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

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

2nd Semester Regular Examination 2016-17
ROBOTICS
Branch: CAD / CAM ENGG, MACHINE DESIGN, MECHANICAL SYSTEMS DESIGN, SYSTEM DESIGN

Time: 3 Hours
Max Marks: 100
Q.CODE: Z846

Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.

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

a) Write about the historical development of Robot manipulators.
b) State and explain Laws of Robotics. Define the terms: Work envelope, Payload with respect to robot.
c) With aid of sketches briefly describe Pitch-Roll-Yaw motions of a robot wrist.
d) Why homogeneous coordinates are required in modeling of robotic manipulators.
e) Difference between active and passive gripper.
f) Differentiate between direct and inverse kinematics.
g) The coordinates of point P with respect to a moving coordinate frame are given as P = $[0.5 \;\; 0.8 \;\; 1.3]^T$. What are the coordinates of P with respect to fixed coordinate frame, if the moving frame rotated by 45^0 about X-axis of the fixed frame.
h) What are the advantages and disadvantages of stepper motors over D.C. servo motors?
i) What are the advantages of flexibility in manufacturing?
j) Describe briefly the robot languages elements and functions.

Q2 a) **(10)**

For the object shown in figure 2.1, find the homogeneous transformation matrices ${}^0A_i$ for i = 1, 2 also find ${}^1A_2$.

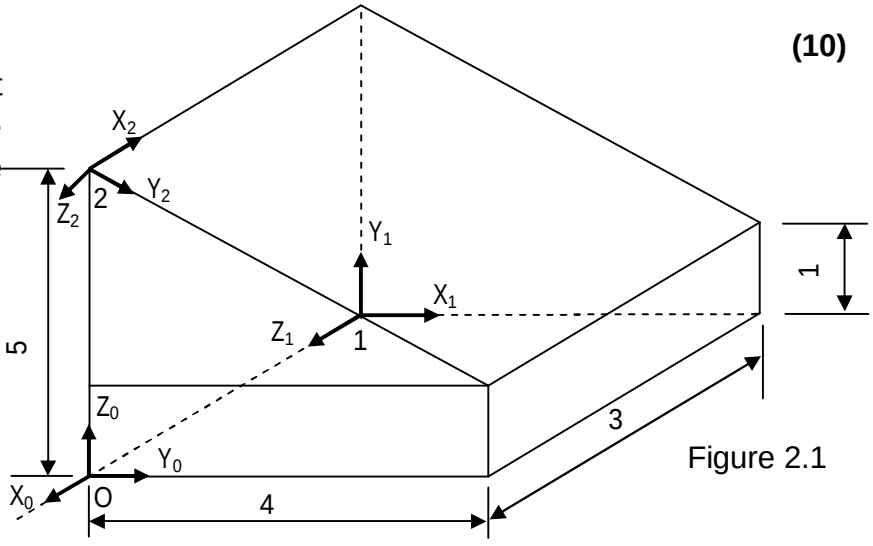

Figure 2.1

b) A robotic end effector is positioned as shown in figure – 2.2. The yaw of the end effector is $\left[\frac{\pi}{2}\right]$ about Z – axis. The pitch of end effector is π, about X-axis and the roll of the end effector is $\left[-\frac{\pi}{2}\right]$, about Y – axis. **(10)**

(a) Draw the sketch of the end effector in sequence after each of yaw, pitch and roll motions.

(b) The composite transformation matrix, which maps the tip co-ordinates into the end effector's wrist frame.

(c) Find the co-ordinates of a point $p(1, 1.6, 1.2)^T$ at tool tip with respect to wrist co-ordinate frame.

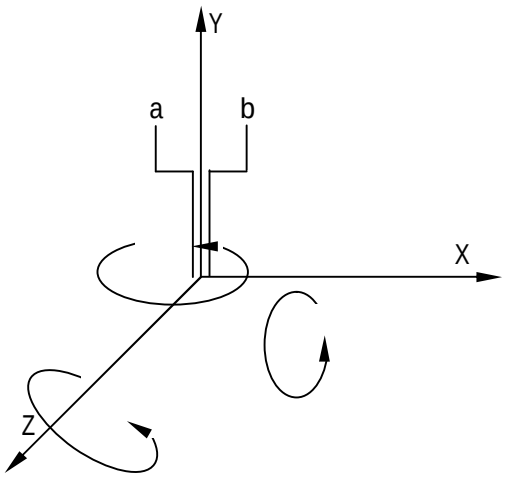

Figure – 2.2

Q3 a) Explain and compare different types of actuating systems i.e., hydraulic, electric and pneumatic systems with respect to robotic systems. **(10)**

b) What are the different types of hydraulic actuators used in robotics? Explain the working principle of Pneumatic-actuator. **(10)**

Q4 a) 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)**

b) In a robotic set-up, a camera is attached to the fifth link of a 6-DOF. It observes an object and determines its frame relative to the camera frame. Using the following information, determine the necessary motion the end effector must make to get to the object: **(10)**

$$^{5}T_{camera} = \begin{bmatrix} 0 & 0 & -1 & 3 \\ 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad ^{5}T_{robot\ hand} = \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{\text{camera}}T_{object} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad ^{\text{robot hand}}T_{end\ effector} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Q5 a) With the help of neat diagram, illustrate the scheme of robot sensors. State and explain in details with diagram about five types of sensors used in robotics. Describe four different type of proximity sensor. **(10)**

b) Obtain the inverse kinematics solution for the 3-degree of freedom planner manipulator shown in the figure 5.1. **(10)**

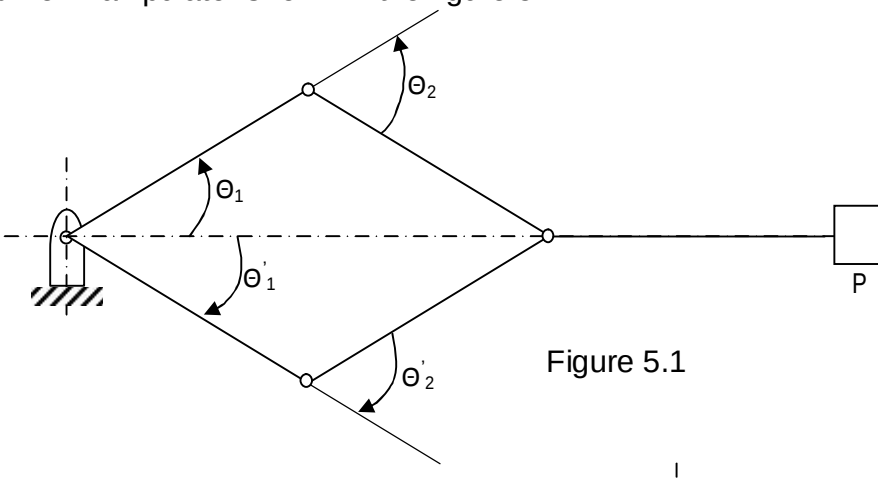

Figure 5.1

Q6 a) Four drill holes are to be made on a circular work piece of diameter 100 mm as shown in the figure 6.1. Four holes are to be located in a circle of diameter 50 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)**

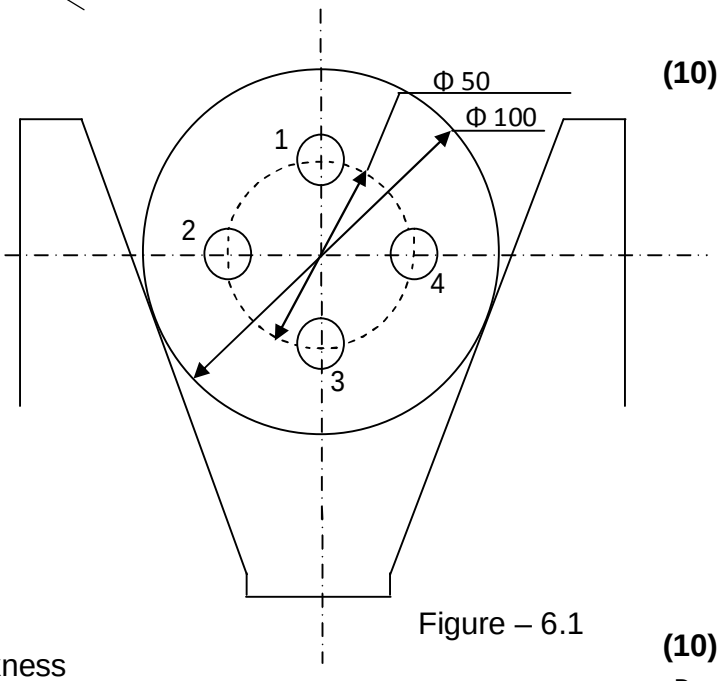

Figure – 6.1

b) Two plates of 8 mm thickness are to be welded with square butt joint as shown in the figure 6.2. 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 VAL programe in global-coordinates. **(10)**

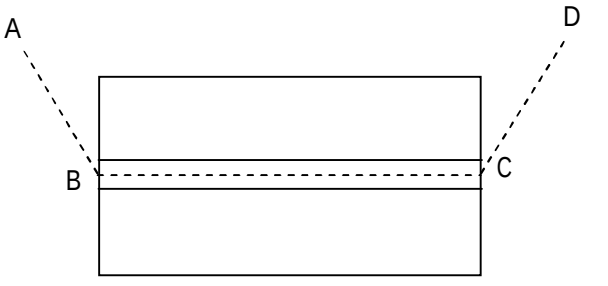

Figure – 6.2

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? **(8)**

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. **(12)**