CO4	**Identify the elements of Computer Integrated manufacturing system.**		
M 4.01	Understand the need, benefits and features of CIM	4	Understanding
M 4.02	Identify Flexible Manufacturing System layout for given using group technology concepts and familiarize with computer aided process planning	6	Applying
M 4.03	Recognize use of robotics in the field of manufacturing.	5	Understanding
	Series Test – II	1	

Contents:

Computer integrated manufacturing system- Evolution of manufacturing Systems- need of automation-benefits of CIM-basic structure of CIM- Direct Numerical Control-Computer Aided Process Planning.

Flexible manufacturing system- Definition, objective and Need- components- group technology- part family -Classification -Single Machining Cell-Flexible manufacturing cell-FMS-Automated guided vehicle (AGV)- FMS Layouts and their salient features- Single line- dual line- loop- ladder- Carousel- robot centered.

Robotics- Introduction; Definition- Robot anatomy (parts) and its working- Types of joints-Configuration of robots; Cartesian, Cylindrical, Spherical, Scara- applications of industrial robots

Automation

Automation is a technology that applies to the implementation, operation, and control of mechanical, electronic, and computer systems.

Computer-integrated manufacturing (CIM) is a manufacturing approach that uses computers to control the entire production process. This includes everything from product design and engineering to production planning and scheduling to manufacturing and quality control.

The main activities performed under CIM include:

- Product design and engineering: CIM systems can be used to design and engineer products using computer-aided design (CAD) and computer-aided engineering (CAE) software. This can help to reduce the time and cost of product development.
- Production planning and scheduling: CIM systems can be used to plan and schedule production using computer-aided process planning (CAPP) and computer-integrated production management (CIPM) software. This can help to improve the efficiency of the production process.
- Manufacturing: CIM systems can be used to control the manufacturing process using computer-aided manufacturing (CAM) software. This can help to improve the accuracy and consistency of the manufacturing process.
- Quality control: CIM systems can be used to inspect and test products using computer-aided inspection (CAI) software. This can help to improve the quality of products and reduce the number of defects.

Benefits of CIM

- Improved efficiency: CIM can help to reduce the time and effort required for various manufacturing processes, resulting in increased efficiency.
- Improved quality: CIM allows for better quality control and reduces the chances of human error.
- Reduced costs: CIM can help to reduce labour costs and material waste, resulting in lower production costs.
- Increased flexibility: CIM allows for greater flexibility in the manufacturing process, enabling companies to respond quickly to changing market demands.
- Increased productivity
- Improved product traceability

- Reduced inventory levels
- Improved customer service
- Enhanced safety

Major elements of CIM

Nine major elements of a CIM system are in Fig 3 they are,

I. Marketing
II. Product Design
III. Planning
IV. Purchase
V. Manufacturing Engineering
VI. Factory Automation Hardware
VII. Warehousing
VIII. Finance
IX. Information Management

Figure 2 Major elements of CIM systems

i. **Marketing**: The need for a product is identified by the marketing division.
ii. **Product Design**: The design department of the company establishes the initial database for production of a proposed product. In a CIM system this is accomplished through activities such as geometric modelling and computer aided design.
iii. **Planning**: The planning department takes the database established by the design department and enriches it with production data and information to produce a plan for the production of the product.
iv. **Purchase**: The purchase departments is responsible for placing the purchase orders and follow up
v. **Manufacturing Engineering**: Manufacturing Engineering is the activity of carrying out the production of the product, involving further enrichment of the database with performance data and information about the production equipment and processes.
vi. **Factory Automation Hardware**: Factory automation equipment further enriches the database with equipment and process data, resident either in the operator or the

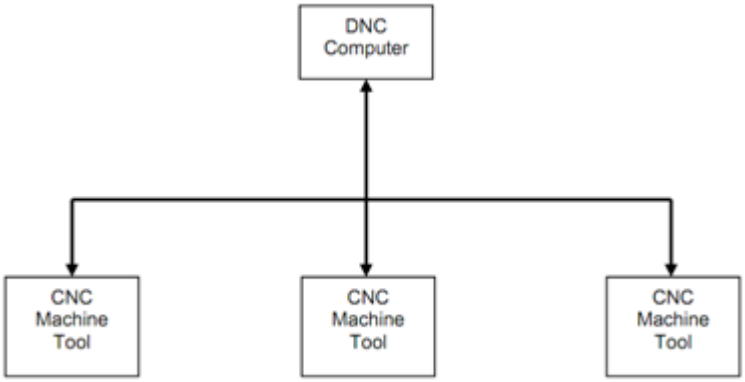
equipment to carry out the production process. In CIM system this consists of computer-controlled process machinery such as CNC machine tools, flexible manufacturing systems (FMS), Computer controlled robots, material handling systems, computer controlled assembly systems, flexibly automated inspection systems and so on

vii. **Warehousing**: Warehousing is the function involving storage and retrieval of raw materials, components, finished goods as well as shipment of items.

viii. **Finance**: Finance deals with the resources pertaining to money. Planning of investment, working capital, and cash flow control, realization of receipts, accounting and allocation of funds are the major tasks of the finance departments.

ix. **Information Management**: Information Management is perhaps one of the crucial tasks in CIM. This involves master production scheduling, database management, communication, manufacturing systems integration and management information systems.

Direct numerical control (DNC), also known as distributed numerical control, is a common manufacturing term for networking CNC machine tools. DNC systems allow for the centralized management and distribution of NC programs to CNC machines on the shop floor.



DNC systems typically consist of a central computer server and a network of CNC machines. The central computer server stores the NC programs and distributes them to the CNC machines on demand. The CNC machines can then execute the NC programs to produce the desired parts.

DNC systems offer a number of benefits over traditional CNC systems, including:

Improved efficiency: DNC systems can help to improve the efficiency of CNC machining operations by reducing the time and effort required to manage and distribute NC programs.

Improved accuracy: DNC systems can help to improve the accuracy of CNC machining operations by ensuring that the latest version of the NC program is always being used.

Reduced costs: DNC systems can help to reduce the costs of CNC machining operations by reducing labor costs and material waste.

Increased flexibility: DNC systems can help to increase the flexibility of CNC machining operations by allowing for easy changes to NC programs.

DNC systems are widely used in a variety of industries, including automotive, aerospace, and electronics manufacturing.

Computer-Aided Process Planning (CAPP) is a technology-driven approach used in manufacturing to assist engineers and planners in developing efficient and optimized plans for manufacturing a product. It combines computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies with specialized software to generate detailed manufacturing instructions and workflows. Here's an overview of the key aspects and benefits of Computer-Aided Process Planning:

Components of Computer-Aided Process Planning:

1. **CAD Models:** CAPP typically begins with the use of CAD models or digital representations of the product to be manufactured. These models provide essential geometric and dimensional information about the product.
2. **Part Information Database:** A database containing information about materials, available tools, machinery, and manufacturing processes is used as a reference in the planning process.
3. **Process Knowledge Base:** This knowledge base contains rules, algorithms, and best practices related to various manufacturing processes and techniques. It serves as a repository of manufacturing expertise.
4. **CAPP Software:** The heart of CAPP is the specialized software that utilizes CAD models, the part information database, and the process knowledge base to generate manufacturing plans and instructions.

Flexible Manufacturing System

It is a manufacturing system that is capable of producing a variety of products with minimal changeover time. FMS systems are typically used in industries where there is a high demand for product variety and customization. FMS systems typically consist of a number of CNC machines that are connected together by a computer-controlled system. The computer-controlled system is used to schedule and control the production process.

Advantages of FMS systems

Increased flexibility: FMS systems allow for greater flexibility in the production process, enabling companies to respond quickly to changing market demands.

Reduced costs: FMS systems can help to reduce labour costs and material waste, resulting in lower production costs.

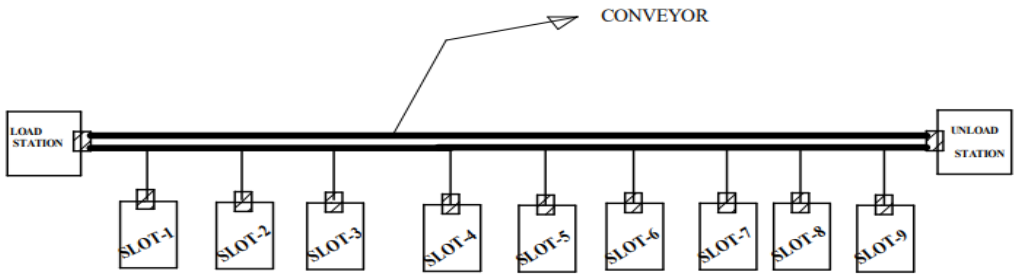
Improved quality: FMS systems can help to improve the quality of products by reducing the chances of human error.

Increased productivity: FMS systems can help to increase productivity by reducing changeover times and improving the efficiency of the production process.

FMS Layouts

Line layout

An Automated guided vehicle is most efficient when the movement is in straight-lines along the AGV path in a single-row machine layout. Machines are arranged only on one side of AGV path, and in double row machine layout, machines are arranged on both sides.



Line layout

Loop layout

The loop layout uses conveyor systems that allow unidirectional flow of parts around the loop. A secondary material handling system is provided at a workstation which permits the flow of parts without any obstruction.

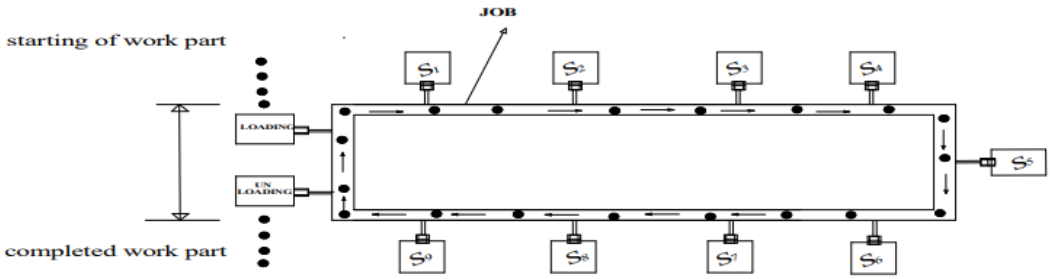


Fig. : Loop layout

Ladder type layout

Ladder type layout consists of rungs on which workstations are located. This reduces the average travel distance thereby reducing the transfer time between workstations.

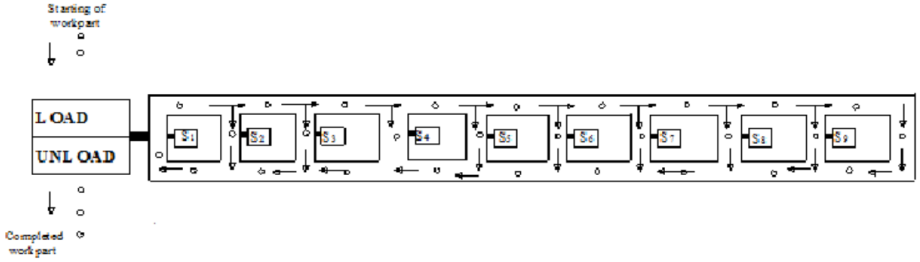


Fig. : Ladder layout

Carousel layout

In the Carousel layout configuration, parts flow in one direction around the loop. The load, unload stations are placed at one end of loop.

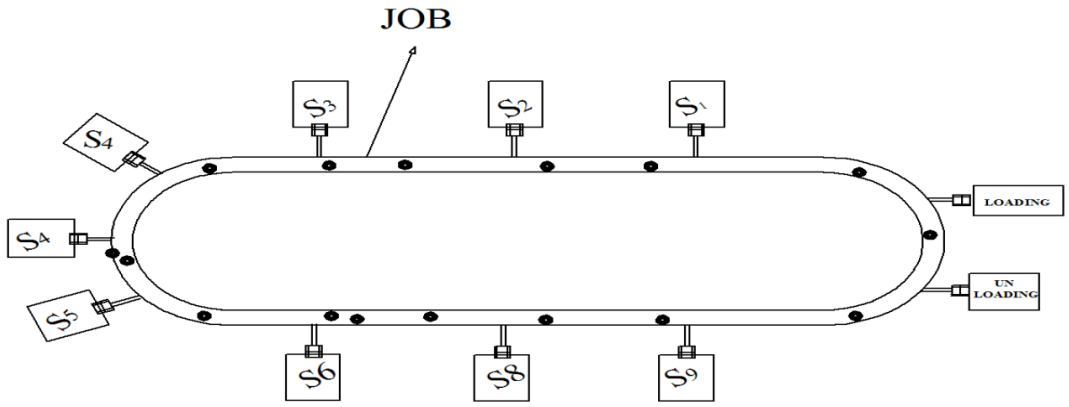


Fig. : Carousel layout

Robot centred cell

If a handling robot is used in a Flexible manufacturing system cell, the machines are laid out in a circle, such a layout is called circular layout.

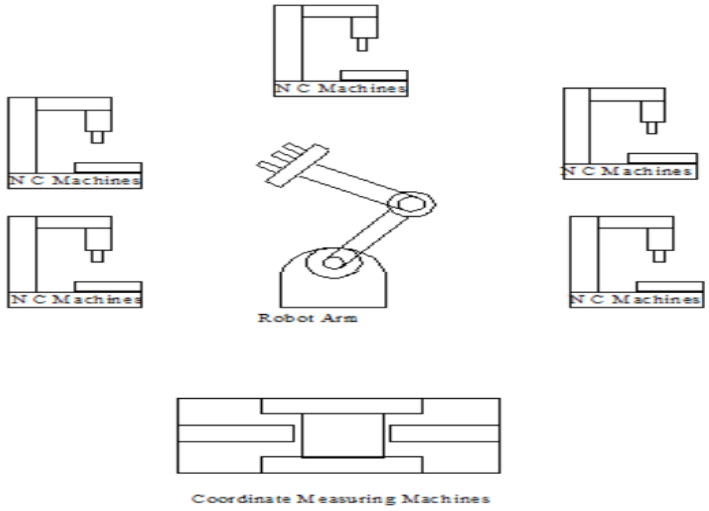


Fig. : Robot centered cell

ROBOTICS

A robot is a programmable device that consists of mechanical and electronic components and is used to perform various functions like material handling.

REASONS FOR USING ROBOTS

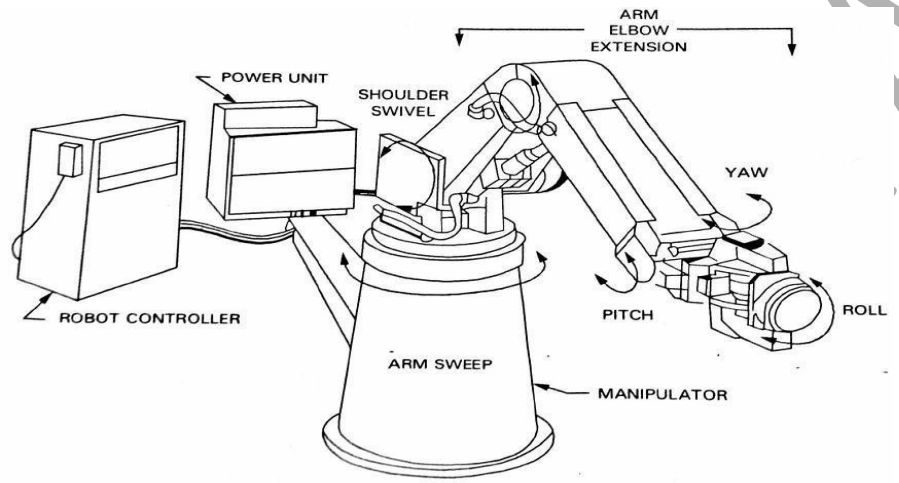
- It replaces human operators in dangerous workplaces.
- It strengthens and reaches requirements which are beyond the capacity of human operators.
- It eliminates errors due to tiredness and lack of concentration.

- Ability to be reprogrammed to perform a different task.
- It achieves unmanned operations during night shifts**.**

BASIC ELEMENTS OF ROBOTS

Although industrial robots may vary widely, they are all made up of the following components.

1. Manipulator
2. Controller
3. Sensors
4. End effectors
5. Power source

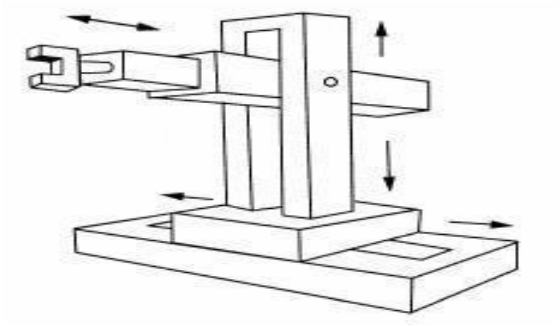


CLASSIFICATION OF ROBOTS

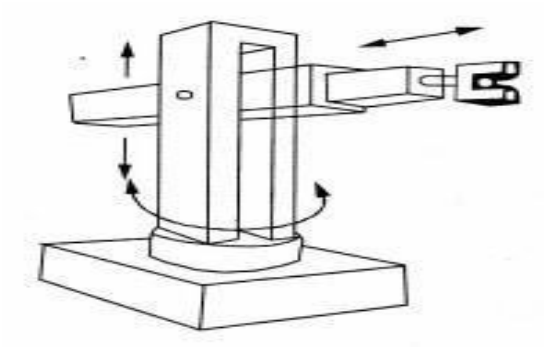
1. According to the type of control
   a. Point-to-point robots
   b. Continues robots
   c. Computed trajectory robots
   d. Servo-controlled robots
2. According to capability
   a. Sequence controlled robots
   b. Adaptive robots
   c. Intelligence robots
3. According to the configuration
   a. Cartesian robot
   b. Cylindrical robot
   c. Spherical robot
   d. Articulated robot
4. Based on manipulation function
   a. Pick and place robots
   b. Special purpose robots
   c. Universal robots

Classification of robots according to the configuration

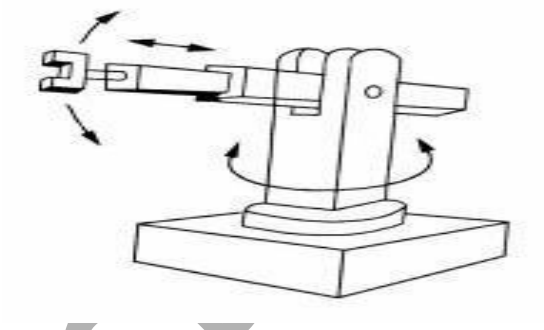
1. Cartesian robot:-Links has motion in 3 linear axis



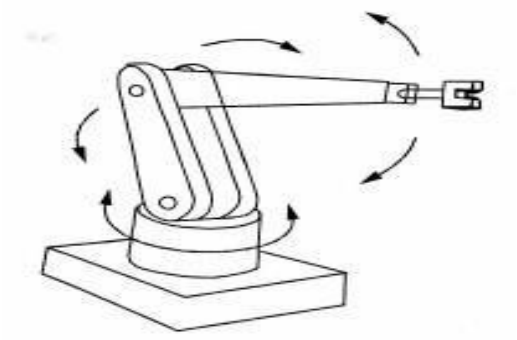
2. Cylindrical robot:-Links has 2 linear motions and 1 rotary motion



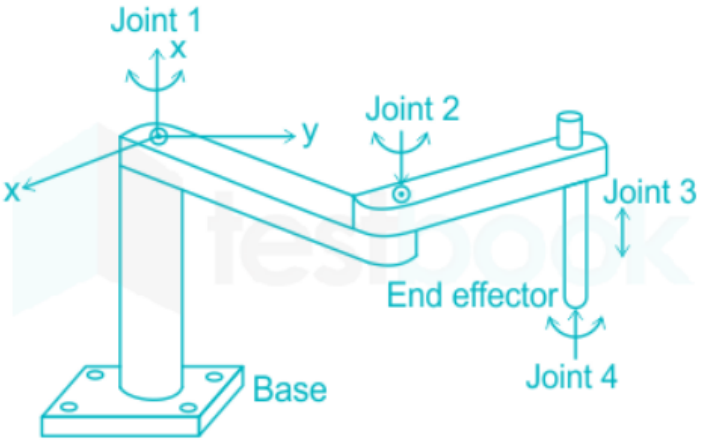
3. Spherical Robot:-Links has 1 linear motion and 2 rotary motions



4. Articulated robot:-Links has motion in 3 rotary axis's



5. SCARA Robot configuration



SCARA ROBOT

- SCARA is an acronym for **Selective Compliance Articulated Robot Arm**, meaning it is compliant in the X-Y axis, and rigid in the Z-axis. **It has 4 degree of freedom**
- The SCARA configuration is unique and designed to handle a variety of material handling operations.
- SCARA Robots are a popular option for small robotic assembly applications.
- The SCARA robot is most commonly used for pick-and-place or assembly operations where high speed and high accuracy is required.
- It has only one forward kinematic solution and two inverse kinematic solution.

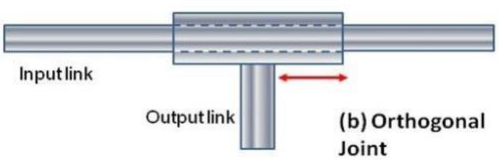
TYPES OF JOINTS

Joints are used to connect the links in the robot. And they provide relative motion between the links of the robot. Different types of joints are

1. Liner joint(L joint):-Permits linear sliding motion between 2 parallel links

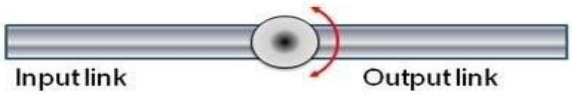
(a) Linear Joint

2. Orthogonal joint (O-joint):-Permits linear sliding motion between 2 links which are perpendicular to each other.



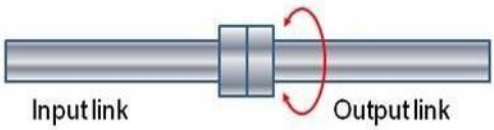
(b) Orthogonal Joint

3. Rotational joint(R-joint):-Provide rotational relative motion between 2 parallel joints



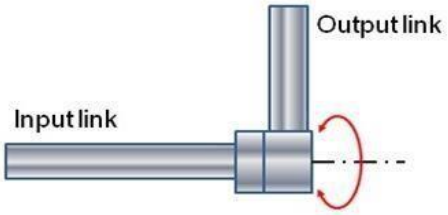
(c) Rotational Joint

4. Twisting joint (T-joint):-Permits rotary motion between links



(d) Twisting Joint

5. Revolving joint (V joint):-Permits motion between links which are perpendicular to each other



(e) Revolving Joint

Robot can be divided into two parts:

1. Body and arm assembly 2.Wrist

Each of the above has 3 degrees of freedom obtained by combination of the 5 types of joint.

A manipulator having 5 degrees of freedom could be ***TLR-TR***

END EFFECTORS

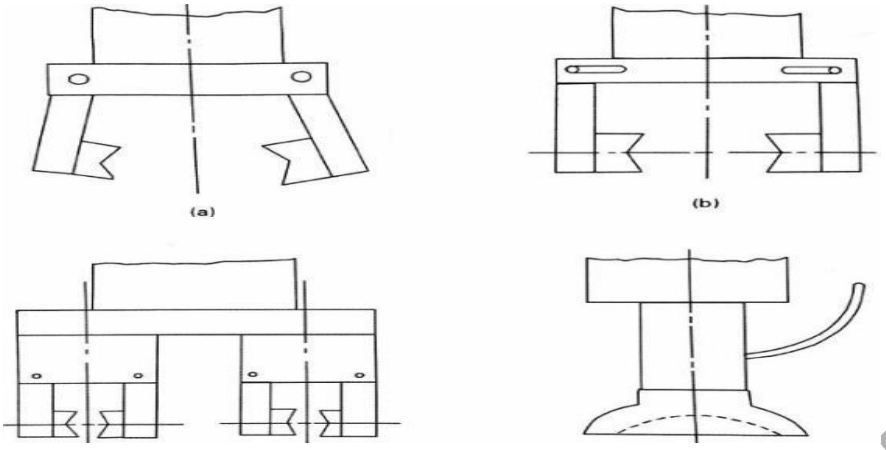
An end effector is attached to the robot's wrist to perform specific tasks such as handling of parts, tools and welding torches. They may be classified as

1. Grippers 2. Tools

Grippers are used to hold either work piece or tool.

Tools are directly attached to the robot wrist and become the end effector.

DIFFERENT TYPES OF END EFFECTORS



ADVANTAGES OF ROBOTS:

1. Can eliminate human errors

2.Can used in dangerous working conditions

3.Reduce wastage

4.Improve the productivity

5.Increase product quality

6.Improve flexibility

APPLICATIONS OF ROBOTS

- Material handling
- Machine loading application
- Spray painting application, Welding application
- Machining operations, Assembly of parts
- Inspection purpose, Automotive and air space industry
- Logistics & Storage