems, including static and dynamic structural analysis.
CO4: Apply FEM techniques to analyze and optimize the behavior of engineering structures and components under various

loading and boundary conditions.
CO5: Evaluate the accuracy and reliability of FEM results through verification and validation techniques, including convergence studies and comparison with experimental data.
CO6: Evaluate and interpret FEM results to assess structural integrity, optimize designs, and make informed engineering decisions.

**Text/Reference Books:**

1. Chandrupatla T.R., and Belegundu A.D., Introduction to Finite Elements in Engineering, Pearson Education
2. David V Hutton, Fundamentals of Finite Element Analysis McGraw-Hill Int. Ed.
3. Rao S.S. The Finite Element Method in Engineering, Pergammon Press.
4. Logan D.L., A First course in the Finite Element Method, Third Edition, Thomson Learning,
5. Robert D.Cook., David.S, Malkucs Michael E Plesha , Concepts and Applications of Finite Element Analysis.
6. Reddy J.N, An Introduction to Finite Element Method, McGraw-Hill International Student Edition
7. O.C.Zienkiewicz and R.L.Taylor, The Finite Element Methods, Vol.1. The basic formulation and linear problems, Vol.1, Butterworth Heineman.

**System Modelling and Simulation**

| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Category | **Professional Elective Course-III** | | | | |
| Course title | System Modelling and Simulation | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester VI |
| | 3 | 0 | 0 | 3 | |
| Classwork | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. To provide a comprehensive understanding of system modeling and simulation techniques for analyzing and predicting the behavior of complex systems.
2. To develop the skills necessary to create mathematical models of systems and simulate their dynamic behavior using appropriate simulation tools and software.
3. To equip students with the knowledge and tools to analyze and optimize system performance, considering factors such as efficiency, reliability, and cost-effectiveness.
4. To foster an understanding of the application of system modeling and simulation across various disciplines, including engineering, business, and healthcare, enabling students to tackle diverse real-world problems.

**Unit I**

Introduction-Systems, System types, System Modeling, Types of system modelling, Classification and comparison of simulation models, attributes of modelling, Comparison of physical and computer experiments, Application areas and Examples.

**Unit II**

Mathematical and Statistical Models- Probability concepts, Queuing Models, Methods for generating random variables and Validation of random numbers.

**Unit III**

Language-System modelling, programming languages, comparison of languages, Identifying and selection of programming language, feasibility study of programming language for the given application.

**Unit IV**

Experiments-Simulation of different systems, Analysis, validation and verification of input and output simulated data, study of alternate techniques.

**Unit V**

Case study-Developing simulation model for information centers, inventory systems and analysis of maintenance systems.

**Course Outcomes:**

CO1: Understand the principles and techniques of system modeling and simulation for representing and analyzing complex systems.
CO2: Develop skills in selecting appropriate modeling methodologies and simulation tools based on system characteristics and objectives.
CO3: Apply mathematical and computational modeling techniques to represent system behavior, dynamics, and interdependencies.

CO4: Demonstrate proficiency in using simulation software to create and execute system models, analyzing system performance and behavior under different scenarios.
CO5: Evaluate the validity and reliability of simulation results through verification and validation techniques, including sensitivity analysis and comparison with real-world data.
CO6: Collaborate effectively in multidisciplinary teams to design and conduct system simulations, interpret results, and make informed decisions for system optimization and improvement.

**Text Books:**
1. Geoffrey Gordon, "System Simulation", Second edition, Prentice Hall, India, 2002.
2. Jerry Banks and John S.Carson, Barry L.Nelson, David M.Nicol, "Discrete Event System Simulation", Third edition, Prentice Hall, India, 2002.

**Reference Books:**
1. Robert E. Shannon, "System Simulation The art and science",, Prentice Hall, New Jersey, 1995.
2. D.S. Hira, "System Simulation", S.Chand and company Ltd, New Delhi, 2001.

**Industrial Robotics**

| | | | | | |
|---|---|---|---|---|---|
| Course code | | | | | |
| Category | **Professional Elective Course-III** | | | | |
| Course title | Industrial Robotics | | | | |
| **Semester and Credits** | L | T | P | **Credits** | Semester VI |
| | 3 | 0 | 0 | 3 | |
| Classwork | 30 Marks | | | | |
| Exam | 70 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Note**: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

**Course Objectives:**

1. To introduce the basic concepts, parts of robots and types of robots.
2. To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
3. To select the robots according to its usage.
4. To discuss about the various applications of robots, justification and implementation of robot.

**UNIT-I**

**Introduction**:
Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.

**UNIT-II**

**Robots for Inspection**
Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

**UNIT-III**

**End Effectors**
Gripper force analysis and gripper design, design of multiple degrees of freedom, active and passive grippers. SELECTION OF ROBOT: Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society.

**UNIT-IV**

**Other Applications**
Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

**Course Outcomes:**

CO1 : Learn about the basic concepts, parts of robots and types of robots.

CO2: To design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.
CO3: Ability in selecting the required robot
CO4: Know various applications of robots

**Text Books:**


1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering – An integrated Approach" Prentice HallIndia, New Delhi, 2001.
2. Mikell P. Groover,"Automation, Production Systems, and Computer Integrated Manufacturing", 2nd Edition, John Wiley & sons, Inc, 2007


**References:**


1. James A Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.
2. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994