

INDUSTRIAL ROBOTICS
(MECH 4127)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) AML is a
(a) first generation robot programming language
(b) second generation robot programming language
(c) third generation robot programming language
(d) fourth generation robot programming language.
- (ii) Drives are also known as
(a) sensors (b) controller
(c) actuators (d) manipulator.
- (iii) Which among the following is not the functionality of Robots?
(a) Reprogrammability (b) Multifunctionality
(c) Efficient Performance (d) Responsibility.
- (iv) The robot designed with articulated coordinate systems has
(a) three linear movements
(b) three rotational movements
(c) two linear and one rotational movement
(d) two rotational and one linear movement.
- (v) Which of the following terms refers to the use of compressed gasses to drive (power) the robot device?
(a) Pneumatic (b) Piezoelectric
(c) Hydraulic (d) Photosensitive.
- (vi) APPRO P, 50 command in VAL II
(a) moves the end effector from p
(b) moves the end effector to p
(c) moves the end effector 50 mm above p
(d) none of the above.

- (vii) Which of the following operations can be performed by an industrial robot?
 (a) Pick and place (b) Spray coating
 (c) Welding (d) All of the above.
- (viii) A sensor is a device that converts
 (a) Physical quantity into measurable signals
 (b) Physical quantity into mechanical signal
 (c) Electrical signal into physical quantity
 (d) Physical quantity into electric signal only.
- (ix) Which of the following interpolation schemes is suitable for leadthrough programming?
 (a) Joint interpolation (b) Straight line interpolation
 (c) Circular interpolation (d) Irregular smooth motion.
- (x) Which of the basic parts of a robot unit would include the computer circuitry that could be programmed to determine what the robot would do?
 (a) Sensor (b) Arm (c) Drive (d) Controller.

Fill in the blanks with the correct word

- (xi) _____ type of sensor is used to detect both metallic and non-metallic objects.
- (xii) Work volume of a polar coordinate robot is _____.
- (xiii) _____ is the difference between the maximum and minimum values of the input of a sensor.
- (xiv) One of the most suitable welding processes to be employed with robot is _____.
- (xv) Example of a continuous path robotic welding process is _____.

Group - B

2. (a) Classify and explain the robots on the basis of coordinate system?
 [(CO1)(Understand/LOCQ)]
- (b) Consider the forward transformation of the two-joint manipulator shown in Fig.1. Given that the length of link L_1 is 12 cm, the length of link L_2 is 10 cm, the angle θ_1 is 30° and the angle θ_2 is 45° . Compute the coordinate position (x and y coordinates) for the end of the arm P_w .

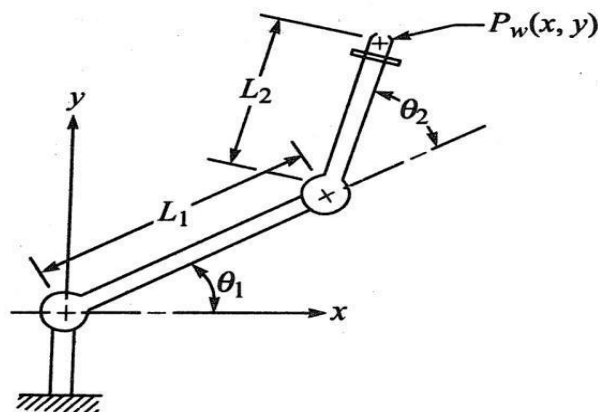


Fig.1

[(CO2)(Evaluate/HOCQ)]

6 + 6 = 12

3. (a) With a neat sketch explain the three degrees of freedom associated with the robot wrist. *[[CO1](Analyse/IOCQ)]*
- (b) Frame {B} is rotated relative to frame {A} about z-axis by 30° and translated 10 units in positive x-axis and 5 units in positive y-axis. Frame {C} is rotated relative to frame {B} about x-axis by 45° and translated 15 units in positive x-axis and 10 units in positive z-axis. Find the transformation matrix that describes frame {C} relative to frame {A} (${}^A_C T$), then find the position of point "P" relative to frame {A} if ${}^C P = [6 \ 5 \ 7]^T$. *[[CO2](Evaluate/HOCQ)]*

$$5 + 7 = 12$$

Group - C

4. (a) Differentiate between the hydraulic and pneumatic actuators. *[[CO3](Analyze/IOCQ)]*
- (b) Explain any one of the mechanical gripper used in robot with a suitable diagram. *[[CO4](Understand/LOCQ)]*
5. (a) What are double-acting pneumatic cylinders? State the advantages and limitations of pneumatic actuators. *[[CO3](Analyze/IOCQ)]*
- (b) How magnetostrictive grippers work? Write its applications. *[[CO4](Understand/LOCQ)]*

$$6 + 6 = 12$$

$$6 + 6 = 12$$

Group - D

6. (a) What are the advantages, limitations and use of capacitive proximity sensor? *[[CO3](Analyze/IOCQ)]*
- (b) Explain how strain gauge works with a suitable diagram and write down the use of strain gauge. *[[CO3](Remember/LOCQ)]*
7. (a) Explain the working principle of an absolute rotary encoder with a diagram. What are the advantages of this type of encoder? *[[CO3](Analyze/IOCQ)]*
- (b) How to select suitable sensors for a robot? *[[CO3](Apply/IOCQ)]*

$$6 + (4 + 2) = 12$$

$$(4 + 2) + 6 = 12$$

Group - E

8. (a) What are the different methods of robot programming? Discuss them briefly. *[[CO5](Understand/LOCQ)]*
- (b) Discuss about the different interpolation schemes in robot motion. *[[CO5](Understand/LOCQ)]*
9. (a) Discuss briefly about the different material handling operations performed by industrial robots? *[[CO6](Understand/LOCQ)]*

$$6 + 6 = 12$$

(b) Discuss how a robot can be employed in spot welding? What are the advantages and disadvantages of using robots in spot welding?

[[CO6)(Analyse/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	44	42.5	13.5

Course Outcome (CO):

After the completion of the course students will be able to

CO1 Identify different components of industrial robots and classify based on different criterion

CO2 Analyze and apply robot kinematics

CO3 Explain working principle and application of different sensors, actuators, drives

CO4 Describe the working and application of different types of end effectors

CO5 Explain and apply robot programming

CO6 Describe the various applications of robots in industry

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*