

## FACULTY OF ENGINEERING

B.E. 4/4 (ECE/Inst./M/P) II – Semester (Main) Examination, May / June 2012

Subject : **Robotics** (Elective – III)

Time : 3 hours

Max. Marks : 75

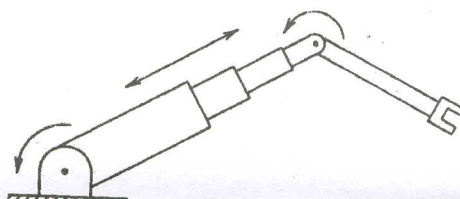
**Note:** Answer all questions from Part–A and answer any **FIVE** questions from Part–B.

### PART – A (25 Marks)

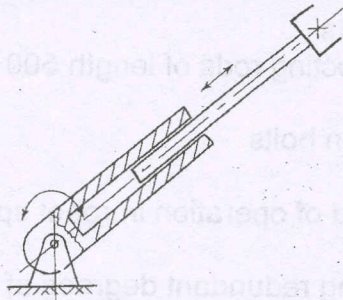
1. What type of end effectors are used in the following robot applications? 3
  - a) To transport large thin sheets
  - b) To load semi finished connecting rods of length 500 mm on to a grinding machine
  - c) To tighten hexagonal nuts on bolts
2. What is the importance of speed of operation in robot specifications? 2
3. Explain the advantages of having redundant degrees of freedom in a robotic manipulator. 2
4. Do DH representations give a unique frame assignment? Explain your answer. 3
5. Consider a movable right coordinate system  $OXYZ$  if it is undergoing the following motions : Rotation of  $30^\circ$  about y axis followed by rotation of  $60^\circ$  about new z axis. Sketch the initial and final coordinate frames. 3
6. Define all the parameters that control the number of solutions to given inverse kinematics problem. 2
7. Prove that  $\{ T \} = [J]^T \{ F \}$  where  $\{ T \}$  is joint torque vector,  $[J]$  is manipulator Jacobian and  $\{ F \}$  is end point vector. 3
8. What are the functions of a controller in an industrial robot? 2
9. Derive the dynamic equation of motion of a single degree freedom vibrating body in natural free vibration. Explain different terms involved in the equation. 3
10. What is computed Torque control method? 2

### PART – B (5 x 10 = 50 Marks)

- 11.a) Mention the specifications of a robot used for manufacturing PCB's. 4
  - b) Sketch the configuration and workspace of Cylindrical and Cartesian type of Robots. 6
12. Obtain the overall transformation matrix for the robot configuration given in fig (1). 10



13. Find all the possible solutions by performing inverse location in a two degree of freedom RR type of planar robot when its end effector is to be located at (3m, 5m). Take  $l_1 = l_2 = 4m$  10
14. A planar manipulator arm with one rotary and one prismatic joint is given in fig(2). 10
- Compute the Jacobian for the arm
  - What will be the velocities if the endpoint is required to move at a constant velocity along a flat surface?



A 2-DOF planar arm with a rotary and a prismatic joint

Fig. (2)

- 15.a) Derive dynamic equations of a 2 degree of freedom PP type of planar robot using Lagrange-Euler formulation. 5
- A joint of a manipulator is required to move from  $\theta = 30^\circ$  to  $120^\circ$  in 6 seconds. Find a suitable linear trajectory with parabolic blend. Determine the parameters of trajectory. Assume constant accelerations of  $30 \text{ deg/s}^2$ . 5
- 16.a) With a neat sketch explain the working of any one kind of proximity sensor. 4
- Explain the process of image analysis in Machine vision? 6
- 17.a) Classify the robots according to the drive technology used and enumerate relative merits and demerits. 5
- Explain with a neat sketch the working of a device used for obtaining a digital image. 5