Duration:3 Hours **Total Marks:80**

N.B.
1. Question no. **1 is compulsory**.
2. Attempt ANY **THREE** questions **out of remaining FIVE** questions.
3. Illustrate your answer **with neat sketch** wherever necessary.
4. Figures to the right indicate full marks.

Q1. Attempt any **FOUR** of the followings: **(20)**

a) Explain the forward and inverse kinematic in robotics.
b) Explain and illustrate the D-H representation of link and joint parameters for a serial manipulator as shown in Fig.1.

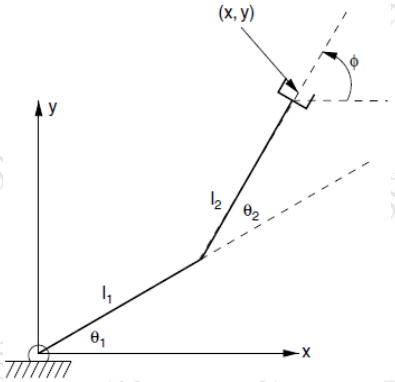

Fig.1. Serial Manipulator

c) Explain significant difference between soft and hard automation.
d) What is tactile sensor?
e) Explain edge detection method in machine vision.

Q2. a) State and explain different joints used in robotic system. Identify joints and find degree of freedom of a serial manipulator as shown in Fig.1. **(10)**

b) Explain the trajectory planning usingcubical trajectory function. **(10)**

Q3. a) For a serial manipulator shown in Fig. 1, find the composite transformation matrix using direct/forward kinematic analysis. **(12)**

b) State the principles of materials handling system? Explain the role of materials handling system in assembly and inspection. **(8)**

Q4. a) What is segmentation in Machine Vision. Explain thresholding method used for converting grey scale image into binary black-and-white image. **(7)**
b) Explain robot learning method. **(7)**
c) Explain any one state space search algorithm. **(6)**

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Q5. a) Explain construction, working principle and applications of proximity sensor. **(8)**

b) Explain social and economic issues in employing robots. **(8)**

c) Explain robot dynamics with help of robot as shown in figure 1. **(4)**

Q6. Write a short notes on the followings **(ANY FOUR):** **(20)**

a) Position and velocity sensors

b) Motion planning of robot

c) Robot task planning

d) Homogeneous transformation

e) Programming languages for Robot

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