

<b>Total Contact Hours:</b>	<b>160</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Theory(Hours):</b>	<b>64</b>	<b>2</b>	<b>3</b>	<b>3</b>
<b>Practical (Hours):</b>	<b>96</b>			

**Aims**

- To understand the basic concepts of robotics
- To understand the application of robots in industry
- To identify the operating principles and configurations of industrial robots

**COURSE CONTENTS****1. ROBOT ANATOMY AND RELATED ATTRIBUTES 8 Hours**

- 1.1. Robotics
- 1.2. Concept of Joints and Links
  - 1.2.1. Degree of Freedom
  - 1.2.2. Work Volume
  - 1.2.3. Types of Robotic Joints
- 1.3. Common Robot Configurations
  - 1.3.1. Polar Configuration
  - 1.3.2. Cylindrical Configuration
  - 1.3.3. Cartesian Configuration
  - 1.3.4. Articulated/Joint-Arm Configuration
  - 1.3.5. SCARA (Selective Compliance Assembly Robot Arm)
  - 1.3.6. Different Wrist Configuration
- 1.4. Describe the types of Joint Drive Systems
  - 1.4.1. Electric Drives
  - 1.4.2. Hydraulic and Pneumatic Drives

**2. ROBOT CONTROL SYSTEM 4 Hours**

- 2.1. Classification of Robot Controllers
  - 2.1.1. Limited sequence control
  - 2.1.2. Playback with point-to-point control
  - 2.1.3. Playback with continuous path control
  - 2.1.4. Intelligent control

**3. END EFFECTORS 4 Hours**

- 3.1. Robot Grippers as end effectors

3.2. Tools as end effectors

#### **4. SENSORS IN ROBOTICS**

**12 Hours**

4.1. Tactile sensors

4.1.1. Force Measurement

4.1.2. Pressure Measurement

4.2. Proximity sensors

4.2.1. Micro switches in Robotics

4.2.2. Photosensitive Sensor in Robotics

4.3. Machine vision system

4.3.1. Image Acquisition

4.3.2. Vision Sensors

4.3.2.1. Cameras and Camera selection

4.3.2.2. IR Distance Sensors

4.3.2.3. Ultrasonic and Laser Sensor

#### **5. INDUSTRIAL ROBOT APPLICATIONS**

**8 Hours**

5.1. Advantages of using Robots in Industries

5.2. Robots in Material Handling Applications

5.2.1. Material transfer applications

5.2.2. Machine Loading/Unloading Applications

5.3. Robots in Processing Operations

5.3.1. Spot Welding

5.3.2. Continuous Arc Welding

5.3.3. Spray Coating

5.3.4. Other Processing Applications

5.4. Robots in Assembly and Inspection

#### **6. ROBOT PROGRAMMING**

**4 Hours**

6.1. Robot Program

6.2. Lead-through Programming

6.3. Robot Programming Languages

6.4. Simulation and Off-Line Programming

#### **7. ENGINEERING ANALYSIS OF INDUSTRIAL ROBOTS 16 Hours**

7.1. Introduction to Manipulator Kinematics

7.1.1. Frame

7.1.2. Forward Kinematics of Manipulators

7.1.3. Reverse Kinematics of Manipulator

7.1.4. Trajectory Generation

- 7.1.5. Spatial description of position, orientation and frame
- 7.1.6. Mappings
- 7.1.7. Operators
- 7.1.8. Transformation Arithmetic
- 7.2. Concept of Accuracy and Repeatability
  - 7.2.1. Control resolution
  - 7.2.2. Accuracy
  - 7.2.3. Repeatability

## **8. FUTURE TREND IN ROBOTICS**

**8 Hours**

- 8.1. Robots in Rehabilitation
- 8.2. Concept of Behavior Based Robotics
- 8.3. Biological Inspired Robots

## **RECOMMENDED BOOKS**

- 1 Robots and Manufacturing Automation:, .C. Ray Asfahl, John Wiley & Sons Inc., USA
- 2 Analytical Robotics and Mechatronics: Wolfram Stadler, McGraw-Hill, Intl. Edition.
- 3 Introduction to Robotics, Analysis, Systems, Applications: S. B. Niku (Prentice Hall) (2001)
- 4 Industrial Robotics Technology :M.P. Groover
- 5 Mechatronic Design Automation: Emerging Research and Recent Advances (Mechanical Engineering Theory and Applications: Zhun Fan (2010)
- 6 Mechatronics 2013: Recent Technological and Scientific Advances: Tomás Brezina and Ryszard Jablonski (2013)

## **INSTRUCTIONAL OBJECTIVES**

### **1. ROBOT ANATOMY AND RELATED ATTRIBUTES**

- 1.1. Define Robotics
- 1.2. Describe the concept of Joints and Links
  - 1.2.1. Define Degree of Freedom
  - 1.2.2. Define Work Volume
  - 1.2.3. Explain the types of Robotic Joints
    - 1.2.3.1. Linear Joint
    - 1.2.3.2. Orthogonal Joint
    - 1.2.3.3. Rotational Joint
    - 1.2.3.4. Twisting Joint
    - 1.2.3.5. Revolving Joint
- 1.3. Describe the Common Robot Configurations
  - 1.3.1. Describe Construction, DOF, Work Envelop and Applications of Polar Configuration
  - 1.3.2. Describe Construction, DOF, Work Envelop and Applications of Cylindrical Configuration
  - 1.3.3. Describe Construction, DOF, Work Envelop and Applications of Cartesian Configuration
  - 1.3.4. Describe Construction, DOF, Work Envelop and Applications of Articulated/Joint-Arm Configuration
  - 1.3.5. Describe Construction, DOF, Work Envelop and Applications of SCARA (Selective Compliance Assembly Robot Arm)
  - 1.3.6. Describe different Wrist Configuration and the concept of degree of freedom
- 1.4. Describe the types of Joint Drive Systems
  - 1.4.1. Describe Electric Drives
    - 1.4.1.1. Explain the types
    - 1.4.1.2. Describe their characteristics and selection
  - 1.4.2. Describe the Hydraulic and Pneumatic Drives
    - 1.4.2.1. Explain their working principle
    - 1.4.2.2. Explain their components
    - 1.4.2.3. Explain their characteristics

### **2. ROBOT CONTROL SYSTEM**

- 2.1. Describe the Classification of Robot Controllers
  - 2.1.1. Characteristics and Applications of Limited sequence control
  - 2.1.2. Characteristics and Applications of Playback with point-to-point control
  - 2.1.3. Characteristics and Applications of Playback with continuous path control
  - 2.1.4. Characteristics and Applications of Intelligent control

### **3. END EFFECTORS**

- 3.1. Describe Grippers used in industrial robot applications
- 3.2. Explain some Tools used in industrial robot application

#### **4. SENSORS IN ROBOTICS**

- 4.1. Brief describe Tactile sensors
  - 4.1.1. Force Measurement
  - 4.1.2. Pressure Measurement
- 4.2. Brief describe Proximity sensors
  - 4.2.1. Explain the use of Micro switches in Robotics
  - 4.2.2. Explain the use of Photosensitive Sensor in Robotics
- 4.3. Describe Machine vision system
  - 4.3.1. Image Acquisition
    - 4.3.1.1. Explain the concept of Illumination
    - 4.3.1.2. Explain the concept of Digitization
      - 4.3.1.2.1. Sampling
      - 4.3.1.2.2. Quantization
  - 4.3.2. Vision Sensors
    - 4.3.2.1. Cameras and Camera selection
      - 4.3.2.1.1. Characteristics of CCD Camera
      - 4.3.2.1.2. Characteristics of CMOS Camera
    - 4.3.2.2. IR Distance Sensors
      - 4.3.2.2.1. Explain basic principle of operation
      - 4.3.2.2.2. Characteristics
    - 4.3.2.3. Ultrasonic and Laser Sensor
      - 4.3.2.3.1. Explain basic principle of operation
      - 4.3.2.3.2. Characteristics and Sonar Effect

#### **5. INDUSTRIAL ROBOT APPLICATIONS**

- 5.1. Describe the advantages of using Robots in Industries
- 5.2. Describe the use of robots in Material Handling Applications
  - 5.2.1. Material transfer applications
  - 5.2.2. Machine Loading/Unloading Applications
- 5.3. Describe the use of robots in Processing Operations
  - 5.3.1. Spot Welding
  - 5.3.2. Continuous Arc Welding
  - 5.3.3. Spray Coating
  - 5.3.4. Other Processing Applications like Drilling, Grinding, Laser Cutting
- 5.4. Describe the use of robots in Assembly and Inspection

#### **6. ROBOT PROGRAMMING**

- 6.1. Define Robot Program
- 6.2. Briefly explain Lead-through Programming
  - 6.2.1. Advantages and disadvantages
- 6.3. Briefly explain Robot Programming Languages
  - 6.3.1. Advantages and disadvantages
- 6.4. Simulation and Off-Line Programming

6.4.1. Advantages and disadvantages

## **7. ENGINEERING ANALYSIS OF INDUSTRIAL ROBOTS**

7.1. Introduction to Manipulator Kinematics

7.1.1. Define Frame

7.1.2. Define Forward Kinematics of Manipulators

7.1.3. Define Reverse Kinematics of Manipulator

7.1.4. Define Trajectory Generation

7.1.5. Describe the Spatial Description of Position, Orientation and Frame

7.1.5.1. Description of Position

7.1.5.2. Description of Orientation

7.1.5.3. Description of Frame

7.1.5.4. Basic Calculation for Position, Orientation and Frame description

7.1.6. Describe Mappings

7.1.6.1. Mappings involving translated frames

7.1.6.2. Mappings involving rotated frames

7.1.6.3. Mappings involving general frames

7.1.6.4. Basic Calculation of Frame translation and rotation

7.1.7. Describe Operators

7.1.7.1. Translation operator

7.1.7.2. Rotation operator

7.1.7.3. Transformation operator

7.1.8. Describe Transformation Arithmetic

7.1.8.1. Basic Calculation of Transformation Matrix

7.2. Understand the concept of Accuracy and Repeatability

7.2.1. Define Control resolution

7.2.2. Define Accuracy

7.2.3. Define Repeatability

**LIST OF PRACTICALS:**

1. Identify basic components of Robot in your lab
2. Basic practice using jog mode of pendant
3. Operation practice after Joint Position Teaching
4. Understanding and practice of velocity and time
5. Practice absolute coordinate and relative coordinate
6. Practice the movement of gripper
7. Practice to control the program storage and retrieval
8. Assembling a Robot using any Robot Development Kit and Explore its Work Envelope
9. Programming a Robot using any Robot Development Kit and Execution of the Assigned Task