(03 Hours) 80Marks

Note:

1. Question No.1 is compulsory.
2. Attempt any **Three** questions from remaining.
3. Assume suitable data if required.
4. Illustrate your answers with sketches wherever necessary.

Q1) Attempt **any Four** of the following

(a) Define robots and explain laws of robotics. **05M**

(b) Explain with suitable example SPEED, MOVES and SIGNAL commands. **05M**

(c) Explain different types of joints used in robotics with degree of freedoms. **05M**

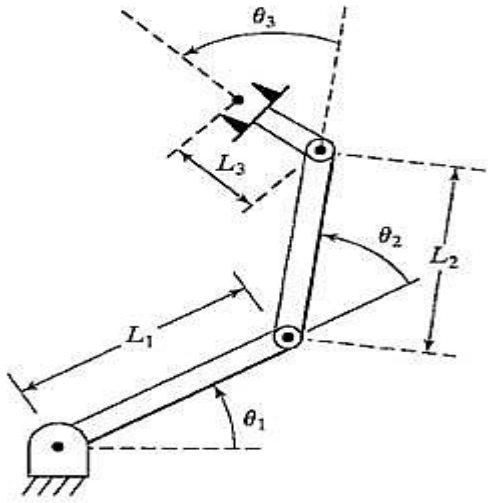
(d) Explain point to point and continuous path control used in robotics. **05M**

(e) Explain why solutions to inverse kinematics problem are generally difficult. **05M**

Q2) (a) What are the considerations for applying DH algorithm? Derive link transformation matrix. **10M**

(b) What are the features and capabilities of future robots, explain any on future application with example. **10M**

Q3) (a) For the following planar manipulator: **10M**



i) Assign the coordinate frame based on the D-H representation.

ii) Determine all the D-H parameters.

iii) Write all the joint/link matrix.

iv) Write the combined ${}^{Base}T_{Tool}$ matrix.

(b) Draw AS/RS system and its elements? Explain its types in detail. **10M**

Q4) (a) Explain internal and external state sensors used in robotics with examples. **10M**

(b) Explain application of robots for performing continuous arc welding with its advantages and disadvantages. **10M**

Q5) (a) Explain in detail safety considerations for robot workplace design. **10M**

(b) Write a program for the robot to pick up two blocks (the blocks are of different sizes) from fixed positions on either side of center position, and to stack the blocks in the center position. The larger block will always be on one side of the center and the smaller block will always be on the other side of the center position. The smaller block is to be placed on top of the larger block. **10M**

Q6) (a) Explain preventive maintenance and spare parts policy used in industrial robots maintenance. **10M**

(b) The coordinates of point P with respect to a moving coordinate frame are given as $\mathbf{P} = (0.5, 0.8, 1.3)^T$. What are the coordinates of P with respect to fixed coordinate frame, if the moving frame is rotated by 45° about Y-axis, followed by a rotation of 120° about Z-axis and a final rotation of 90° about X-axis. **10M**

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