B. PRODUCTION ENGINEERING 4TH YEAR 2ND SEMESTER EXAMINATION – 2019

ROBOTIC ENGINEERING
(ELECTIVE – II)

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

Use separate Answer-Script for each part

PART - I (60 marks)
Answer any **six** questions

1. What is the working envelope of a robot? Draw the working envelope of cylindrical and Cartesian robot configurations. 2+4+4

2. 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 and the electrical interface between them & the various components of the robot controller. 10

3. Why are additional 3 degrees of freedom required at the robot wrist? Show a robot wrist using a neat sketch. 2+8

4. A cylindrical work-piece of weight 8 kgf with its axis vertical is to be gripped by a robot gripper with three fingers, using friction between the object and the fingers. The co-efficient of friction, u = 0.1. The gripper is attached to a SCARA type robot. Calculate the minimum gripping force, to be exerted by each finger when the work piece is being picked up vertically upwards with an acceleration, g/8. 10

5. Show two different types of mechanism of two fingered parallel jaw type robot grippers (with revolute & prismatic joints). What are the advantages & limitations of using these two types of robot gripper? 7+3

6. 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 rectification of misalignment in peg and hole assembly. 10

7. Show the various robot configurations using neat sketches, stating their co-ordinate systems. What is the advantage of SCARA configuration in industrial applications. 8+2

8. Explain the working principle of the vacuum gripper. State the applications of vacuum grippers in industry. 9+1

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PART - II (40 marks)

Answer any **four** questions

1.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 :
   i) MOVE and MOVES instructions in VAL-II
   ii) range and proximity robot sensors 4

2.a) What do you mean by point-to-point and continuous path motions in robots. 3

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 a vision system that recognizes the parts, and sends a binary value '1' (= ON) to any one of four binary input channels (numbered 1, 2, 3 & 4). Write a robot program in VAL-II for performing the operation. 7

3.a) What are the reasons for employing sensors in robots? 4

b) Explain briefly the working principle of an inductive proximity sensor. 6

4. What do you mean by direct and inverse kinematics in robotics? What is a basic homogeneous 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? 4+2+4

5. 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 direct kinematics in robotics. 10

6.a) What is 'segmentation' in vision processing? Discuss edge detection technique. 1+5

b) Discuss 'template matching' technique of 'object recognition' in robot vision system. 4