Ref. No. : Ex/PG/PROD E/T/112A/2018

# M. Production Engineering 1st Year 1st Semester Examination – 2018

## SUBJECT : ROBOTICS

**Time : Three hours** **Full Marks 100**

**ANSWER ANY FIVE QUESTIONS**

1. a) Show the various robot configurations using neat sketches, stating co-ordinate systems, they are using. What is the advantage of SCARA configuration in industrial applications? 8+2

   b) Show the basic components of a robot using a neat sketch of an industrial robot, indicating the locations of actuators and internal sensors for the various joints. 10

2. a) What do you mean by the working envelope of a robot? Draw the working envelopes for any two types of robot configuration. 2+8

   b) Why are additional 3 degrees of freedom required at the robot wrist? Show how this can be achieved, using a neat sketch. 2+8

3. a) Show the mechanisms of two fingered parallel jaw type robot grippers with revolute joint & prismatic joint. State the relative advantages and disadvantages of these two types of robot grippers. 8+2

   b) A cube of weight 5 kgf is to be gripped by a robot, using friction between the object and the two parallel opposing fingers which are always vertical. The co-efficient of friction, $\mu = 0.3$. The gripper is attached to a SCARA type robot. Calculate the minimum gripping force, to be exerted by each finger when
      i) The cube is held up stationary
      ii) The cube is being picked up vertically upwards with an acceleration, g/6 ( g = acceleration due to gravity) 10

4. a) Explain the working principle of the vacuum gripper. State the applications of vacuum grippers in industry. 8+2

   b) Discuss with a neat sketch, about the function and the working principle of a RCC device, that can be employed at the robot wrist for assembly. 10

5. a) State the advantages and limitations of different drive systems used for industrial robots 10

   b) Explain the need for internal sensors at each joint of a robot. Also explain the need for employing external sensors in robots. 10

6. a) Explain the world coordinate system and joint coordinate system for defining a 'location variable' in a robot language. 4

b) Distinguish between the following instructions in VAL-II :
   i) MOVE and MOVES
   ii) CLOSEI and CLOSE
   iii) CIRCLE and PCIRCLE 6

c) Write a robot program in VAL-II for a palletizing operation, in which a robot has to pick up 35 objects from a fixed location, and to place them in a pallet in the form of an array of 5 rows and 7 columns. The rows and columns are parallel to x-axis and y-axis respectively, and are 140 mm & 100 mm apart respectively. 10

7. a) Distinguish between the following types of robot sensors with suitable examples:
   (i) internal and external robot sensors
   (ii) contact and non-contact robot sensors
   (iii) range and proximity robot sensors 4+4+4

b) A robot has to pick up four different types of parts in a repeated fashion from a fixed location whenever any part is present there, and to place them in four different locations depending on the types of the parts. The presence of a particular type of part is indicated to the robot controller by turning 'on' any one of four binary input channels (numbered 1, 2, 3, 4) by a vision system, that recognizes the types of the parts. Write a robot program in VAL-II for performing this operation. 8

8. a) Explain briefly the working principle of an absolute optical encoder used for providing feedback of joint position in robots. What would be the angular resolution of such encoder having 12 tracks? 9+1

b) Explain briefly the working principles of (i) an inductive and (ii) optical proximity sensors. 5+5

9. a) What do you mean by direct and inverse kinematics in robotics? How would you obtain a composite homogeneous transformation matrix from the basic homogeneous transformation matrices for a sequence of rotations and translations of a coordinate frame with respect to a fixed coordinate frame? 4+4

b) Discuss Denavit-Hartenberg (D-H) method for establishing a coordinate frame to each link of a robot arm and to obtain a transformation matrix relating two successive coordinate frames. Hence, discuss its use in forward transformation in robotics. 12