**DHANALAKSHMI SRINIVASAN COLLEGE OF ENGINEERING AND TECHNOLOGY**

**Mamallapuram, Chennai-603104.**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**QUESTION BANK**



**Subject Code:** *ME 8099* ***Year / Semester:* IV */* VIII**

**Subject Name**: *Robotics*

# UNIT- I – FUNDAMENTALS OF ROBOT PART - A

## Name the commonly used robot configurations. (April/May 2010, Nov/Dec 2020,April/May 2021)

The Commonly used robot configurations are: Cartesian coordinate system, cylindrical coordinate system, Polar spherical coordinate system and revolute coordinate system.

## Name the important parts of harmonic drive?

The important parts of harmonic drives are: Rigid circular spline with internal teeth. Flex spline with external teeth and Elliptical wave generator.

## Sketch the revolving joint and show the relative joint motions.

Output

Input

## What is RIA Definition of Robot. (Nov/Dec 2010, 2013 May/June 2009,Nov/Dec 2020, April/May 2021)

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.

## State the advantages and limitations of hydraulic drive.

It gives greater speed and strength, It gives highest power to weight ratio, It is used for heavy pay loads, It can be used for large working envelope, It is safe and reliable to work in wet and dirty conditions.

**Disadvantages:** It can be used in hazardous environment.

## What are the types of hydraulic actuators?

The types of hydraulic actuators are:

***Linear hydraulic actuators:*** Single acting cylinder, Double acting cylinder, Double acting double rod cylinder. ***Rotary Actuators:*** Gear motor, Vane motor, and Piston motor.

## What is meant by work space?

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

## What is meant by work volume and work envelope? (May/June 2013) (Nov/Dec 2013,2014)

The volume of the space swept by the robot arm is work volume. The work envelope is described by the surface of the work space. **9.What is meant by Accuracy of the robot.**

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

## What is meant by precision of Robot?

The ability of the robot to reach the reference points repeatedly with accuracy.

## What is meant of resolution of the robot?

The smallest increment/decrement of motion for which the robot can be controlled is termed as resolution.

## What is meant by repeatability of robot?

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

## What is meant by quality of Robot?

A robot is said to of very high quality if its precision and accuracy are more.

## Classify the motion control of robot arm?

Limited Sequence Control, Point to Point control, Continuous path control, Intelligent Control.

## What is meant by pay load capacity of Robot? (Nov/Dec 2010,Apr/May 2017)

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

## State the advantages and limitations of a hydraulic drive?

Advantages :-

* + It gives greater speed and strength.
  + It gives highest power to weight ratio .
  + It is used for heavy pay loads.
  + It can be used for large working envelope.
  + It is safe and reliable to work in wet and dirty conditions.
  + It can be used in hazardous environment. Disadvantages:-
  + It occupies more space.
  + Maintenance should be done regularly.

## What is robot anatomy? (Nov/Dec 2009)

Robot anatomy is the study which deals with the construction and components of a robot. It deals with the components such as body, arm, wrist and joints of a robot.

## List out the types of joint notations? (Nov/Dec 2008)

Linear Joint (L), Rotational Joint(R), Twisting Joint(T), Revolving Joint(V), Orthogonal Joint(O).

## What is meant by Pitch, Yaw, Roll? (Nov/Dec 2008,Nov/Dec 2015)

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

## Define base and tool coordinate system. (Nov/Dec 2012, 2015, 2016)

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 00 position of the robot is rotated around each axis so that the tool coordinates system becomes parallel to a base coordinate system.

## Classify the robot as per the type of control and mobility. (May/ June 2013)

Limited Sequence robot, Play back robot with Point to Point control, Play back robot with continuous path control, Intelligence robot.

## List the applications of robot in manufacturing area? (May/ June 2013)

Material transfer, Loading and unloading, processing operations, assembly and inspection.

## Write any two laws of robotics. (May/ June 2014, 2017)

A robot may not injure humanity, or through inaction, allow humanity to come to harm.

A robot must obey orders given to it by human beings, except such orders would conflict with a higher order law.

## Expand ‘SCARA’. (May/ June 2014)

Selected Compliance Assembly Robot Arm

## List out various methods of controlling a mechanical manipulator in the joint variable space. (Nov/Dec 2014)

Electrical actuation, Hydraulic, Pneumatic, Non servo (open loop) control and Servo (closed loop) control

## What is the term spatial resolution means in robotics. (May/ June 2015)

Spatial resolution is the smallest increment of movement into which the robot can divide its work volume. Spatial resolution depends on two factors: the systems control resolution and the robots mechanical inaccuracies

## Define work envelope of the manipulator. (May/ June 2015, 2017)

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

## What do you understand from the notation TRR of a Robot.(Nov/Dec 2016).

Robot with three joints with twisting, rotational, rotational joints

## What is a DDR? What is its advantages? (May/June 2018)

Direct Drive Robot (DDR) can be taught with the click of a button. At the center of the highly flexible and configurable Bio Cell System, the DDR is fast, precise, and designed with safety in mind. State-of-the-art direct drive technology reduces the number of moving parts, resulting in a robotic arm that has increased reliability and speed, moving smoothly with precision and accuracy. **30.Justify whether the following statement is true or false.**

## Degrees of freedom depend upon the number of actuators used in a robot (May/June 2018)

True, DOF depend on the number of Actuators used in a robot.

## What is 4D environment and 4A task? (Nov/Dec 2018).

4D environment 4A task

* + Dangerous ● Automation
  + Dirty ● Augmentation
  + Dull ● Assistance
  + Difficult ● Autonomous

## Illustrate Tool frame and base frame in a manipulator. (Nov/Dec 2018).

The base frame is located near the base of the robot and is not adjustable and it is the fundamental starting point for our robot system. Tool frames are special frames that are defined to a tool on the end of a robot arm. The tool frame defines a coordinate frame for a specific tool that the robot is using.

**PART - B**

1. Briefly explain the different types of robots. (16) **(Nov/Dec 2012, Nov/Dec 2020,April/May 2021)**
2. i) Write short notes on Joint Notation Scheme. (8) **(May/June 2012)**

ii) Write short notes on technical specification in Robotics. (8) **(May/June 2013)**

1. Explain robot parts and their functions with neat sketch (16) **(Nov/Dec 2012,2014)**
2. Explain Various Industrial Applications of Robots. (16) **(Nov/Dec 2012)**
3. Explain the four common Robot configurations with neat sketch. (16) **(May/June 2012, 2014, 2017) (Nov/Dec 2010,2011, Nov/Dec 2020,April/May 2021)**
4. With the circuit diagram explain the various control systems of Robot (16)
5. How will you specify a robot? Explain in detail (16)
6. Explain: Robot anatomy and Robot wrist. (16) **(May/June 2012, 2013) (Nov/Dec 2012, 2017)**
7. i).Write in detail about the need of a Robot? (8) **(Nov/Dec 2014).**

ii). Explain with a neat sketch Selective Compliance Assembly Robot Arm(8) **(Nov/Dec 2013)**

1. Explain the selection criteria and factors in the design of a robot. (16) 11.write a short note on the following. **(May/June 2013)**
   1. Types of robot controls ii)Spatial Resolution iii)Repeatability 12.i)Discuss about the need for robots **(Nov/Dec 2014).**
   2. Present a brief survey on how robots are applied in inspection work.

13.i.Explain with a neat sketch the basic components of a robot connected as a system**.(Nov/Dec 2014)**

ii)Sketch and explain 3 DOF associated with wrist.

1. Discuss in detail about functions and need of industrial robots**(Apr/May 2017)**
2. Briefly explain the influence of the parameters in the performance of robot.
   1. center of gravity ii. Speed iii. Stability iv. Precision of the robot **(Apr/May 2018)**
3. With neat sketches explain the classification of robot based on
   1. configurations, ii. Degrees of freedom, iii. Work volume iv. Controls **(Apr/May 2018)**

17.i.How to calculate the DOF of serial Manipulator. ii.Furnish the details of various joints used in serial robots.

iii.Describe the roll, pitch, yaw motion of a RRT wrist configuration**.(Nov/Dec 2018)** 18.Elaborate the construction, Kinematic chain description and work volume of serial manipulators. **(Nov/Dec 2018)**

**PART - C**

1. Explain any five work envelope of a robot with suitable diagram and mention its applications.

## (Nov/Dec 2015, 2016)

1. Describe the important specifications of a robot and choose a suitable robot configuration for transferring 200 gram aluminium rod of 150 mm length. Give your justification.(**Nov/Dec 2015)** 3.Explain the Various specification that one should look forward to purchase a commercial robot.**(Nov/Dec 2016)**

**4.**With a neat sketch explain the 3P,TLO,2RP,VRO configuration and discuss the characteristics, work volume and application of each.**(Nov/Dec 2017)**

**UNIT II – ROBOT DRIVE SYSTEMS AND END EFFECTORS PART - A**

1. **Define End effectors**. **(Nov/Dec 2012,2015,2017, Nov/Dec 2020,April/May 2021)**

End effectors is a device that is attached to the end of the wrist arm to perform specific tasks.

## Give some examples of Robot End effectors. (May/June 2013, Nov/Dec 2015)

Gripper, Tools, Welding equipments, End of the arm tooling.

## What is meant by a Gripper and what are the types of the gripper? (Nov/Dec 2016)

A device used to hold or grasp an object is termed as a Gripper. The types of the gripper that can be used are, Magnetic gripper, Mechanical gripper, Hooking gripper, and Vacuum Gripper.

## What is stripping device?

A device used to remove a work piece from the magnetic gripper.

## What are the types of mechanical grippers? (May/June 2012, 2014, Nov/Dec 2020,April/May 2021)

Linkage Actuation gripper, Gear and rack actuation gripper, Cam actuation gripper and screw actuated gripper.

## Give examples of tools used as Robot End effectors?(Apr/May 2017)

Spot Welding, Arc Welding, Spray painting, Water jet cutting.

## What is a transfer function?

The transfer function relates the Laplace transformation of the system output to a Laplace transformation of the system input**.**

## What is Summing function?

Summing function may have any number of arrows entering but only one leaving.

## What is take of point?

Take of points permit signals and variables to be shared among more than a single component.

## What is a functional Block?

Functional block represents one of the components of the system and contains the transfer function for the component.

## What is a signal arrow?

Signal arrow indicates the direction of variables and signals in the diagram.

## Name some of the Feed back devices used in robotics.

Potentiometers, Resolvers, Encoders etc.,

## What are the types of encoders?

Absolute encoder, Incremental encoder

## What are the factors to be considered while designing grippers?

Material specification, Part specification, Performance specification, source specification, Position specification, Environmental specification

## What are actuators?

Device used for converting hydraulic, pneumatic or electrical energy into mechanical energy. The Mechanical energy is used to get the work done.

## What is the principle used in Vacuum Cup.?

Vacuum pump and venture Principle.

## What is the difference between internal and external grippers? (Nov/Dec 2008,May/June 2015)

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 fit. 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.

## List any limitations of magnetic grippers.

Residual magnetism, Side Slippage, More than one sheet will be lifted by the magnet from a stack.

## List the types of drive systems used in robotics.

Electrical Motors like servomotors, stepper motors, Hydraulic actuators, Pneumatic actuators.

## Name the feedback devices used in robotics

Potentiometer, Resolver, Encoder.

## State limitations of stepper motor as a drive system for a robot. (Nov/ Dec 2013, 2014,Apr/May 2017)

The control of stepper motor is dependent on the ability of the switching electronics to switch the windings at precisely the right moment. If the windings are switched very quickly, the motor will not keep up with the command signal and perform erratically. The speed-torque degrades badly at certain frequencies of operation.

## When Will Hydraulic drive be preferred in a robot. (May/ June 2013)

To carry Heavy loads and used in material handling.

## What are the problems associated with mechanical gripper? (Nov/Dec 2014)

Residual magnetism, Side Slippage, More than one sheet will be lifted by the magnet from a stack.

## Write the salient features of servo motor. (Nov/Dec 2015)

The servo motor is specialized for high-response, high-precision positioning. As a motor capable of accurate rotation angle and speed control, it can be used for a variety of equipment.

## In what ways do end effectors differ from the human hand. (May/ June 2015)

End effectors may consist of a gripper or a tool. There are four general categories of robot grippers, these are 1.Impactive 2.Ingressive3.Astrictive.4.Contigutive. But this type of gripping is not possible in human hand.

## What are the disadvantages of pneumatic drives in robotics.(Nov/Dec 2016)

More noise and vibration Not suitable for Heavy load

## List the advantages of stepper motor used in robotics (Nov/Dec 2017)

1. Low cost for control achieved 2. High torque at startup and low speeds 3. Ruggedness 4.Simplicity of construction 5. Can operate in an open loop control system 6. Low maintenance 7.Will work in any environment 8. High reliability.

## Write the end effectors used for the following applications.

* 1. **spot welding ii)Spray painting iii)polishing iv)Glass Cups (Apr/May 2018)**

i)Spot Welding- Welding Torch ii)Spray Painting- Painting Gun iii)Polishing-

iv)Glass Cups- Vacuum grippers

## Distinguish between a Gripper and tool. (Apr/May 2018)

A device used to hold or grasp an object is termed as a Gripper. whereas a tool is intended to do any specific operation.

## Identify the parameters to be sensed in each joints of robot. (Nov/Dec 2018)

Joint angle, force exerted at the joints, speed of the joint movement, position of the joint

## List the few characteristics of good electrical actuator consideration robotics(Nov/Dec 2018)

High maximum torque  High maximum angular speed  High power/weight ratio  High energy performance  High force generation bandwidth  Low mechanical impedance in the event of position disturbances.

**PART - B**

1. Explain Electric Actuators system with neat sketch. (16)
2. Explain Mechanical drives system with neat sketch. (16)
3. Explain Pneumatic and hydraulic actuators system with neat sketch. (16)
4. Explain the types of end effectors with neat sketch. (16)
5. Explain various types of Gripper mechanisms. (16) **(Nov/Dec 2012)**
6. Explain power and signal transmission of robot actuators system. (16)
7. i) Write note on Gripper selection and design. (8) **(Nov/Dec 2013,2018)**

ii) Write a note on Magnetic Grippers. (8) **(Nov/Dec 2013, 2017,Apr/May 2018)**

1. Explain the working of a AC & DC servo motors.(16) **(Nov/Dec 2012)**
2. Explain the working of a Stepper motor with suitable diagrams (16) **(Nov/Dec 2012,2014)**
3. Write short notes on Vacuum cups, Adhesive grippers, Hooks, Scoops and other miscellaneous grippers in detail (16) **(Nov/Dec 2014,2017,Apr/May 2017,Apr/May 2018)**
4. Compare the features of the various drive systems for an Industrial robot. **(May/June 2012,2014)**

12.i)Explain the robot and End effectors interface functions. **(May/June 2014)**

ii)Discuss the factors that can be influenced in the selection of gripper.

13 i)Explain about selection and design considerations of gripper**.(Nov/Dec 2014)**

ii)Explain the various drive system used with an industrial robot and compare their features, merits and demerits. (**Nov/Dec 2020,April/May 2021)**

14.Classify the end effectors . Draw the different mechanism used in the gripper and give application **(Nov/Dec 2015,2016)**

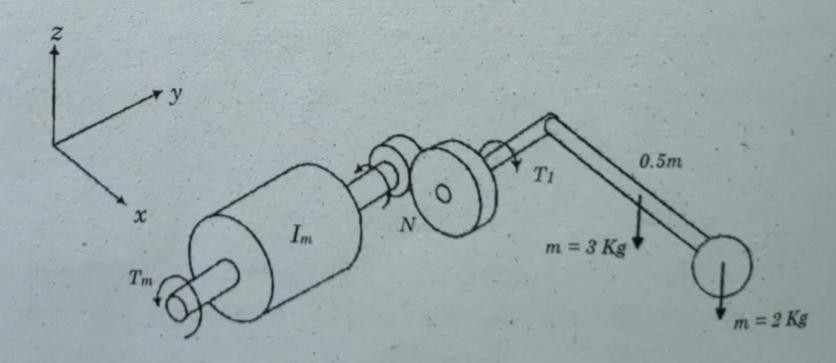
15(i) Discuss the design and selection parameters of three fingered grippers **(Nov/Dec 2016)**

(ii)Compare the servo motor with stepper motor for industrial robot along with your justification .

16. Discuss the salient features, capabilities, applications, merits and limitations of stepper and servo motors. **(April/May**

## 2017,2018)

17 i.Describe the elements of hydraulic actuation system components in details (Nov/Dec 2018)

ii.A motor with rotot inertia of 0.015 kgm2 and maximum torque of 8 nm is connected to a uniformly distributed arm with a concentrated mass at its end, as shown in the fig. ignoring the inertia of a pair of reduction gears and viscous friction in the system. calculate the total inertia felt by the motor and the maximum angular acceleration it can develop if the gear ratio is (a) 3 or (b) 30.

18. i)List the factors to be considered in selection of gripper. **(Nov/Dec 2018)**

ii)With a neat sketch explain the rack and pinion mechanical gripper and screw actuated

mechanical gripper.

**PART - C**

1.Compare the servo motor with stepper motor choose suitable drive system for industrial robot along with your justification.**(Nov/Dec 2015,Apr/May 2017)**

2.(i)Explain the working of a hybrid stepper motor with a neat sketch. (ii)Write short notes on Servomotor with neat sketch**(Nov/Dec 2017)**

1. Discuss the salient features, capabilities, application merits and limitations of non servo and servo controlled robots. **(Nov/Dec 2013)**
2. Discuss the performance characteristics of actuators, compare electrical, pneumatic, hydraulic actuators for their characteristics. **(Nov/Dec 2020,April/May 2021)**

**UNIT III – SENSORS AND MACHINE VISION PART - A**

1. **What is frame grabber? (May/June 2012)**

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

## What is the common imaging device used for robot vision system?(Nov/Dec 2016)

Black and white vidicon camera, Charge coupled devices, Solid state camera, and charge injection device.

## Define Robot Vision. ?(Nov/Dec 2013)

Robot vision is a sensor based technology used for identifying parts and components and navigation. It uses high level sensor technology.

## What is frame of vision data?

The digital image of a camera is called frame of vision data.

## What is segmentation? (Nov/Dec 2008)

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

## What is thresholding?

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

## What is Region growing?

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

## What are the functions of machine vision system?

Sensing and digitizing image data, Image processing and analysis and Application.

## What are the applications of the Machine vision system?

Inspection, Identification, Visual Servicing and Navigation.

## What is a Sensor? (Nov/Dec 2012, Nov/Dec 2020,April/May 2021)

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

## What is Transducer? (Nov/Dec 2012, Nov/Dec 2020, April/May 2021)

Transducer is a device used to convert one form of information in to another form without changing the information content.

## What are the basic classifications of the sensors?

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

## What are the desirable features of a sensor?

Good Accuracy, High precision, Wide operating range, Instant sped of response, Good repeatability, Low cost and ease in operation.

1. **What is a tactile sensor? List the types of Tactile Sensors? (May/June 2009,Nov/Dec 2018))** Tactile sensor is a device which indicates the contact between themselves and some other solid objects. Types of Tactile sensors are Touch (digital) Sensors and Force (Analog) Sensors.

## What is a touch sensor?

Sensor which senses the presence or absence of a object by having physical contact between the object.

## List the components of the force twist?

Metallic frame, Bracket for tool mounting and strain gauges.

## What is tactile array sensor?

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

## What is a Proximity sensor? (Nov/Dec 2011)

Sensors which senses the presence or absence of the object without having a physical contact between them is a proximity sensor.

## What are the classifications of a proximity sensor?

Inductive Sensor, Capacitive sensor, Ultrasonic Sensor, Magnetic sensor.

## What is a Range sensor?

Sensor which senses the range or the exact distance between the object and the vision is the range sensor.

## What is a Voice sensor?

It is an advanced sensor system used to communicate commands or information orally to robot.

## What is a Vision Sensor?

It is a advanced sensor system used in conjunction with pattern recognition and other technique to view and interpret event occurring in the robot work space.

## What is Quantization?

Each sampled discrete time voltage level is assigned to a finite no of amplitude levels. These amplitude levels correspond to the gray scale used in the system. The predefined amplitude levels are characteristic to a particular A to D converter and consist of discrete values of voltage levels is defined by,

No of quantum levels = 2n- no of bits of Analog to Digital converter.

## What is meant by encoding?

Encoding is defined as the representation of an amplitude level by a binary digit sequence.

## What is meant by sampling?

The given analog signal is sampled periodically to obtain a series of discrete time analog signals.

## What are the basic lighting devices?

Diffuse surface devices, Condenser projectors, Flood or spot projectors, Collimators, Imagers.

## What are the phases of A/D conversion?

Sampling, Quantization and Encoding.

## What are the various techniques in image processing and analysis?

Image data reduction, Segmentation, Feature extraction, Object recognition.

## What is meant by image data reduction?

The objective of image data reduction is to reduce the volume of the data by, Digital conversion and Windowing methods.

## What is meant by windowing?(Nov/Dec 2016)

Windowing involves using only a portion of the total image stored in the frame buffer for the image processing and analysis this portion is called window.

## What is meant by Digital Conversion?

Digital conversion reduces the number of gray levels used by the machine vision system.

## What is meant by segmentation?

The objective of segmentation is to group areas of an image having similar characteristics or features in to distinct entities representing parts of the image.

## What are the techniques involved in segmentation?

Thresholding, Region growing, and edge detection.

## What is meant by edge detection in image analysis?(May/June 2015)

Edge detection considers the intensity change that occurs in the pixels at the boundary or edges of a part.

## What is meant by feature extraction?(Apr/May 2017)

Feature extraction is usually accomplished by means of features that uniquely characterize the object.

## What are the techniques used in object recognition?

Template matching technique and Structural technique are used in object recognition.

## What is meant by Structural technique?

Structural technique of pattern recognition considers relationships between the features or edges of an object.

## How will be sensors evaluated? (May/June 2013)

Sensors will be evaluated based on their accuracy, precision, operating cost, speed of response, calibration, reliability, cost and ease of operation.

## Explain the function of Piezoelectric sensors. (May/June 2013,Nov/ Dec 2017,Apr/May 2018))

Piezoelectric sensors are used for indicate or measure vibrations.

## What is meant by Gray scale?(Nov/Dec 2013)

Grayscale is a range of [monochromatic](http://www.techterms.com/definition/monochrome) shades from black to white. Therefore, a grayscale image contains only shades of gray and no color. Grayscale is a range of shades of gray without apparent color.

## Differentiate between a transducer and a sensor. . (May/June 2014)

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

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

1. **How does charge coupled device differ from charge induction device. (May/June 2014)** Charge induction device uses an electromagnetic field to transfer energy between two objects whereas charge coupled device is a device for the movement of charge usually within the device to an area where the charge can be manipulated.

## What do you mean by thresholding? How it is accomplished (Nov/Dec 2014)

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

## Give an example of touch sensor in the context of a robot. (Nov/Dec 2014)

Touch sensors can be used to obtain information associated with the contact between a manipulator hand and objects in the workspace.

## Mention any two examples for contact and non contact sensor (Nov/Dec 2015)

Contact Sensor: Load cell, Tactile sensor

Non Contact Sensor: Proximity sensor, hall effect sensor

## What are area of application of image processing in the field of robotics? (Nov/Dec 2015)

Inspection, Identification, Visual Servicing and Navigation.

## What are the functions of sensors?(May/June 2015)

Safety monitoring, Interlocking in work cell control, Quality control in work part inspection, Data collection of objects in the robot work cell

## How time of flight camera works(Nov /Dec 2017, Nov/Dec 2018)

A **time-of-flight camera** is a range imaging **camera** system that resolves distance based on the known speed of light, measuring the **time-of-flight** of a light signal between the **camera** and the subject for each point of the image.

## What are the applications of position sensors ? (April/May2017)

Major applications of position sensors include: Medical equipments , Packaging machines, Injection molding machines, Bullet trains taking round curves, Drive-by-wire cars, Fly-by-wire aircraft systems

## List out the Various Lighting techniques used in machine vision Systems. (April/May2017)

* + Front lighting
  + Back lighting
  + Dark field lighting
  + Diffuse lighting
  + Polarized lighting

## What is LVDT(Nov/Dec 2020,April/May 2021)

An LVDT (linear variable differential transformer= is an electromechanical sensor used to convert mechanical motion or vibrations, specifically rectilinear motion, into a variable electrical current, voltage or electric signals,

**Part- B**

1. Briefly explain the characteristics of Sensors. (16) **(May/June 2012, 2013,2017)**
2. Briefly explain the working principle of position sensors with neat sketch. (16)
3. Briefly explain the working principle of Range sensors with neat sketch. (16) **(Nov/Dec 2008)**
4. Briefly explain the working principle of Proximity sensors with neat sketch. (16) **(May/June 2012,2018) (Nov/Dec 2013)**
5. Explain the Machine vision systems of Robot. (16) **(May/June 2012, 2013,2014, (Nov/Dec 2018, Nov/Dec 2020,April/May 2021)**
6. Describe the classifications of sensors and the factors to be considered for its selection (16)

## (May/June 2013)

1. Explain the applications of robotic vision systems (16)
2. Explain with neat sketches the various types of Vision Cameras.
3. Write notes on (a) Thresholding (b) Edge detection (c) Object recognition (d) Smoothing (16) 11.What is tactile sensor? explain any four types with its practical applicatons**(May/June 2014)** 12.i)explain how image segmentation helps to improve the quality of images in a vision system

ii)describe the Four different types of photo electric sensors.**(Nov/Dec 2014, Nov/Dec 2020,April/May 2021)**

13.i)Explain in detail the tactile and non tactile sensors.

ii)explain the principles of Edge Detection technique**(Nov/Dec 2014)**

14.Explain the working principle of LVDT, Hall effect sensor and compliance sensor along with respective circuit. give the limitations of all three sensor mentioned. .**(Nov/Dec 2015,2016,2017)** 15.What is optical encoder and explain the construction and working of different types of optical encoders? (8**) (Nov/Dec 2017,Apr/May 2018)**

1. With a neat sketch explain how image is processed and analyzed in Robot Vision System.

## (Apr/May 2018)

1. Brief the resistive, capacitive and optical tactile sensing in detail. **(Nov/Dec 2018)**

## PART-C

1. Explain the following concepts in machine vision systems. (i)Type of lighting and image sensors

(ii)Image processing steps involved in machine vision systems **(Nov/Dec 2017)**

1. Write any one algorithm for edge detection and segmentation of an image .Describe the industrial applications of image processing in the field of mechanical engineering.**(Nov/Dec 2015)**
2. Explain the various techniques in Image Processing and Analysis. Describe the industrial application of image processing in the field of mechanical engineering **(Nov/Dec 2016)**(16)

## UNIT- IV – ROBOT KINEMATICS AND ROBOT PROGRAMMING

* 1. **What are the methods of Robot programming? (May/June 2013)**

Lead through methods, Textual robot programming, and Mechanical Programming.

## What are the ways of accomplishing lead through programming?

Powered lead through programming and Manual lead through programming are the two ways of lead through programming.

## What is a teach pendant? (May/June 2012,Nov/Dec 2016)

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.

## What are the methods of teaching?

Joint movements, XYZ Coordinate motions, and Tool coordinate motions.

## What is forward kinematics? (Nov/Dec 2010)

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

## What is Reverse Kinematics? (May/June 2013)

The scheme to determine the position of the robot in the world coordinate system knowing the joint angles and link parameters of the robot.

## What is trajectory planning?

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

## Define Degrees of freedom.(Nov/Dec 2017)

The number of independent ways by which a dynamic system can move without violating any constraint imposed on it, is called degrees of freedom. In other words it can be defined as the minimum number of independent coordinates which can specify the position of the system completely.

## 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 effectors has been positioned to the desired point.

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

To define a working position for the end effectors, To avoid obstacles.

## 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).

## Define servo controlled robots.

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

## 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.

## 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.

## 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.

## List some of the Robot programming languages.

WAVE, AL, AML, MCL, VAL, PAL, RAIL, HELP

## What is powered lead through programming?

The powered lead through is the common programming method in the industries. A teach pendant is incorporated in this method for controlling the motors available in the joints. It is also used to operate the robot wrist and arm through a sequence of points. The playback of an operation is done by recording these points.

## Write some commands used for end effectors.

OPEN, CLOSE, OPENI, CLOSEI, CLOSE 40 MM, CENTER, OPERATE TOOL (SPEED=125 MM)

## What are the operating modes of robot language?

Monitor mode, Run mode, Edit mode.

## List any four motion commands in VAL language.(May /June 2015)

MOVE P1, MOVES P1, APPRO P1, 50, DEPART 50.

## Define Manipulator.(May/June 2012,2014)

Robot manipulator is a device used to manipulate the materials. Manipulator comprises the robot body, arm, wrist and different joints.

## Write a short note on importance of kinematic study of the robot. (Nov/Dec 2014,May/June 2015)

Kinematics is a subject which deals with relative motion between relative motions between the various parts and often referred as geometry of motion. It will enable us to calculate what each joint variable must be If we desire the hand to be located at a particular point and have a particular orientation.

## List out any four methods of entering commands in to the robot controller memory. (Nov/Dec 2014, Apr/May 2017)

* + - Manual programming method
    - Walk through programming method
    - Lead through method or teach pendant
    - Off-line programming method.

## Differentiate between the forward and inverse kinematics and give its application. (Nov/Dec 2015,2016)

**Forward kinematics** is a scheme to determine joint angles of robot by knowing its position in the World Coordinate system.

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

## What are the limitations of on-line and off-line robot programming(Nov/Dec 2015) limitations of on-line programming

1. Difficult to edit unwanted datas
2. Difficult to incorporate external sensor data (iii)Large memory is required.

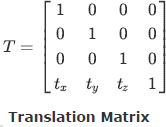
## limitations of off-line programming

1. Virtual models will never be able to represent the real world with 100% accuracy. Programs may still need to be altered after they are applied to the real robot.
2. Might take longer overall. Although offline programming reduces the downtime of the robot, it means that someone has to spend extra time developing the simulation, as well as testing it on the robot.
3. Can sometimes end up wasting time sorting out simulator issues instead of solving production challenges.

## State the reasons for homogeneous transformation. (April/May 2017)

If a coordinate frame is attached to each link, the relationship between two links can be described with a homogeneous transformation matrix. A homogeneous transformation matrix combines a translation and rotation into one matrix.

## Write a translational matrix of X, Y, Z of a frame? (Nov/ Dec -2017)



* 1. **How to calculate degrees of freedom of a serial manipulator? (Nov/Dec2017)**

The degrees of freedom of a serial manipulator1 can be obtained from the well-known Chebychev Grubler-Kutzbach criterion

where dof is the computed degree of freedom with N as the total number of links including the fixed link (or base), J as the total number of joints connecting two consecutive links, Fi as the degrees of freedom at the i th joint, and λ = 6, for motion in 3D , λ = 3, for planar motion

## If a POINT P=4.2i-6.8j+3.5 k has rotated in CCW direction for an angle of 65◦ about X axis. Find the new point achieved. (Apr/May 2018)

**Rotation about X-axis,**

1 0 0

Rot (X,65) =

0 𝑐𝑜𝑠 65 sin 65

0 −𝑠i𝑛65 𝑐𝑜𝑠65

New point, PNew= Rot (X,65) \*Pold

1 0 0

4.2

PNew

0 𝑐𝑜𝑠 65 sin 65

0 −𝑠i𝑛65 𝑐𝑜𝑠65

\* −6.8

3.5

PNew=

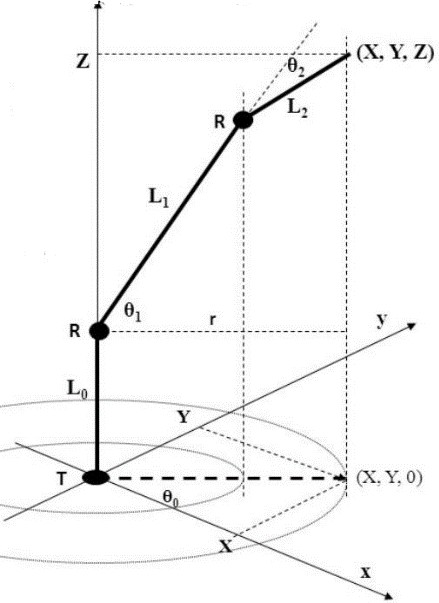
4.2

0.30

7.63

PNew=4.2i+0.30j+7.63k

## Write the Direct Kinematic equation of a 3 DOF TRR configuration robot. (Apr/May 2018)



Direct Kinematic equation:

r = L1Cos ɵ1 + L2 Cos ɵ2 X = r Cos ɵ0

Y = r Sin ɵ0

Z = L0+L1 sin ɵ1+L2 Sin (ɵ1+ɵ2)

## 31.A vector p is 5 units long and is in the direction of a unit vector q described below .express the vector in matrix form. (Nov/Dec2018)

0. 371

**qunit=** 0. 557

qz

qunit=0.371i+0.557j+5k

1 0 0

0 1 0

0 0 1

0.371

0.557

5

0 0 0 1

## Write the Matrix about Z axis rotation by the angle Ф. (Nov/Dec2017)

Rot (z,Ф) =

𝑐𝑜𝑠 Φ −𝑠i𝑛Φ 0

𝑠i𝑛 Φ 𝑐𝑜𝑠 Φ 0 0 0 1

## Write down the basic Types of robot Programming (Nov/Dec 2020, April/May 2021)

* + Teach Pendant Method
  + Lead through Programming method
    - Powered Lead Through
    - Manual Lead Through
  + Offline Programming using Textual Robot Languages

**Part-B**

1. Derive the forward and reverse transformation of 2-Degree of freedom arm. (16) **(Nov/Dec 2013)**
2. Derive the forward and backward transmission for a robot with 3- degree of freedom arm.

## (Nov/Dec 2016)(16)

1. Explain Manipulator kinematics with neat sketch. (16)
2. Explain the different types of programming methods in detail. (16) **(May/June 2012)**
3. Briefly explain the generations of Robot Programming Languages in detail. (16)
4. i) Explain the teach pendant for Robot system (8)

ii) Explain Lead through methods. (8) **(May/June 2012)**

1. Explain Motion, End Effector and Sensor commands with example. (16)
2. Write a palletizing program to pick the parts from a input chute and place them on a pallet with 24 positions. (16)
3. Explain the different commands used in VAL programming language. (16) **(May/June 2012,2014)**
4. i) Explain the capabilities of and limitations of lead through programming.(8) **(Nov/Dec 2013,Apr/May 2017)**

ii) Explain the methods of defining positions in space. (8)

1. Explain the functions of an inverse kinematics algorithm. **(May/June 2014)**
2. Discuss Various programming languages used in computer controlled robots.(Nov/Dec 2014) 13.i)Explain Denavit-Hartenburg parameters with suitable Examples and sketch.(**Nov/Dec 2016,2018)**

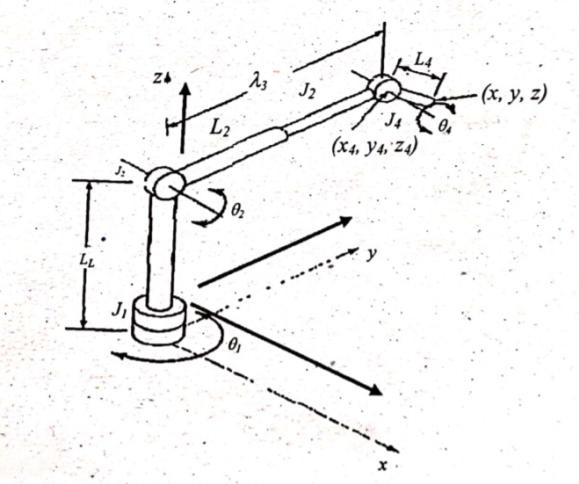
ii) Explain WAIT, DELAY, SIGNAL Command with suitable examples.(Nov/Dec 2014) 14).Explain the four statements of VAL robot programming language with at least two examples command. Write a VAL program for pick and place operation for your assumed environment. Draw your environment diagram showing the industrial robot. **(Nov/Dec 2015, 2016)** .

15).Describe the kinematics and dynamics of a robot **(Apr/May 2017, Nov/Dec 2020, April/May 2021)**

16). Discuss about the advantages and disadvantages of lead through programming in detail.

## (Apr/May 2017)

17).Give the world coordinates for a TRL: R robot shown in figure. x= 300 mm, y =350mm, and a=45◦ and given that links have values of L0=0, L1=325mm, ʎ3 has a range from 300 to 500 mm and L4=25mm,determine the joint angles ɵ1 ,ɵ2, ʎ3 and ɵ4. **(Nov/Dec 2018)**



## PART-C

1. Explain the steps to solve the forward and inverse dynamics of a serial manipulator**(Nov/Dec 2017)**
2. Derive the forward and inverse kinematic solution of RR planar manipulator **(Nov/Dec 2017)**
3. Illustrate the forward kinematics of a 3 DoF Industrial robot with rotational joints. Draw suitable diagram for your illustration. Mention the advantages of forward kinematics over inverse kinematics. **(Nov/Dec 2015)**
4. (i)Write a robot programming for a robot performing the task in a textile shop.

(ii)In a TRR Configuration Robot length of links l1=38 cm, l2= 18 cm respectively. if l1and l2 making an angle of 42◦ and 88 ◦ w.r.t XZ plane and the base is twisted an angle of 28 ◦w.r.t X-axis. Find the end position of the robot. **(Apr/May 2018)**

1. Write a robot program to pick parts off a conveyor and load them in to a pallet that is about 12 in. from the pickup point .A mechanical stop on the conveyor is used to locate the parts in a known position for the pick up 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 parallel to be x and y world coordinate. **(Apr/May 2018)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **link** | **a1** | **ἀ1** | **d1** | **ɵ1** |
| **1** | 0 | 0 | d1 | ɵ1 |
| **2** | 0 | -90 | d2 | 0 |
| **3** | 0 | 0 | d3 | 0 |

1. Design cylindrical robot R2P for the given D-H table and derive the forward transformation matrix **(Nov/Dec 2018)**
2. Design and develop the forward and reverse transformation of RR planar manipulator **(Nov/Dec 2018)**
3. Derive forward and inverse kinematics equation of manipulator for a particular position.

## (Nov/Dec 2020,April/May 2021)

1. Describe any one algorithm for image edge detection and image segmentation with advantages.

## (Nov/Dec 2020,April/May 2021)

1. Using VAL language, Discuss the basic commands and explain the structure of the program for a typical pick and place operation. (**Nov/Dec 2020,April/May 2021)**

**UNIT V – IMPLEMENTATION AND ROBOT ECONOMICS**

**PART A**

1. **What is Palletizing and Depalletizing operation?**

Palletizing is the operation in which the robot picks cartons from a conveyor and places them on to a Pallet. Depalletizing operation is the reverse of palletizing operation in which the robot removes cartons from the pallet and places them on to a conveyor or other location.

## What are the different types of material handling operation?

Pick and placing, Palletizing and Depalletizing, Machine loading and unloading Parts feeding, storage and retrieval, Sorting of the parts from the conveyors.

## Which type of robot is commonly used for pick and place operation?

Cylindrical coordinate Robot is commonly used for pick and place operation.

## What are the Gantry Robots?

If the robots are mounted over head they are called Gantry robots.

## How the Work pieces are fed to the Robot by some mechanical feeding device?

The work pieces are fed in to the robot by some mechanical feeding device or conveyor in a known location and orientation.

## What is the interpretation of manufacturing system?

Manufacturing system is defined as the system which converts the input in to a suitable output.

## What are the technologies used in the manufacturing system?

Computer aided design and computer aided manufacturing, Flexible manufacturing system computer integrated manufacturing system, agile and Lean manufacturing.

## What is a Pallet?

Pallet is a storage area which consists of a number of cells to store work piece of different size.

## List the use of Robot in Loading and Unloading?

Die Casting, Injection moulding, Forming, Stamping and Trimming process.

## 10 Define: Part presentation.

In order to perform an assembly task the part that is to be assembled must be presented to the robot. This is called part presentation.

## Explain Bowl feeders.

Bowl feeders are devices used for feeding and orienting small parts in automated assembly operations. They are made up of two main components. They are the bowl and the vibrating base.

## What is APAS?

Adaptable Programmable Assembly system was developed by National Science Foundation and Westing House Electric Corporation. The purpose was to advance the state of the art in the automated batch assembly.

## Explain Designing for Robotic Assembly?

Certain assembly tasks are very difficult for the robot ro perform than others. If possible this difficulty factor should be considered in the design of product. Another consideration in the design of an assembly is the direction in which the parts are to be added in the assembly operation.

## What are the Basic configurations of assembly systems?

A single workstation assembly, A series of work station assembly, Combination of both.

1. **What is AGV? (Nov/Dec 2012, 2011,2017,May/june 2015, Nov/Dec 2020,April/May 2021)** Automated Guided Vehicle is an independently operated self-propelled vehicle guided along defined pathways in the floor. It is normally powered with batteries. It is used for handling of materials from one place to another place.

## Write some applications of AGV?

Driverless train operations, Storage distribution system, Assembly line operation, FMS.\

## List out types of AGV vehicles? (Apr/May 2018)

Towing vehicles, Unit load vehicles, Pallet trucks, Fork trucks, Light load Vehicles, Assembly line vehicles.

1. **What are the different methods of economic analysis? (Nov/ Dec 2013,Apr/May 2017)** Payback method, Equivalent uniform annual cost (EUAC) method, Return on investment (ROI) method.

## 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.

## Define EUAC Method. (Nov / Dec 2018)

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.

## Define Payback period.

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

## Define a dead man 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.

## What are the functions of work cell controller? (May/ June 2013, Nov/Dec 2020,April/May 2021)

Sequence control, operator interface, safety monitoring

## Write Short notes on RGV. (Nov / Dec 2013) (May / June 2012,2014,2017)

Rail Guided Vehicle (RGV) is a flexible transportation vehicle. It can link multiple destinations and be a good & economic alternative of conveyor by its characteristic that it can eliminate complex and fixed layout of conveyors, which enables simple and easily maintainable transportation system. In a system multiple vehicles can be operated according to the transportation requirement. RGV system constitutes of transportation rail, vehicles and controller. RGV rail can be installed linear or circular. RGV is controlled by distribution control system and can be expanded easily as the system parameter changes.

## What are the three levels of safety sensors used in a robot? (April/May 2009, 2010, 2011Nov/Dec 2017)

Level – 1: Perimeter penetration detection

Level – 2: Intruder detection inside the work cell

Level – 3: Intruder detection in the immediate vicinity of the robot

## What are the functions of work cell controller? (May/June 2013)

Sequence control, Operator interface, Safety monitoring.

## What are the three basic modes of operation in a robot language operating system(May/June 2014)

Monitor mode, Run mode, Edit mode

## List out any two important factors in the selection of robot for an application.(Nov/Dec 2014).

Types of control system, Work volume, ease of programming, Number of axes

## State some of the reasons made use of robots in welding operation(Nov/Dec 2014).

* + Welding guns are heavy and the speed of assembly lines require precise movement.
  + It may be used in places where human would be in danger.
  + They are faster than people

## Distinguish between the AGV and Robot. (Nov/Dec 2015).

Automated Guided Vehicle is an independently operated self-propelled vehicle guided along defined pathways in the floor. It is normally powered with batteries. It is used for handling of materials from one place to another place.

Robot is 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.

## Mention the limitations of implementing robots in industry. (Nov/Dec 2015,2016).

Need proper Maintenance, Requires trained personnel to operate robots.

## What are the four basic categories in industrial robot applications.(May/June 2015)

Material transfer, machine loading, Welding, Assembly

## What are the steps to be followed by the company in order to implement robot program in its operations. (May/June 2018)

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

## What are the Sensors used in Robot Work Cell? (Nov/Dec 2018)

* Proximity Sensor
* Range Sensor
* Piezoelectric Sensor
* Ultrasonic Sensor
* Tactile Sensor
* Vision Sensor.

**Part-B**

1. Briefly explain AGV & RGV types of robots in detail. (16)
2. Briefly explain the methods of economic analysis of Robots in detail (16) **(Nov/Dec 2013, Nov/Dec 2020,April/May 2021)**
3. Briefly explain the Safety sensors and safety monitoring of Robots in detail (16) **(May/June 2012,2014,Nov/Dec 2014)**
4. Briefly explain the Workplace design consideration for safety of Robots in detail (16**) (Nov/Dec 2017)**
5. Briefly explain the various steps involved for implementing the robot in industries. (16**)(May/June 2012, 2013)**

## (Nov/Dec 2013,2014,2015,2016)

1. Explain in detail the EUAC method of Economic Analysis?(8) **(May/June 2012, 2013,2014, Nov/Dec 2020,April/May 2021)**
2. How economic analysis is done in Payback method? Explain with examples.(8) **(Nov/Dec 2012)**
3. Write about the return on investment method (ROI) in detail with an example. (8)**(May/June 2013, Nov/Dec 2020,April/May 2021)**
4. Suppose the total investment on the robot is estimated to be Rs.500,00. There is one shift operation of 2000 hours and 1 man replaced. Assuming labor rate inducing direct overheads to be Rs80/hour, robot running costs including maintenance and depreciation to be Rs1,00,000 and added value of increased output be Rs.1,20,000 determine the payback period. (16)**(Nov/Dec 2016)**
5. Explain the various cost associated with robot project. (16)
6. list and explain direct and indirect costs involved in a robot application project. Justify, whether you gain profit or loss **(May/June2014)**

12.i)Explain with an example the procedure of applying Pay back method in the economic analysis of robots.

ii)what is meant by blocking in AGV’s? explain the methods used in commercial AGV’s to accomplish blocking? **(Nov/Dec 2014)**

1. Explain the Obstacle Detection and avoidance in AGV’S **(Apr/May 2017)**
2. Explain the factors to be considered for Industrial Applications of Robots**(Apr/May 2017)**
3. With neat sketches explain the following

i)Economic Analysis of Robotic ii)Robotic Work cell **(Apr/May 2018)**

1. With neat sketches explain the following
2. AGV ii)Safety Considerations for Robot operation**. (Apr/May 2018)**

17.i)write short notes on AGV **(Nov/Dec 2018)**

1. Furnish the most familiar robotic languages and detail the construction of teach pendant. 18.Elaborate the various levels of safety of robot in industrial environment **(Nov/Dec 2018)**

## PART-C

1. Illustrate the pay back and rate of return method of economic analysis while implementing robots in industry with suitable example problem. **(Nov/Dec 2015)**
2. List the various benefits of adopting AGV in industry
3. With a neat sketch explain the construction and uses of teach pendant **(Nov/ Dec 2017)**