EE 2023 ROBOTICS AND AUTOMATION
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Two Marks Questions & Answers

UNIT I

1. What is a robot?

An industrial robot is a general purpose robot which possesses certain anthropomorphic or human like characters such as their movable arms.

2. State the Asimov's laws of robotics.

(i)   A robot may not injure a human being or through inaction allow a human to be harmed.

(ii)   A robot must obey orders given by human to be harmed.

(iii)   A robot must its own existence unless that conflicts with first or second law.

3 What are the technical features to be considered while designing a robot?

- Robot anatomy
- Work volume
- Drive systems
- Control systems and dynamic performance
- Precision of movement
- End factors
- Sensors
- Robot programming and work cell control
- Applications

4. What is a robot anatomy?

Robot anatomy is concerned with physical construction of body, arm, and wrist of machine. The body, arm, wrist assembly is called the manipulator.

5. What are the configurations of a robot?

(i)   Polar configuration

(ii)   Cylindrical configuration

(iii)   Cartesian configuration

(iv)   Jointed arm configuration

6. Define robot motion.

Robots are defined to perform productive work. This is accomplished by enabling the robot to move its body, arm and wrist through a series of motions or positions.

7. What are the three degrees of freedom related to robot?

They robot movements can be divided into two general categories:

- Arm and body motions
- Wrist motions

They are termed as degrees of freedom:

1. Vertical traverse
2. Radial traverse
3. Rotational traverse

8. Define Work Volume.

The Work Volume of the manipulator is defined as the envelope or space within which the robot can manipulate the end of its wrist.

9. Define control system of a robot.

Control systems are an integral part of a work cell or large complex of equipment and have the primary purpose of controlling, monitoring, analyzing, or measuring a process or other equipment.

Control systems of a robot is concerned with the manipulator of a robot which moves its arm, wrist and end-effectors after it receives signals from the controller in the same way a man moves his arm or his body according to the signals sent by the brain. So the controller acts as a brain of the robot.

Control systems in a robot may be of two types (i) open loop and (ii) closed loop systems.Control may again be grouped as (i) non-servo and (ii) servo systems.

10. What are the types of robot control (or) What are the main basic control actions used in robot?

- Limited-sequence robot.
- Playback robot with point-to-point control.
- Playback robot with continuous-path control.
- Intelligent robots.

11. What is an intelligent robot?

An intelligent robot is one robot that exhibits a behavior that makes it seem intelligent. They possess the capability not only to play back a programmed motion cycle but also to interact with its environment in a way that seems intelligent. They make decisions when things go wrong during the work cycle, communicate with human beings, make computations during the motion cycle, and operate in response to advanced sensor inputs such as machine vision.

12. What is meant by degrees of freedom?

The individual joint motions associated with the two motions (arm and body motions and wrist motions) are known as degrees of freedom.

13. What are the various generations of robot?

- First generation robots (e.g.) mechanized dolls.
- Second generation robots (e.g.) Programmable machine such as UNIMATE
- Third generation robots (e.g.) Intelligent robot such as SCARA

14. Define Robotics and Robot.

Robotics is the technology which deals with robots. According to the Robotics Industries Association, "An industrial robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or special devices through variable programmed motions for the performance of a variety of tasks".

15.What is mean by automation?

Automation is a technology that is concerned with the use of electronic mechanical and computer based system in the operation control and production.

16.Write are the Benefits of industrial automation?

- Improved product quality
- Improved safety
- Increased manufacturing flexibility
- Improved operation reliability
- Improved decision making

17. What is mean by workspace?

The space in which the end point of the robot arm is capable of operating is called as a workspace in other words reachabillity of robot arm is known as workspace.

18. What is meant by work envelop?

The work envelop is described by the surface of the workspace.

19. What are the Advantages and disadvantages of robot?

Advantages

- Greater flexibility, reprogrammability, adjustable kinematics dexterity
- Greater response time to inputs than humans
- Improved product quality
- Maximize capital intensive equipment in multiple work shifts.

Disadvantages

- Replacement of human labour
- More unemployment
- Significant retraining costs for both unemployed and users of new technology
- Advertising technology does not always disclose some of the hidden disadvantages

20. What are the limitations of robot?

Assembly dexterity does not match that of human beings, particularly where eye-hand coordination required.

- Payload to robot weight ratio is poor, often less than 5%
- Robot structural configurations often constrain joint limits and thus the work volume
- Work volume can be constrained even further when parts of substantial size are picked up when tooling/sensors added to the robot
- The robot repeatability and/or accuracy can constrain the range of potential application

PART-B

1.Explain with neat sketches five important robot configurations.

2.Explain the following terms : (i) Accuracy (ii) Degree of freedom
(iii) Repeatability (iv) Speed

3. a) What are 'human form' robots? State 3-laws of Asimov on robots.
   b) Sketch 6- degree freedom robot and state important parts and their functions.

4.(a) What is a robot? Describe the function of the basic components of a robot.
  (b) Discuss the reasons for using a robot instead of a human being to perform a specific task.

5.(a) How do you specify a robot? Is robotics automation? Discuss the different classification systems of robots.
  (b) Discuss the differences between servo controlled and non-servo controlled robots. Sketch and explain the servo control system for point to point positioning.

6. (a) Define automation. Distinguish between fixed automation and programmable automation.
   (b) Give the classification of industrial robots based on their control systems. Discuss in detail the play back robots with continuous path control and intelligent robots.

7.(a) Compare the various attributes of robot with those of human being. Explain a robot structure with a sketch.

(b) What are the various types of joints used in robots? Sketch the following robots indicating the joints and degree of freedom. (i) SCARA robot.(ii) Gantry robot.

8. (a) Discuss the anatomy of robot and explain the important parts o a robot with a neat sketch.

(b) State the Asimov's laws of robotics and how do you specify a robot.

9. (a) Explain the terms Resolution, Accuracy, Repeatability, Pay load and Work Volume of an industrial robot.

(b) Explain the different types of manipulator configurations with neat sketches.

10. (a) Using neat sketches , describe the following four robot configurations
Polar configuration, cylindrical configuration, Cartesian co-ordinate configuration and jointed arm configuration. State the relative merits of these four configurations.

(b)Describe the dynamic stabilization of a robot body.

(c) Sketch and explain the servo controlled robotic system and how it is different from feed forward servo.

UNIT II

1. Define robot drive system.

The robot's capacity to move its body, arm and wrist is provided by the drive system which is used to power the robot. It determines   (i) the speed of arm movement
                  (ii) Strength of robot
                  (iii) Dynamic performance

2. What are the types of robot drives?

- Hydraulic drive
- Electric drive
- Pneumatic drive

3. What is a hydraulic drive?

It is associated with larger robots such as Unimate 2000 series. They are designed to actuate either rotational joints or linear joints.

4. What is a pneumatic drive?

It is designed for smaller robots that possess fewer degrees of freedom (2 to 4 joint motions). They are limited to simple pick- and –place operations with fast cycles.

5. What is an electric drive?

They do not provide as much speed or power as hydraulic systems. Accuracy and repeatability are better. They are actuated by dc stepping motors or dc servomotors.

6. What is an actuator?

Actuator is a device in robots that converts electric, hydraulic, or pneumatic energy into motion.

7. State the merits and demerits of hydraulic actuators.

Merits:
- Greater speed.
- Greater strength.

Demerits:
- Adds to the floor space required by the robot.
- Oil leak in them is a nuisance.

8. What are the factors that determine the load carrying capacity of robot?

- Size
- Configuration
- Construction
- Drive system

9. Give the classification of a robotic sensor.

Types of contact type robotic sensors include:

- Force sensors
- Torque sensors
- Touch sensors
- Position sensors

Types of non-contact type robotic sensors include:

- Electro-optical imaging sensors
- Proximity sensors
- Range imaging sensors

10. What is a tactile sensor?

Tactile sensors are devices which indicate contact between themselves and some other solid object; they can be divided into touch sensors and force sensors.

11. What is a Touch sensor?

Touch sensors are used to indicate that contact has been made between two objects without regard to the magnitude of the contacting force.

12. What is a force sensor?

Force sensors (also sometimes called stress sensors) indicate not only that has been made with the object but also the magnitude of the contact force between the two objects.

13. What is a proximity sensor?

Proximity sensors are devices that indicate when one object is close to another object.

14. What is range sensor?

Some of these sensors can be used to measure the distance between the object and the sensors and these devices are called range sensors.

15. What are miscellaneous sensors?

This includes the remaining types of sensors and transducer that might be used for interlocks and other purposes in robotics work cell. This includes devices with the capability to sense variables such as temperature, pressure, fluid flow and electrical properties.

16. What are the uses of sensors in robotics?

The uses of sensors can be divided into four basic categories:

- Safety monitoring
- Interlock in work cell control
- Part inspection for quality control
- Determining positions and related information about objects in the robot.

17. What do you mean by interlocks in work cell control?

Interlocks are used to coordinate the sequence the sequence of activities of the different pieces of equipment in the work cell.

18. What is an optical proximity sensor?

Optical proximity sensor can be designed using both visible and invisible (infrared) light sources. Infrared sensors may be active and passive.

19. What is an acoustical proximity sensor?

Ultrasonic frequencies (above 20,000Hz) are often used in acoustic devices because the sound is beyond the range of human hearing one type of acoustical proximity sensor uses a cylindrical open –ended chamber. The emitter sets up a pattern of standing waves in the cavity which is altered by the presence of an object near the open end. A microphone located in the wall of the chamber is used to sense the change in the sound pattern.

20. What is eddy current proximity sensor?

Eddy current devices create a primary alternating field in the small region near the probe. This field induces eddy current in an object placed in the region so long as the object is made of a conductive material. This eddy current produces their own magnetic field which interacts with the primary field to change its flux density. The probe detects the change in the flux density and this indicates the presence of the object.

PART-B

1. (a) What are the types of hydraulic actuators used in robotics? Explain their characteristics?

   (b) Compare stepping motors with dc servomotors as robot drives.

2. (a) Explain the following sensors used in robots (i) Range sensor (ii) Proximity sensor.

   (b) How do you sense the positional accuracy of a robot? What is the suitable type of sensors to measure the position? Explain.

3. Explain the principle of working of the following sensors used in robots:

   (i) Tactile sensor (ii) Magnetic sensor.

4. What is Machine vision? Explain the techniques of image processing.

5. (a) Distinguish between shunt wound motor and series wound motor. Sketch and explain the principle of operation of stepper motor.

   (b) Distinguish between tactile and non-tactile sensors. Sketch and explain the working of an acoustic sensor.

6. Discuss in detail about photo detector tactile sensors with neat sketches.

7. What is robot vision? Describe a vision sensor used to take the image of an object.

8. Explain with a neat sketch principle of working of a harmonic drive.

9. Explain how proximity and range sensors can be built using (i) optical devices (ii) Acoustical devices and (iii) eddy current devices.

10. Write short notes on the following: (i) Fiber optic sensors (ii) Selection of robots.

UNIT III

1. What is a joint?

A joint is a part of manipulator which provides relative motion between various components of the body, arm and wrist assembly.

2. What is a link?

Connecting the various manipulation joints together are rigid members that are called links.

3. What is orientation?

The robot must have a precise pick up location to get the parts from the conveyor or other work handling system. At this pick up point, the parts must be in a known orientation to enable the robot to grasps hold it consistently and accurately.

4. What are three common types of motion?

- Slew motion
- Joint-interpolated motion and Straight line motion

5. State the advantages of joint interpolated motion over slew motion?

The advantages of joint interpolated motion over slew motion are that the joints generally drive at less than their respective maximum velocities, thus reducing maintenance problems for the robot.

6. What are the advantages of slew motion?

Slew motion generally results in unnecessary wear on the joints and after that leads to unanticipated results in terms of the path taken by the manipulation.

7. Define the end of arm position in the world space.

Defining the arm position in the world space involves the use of a Cartesian coordinate system that is external to the robot. The end arm position would be defined in the world space as $P_w = (x, y)$.

8. What is manipulator dynamics?

Manipulator dynamics is associated with the precise control of each joint in order to obtain the accurate control of the manipulator. It deals with the forces and inertias reflected at each joint.

9. What is robot arm dynamics?

It is concerned with the analysis of torques and forces due to acceleration and deceleration.

10. What is an end effector?

An end effector is a device which is attached to the wrist of the robot arm and enables the robot to perform a specific task.

11. What are the types of end effectors?

The types of end effectors are (i) Grippers – Single and double grippers (ii) Tools.

12. What are the various types of grippers?
- Mechanical Gripper
- Vacuum cups
- Magnetic Grippers
- Adhesive Grippers
- Hooks, Scoops and other miscellaneous devices.

13. What is a vacuum gripper?

Vacuum grippers are those which use suction cups for handling certain types of objects.

14. Give the advantages of vacuum cup/ suction grippers.
- Requires only one surface of the part for grasping.
- Applies a uniform pressure distribution on the surface of the part.
- Relatively light-weight gripper.
- Applicable to a variety of different materials.

15. Mention the advantages of magnetic grippers.
- Pickup times are very fast.
- Variations in part size can be tolerated. The gripper does not have to be designed for one particular work part.
- They have the ability to handle metal parts with holes.
- They require only one surface for gripping.

16. Give the disadvantages of magnetic grippers.
- Residual magnetism remaining in the work piece causes a problem in handling and limits precision.
- Only one sheet can be picked up from a stack.

17. What is a magnetic gripper?

A magnetic gripper is one which uses a permanent magnet for handling ferrous materials.

18. What are the tools used as end effectors in robot applications?
- Spot-welding tools
- Arc-welding torch
- Spray-painting nozzle
- Rotating spindles for drilling, routing, wire brushing, grinding.
- Liquid cement applications for assembly
- Heating torches
- Water jet cutting tool

19. What are the factors to be considered in the selection and design of grippers?
- Part to be handled such as weight and size, shape, tolerance, surface condition etc.,
- Actuation method
- Power signal transmission.
- Gripper force.
- Positioning problems
- Service conditions
- Operating environment

- Temperature protection
- Fabrication materials.

20. What is a manipulator?

The manipulator of an industrial robot is a series of joints and links which provides relative motion between the various parts.

PART-B

1. (a) Discuss the different types of mechanical grippers used on industrial robots.
   (b) Compare mechanical grippers with other types of grippers used in robots
2. Define the following terms and compare their characteristics:
   (i) End effectors (ii) Gripper (iii) Tool
3. (a) Distinguish between two-point and three-point centering of robot gripper. Explain any two types of grippers used for robots.
4. What is the function of a manipulator? Sketch and explain a robotic manipulator arm.
5. Explain the variable structure systems for the control of manipulators.
6. How is a robot end- effector specified? Discuss the deign considerations in the robot end- of the arm tooling.
7. What are the different types of actuators used for robots? Explain the working of a hydraulic actuator system.
8. Classify the robot end-effector from the view point of control. Sketch and explain a cam actuated gripper used for robots.
9. What is the function of a manipulator? Discuss the working of a robotic manipulator arm with a sketch.
10. Explain the principle of adhesive grippers. Write down a table depicting a checklist of factors in the selection and design of grippers.

UNIT IV

1. What is forward transformation?

Transforming from joint space to world space is called forward transformation.

2. What is reverse transformation?

Transforming from world space to joint space is called reverse transformation.

3. What is homogeneous transformation?

The homogeneous transformation is a 4 x 4 matrix which maps a position vector expressed in homogeneous coordinates from one coordinate system to another coordinate system.

4. State Lagrange-Euler formulation.

The Lagrange-Euler (L-E) formulation $\frac{d}{dt}\left[\frac{\partial L}{\partial q_i}\right] - \frac{\partial L}{\partial q_i} = \tau_i \quad$ i = 1,2,………,n

Where L= Lagrangian function = K-P

K= Total kinetic energy of the robot arm

P= Total potential energy of the robot arm

q_i = Generalized coordinates of the arm

q= First time derivative of the generalized coordinate q_i

τ_i = Generalized force (or torque) applied to the system at joint i to drive link i.

5. What are the generations of robot programming languages?

- First generation languages (e.g.,) VAL
- Second generation languages (e.g.,) AML,RAIL, MCL,VAL II
- Future generation languages (e.g.,) Model based languages and task object language.

6. What are the limitations of First generation languages?

- Inability to specify complex arithmetic computations.
- Inability to make use of complex sensors and sensor data.
- Limited capacity to communicate.

7. What are the features of second generation languages?

- Motion control
- Advanced sensor capabilities
- Limited intelligence
- Communications and data processing

8. What is the concept used in future generation languages?

"World modeling" is the concept used in future generation language. Using this concept the robot possesses knowledge of three- dimensional world and is capable of developing its own step-by-step procedure to perform a task.

9. What are the modes of operation in a robot language operating system?

- Monitor mode
- Run mode
- Exit mode

10. What are the methods of Robot programming?

- Lead through programming or Teach-by-showing method
- Textual robot programming

11. What is Lead through programming?

Lead through programming requires the programmer to move the manipulator through the desired motion path and the path is committed to memory by the robot controller. In Lead through programming, the robot is moved through the desired motion path in order to record the path into the controller memory.

12. What are the methods of accomplishing lead through programming?

- Powered lead through makes use of a teach pendant to control the various joint motors, and to drive the robot arm and wrist through a series of points in space.
- Manual lead through (walk- through method) is used for continuous-path programming where the motion cycle involves smooth complex curvilinear movements of robot arm.

13. What are the methods of defining positions in space in lead through programming?

- Joint movements
- x-y-z coordinate motions
- Tool coordinate motions

14. What are the reasons for defining points in lead through programming?

- To define a work position for the end effector.
- To avoid obstacles.

15. What are the types of interpolation schemes used in lead through programming?

- Joint interpolation.
- Straight line interpolation.
- Circular interpolation.
- Irregular smooth motions.

16. What is meant by branching in lead through programming?

Branching is method of dividing a program into convenient segments that can be executed during the program. A branch is nothing but a subroutine.

17. What are the limitations of lead through programming?

- Robot cannot be used in production while it is being programmed.
- As the complexity of the program increases, it becomes more difficult to accomplish lead through programming.
- Lead through programming is not compatible with computer based technologies such as CAD/CAM, data communication networking and integrated manufacturing information systems.

18. What is textual programming?

In textual programming, it uses a textual language to define the logic and sequence of the program, while the specific points locations in the workspace are defined using teach pendant control.

19.List out basic modes of operation in robot language structure.

The three basic modes of operations are

- Monitor mode
- Run mode
- Edit mode

20.State that robot language element.

- Constant, variables
- Motion command
- End effector and sensor command
- Computation and operations.

PART-B

1. Explain the characteristics of the solution to the inverse kinematic problem.
2. Classify various teaching methods of robot and explain briefly each of them.
3. Discuss the geometry based direct kinematic analysis of articulated robot.
4. What is homogeneous transformation (HT) of coordinates? Write the Homogeneous transformation matrices for (i) Translation in 3D space. (ii) Rotation in 3D.
5. Classify various teaching methods of robot and briefly discuss about each of them.
6. Write the homogeneous transformation matrix for a rotation of 90 degrees about the z axis followed by a rotation of 90degrees about the axis, followed by a translation of (3, 7, 9).
7. What are the various inputs to an inverse kinematics algorithm? Explain functioning of an inverse kinematic algorithm.
8. Explain the geometric based direct kinematic analysis of articulated robot.
9. What is a Jacobian work envelope? Explain in brief.
10. What are the advantages and disadvantages of off-line programming? Name four of the well known off-line programming systems.

UNIT V

1. What is machine interference?

When two or more machines are serviced by one robot, idle time is experienced by one or more machines while another machine is being serviced by the robot. This is called machine interference.

2. What is meant by interlock in robot cell design?

An interlock is a method of preventing the work cycle sequence from continuing unless a certain condition or a set of conditions are satisfied.

3. What is a Programmable controller?

A Programmable controller is a digitally operating device with programmable memory capable of generating output signals according to operations and other functions performed on input signals.

4. What are the major groups of Robot Time and Motion (RTM)?

- Motion elements
- Sensing elements
- End effector elements
- Delay elements

5. What are the considerations in work cell design?

- Changes to other equipment in the cell.
- Part position and orientation.
- Part identification problem.
- Protection of robot from its environment.
- Utilities.
- Control of work cell.
- Safety.

6. What is a mobile robot?

The third category of robot cell design, is one in which the robot is capable of moving to various pieces of equipment within the cell. This is typically accomplished by mounting the robot on a mobile base which can be transported on a rail system. The rail base systems used in robot cells are either tracks fastened to the floor of the plant or overhead rail system.

7. Name some of the considerations in robot material handling.

- Part positioning and orientation.
- Gripper design
- Robot work volume
- Robot weight capacity
- Accuracy and repeatability
- Robot configuration, degrees of freedom and control.

8. What do you mean by pick and place operation?

Pick and place operation involve tasks in which the robot picks up the part at one location and moves it to another location.

9. What is meant by machine loading and unloading?

The robot must load the raw work part or raw material into the machine but the part is ejected from the machine by some other means. The machine produces finished parts from raw materials that are loaded directly into the machine without robot assistance. The robot unloads the part from the machine.

10. What is palletizing and related operation?

The use of pallets for materials handling and storage in industry is widespread. Instead of handling individual cartons or other containers, a large number of these containers are placed on a pallet and the pallet is then handled.

11. What is stamping press operation?

Stamping press operation is used to cut and form sheet metal parts. The process is performed by means of a die set held in a machine tool called a press.

12. How robot is used in spot welding?

Spot welding is a process in which two sheet metal parts are fused together at localized points by passing a large electric current through the parts where the weld is to be made. Robots have been employed on this type of production line, where a welding gun is attached as the end effector to each robot wrist and the robot is programmed to perform a sequence of welds on the product as it arrives the work station.

13. How robot is used in continuous arc welding?

Arc welding is a continuous welding process as opposed to spot welding which might be called a discontinuous process. The arc from the welding process emits ultraviolet radiation which is injurious to human vision. The robot is equipped with a welding rod wire feed system and the required power source to provide the electrical current for the operation.

14. How robot is used in spray coating?

Spray coating operations to which robots have been applied include painting of car bodies, engines, other components in the automotive industry. In most robot spray- coating application, the robots are usually part of a system that includes a conveyor for presenting the parts to the robot and a spray booth for shielding the spraying operation from the factory environment.

15. What are the problems faced by robot in arc welding?

Arc welding is often performed in confined areas that are difficult to access such as the inside of tanks, pressure vessels and ship hulls where human can position them into these areas whereas robot cannot.

16. What is a bowl feeder?

Bowl feeders are the most commonly used devices for feeding and orienting small parts in automated assembly operation.

17. What is a magazine feeder?

The use of magazine feeders is one technique in which pre oriented parts can be received at the work station. For example in a sheet metal stamping operation, the parts always

come out of the pres in the same way. It is therefore possible to load the stamped parts one on top of the next in the same orientation into some kind of tube or other container. This container would constitute the magazine.

18. What is a parallel assembly system?

In parallel assembly system, the work can be either of two or more routes to have the same operation performed. The use of two parallel stations effectively halves the cycle time which doubles the production rate.

19. What is a vision inspecting system?

Robotic vision systems are capable of analyzing two-dimensional scenes by extracting certain features from the images. It includes part location, part identification etc.

20. What is robot manipulation inspection?

This method of robotic inspection involves the robot moving an inspection or testing device around the part or product.

PART-B

1. What are the various applications of robots in hazardous areas? Discuss them in detail.
2. Explain the concept of tracking window in in-line robot work cell.
3. What is a robotic work cell? Explain the design considerations of a robotic cell.
4. Explain the non-manufacturing areas of application of industrial robots.
5. Discuss economic analysis as applied to industrial robots.
6. Why is it that a robot used for die-casting application cannot be used for welding?
7. Write down a sample form that can be used to compare application features against robot technical specifications and with the help of a suitable example, explain how a robot can be selected for a given application.
8. What are the technical problems encountered in applying robots to arc welding? Describe the features of a welding robot.
9. Explain briefly about robot spray coating.
10. What is a robot cell? Discuss the popular robotic cell layouts.