Assignment - I

1) Explain the advantages and dis-advantages of using robotes in industries.

Ans:-

Advantages:

* Increased productivity:- Robots can work continuously without breaks, enabling around the clock operations. This significantly boosts production output compared to human workers who require rest and shift changes.

* consistency and precision:- Robots perform tasks with high accuracy and precision, ensuring consistent quality of products. This reduce wastage and improves overall product quality.

* work in hazardous Environments:- Robots are often deployed in dangerous conditions, such as high temperature toxic environments, or in handling hazardous materials, where human safety is a concern.

* flexibility in Reprogramming:- modern robots can be reprogrammed to handle different tasks, making them versatile and adaptable to new manufacturing processes.

Disadvantages:

* High initial cost:- Setting up robotic systems require significant capital investment. Purchasing the robots, installation, and setting up proper safety systems can be expensive.
* Job Displacement:- The automation of tasks traditionally performed by humans can lead to job losses, especially in certain industries. This may contribute to economic and social issues.
* Technical Expertise Required:- Robots need skilled technicians for programming, maintenance, and troubleshooting. These workforce must be trained to manage these tasks, which requires additional resources and time.
* Limited flexibility:- While robots excel in repetitive tasks, they may struggle with tasks requiring human intuition, creativity or adaptability in dynamic environment. Complex decision making and tasks with significant variability are challenging for robots.

Q: Discuss the five common robot configurations with their sketch.

1) Cartesian Robot:-

* It is also known as rectilinear robot and X-Y-Z robot. It consists of three sliding joints, two of which are orthogonal O-joints
* Number of Revolute joints Nil.
* Number of Prismatic joints Three (X-Y-Z)
* Example PS-I robot - IBM's
* Type of work space rectangular

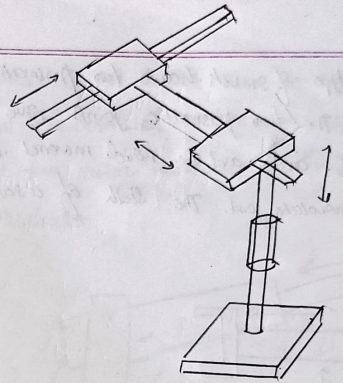
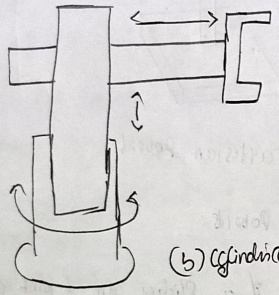


Fig: Cartesian Robot

2) Polar Configuration Robots:-

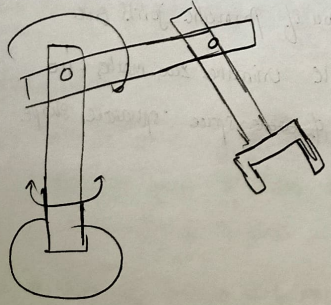
* It consists of a sliding arm L-joint, actuated relative to the body, which rotates about both a vertical axis (T-joint) and horizontal axis (R-joint)
* Number of Revolute joints Two,
* Number of Prismatic joints one
* Example Unimate 2000 models - 110
* Type of work space spherical shape

2. Cylindrical Robot:- This type of robots have two prismatic joints and one revolute joint. The two prismatic joints give linear movements about any two axes and the third movement obtained is produced by the revolute joint. The sketch of a SCARA robot is given

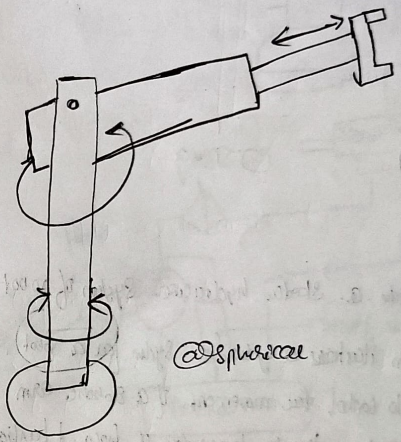


(b) Cylindrical

3. Articulated / Anthropomphic Robot: The Robots of this type have three revolute joints giving three rotary movements resembling the human hand

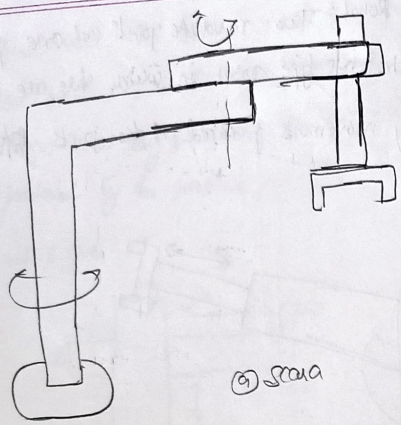


+ Spherical (2 RP) Robot:- Two revolute joints and one prismatic joint characteristic this type robot in which there are one linear and two rotary movements produced at the joints refer for the illustration



(a) Spherical

+ SCARA (Selective Compliance Assembly Robot Arm): This is specially configured robot which has two horizontal and parallel revolute joints which have vertical and one prismatic joint which can move the arm vertically up and down. This finds use in assembly operations. Shown schematic of the SCARA robots



(a) SCARA

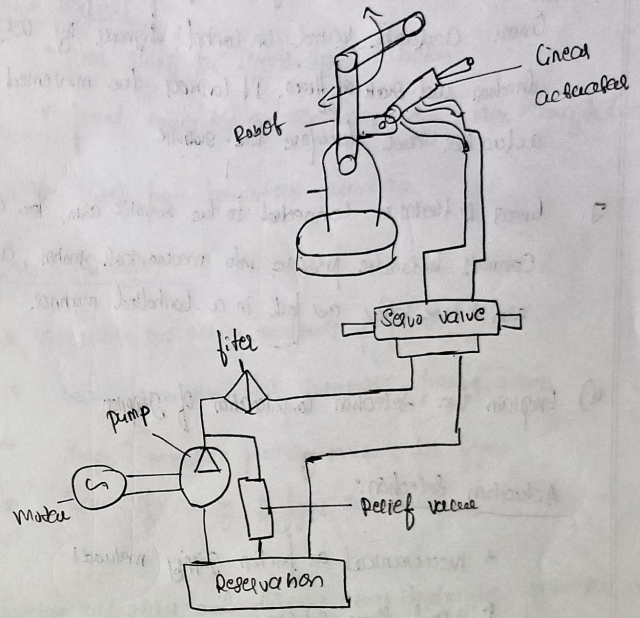
(3) Explain with a sketch hydraulic system of robot

This diagram illustrates a hydraulic system for a robot, using hydraulic components to control the movement of a robotic arm. Key components include a reservoir, pump, motor, filter, relief valve, servo valve, and linear actuators, which work together to control the robot's movements.

1) Reservoir:- This component stores hydraulic fluid. Fluid is essential for transferring energy throughout the system.

2) Pump:- Driven by a motor, the pump draws fluid from the reservoir and pressurizes it. This pressure generates the necessary force to move the robotic arm.

3) Motor:- The motor powers the pump, helping it circulate hydraulic fluid through the system.



(b) hydraulic system for Robot

4) filter:- The filter ensures that only clean hydraulic fluid enters the system by removing any impurities, which prevents damage to the system components.

5) Relief valve:- This valve control the maximum pressure within the system to prevent overload and damage. If the pressure exceeds a certain limit the valve releases excess fluid back to the reservoir.

6. Servo valve:- This valve regulates the speed flow to the linear actuator based on control signals. By adjusting the direction and rate of flow. It controls the movement of the actuator and therefore the robot.

7. Linear Actuator:- connected to the robotic arm, the actuator converts hydraulic pressure into mechanical motion, allowing the arm to move back and forth in a controlled manner.

4) Explain the Selection Consideration of Gripper:

Actuation Selection:-

* mechanical or friction gripping methods
* pad shape selection
* vaccum actuation
* magnetic gripping
* Adhesive gripping

Drive Selection:-

* pneumatic drive systems.
* Hydraulic drive system for heavy duty operation
* Speed reduction of the mechanical transmission

* protection selection
  * Heat sweld for sensors and actuators
  * forced cooling by air or water cooling to take away the heat
  * sweld from hazardous chemicals.
* Process Selection
  * Accurate processing methods for fingers.
  * leak prevention for pneumatic gripper actuators
  * Shape compatible processing methods for fingers.
  * Ease of assembly of fingers and linkages

(5) Explain actuators and discuss about hydraulic actuators used in a robot system:

* Actuators: are devices used in robotics and mechanical systems to convert energy into motion. they play a crucial role in controlling movement by providing the force necessary to move manipulate objects. Actuators respond to control signal like electrical current - hydraulic pressure or pneumatic pressure, to perform specific tasks, common types of actuators include electric, pneumatic and hydraulic actuators, each having unique application based on power needs, control precision and environmental considerations

Hydraulic Actuators:

The hydraulic actuators receive pressurised hydraulic oil with controlled direction and pressure through a system known as "power parts". The speed and volume flow rate are also controlled by the elements of the power train. The produces linear motion the hydraulic cylinders are used and hydraulic motors are used produce rotational movements. A list of almost of a hydraulic power pack along with their function are given here

* Reservoir or tank: Stores and supply hydraulic oil to the system in a closed circuit.
* Hydraulic pump: Receives oil from the reservoir and pressurises the oil in accordance with its capacity.
* Electric motor: Receives electric current from mains and provides rotational movement to the pump.
* Valves: Control the direction of flows, regulate the pressure and provide safety to the system

Discuss the impact of robotics on direct labour

* A robot performing multiple tasks can be a substitute for more than one human workers leading to the displacement. Shift of direct labour to indirect labour activities and change in strategy in the appointment of new workers.
* The set up of the work space and operating the robots need the education and training the direct labour in conversion to indirect labour which involves diversion from direct manual participation in the production work performed.
* The change from direct to indirect jobs is sequential removal of skill, monotony and organisation of activities in the conventional work area occupied by non-robotic machines
* The new workers appointed in a robot installed industries need to be knowledgeable in installing, programming, inspecting, house keeping and maintenance of the industrial robots.
* The knowledge content, the technological skill and the education standard of the operator has to be improved as the experience needed in a robotic cell has to be considered

11. Discuss force analysis of grippers mechanism in detail.

A gripper mechanism consisting of fingers, linkages, frame and a pneumatic cylinder is Air pressure supplied to the cylinder aids in actuating the fingers to grab an object with a gripper force P_3, P_4.

If the mass of the object is 'm' and 'g' is gravity acceleration

The force due to mass = mg = W newtons

The friction between the fingers pads is responsible for the gripper to hold the object counting the force W

The friction force is given by:

$$f = \mu N P_g$$

μ: coefficient of friction

N = the number of fingers

Due to the unloading of circumstances the capacity the finger load is increased due to incorporate a safety by a factor of safety n.

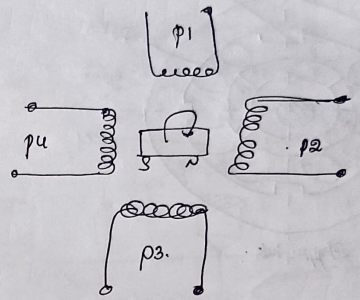
$$F_d = \text{design force} = n.W$$

Equating equation (8.15) $\Rightarrow$ $n.W = \mu N P_g$

$$P_g = \frac{n.W}{\mu.N} = \frac{n.mg}{\mu N}$$

$$P_g = \frac{n.m(g+a)}{\mu N}$$

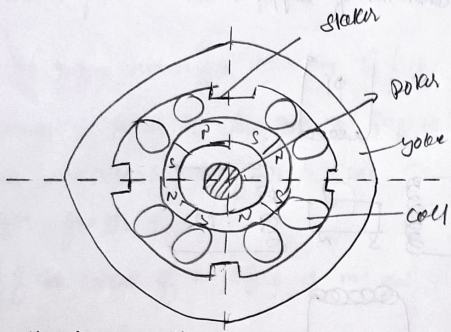
10. Describe the construction of Stepper motor



(a) Schematic of stepper motor

* The stepper motor are unique type of motor that produces rotational movement in the form of finite equal steps. The intermittent electrical pulse make the stepper motor shaft to rotate in steps.

Eg. Discuss the schematic arrangement of the stepper motor principle. The stator in this case is made up of four electromagnetic poles. The rotor is a permanent magnet with two poles N and S, when the excitation of pole 2 (P_2) is equal to P_3 pole the magnetic nature of the rotor by 90 clockwise. By continuous change in excitation in the order P_2-P_3-P_4-P_1-P_2 the clockwise rotation is produced in the shaft of the rotor. which results in continuous movement



Multiple pole stepper motor.

(13) Explain performance parameters used to describe a servo describe repeatability resolution and accuracy

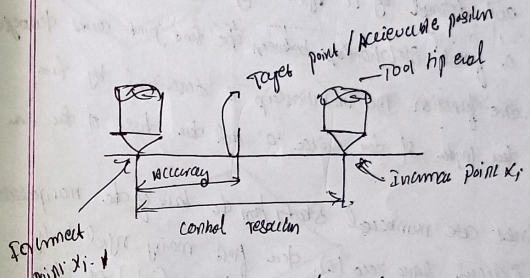
* **Accuracy:** Accuracy refers to how close a measurement is to the true value or standard. It's the degree to which the result of measurement conforms to the correct value or standard

* **Repeatability:**

Repeatability is the ability of a measurement system to give consistent results for the same input under the same conditions. It refers how much the measurements vary when repeated several times. High repeatability means the results are consistently close to each other

3. **Resolution:**

Resolution is the smallest detectable change in the measured quantity that the system can reliably display. A high-resolution system can detect very minute changes in the input.



Representation of control resolution and accuracy

14 Short notes on

* robot links

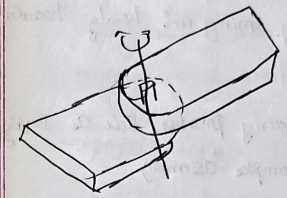
The two adjacent joint axes of a robotic manipulator are connected and defined by a rigid body called "link" which maintains a fixed relationship between the two joint axes through a kinematic function. The relationship is described by two variables - link length of the link 'a' and the twist of the link

The links are numbered starting from the base of the manipulator which is called link zero (0). The first moving rigid body is link 1. Between the joint axes i and (i-1) the link is numbered (i-). A general link is represented.

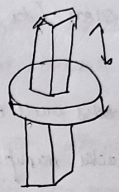
* joints in robots:

The relative motion featured by the study action between the two surfaces describes the characteristic connection known as the 'lower pair'. The lower pair formed between two links is termed as joint. The motion in the joint can be translatory as prismatic/ rotational. About or along the certain axes. The joints can exhibit one or more relative motion/ at a time, depending on

these they are classified into following categories

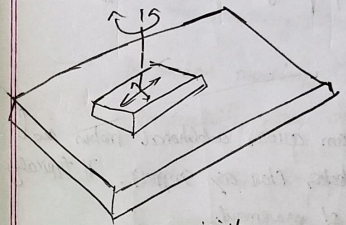


(a) Revolute pair

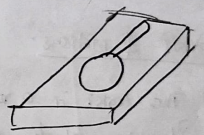


(b) prismatic pair

c. cylindrical pair



planar joint



(d) Spherical joint

(3) Need for Robot:

The need of robots arises from their ability to perform repetitive, hazardous, and precision-based tasks with high efficiency, speed and accuracy by reducing incurable

→ Efficiency and productivity. Robots can work continuously without fatigue, significantly increasing production rates

- Safety: Robots can handle dangerous tasks, reducing human exposure to risks in areas like manufacturing, mining and handling hazardous materials
- Precision: Robots excel at tasks requiring precision, such as surgery, semiconductor manufacturing and complex assembly
- Labor shortage Solutions: In industries facing labor shortages, robots help bridge gaps by performing routine or difficult jobs

(4) Levels of motions:

The wrist in a robotic arm allows additional motion and flexibility at the end effector, like a gripper. It typically provides three main type of movement.

Yaw - Side-to-side rotation

Pitch - Up-and-down rotation.

Roll - Twisting or rotating around the main axis of the first. These motions allow robots to position and orient tools or objects precisely, essential in applications like assembly lines, painting and precision machining

(5) Management of Robotics

Management in robotics involves overseeing the development, deployment and maintenance of robotic systems in an organization. It covers areas such as.

→ Project planning:- Ensuring robots are integrated seamlessly into existing processes or developing new processes around robotics

→ Resource allocation:- Budgeting, training staff and setting up the necessary infrastructure.

→ Performance monitoring:- Tracking efficiency, effectiveness and productivity gains achieved through

→ Ethical and Social Considerations:- Managing the impact of robotics on employment, privacy and safety. Robotics management ensures robots align with the strategic objectives of a business, enhancing overall efficiency and adaptability