

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

- Q.1(a) $\frac{A}{B}R$ is a 3×3 rotation matrix with eigenvalues 1, and $e^{\pm i\theta}$, where $i = \sqrt{-1}$. What is the physical meaning of the eigenvector of $\frac{A}{B}R$ associated with the eigenvalue 1? [2]
- Q.1(b) For a given 3RP SCARA robot shown in Fig.Q.1(b) tabulate the DH parameters. [3]

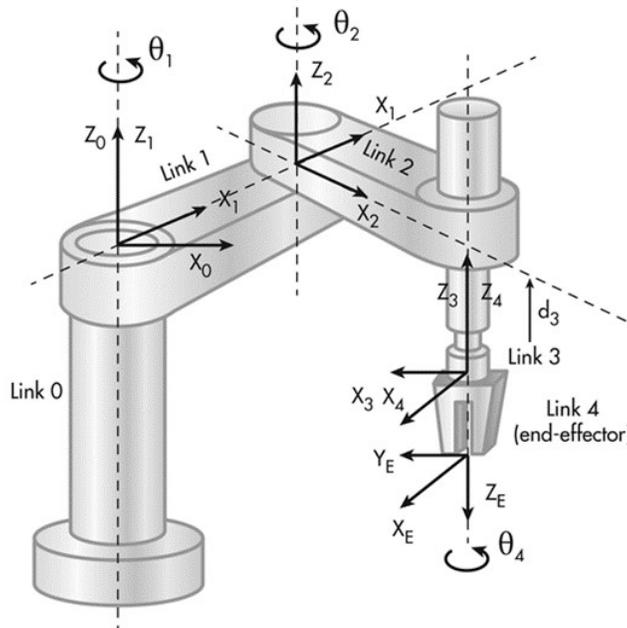


Fig. Q.1(b)

- Q.1(c) Write forward kinematics transformation matrices of the robot shown in Fig. Q.1(b). [5]
- Q.2(a) Describe the functionality of steppers motors. [5]
- Q.2(b) List any three advantages and disadvantages of a hydraulic actuator. [5]
- Q.3(a) Throw some lights on repeatability and accuracy. [2]
- Q.3(b) Derive the inverse kinematics of the manipulator shown in Fig. Q.3(b). [4]

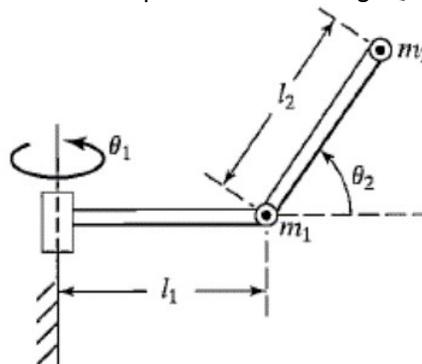


Fig.Q.3(b)

Q.3(c) Derive the Jacobian matrix for the manipulator shown in Fig.Q.3(b). [4]

Q.4(a) Compute the motion of the system in Fig. Q.4(a) if parameter values are $m = 1$, $b = 7$, and $k = 10$ and the block is released from the position $x = 1$ with an initial velocity of $\dot{x} = 2$. [4]

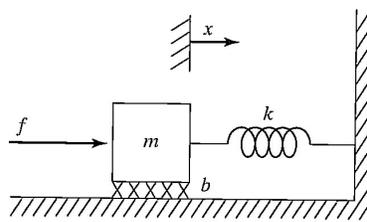


Fig.Q.4(a)

Q.4(b) Consider the system shown in Fig.Q.4.(a) with the parameter values $m = 1$, $b = 4$, and $k = 5$. The system is also known to possess an unmodeled resonance at $\omega_{res} = 6.0$ radians/second. Referring Fig.Q.4(b) determine the gains k_v and k_p that will critically damp the system with as high a stiffness as is reasonable. [6]

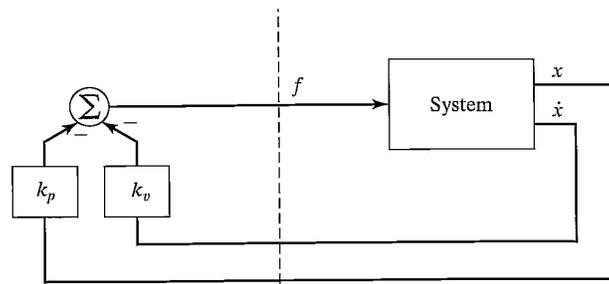


Fig. Q.4(b)

Q.5(a) Write a robot program (in a language of your choice) to pick a block up from location A and place it in location B. [5]

Q.5(b) Using any robot language, write a general routine for unloading an arbitrarily sized pallet. The routine should keep track of indexing through the pallet and signal a human operator when the pallet is empty. Assume the parts are unloaded onto a conveyor belt. [5]