May/June 2019
B.Tech. (EIC) VIII the Semester
ROBOTICS ENGG. AND AUTOMATION
(EIC-408)

Time : 3 Hours]   [Max. Marks : 60

Instructions :

(i)   *It is compulsory to answer all the questions (2 marks each) of Part-A in short.*

(ii)   *Answer any four questions from Part-B in detail.*

(iii)   *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1.   (a)   Differentiate between accuracy and repeatability. (2)

     (b)   Briefly compare forward and inverse kinematics. (2)

     (c)   For which type of robot precision is uniform throughout the work envelope? For which type of robot vertical precision is uniform? (2)

     (d)   What are advantages and disadvantages of cylindrical arm configuration over a polar arm configuration? (2)

(e) What do you understand by screw transformations? Where these transformations can be useful ? (2)

(f) What problems will be encountered if the frames are arbitrarily assigned to develop the forward kinematic model of a manipulator?

(g) What are closed form solutions to inverse kinematic problems? (2)

(h) Discuss mechatronics. (2)

(i) Differential between Fuzzy Logic and Boolean Logic. (2)

(j) Discuss method of robot programming. (2)

PART–B

2. (a) The end-effector of a robot is rotated about fixed axes starting with a yaw of $-\pi/2$, followed by a pitch of $-\pi/2$. What is the resultant rotation matrix? (5)

(b) Discuss robot anatomy in detail. (5)

3. (a) Why Denavit-Hartenberg representation does not give unique frame assignment for a given manipulator? Explain. (5)

(b) Sketch the approximate reachable workspace of the tip of a two-link planar arm with revolute joints. For this arm, first link is thrice as long as second link ($L_1 = 3L_2$) and the joint limits are $30° - \theta_1 < 180°$ and $-100° < \theta_2 < 160°$. (5)

4. Consider a point P in space. Determine the new location of this point after rotating it by an angle of 45 degree about z-axis and the translating it by −1 unit along x-axis and −2 units along z-axis. Pictorially show the transformation of the vector. What will be the equivalent frame transformation for this vector transformation? Show the transformation of frames. (10)

5. (a) With the help of a case, explain Fuzzy Logic application in robotics. Show all steps, and also, give relevant mathematics. (8)
   (b) What is Lagrangian Mechanics? How it is used for robot dynamic analysis and forces? (2)

6. (a) List various methods of path and trajectory planning, and explain any *one* of them in detail. (3)
   (b) Explain working principles of proximity and range sensors. (3)
   (c) Explain working principles of DC servomotors and stepper motors. (4)

7. (a) The second joint of a SCARA manipulator is required to move from $\theta_2 = 30"$ to $150"$ in 5 seconds. Find the cubic polynomial to generate the smooth trajectory for the joint. What is the maximum velocity and acceleration for this trajectory? (6)
   (b) Write a ROBOT program for path planning. Explain this program. (4]