

Seventh Semester B.E. Degree Examination, Jan./Feb. 2021
Robotics

Time: 3 hrs

Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART – A

- 1 a. With neat sketches, explain the various joints useful for construction of robot manipulator. (05 Marks)
 b. With suitable example, explain how the position and orientation of a point on rigid link can be related with basic coordinate and rotating coordinate system. (05 Marks)
 c. Assign the coordinates and determine the DH parameters for PUMA560 manipulator. (10 Marks)
- 2 a. Explain with a block diagram Direct and Inverse kinematics. (06 Marks)
 b. Derive the direct kinematic equations for 3R manipulator shown in Fig. Q2 (b) (14 Marks)

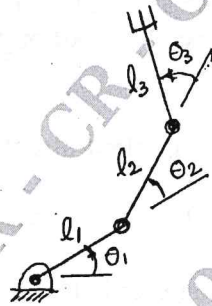


Fig. Q2 (b)

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	θ_1
2	0	l_1	0	θ_2
3	0	l_2	0	θ_3

- 3 a. Figure Q3(a) shows the 3R manipulator, with basic rotations using iterative formulas obtain the linear and angular velocities of each links.

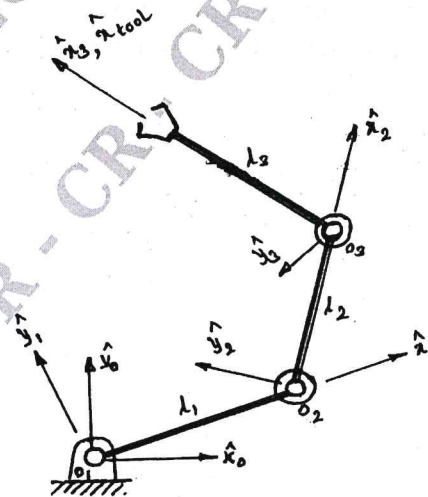


Fig Q3(a)

- b. Obtain the Jacobian matrix for a planar 3R manipulator {tool}. What is the general rule for transforming a $6 \times n$ in to Jacobian matrix in two coordinate system? (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 4 a. Derive the equation of motion for the two degree of freedom system shown in Fig. Q4 (a). (14 Marks)

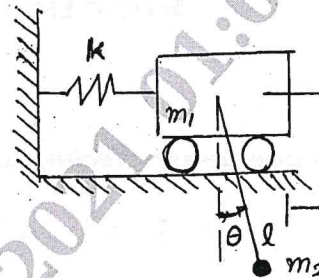


Fig. Q4 (a)

- b. Explain Inertial of a rigid body in dynamics of manipulator. (06 Marks)

PART - B

- 5 a. Obtain the coefficients of a cubic polynomial $\theta(t) = a_0 + a_1t + a_2t^2 + a_3t^3$, if $\theta(0)$, $\theta^0(0)$ and $\theta(t_f)$ are specified. (10 Marks)
- b. The first joint of a 3R Robot is to rotate from 30° to 60° . The initial and final angular velocities are $+10$ deg/sec and -30 deg/sec. The motion is to be completed in 3sec. Obtain the cubic trajectory plan. (10 Marks)
- 6 a. With the help of block diagrams briefly explain structure and model-reference adaptive control of a robotic arm. (10 Marks)
- b. Prove single axis PID control mathematically with the help of block diagram. (10 Marks)
- 7 a. Compare the features of hydraulic, pneumatic and electric actuator used in robots. (12 Marks)
- b. Explain with a neat sketch construction and operation of 4 pole stepper motor. (08 Marks)
- 8 a. Explain with a neat sketch principle and construction of inductive proximity sensor. (10 Marks)
- b. Explain the features of sensor used in robots. (06 Marks)
- c. Explain with a neat sketch any type of position sensor. (04 Marks)
