M. PRODUCTION ENGINEERING 1ST SEMESTER EXAMINATION – 2017

SUBJECT : ROBOTICS

Time : Three hours **Full Marks 100**

ANSWER ANY FIVE QUESTIONS

1. a) 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

   b) 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

2. a) A cube of weight 8 kg is to be gripped by a SCARA type robot, using friction between the object and the two parallel opposing fingers. The co-efficient of friction, $\mu = 0.4$. 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/4 10
      (g = acceleration due to gravity)

   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 Define working envelope of a robot? Draw the working envelopes for Cylindrical and Cartesian types of robot configuration 2+8

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

4. a) Explain the working principle of RCC device used for assembly. 10

   b) Classify end effectors. Show the mechanisms of two fingered parallel jaw type robot grippers with actuators connected. State the advantages of using this type of robot grippers. 2+6+2

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. 5+5

6. a) What do you mean by 'location variable' in a robot language? Explain the world coordinate system and joint coordinate system for defining a location variable in a robot language. 2+4

   b) Distinguish between the following instructions in VAL-II :
      i) MOVE and MOVES
      ii) CLOSEI and CLOSE 4

   c) Write a robot program in VAL-II for a palletizing operation, in which a robot has to pick up 30 objects from a fixed location, and to place them in a pallet in the form of an array of 5 rows and 6 columns. The rows and columns are parallel to x-axis and y-axis respectively, and are 150 mm & 120 mm apart respectively. 10

7. a) What are the reasons for employing sensors in robots? Distinguish between internal and external sensors with suitable examples. 4+4

   b) What are meant by range and proximity sensors, and what are they used for? 4

   c) A robot has to pick up three different types of parts in a repeated fashion from a fixed location whenever any part is present there, and to place them in three different locations (*i.e.*, to sort them) 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 three binary input channels (numbered 1, 2, 3) 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 10 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? What is the advantage of a homogeneous transformation matrix over 3x3 transformation matrix? 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? 3+3+4

   b) Following Denavit-Hartenberg (D-H) method, discuss how a coordinate frame may be established to each link of a robot arm, and hence discuss its use in direct kinematics in robotics. 10