Department of Mechanical Engineering

U23RAO11 –Industrial Robotics and Material Handling System

Syllabus:

UNIT I	**INTRODUCTION**	**No. of Periods: 9**
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**	**No. of Periods: 9**
Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.		
UNIT III	**OTHER APPLICATIONS**	**No. of Periods: 9**
Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.		
UNIT IV	**END EFFECTORS**	**No. of Periods: 9**
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 V	**MATERIAL HANDLING**	**No. of Periods: 9**
Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, monorails, rail guided vehicles, conveyor systems, cranes and hoists, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS).		

Objectives:

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To select the robots according to its usage.
- To discuss about the various applications of robots, justification and implementation of robot.
- To know about material handling in a system.

Text Book:

1. Richaerd D Klafter, Thomas Achmi elewski and Mickael Negin, “Robotic Engineering – An integrated Approach” Prentice Hall India, New Delhi, 2001.

2. Mikell P. Groover,”Automation, Production Systems, and Computer Integrated Manufacturing“, 2nd Edition, John Wiley & sons, Inc, 2007

Reference Book:

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

Website:

W1. https://www.genesis-systems.com/blog/robotic-material-handling-and-tending-a-basic-overview

W2. https://www.robotics.org/content-detail.cfm/Industrial-Robotics-Industry-Insights/Robotic-Material-Handling/content_id/3767

W3. https://www.slideshare.net/ManojK55/material-handling-robots

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UNIT 1

1. What are the main types of industrial robots?

The main types of industrial robots are articulated robots, SCARA robots, delta robots, and Cartesian robots.

2. What is an articulated robot?

An articulated robot has rotary joints and is commonly used for tasks requiring a wide range of motion, such as welding and assembly.

3. How is the load handling capacity of an industrial robot defined?

Load handling capacity is defined as the maximum weight a robot can lift and manipulate safely and accurately.

4. Why is load handling capacity important in industrial robotics?

Load handling capacity is crucial for ensuring the robot can handle the required materials without overloading, which could lead to mechanical failure or inaccuracies.

5. What factors must be considered in robotic material handling?

Factors include the weight and size of materials, handling speed, precision, safety, and integration with existing systems.

6.How does safety play a role in robotic material handling?

Safety measures prevent accidents and injuries, ensuring the robot operates within safe parameters and interacts safely with human workers.

7. What is the purpose of material transfer in industrial settings?

The purpose of material transfer is to move materials efficiently from one location to another, optimizing workflow and reducing manual handling.

8. What are common applications of robots in material transfer?

Common applications include picking and placing items on conveyor belts, moving parts between workstations, and transporting finished products.

9. What is the benefit of using robots for machine loading and unloading?

The benefit is increased efficiency and precision, reduced human error, and improved safety by automating repetitive and potentially hazardous tasks.

10. How does robot automation in machine loading and unloading enhance productivity?

Automation enhances productivity by allowing continuous operation, reducing downtime, and freeing human workers for more complex tasks.

UNIT 2

1 What are robotic vision systems?

Robotic vision systems are technologies that enable robots to process and interpret visual information from the environment, allowing them to perform tasks like object recognition, inspection, and navigation.

2. What are the key components of a robotic vision system?

The key components of a robotic vision system include cameras or sensors, image processing software, and algorithms for analyzing and interpreting visual data.

3. What is image representation in the context of robotic vision?

Image representation refers to the methods used to capture and describe visual information from an image, such as pixel values, edges, shapes, and textures, in a format that a robot can process.

4. Why is image representation important for robotic vision systems?

Image representation is crucial because it transforms raw visual data into a structured format that allows for effective analysis, object recognition, and decision-making by the robot.

5. What is object recognition in robotic vision systems?

Object recognition is the ability of a robotic vision system to identify and classify objects within an image based on their features and patterns.

6. How is object categorization different from object recognition?

Object categorization involves grouping objects into predefined categories based on their characteristics, whereas object recognition focuses on identifying specific objects and distinguishing them from others.

7. What is depth measurement in robotic vision systems?

Depth measurement is the process of determining the distance between the robot and objects in its environment, enabling 3D perception and spatial awareness.

8. What techniques are commonly used for depth measurement in robotic vision?

Common techniques for depth measurement include stereo vision, time-of-flight sensors, structured light, and LIDAR.

9. Why is image data compression important in robotic vision systems?

Image data compression is important because it reduces the size of image files, allowing for faster processing, transmission, and storage without significantly compromising image quality.

10. What are some common methods of image data compression?

Common methods of image data compression include JPEG (lossy compression) and PNG (lossless compression).

UNIT 3

1. What is the role of robots in continuous arc welding?

Robots in continuous arc welding automate the welding process, ensuring consistent and precise welds, reducing human error, and increasing production efficiency.

2. What are the advantages of using robots for continuous arc welding?

Advantages include improved weld quality, increased productivity, enhanced safety by reducing human exposure to hazardous conditions, and the ability to work continuously without fatigue.

3. How are robots utilized in spot welding?

Robots are used in spot welding to precisely position and apply pressure to welding electrodes, creating strong, consistent welds in automotive and manufacturing industries.

4. What benefits do robots offer in spot welding applications?

Benefits include higher precision, faster welding cycles, reduced labor costs, consistent weld quality, and the ability to operate in harsh environments.

5. What is the application of robots in spray painting?

Robots in spray painting apply paint uniformly to surfaces, ensuring consistent coverage, reducing paint waste, and minimizing overspray.

6. What are the key advantages of robotic spray painting?

Key advantages include uniform paint application, increased efficiency, reduced health risks to workers, and the ability to paint complex shapes and hard-to-reach areas.

7. How do robots assist in assembly operations?

Robots assist in assembly operations by performing tasks such as inserting components, fastening parts, and performing repetitive tasks with high precision and speed.

8. What are the benefits of using robots in assembly operations?

Benefits include improved accuracy, faster assembly times, reduced labor costs, consistent product quality, and the ability to handle small and delicate components.

9. What safety improvements do robots bring to welding operations?

Robots improve safety in welding operations by reducing human exposure to harmful fumes, intense heat, and UV radiation, and by minimizing the risk of injuries associated with manual welding.

10. How do robots enhance efficiency in spray painting processes?

Robots enhance efficiency in spray painting by delivering consistent paint application, reducing cycle times, minimizing material waste, and ensuring high-quality finishes with minimal rework.

UNIT 4

1. What is the purpose of gripper force analysis in robotic systems?

Gripper force analysis ensures that the gripper applies the correct amount of force to securely hold an object without causing damage, enabling precise manipulation.

2. What factors are considered in the design of a robotic gripper?

Factors include the shape and size of the objects to be handled, the required grip force, material properties of the gripper, and the type of motion required for manipulation.

3. What does the term "degrees of freedom" (DOF) mean in robotics?

Degrees of freedom refer to the number of independent movements a robot or robotic joint can make, determining its ability to position and orient itself or objects in space.

4. Why is designing multiple degrees of freedom important in robotics?

Designing multiple degrees of freedom is important because it allows the robot to perform complex tasks with greater flexibility, precision, and maneuverability.

5. What is the difference between active and passive grippers in robotics?

Active grippers use powered mechanisms (like motors) to grasp and release objects, while passive grippers rely on external forces (like springs or gravity) and mechanical designs to hold objects.

6. Give an example of an application for a passive gripper.

A passive gripper can be used in situations where simple, reliable gripping is needed without complex control, such as picking up objects on an assembly line using spring-loaded mechanisms.

7. What factors influence the choice of a robot for a specific application?

Factors include the required payload capacity, reach, precision, speed, environmental conditions, cost, and the specific tasks to be performed.

8. How does the intended application affect the selection of a robot?

The intended application determines the specific requirements for the robot, such as its size, degree of autonomy, type of end-effector needed, and compatibility with other systems.

9. What is the purpose of robot performance testing?

The purpose of robot performance testing is to ensure that the robot meets the required specifications and performs tasks accurately, reliably, and safely under various conditions.

10. What parameters are commonly evaluated during robot performance testing?

Common parameters include precision, repeatability, speed, payload capacity, response time, and durability.

UNIT 5

1. What is material handling in industrial settings?

Material handling involves the movement, protection, storage, and control of materials and products throughout manufacturing, warehousing, distribution, and disposal processes.

2. Why is material handling important in industrial operations?

Material handling is crucial for optimizing the flow of materials, reducing handling costs, enhancing productivity, and ensuring safety in industrial operations.

3. What is one of the key principles in designing a material handling system?

One key principle is to minimize material handling by ensuring efficient flow paths and reducing unnecessary movements.

4. What considerations are important in material handling systems design?

Considerations include the type and size of materials, handling frequency, layout of the facility, automation level, and safety requirements.

5. What are conventional material handling systems?

Conventional material handling systems include manual and mechanized methods such as forklifts, conveyors, cranes, and carts used to transport materials within a facility.

6. How do conventional material handling systems benefit industrial operations?

They improve efficiency, reduce labor costs, enhance safety, and facilitate the smooth flow of materials within the facility.

7. What are industrial trucks used for in material handling?

Industrial trucks, such as forklifts, are used to lift, transport, and stack materials within warehouses and manufacturing plants.

8. What is a key advantage of using industrial trucks?

A key advantage is their flexibility and mobility, allowing them to handle a wide range of materials and navigate various parts of a facility.

9. What is a monorail system in material handling?

A monorail system consists of a single rail on which trolleys or carriers move materials along a fixed path, often used in manufacturing and assembly lines.

10. What are the benefits of using monorail systems?

Benefits include precise material handling, efficient space utilization, and the ability to automate the transport process in a controlled manner.

PART – B 16 Mark Questions

UNIT I – INTRODUCTION

1. Explain the types of industrial robots with neat sketches and their applications.
2. Discuss the load handling capacity of robots and the factors affecting payload.
3. Explain the general considerations in robotic material handling systems.
4. Describe the material transfer applications of robots in manufacturing industries.
5. Explain the machine loading and unloading operation using robots with suitable examples.
6. Discuss the robotic loading and unloading of CNC machine tools.
7. Explain the concept and advantages of a robot-centered cell with diagram.
8. Compare different industrial robot configurations and their advantages.
9. Explain the role of robots in modern automated manufacturing systems.
10. Discuss the safety considerations in robotic material handling systems.

UNIT II – ROBOTS FOR INSPECTION

1. Explain the components and working of a robotic vision system with diagram.
2. Discuss the different methods of image representation used in robotic vision.
3. Explain the techniques used for object recognition and categorization in robotics.
4. Describe the methods of depth measurement in robotic vision systems.
5. Explain image data compression techniques used in robotic vision.
6. Discuss the applications of robotic vision in industrial visual inspection.
7. Explain the image processing steps used in robotic inspection systems.
8. Discuss the software considerations involved in robotic vision systems.
9. Explain the advantages and limitations of robotic vision systems.
10. Describe the role of machine vision in automated inspection systems.

UNIT III – OTHER APPLICATIONS

1. Explain the application of robots in continuous arc welding with advantages.
2. Describe the spot welding process using robots in automobile industries.
3. Explain the robotic spray painting process and its benefits.
4. Discuss the applications of robots in assembly operations.
5. Explain the use of robots in cleaning and hazardous environments.
6. Describe the design and working of underwater robots.
7. Discuss the advantages of robotic welding compared to manual welding.
8. Explain the applications of robots in electronic component assembly.
9. Discuss the role of robots in hazardous and dangerous environments.
10. Explain various industrial applications of robots with suitable examples.

UNIT IV – END EFFECTORS & SELECTION OF ROBOT

1. Explain gripper force analysis and design considerations of robot grippers.
2. Describe the design of robot grippers with multiple degrees of freedom.
3. Explain the types of end effectors used in robotic systems.
4. Differentiate between active and passive grippers with examples.
5. Explain the factors influencing the selection of a robot for an industrial application.
6. Describe the performance testing methods used for industrial robots.
7. Discuss the economics of robotisation in manufacturing industries.
8. Explain the impact of robots on industry and society.
9. Explain the design considerations for robotic end effectors.
10. Compare mechanical, vacuum, and magnetic grippers used in robotics.

UNIT V – MATERIAL HANDLING

1. Explain the concept and objectives of material handling in manufacturing systems.
2. Discuss the principles and considerations in material handling system design.
3. Explain the different types of industrial trucks used in material handling.
4. Describe the working and applications of monorail material handling systems.
5. Explain the rail guided vehicle systems used in industries.
6. Discuss the types and applications of conveyor systems.
7. Explain the working principles of cranes and hoists.
8. Describe the Automated Guided Vehicle (AGV) system and its advantages.
9. Explain the Automated Storage and Retrieval System (ASRS) with diagram.
10. Compare conventional and advanced material handling systems.