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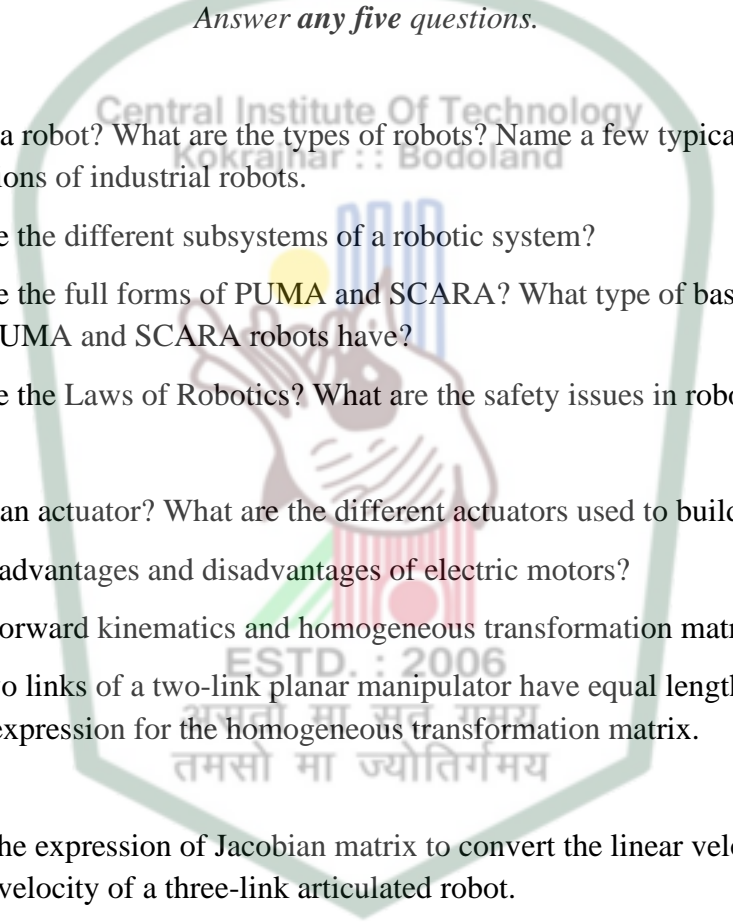
ROBOTICS

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer any five questions.

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1. a) What is a robot? What are the types of robots? Name a few typical applications of industrial robots. 2+2+3
- b) What are the different subsystems of a robotic system? 3
- c) What are the full forms of PUMA and SCARA? What type of basic arms do the PUMA and SCARA robots have? 2+2
- d) What are the Laws of Robotics? What are the safety issues in robot usage? 3+3
2. a) What is an actuator? What are the different actuators used to build a robot? 2+3
- b) List the advantages and disadvantages of electric motors? 5
- c) Define forward kinematics and homogeneous transformation matrix. 4
- d) If the two links of a two-link planar manipulator have equal lengths, find out the expression for the homogeneous transformation matrix. 6
3. a) Derive the expression of Jacobian matrix to convert the linear velocity to angular velocity of a three-link articulated robot. 6
- b) Calculate the Jacobian of a two-link planar arm when $\Theta_1 = 45^\circ$ and $\Theta_2 = 20^\circ$. 4
- c) Define inverse kinematics with an example. 4
- d) The links of a 3R robotic arm are $L_1 = 250$ mm, $L_2 = 350$ mm and $L_3 = 50$ mm. The gripper is at world coordinates given as $x = 300$ mm, $y = 400$ mm and $\alpha = 30^\circ$. Determine the angles θ_1 , θ_2 and θ_3 , which the motor controlling the shoulder, elbow and wrist to be rotated. 6

4. a) Derive the dynamic model of two DoF robotic manipulator using Lagrange-Euler formulation. 15
- b) The second joint of a SCARA manipulator is required to move from $\theta_2=30^\circ$ to 150° in 5 seconds. Find the cubic polynomial to generate the smooth trajectory for the joint. 5
5. a) Discuss the control scheme of a mobile robot in detail. 10
- b) What are the advantages and challenges mobile robots? 4
- c) What is swarm robotics? What are the key attributes of the swarm robotics? 2+4
6. Write short notes on any four of the following 4*5
- a) Grippers and End effectors
- b) DH parameters
- c) DoF and workspace
- d) Human haptics
- e) SLAM robot
7. a) What is Virtual Reality (VR)? Discuss about the interface to virtual world and types of interaction of VR. 2+2+2
- b) Write some suitable applications of VR. 4
- c) How the haptics action helps to solve different robotics application? Describe briefly with diagram. 10

