

(Time: 3 Hours)

[Total Marks:80]

NB.

- (1) Question No.1 is compulsory.
- (2) Attempt any three questions from remaining.
- (3) All questions carry equal marks.
- (4) Assume suitable data wherever necessary.

Q.1 Answer any four of the following:

- a) With neat sketch define Joint and Link parameters. (5)
- b) Explain how tool orientation is specified. (5)
- c) What is homogeneous transformation matrix? Give the transformation matrix for pure translation and pure rotation. (5)
- d) Explain template matching in robot vision. (5)
- e) Justify “Inverse kinematics problem is not unique.” (5)

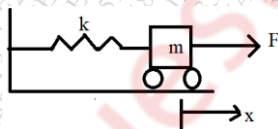
Q.2 a) Develop the DH representation of a four axis SCARA robot and obtain its arm matrix. (10)

- b) Let $F = \{f^1, f^2, f^3\}$ and $M = \{m^1, m^2, m^3\}$ be two initially coincident fixed and mobile orthonormal coordinate frames. Suppose the point P at the tool tip has mobile coordinates $[P]^M = [7, 3, 1]^T$. Find $[P]^F$ after the following transformations,
 - 1. Rotate M by $\Pi/2$ radians about f^3 axis
 - 2. Then translate the rotated M by 4 units along f^1 axis.

Q.3 a) Find the new location and orientation of frame B after a differential rotation of 0.1 radians about the y axis followed by a differential translation of [0.1, 0, 0.2]. (10)

$$B = \begin{bmatrix} 0 & 0 & 1 & 10 \\ 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- b) Derive the force acceleration relationship for a 1 DOF system given below using Lagrangian mechanics as well as Newtonian mechanics. Assume the motion is linear with no inertia. (10)



Q.4 a) Explain robot motion planning using Bug 1 and Bug 2 algorithm. (10)

b) What is a GVD? Sketch all the GVD's resulting due to the basic interactions of the obstacle. Derive the necessary equations. (10)

Q.5 a) Explain Visibility Graph algorithm. (10)

b) Explain the different moments to characterize shapes. (10)

Q.6 Write short notes on any four of the following: (20)

- a) Cartesian Space trajectory
- b) Potential Functions
- c) Shrink and Swell Operators
- d) Work Space Envelope
- e) Perspective Transformations
