Registration No : | | | | | | | | | | |

Total Number of Pages : 03 **M.Tech.**
P2MDCC08

2nd Semester Regular / Back Examination 2017-18
ROBOTICS
BRANCH : CAD / CAM ENGG,
MACHINE DESIGN, MECH. SYSTEM DESIGN, SYSTEM DESIGN
Time : 3 Hours
Max Marks : 100
Q.CODE : C969

Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.
Draw neat sketches wherever necessary. Assume any missing data suitably.
Answer all parts of a question at a place.

Q1 **Answer the following questions: *Short answer type:*** **(2 x 10)**

a) With aid of sketches briefly describe Pitch-Roll-Yaw motions of a robot wrist.
b) State and explain Laws of Robotics. Define the terms: Work envelope, Payload with respect to robot.
c) What do you mean by teach pandant? Justify this statement that human hand has 6 DOF.
d) Why homogeneous coordinates are required in modeling of robotic manipulators?
e) The coordinates of point Q with respect to a moving coordinate frame are given as $Q = [0.5\ 0.8\ 1.4]^T$. What are the coordinates of Q with respect to fixed coordinate frame, if the moving frame rotated by 45^0 about Y-axis of the fixed frame.
f) Discuss the major difference between servo-controlled and non-servo controlled robots.
g) What do you mean by inverse kinematic? Differentiate between direct and inverse kinematics.
h) Describe briefly the robot languages elements and functions.
i) What are the advantages of flexibility in manufacturing?
j) What are the functions of a robot vision system? What are the types of vision sensor used to take the image of an object?

Q2 **a)** What are the different types of hydraulic actuators used in robotics? Explain the working principle of Pneumatic-actuator. **(5)**
b) What are the advantages and disadvantages of stepper motors over D.C. servo motors? **(5)**
c) Compare different types of actuating systems i.e., hydraulic, electric and pneumatic systems with respect to robotic systems. Explain with the help of block diagram of a pneumatic system to generate compressed air. **(10)**

Q3 **a)** A six joint robotic manipulator equipped with a digital camera, which is capable of continuously monitoring the position and orientation of an object. The position and orientation of the object with respect to the camera is expressed by a matrix $[T_1]$, the origin of the robot's base co-ordinate with respect to the camera is given by $[T_2]$, and the position and orientation of gripper with respect to the base co-odinate frame is given by $[T_3]$. **(8)**

$$[T_1] = \begin{bmatrix} 0 & 1 & 0 & 5 \\ 1 & 0 & 0 & 6 \\ 0 & 0 & -1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad [T_2] = \begin{bmatrix} 1 & 0 & 0 & -20 \\ 0 & -1 & 0 & 10 \\ 0 & 0 & -1 & 12 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad [T_3] = \begin{bmatrix} 1 & 0 & 0 & 8 \\ 0 & 1 & 0 & 6 \\ 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine i)The position and orientation of the object with respect to the base co-odinate. ii)The position and orientation of the object with respect to gripper.

b) **(12)**

Write the homogeneous transformation matrices shown in the figure 3.1 for the co-ordinate frames attached to the corners A, B, C and D with respect to the base co-ordinate frame 'O'. Also write the transformation matrix for 'A' with respect to 'C' frame and verify the same by finding the inverse.

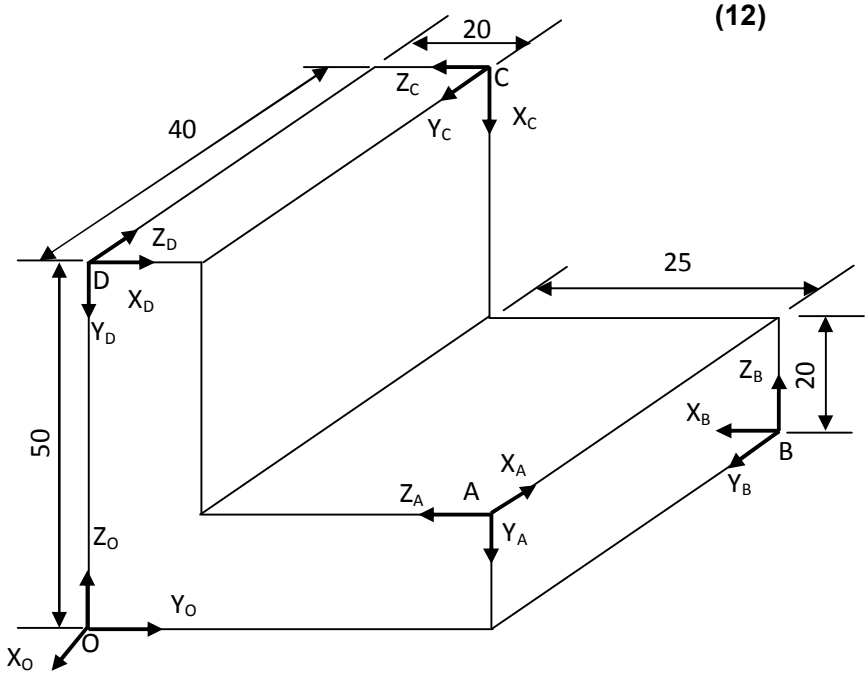

Figure 3.1

Q4 **a)** Derive the forward kinematic equations using Denavit-Hartenberg notation for a three link planner manipulator. **(10)**

b) Obtain the inverse kinematics solution for the 3-degree of freedom planner manipulator shown in the figure 4.1. **(10)**

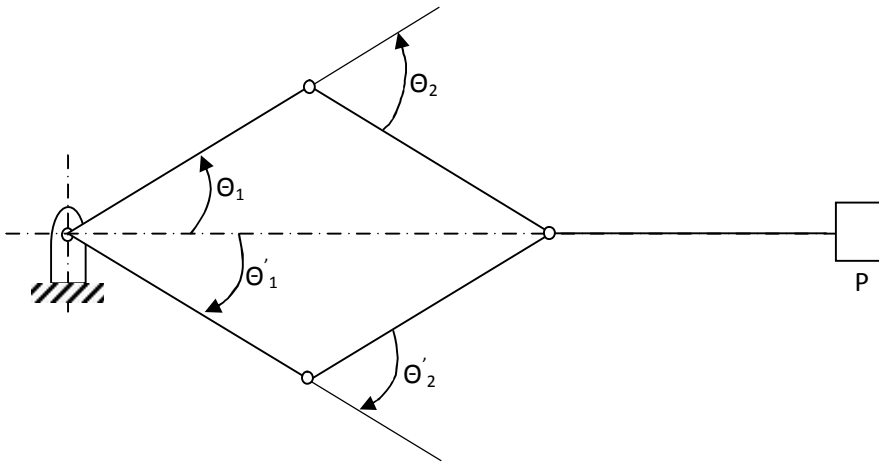

Figure 4.1

Q5 **a)** With the help of neat diagram, illustrate the scheme of robot sensors. State and explain five types of sensors used in robotics. **(10)**

b) How is a robot end-effector specified? State and explain various drives methods used for robot gripper systems. Explain with neat sketch of mechanical, vacuum and adhesive gripper. **(10)**

Q6 **a)** Two plates of 5 mm thickness are to be welded with square butt joint as shown in figure 6.1. The welding is straight weld. The welding torch should start from position A, move to B, continue with continuous arc welding along BC in a straight line and then move to position D. Write a programe in global coordinates. **(10)**

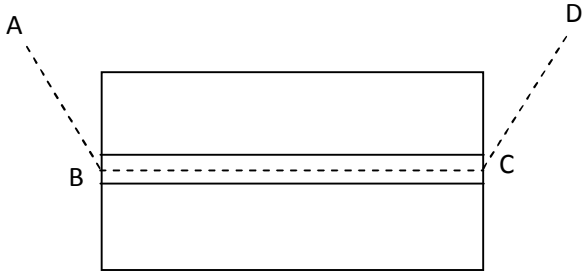

Figure – 6.1

b) Four drill holes are to be made on a circular work piece of diameter 100 mm as shown in the figure 6.2. Four holes are to be located in a circle of diameter 60 mm. Write a program to bring the end-effector holding a drill of 6 mm diameter to each location of the hole in sequential order of 1, 2 3 and 4. **(10)**

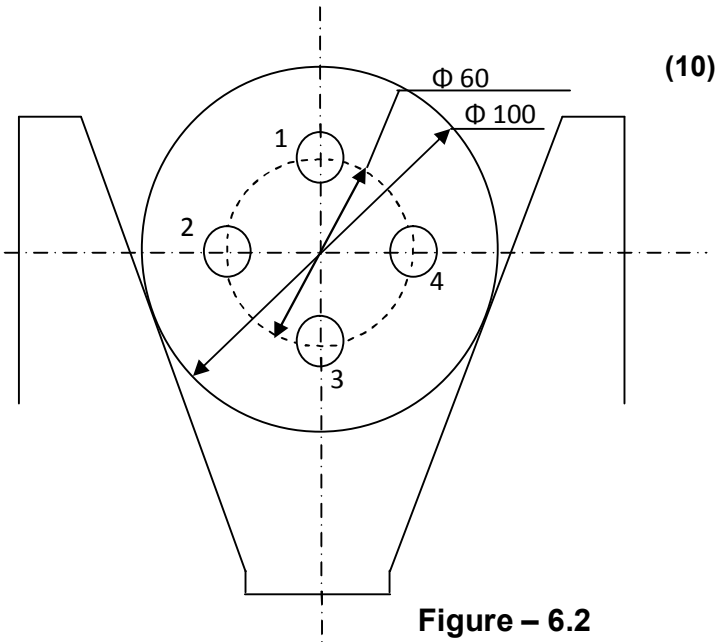

Figure – 6.2

Q7 **a)** What do you mean by robot vision system? What are the functions of a robot vision system? What are the types of vision sensor used to take the image of an object? **(10)**

b) What are the benefits of using flexibility in manufacturing systems? How do you classify robots from the view points of application of FMS? Distinguish between hard automation and flexible automation. **(10)**