KNOWLEDGE INSTITUTE OF TECHNOLOGY

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Department of Mechanical Engineering

Question Bank

ROBOTICS

Department of Mechanical Engineering

UNIT I FUNDAMENTALS OF ROBOTS

Part-A Questions

1. Define a Robot. **(AU-Nov/Dec-2010)**

RIA defines a robot as a ―programmable, multifunction manipulator designed to Move materials, parts, tools or special devices through variable programmed motions for the performance of the Variety of tasks.

2. Explain the types of rotary joint notations **(AU-Nov/Dec-2008)**

- Rotational joint (type R)
- Twisting joint (type T)
- Revolving joint (type V)

3. What is meant by Work space? **(AU-Nov/Dec-2010)**

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

4. What is meant by accuracy of robot?

The robot_s ability to reach a reference point within the robot_s full work volume is known as accuracy of robot.

5. What are the benefits of industrial robots?

- Increased Productivity
- Significant Savings
- Improved Quality
- Better Safety
- Competitive Edge

6. What is repeatability of robot?

Repeatability refers to robot_s ability to return to the programmed point when it is commanded to do so.

7. What is meant by pitch, yaw and roll? **(AU-Nov/Dec-2008)**

Pitch is rotation around the X axis, yaw is around the Y axis, and roll is around the Z axis. Yaw is side to side swinging around an axis. Pitch is up and down movement about an axis and roll is rotatory motion about an axis.

8. What is work volume? **(AU-Nov/Dec-2008)** The volume of the space swept by the robot arm is called work volume.

9. What is meant by Quality of robot?

A Robot is said to be high quality when the precision and accuracy is more.

10. What is meant by robot anatomy? **(AU-Nov/Dec-2009)**

Study of structure of robot is called robot anatomy. Manipulator is constructed of a series of joints and links. A joint provides relative motion between the input link and the output link.

11. What are the three degrees of freedom associated with the arm and body motion?

- Right (or) left movement (X-axis motion) **(AU-Nov/Dec-2009)**
- In and out movement (Y-axis motion)
- Vertical movement (Z-axis motion)

12. Define an Industrial Robot. **(AU-Nov/Dec-2010)**

An industrial robot is an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes. A programmable mechanical device that is used in place of a person to perform dangerous or repetitive tasks with a high degree of accuracy.

13. Define payload capacity of Robot? **(AU-Nov/Dec-2010)**

The maximum load which can be carried by the manipulator at low or normal speed.

14. Define base and tool Coordinate system. **(AU-Nov/Dec-2012)**

A tool coordinates definition system capable of easily obtaining a

transformation matrix for defining a tool coordinates system of a robot. The tool coordinates system at the 0° position of the robot is rotated around each axis so that the tool coordinates system becomes parallel to a base coordinates system.

15. Name the important specifications of an industrial robot. **(AU-Nov/Dec-2012)**

- Accuracy
- Repeatability
- Degree of Freedom
- Resolution
- Envelope

16. What are the four basic robot configurations available commercially**?** **(AU-Apr/May-2010)**

- Cartesian coordinate system
- Cylindrical coordinate system Polar
- or spherical coordinate system
- Revolute coordinate system

17. Define the term work envelop? **(AU-Apr/May-2010)**

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

18. What are the four basic robot configurations available commercially?

- Cartesian coordinate system
- Cylindrical coordinate system
- Polar or spherical coordinate system
- Revolute coordinate system

19. Define payload capacity of robot?

The maximum load which can be carried by the manipulator at low or normal speed.

20. What is repeatability of robot?

Repeatability refers to robot_s ability to return to the programmed point when it is commanded to do so.

Part-B Questions

1. Briefly explain the different types of robots**. (AU-Nov/Dec-2008)**

2. Sketch and explain the four basic robot configurations classified according to the coordinate system.

3. Write short notes on Joint Notation Scheme. **(AU-Nov/Dec-2009)**

4. Write short notes on technical specification in Robotics**.(AU-Nov/Dec-200**8; 2009)

5. Explain the various parts of a robot with neat sketch**. (AU-Nov/Dec-2008)**

6. Explain the main Robot anatomy with neat sketch.

7. Describe the types of joints used in robots.

8. Discuss the four types of robot controls. **(AU-Apr/May-2010)**

9. Explain with neat sketch Selective Compliance Assembly Robot Arm. **(AU-Nov/Dec-2013)**

10. Briefly explain the needs of robots in industries.

11. Briefly explain the following terms :

i) Pay load ii) Compliance iii) Precision iv) Accuracy **(Nov/Dec-2012)**

12. Briefly explain the influence of the parameters in the performance of robot

i) Centre of gravity ii) Speed iii) Stability iv) Precision of the robot . **(Apr/May-2018)**

UNIT II ROBOTS DRIVE SYSTEMS AND END EFFECTORS

Part-A Questions

1. Define End effector.

   End effector is a device that is attached to the end of the wrist arm to perform specific task.

2. Give some examples of Robot End
   - Effector. Gripper
   - Tools
   - Welding equipments
   - End of arm Tooling (EOAT)
3. What is meant by Gripper?

   Gripper is the End effector which can hold or grasp the object.

4. What is the difference between internal grippers and external grippers? **(AU-Nov/Dec-2008)**

In internal grippers, the finger pads are mounted on the inside of the fingers. This mounting allows the pads to fit into the inside diameter of the part it must lift. The pads are pressed against the inside wall of the part.

An external gripper is designed so that the finger pads press against the outside of the component. Grips the exterior surface of the objects with closed fingers.

5. What are the types of Mechanical Grippers**?(AU-Apr/May-2010)**
   - Linkage actuation gripper
   - Gear and rack actuation
   - gripper Cam actuated gripper
   - Screw actuated gripper
6. List any two limitations of magnetic grippers
   - Residual magnetism
   - Side slippage

- More than one sheet will be lifted by the magnet from a stack

7. List any four important factors to be considered in the selection and design of grippers.

   - The gripper must have the ability to reach the surface of a work part. **(AU-Apr/May-2011)**
   - The change in work part size must be accounted for providing accurate positioning.
   - During machining operations, there will be a change in the work part size. As a result, the gripper must be designed to hold a work part even when the size is varied.
   - The gripper must not create any sort of distort and scratch in the fragile work parts.

8. Give some examples of tool as robot End effector.
   - Spot Welding Tools
   - Arc welding Torch
   - Spray painting nozzle
   - Water jet cutting tool

9. Name some feedback devices used in robotics.
   - Potentiometer
   - Resolver
   - Encoder

10. What are the types of encoders?

    (a) Linear encoder

    (b). Rotary encoder

    (i) Absolute encoder (ii) Incremental encoder

11. List out the types of Drive systems used in Robots.
    - Electric motors like: Servomotors, Stepper
    - motors Hydraulic actuators
    - Pneumatic actuators
12. Write the characteristics of actuating
    - systems. Weight
    - Power-to-weight ratio
    - Operating Pressure
    - Stiffness Vs. Compliance
13. List any two unique features of a stepper
    - motor. Moves in known angle of rotation.
    - Position feedback is not necessary.
    - Rotation of the shaft by rotation of the magnetic field.

14. What is a RCC device? for what purpose is it used in a robot?

In robotics, a Remote Center Compliance, Remote Center of Compliance or RCC is a mechanical device that facilitates automated assembly by preventing peg-like objects from jamming when they are inserted into a hole with tight clearance. In a naive design without an RCC, a robot might pick up a peg with its gripper, center the peg over the hole and then push the peg along the axis of the hole.

15. What is a stripping device?

A device used to remove work piece from the magnetic gripper

16. What are the elements of end arm tooling?

1. Mounting plate

2. Power for actuation of tooling motion

3. Mechanical linkage 4.Sensors

17. Why servomotors are preferred with stepper motor in robot applications?

Servomotors are easy to control compared to the stepper motors.

18. What are the parts used in harmonic drive?

1. Elliptical wave generator 2.Flex spline with external teeth 3. Rigid circular spline with Internal teeth.

19. Define end effector and gripper.

End effector is a device that is attached to the end of the wrist arm to perform specific task Gripper is the end effector which can hold or grasp the object

Part-B &Part -C Questions

1. Explain Mechanical drives system.
2. Explain Pneumatic actuators system with neat sketch.
3. Explain various types of Gripper mechanism **(AU-Nov/Dec-2010)**
4. Write note on Gripper selection and design **(AU-Apr/May-2011)**
5. Write a note on Magnetic Grippers.
6. Explain the various drive system used with an industrial robot and compare their features, Merits and demerits. **(AU-Nov/Dec-2010)**
7. Explain the working Principle, construction, applications, advantages and dis advantages of a stepper motor.**(AU-Nov/Dec-2010,Apr/May - 2018)**
8. Discuss the salient features, capabilities, application, merits and limitations of non servo controlled robots.**(AU-Nov/Dec-2013)**

9. With neat sketches explain the working principle of

i) Magnetic gripper ii) Vacuum gripper **(AU-Apr/May – 2018)**

UNIT III SENSORS AND MACHINE VISION

Part-A Questions

1. What is the common imaging device used for robot vision systems?

Black and white videocon camera, charge coupled devices, solid-state camera, charge injection devices.

2. What is segmentation**?(AU-Nov/Dec-2009)**

Segmentation is the method to group areas of an image having similar characteristics or features into distinct entities representing part of the image.

3. What is thresholding?

Thresholding is a binary conversion technique in which each pixel is converted into a binary value either black or white.

4. What are the functions of machine vision system?

- Sensing and digitizing image data
- Image Processing and analysis
- Application

5. Define sensors and transducer.

Sensor is a transducer that is used to make a measurement of a physical variable of interest.

Transducer is a device that converts the one form of information into another form without changing the information content.

6. What are the basic classifications of sensors?

- Tactile Sensors,
- Proximity Sensors,
- Range sensors,
- Voice sensors etc.,

7. What is a tactile sensor**?(AU-Apr/May-2011)**

Tactile sensor is device that indicates the contact between themselves and some other solid objects.

8. What is meant by Region growing?

Region growing is a collection of segmentation techniques in which pixels are grouped in regions called grid elements based on attribute similarities.

9. What is meant by Feature Extraction?

In vision applications distinguishing one object from another is accomplished by means of features that uniquely characterize the object. A feature (area, diameter, and perimeter) is a single parameter that permits ease of comparison and identification.

10. What are the various techniques in image processing and analysis?

- Image data reduction
- Segmentation

- Feature extraction
- Object recognition

11. Give an application example of a proximity sensor.

- Ground proximity warning system for aviation safety
- Vibration measurements of rotating shafts in machinery
- Sheet break sensing in paper machine.
- Roller coasters
- Conveyor systems

12. Brief on the working of inductive type proximity sensor**.(AU-Nov/Dec-2009)**

Inductive proximity sensors operate under the electrical principle of inductance.

Inductance is the phenomenon where fluctuating current, which by definition has a magnetic component induces an electromotive force (emf) is a target object.

To amplify a devices inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it.

13. Name some feedback devices used in robotics.

- Position Sensors
- Velocity Sensors

14. What are the types of encoders?

- Incremental encoders
- Absolute encoders

15. What is frame grabber?

It is a hardware device used to capture and store the digital image.

16. Classify the position sensors**. (AU-Nov/Dec-**

- **2009)** Incremental encoders
- Absolute encoders
- Resistive position sensors
- Linear variable differential
- transformer. Encoders
- Potentiometer
- Resolver.

17. What is a tactile array sensor?

Tactile array sensor is a special type of force senor composed of a matrix of force sensing elements.

18. What is meant by feature extraction and pattern recognition?

In vision applications distinguishing one object from another is accomplished by means of features that uniquely characterize the object.A feature (area, diameter,perimeter) is a single parameter that permits ease of comparison and identification. Pattern recognition means classifying an image (region) into one of a number of known classes.

19. What is meant by an object reorganization

The next step in image data processing is to identify the object the image represents. This identification is accomplished using the extracted feature information described. The recognition algorithm must be powerful enough to uniquely identify the object.

20. What is meant by quantitation and morphology?

The transition between continuous values of the image function (brightness) and is digital equivalent is called Quantitation. Morphology is the study of shapes and those methods used to transform or describe shapes of objects

Part-B & Part –C Questions

1. Briefly explain the characteristics of Sensors.
2. Briefly explain the working principle of position sensors with neat sketch.
3. Briefly explain the working principle of Range sensors with neat sketch.
4. Briefly explain the working principle of Proximity sensors with neat sketch.
5. Explain the Machine vision systems of Robot.**(AU-Nov/Dec-2009)**
6. With suitable sketches explain the working principle and applications of the following**: (AU-Nov/Dec-2010, Apr/May- 2018)**

   i) Proximity sensors ii) Optical encoders

7. Explain the various techniques in Image Processing and Analysis.
8. Enumerate about the measuring distances using Ultrasonic proximity sensors. **(AU-Nov/Dec-2013)**
9. Explain how image segmentation helps to improve the quality of the images in a vision system. **(AU-Nov/Dec-2013, Apr/May - 2018)**

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING

Part-A Questions

1. What are the methods of robot programming?

   - Lead through methods
   - Textual robot languages
   - Mechanical Programming

2. What are the ways of accomplishing lead through programming?

   - Powered Lead through
   - Manual Lead through

3. What is teach pendant?

   The teach pendant is usually a small handheld control box with combinations of toggle switches, dials and buttons to regulate the robot_s physical movements and program capabilities.

4. What are the methods of teaching?

   - Joint movements
   - X-Y-Z coordinates motions
   - Tool coordinate motions

5. What is robot kinematics?

   Forward kinematics

   It is a scheme to determine joint angles of a robot by knowing its position in the world coordinate system.

   Reverse kinematics

   It is a scheme to determine the position of the robot in the world coordinate system by knowing the joint angles and the link parameters of the robot.

6. What is trajectory planning?

   It is defined as planning of the desired movements of the manipulator.

7. Define degrees of freedom.

   The number of independent ways by which a dynamic system can move without violating any constraint imposed on it, is called degree of freedom. In

other words, the degree of freedom can be defined as the minimum number of independent coordinates which can specify the position of the system completely.

8. Explain joint mode of teaching robots.

The teach pendant has a set of toggle switches (or similar controlled devices) operate each joint either of it to directions until the endeffector has been positioned to the desired point.

9. Explain the reasons for defining points in a program.

- To define a working position for the
- endeffector To avoid obstacles

10. What is position representation?

The position of the end of the arm may be represented by the two joint angles q1 and q2.this is known as position representation.

Pj = (q1,q2)

11. Define servo controlled robots.

Servo controlled robots, which are programmed by lead through an textual language methods tend to actuate all axes simultaneously.

12. What is circular Interpolation?

Circular Interpolation requires the programmer to define a circle in the robot_s workspace which is done by specifying three points that lie along the circle.

13. What are irregular smooth motions?

The segments in manual lead though programming are sometimes approximately straight sometimes curved and sometimes back and forth motions. These motions are called irregular smooth motions.

14. What is manual lead through programming?

In manual lead through programming the programmer moves the manipulated wrist to teach spray-painting or arc welding. The movements consist of combination of smooth motion segments.

15. Define servo control robots?

Servo control robots, which are programmed by lead through and textual language methods, tend to activate all access simultaneously.

16. Explain joint mode of teaching robots?

The teach pendant has a set of toggle switches (or similar controlled devices) operate each Joint either of it to directions until the end effector has been positioned to the desired point.

17. Explain redundancy?

Most industrial robots have 6 or less joints, thus, redundancy is not inherent to their design. Some robots, though, do not have a certain joint arrangement in their final orientation joints that can lead to redundancy for certain orientations.

For example, some robots have the final three joint axes (joints 4, 5 and 6 in a six axis Robot) arranged in a roll, pitch, roll sequence.

18. What is trajectory planning?

It is defined as planning of the desired movements of the manipulator.

Part-B & Part-c Questions

1. Derive the forward and reverse transformation of 2-Degree of freedom and 3-degree of freedom arm.
2. Briefly explain the Robot Programming Languages in detail.
3. Explain the teach pendant for Robot system **(AU-Nov/Dec-2010)**
4. Write down the capabilities and limitations of Lead through methods. **(AU-Nov/Dec-2009)**
5. With an example differentiate forward and inverse kinematics. (AU-**Nov/Dec-2009)**
6. Derive the expression for direct and inverse kinematics of 4 degrees of freedom robot manipulator.

7. List the commands used in VAL II programming and describe its functions. **(AU-Nov/Dec-2009)**

8. (i) Draw sketch of four axis robot and show various joint motions. (AU-**Nov/Dec-2013)**

9. Write a VAL robot program to perform pick-place operation on the conveyor system. It consists of two systems. It consists of two conveyors running parallel with centre to centre distance of 600 mm at same level. An industrial Robot is fixed centrally between the conveyors. The robot is used to transfer work pieces from conveyor 1 to 2 at a constant speed. Draw a schematic view of the system. Assume all necessary dimension. (AU-**May/Jun-2013)**

10. Write a robot program to pick parts off a conveyor and load them into a pallet that is about 12 in. from the pickup point. The mechanical stop on the conveyor is used to locate the parts in a known position for the pickup. The parts are to be arranged in a 3 by 4 pattern,40mm apart in both directions. The two directions of the pallet are assumed to be X and Y world coordinate. (AU-**May/Jun-2018)**

UNIT V IMPLEMENTATION AND ROBOTS ECONOMICS

Part-A Questions

1. What are the different types of material handling operation?
   - Manually operated devices—hand trucks, powered trucks, cranes, monorails and hoists.
   - Automated systems—conveyors, AGV_s.
   - Miscellaneous systems—industrial robots, transfer mechanisms, elevators, pipelines, containers, dial indexing tables, etc.

2. What is Gantry Robot?

   Cartesian coordinate robots with the horizontal member supported at both ends are sometimes called Gantry robots.

3. Write some applications of AGV?
   - Driverless train operations
   - Storage distribution system
   - Assembly line operation
   - FMS

4. List out types of AGV vehicles?
   - Towing vehicles
   - Unit load vehicles
   - Pallet trucks
   - Fork trucks
   - Light load Vehicles
   - Assembly line vehicles.

5. Differentiate palletizing and depalletizing.

   A palletizer or palletiser is a machine which provides automatic means for stacking cases of goods or products on to a pallet.

   A depalletizer machine is any machine that can break down a pallet. Usually, a robot is used for this task, although there are some other forms of depalletizersthat can also break down pallets and move products from one place to another using simple push bars and conveyor belts.

6. What are the steps to be followed by the company in order to implement robot programs in its operations?

- Initial familiarization with the technology
- Plant survey to identify potential applications
- Selection of the application
- Selection of the robot
- Detailed economic analysis and capital authorization
- Planning and engineering the installation
- Installation

7. What are the typical technical features required for material transfer? Number of axes: 3to 5

   Control system: limited sequence or point-to-point playback

   Drive system: pneumatic or hydraulic

   Programming: manual, powered lead through

8. What are the different methods of economic analysis?

   1)Payback method

   2)Equivalent uniform annual cost (EUAC) method

   3)Return on investment (ROI) method

9. Write a note on ROI method?

   The return on investment method determines the rate of return for the proposed project based on the estimated cost and revenues.

10. Define EUAC method?

    Equivalent uniform annual cost (EUAC) method converts all of the present and future investments and cash flows into their equivalent uniform cash flows over the anticipated life of the project.

11. Define a deadman switch?

    A dead man switch is a useful control feature during lead through

programming. It is a trigger or toggle switch device generally located on the teach pendant which requires active pressure to be applied tom the devices in order to drive the manipulator.

12. What are the general characteristics that make potential robot application technically practical and economically feasible?

1)Hazardous or uncomfortable working conditions

2)Repetitive operations

3)Difficult handling jobs

4)Multicast operation

13. Define payback period?

IT is the length of time required for the net accumulated cash flow to equal the initial investment in the project.

14. What is image resolution?

The resolution of a digital camera is often limited by the camera sensor (typically a CCD or CMOS sensor chip) that turns light into discrete signals, replacing the job of film in traditional photography. This means that the brighter the image at that point the larger of a value that is read for that Pixel.

15. Define Tracking?

Tracking is defined as the motion of the scene, objects or the camera given a sequence of images Knowing this motion, predict where things are going to project in the next image, so that we don‘t have so much work looking for them.

16. What are the techniques used in object recognition?

1. Template matching technique

2. Structural technique

Part-B & Part-c Questions

1. Briefly explain AGV & RGV types of robots in detail. **(AU-Nov/Dec-2010)**

2. Briefly explain the economic analysis of Robots in detail **(AU-Nov/Dec-2008,Apr/May- 2018)**

3. Briefly explain the Safety sensors and safety monitoring of Robots in detail ***(AU-Nov/Dec-2008)***

4. Briefly explain the Workplace design consideration for safety of Robots in detail.

5. Briefly explain the various steps involved for implementing the robot in industries.

6. Write a critical note on any two methods for economic analysis of industrial robots. **(AU-Nov/Dec-2010)**

7. Explain the factors to be considered for industrial application of robot, Safety consideration for robot operation. (AU-Nov/Dec-**2013,Apr/May-2018)**

8. Explain the procedure of applying the any one method in the economic analysis of robotics**.(AU-Nov/Dec-2013)**

9. Explain the obstacle detection and avoidance in AGV‖s. **(AU-Nov/Dec-2013)**