Ref. No. : Ex/PG/ProdE/T/112A/2024

M.E. PRODUCTION ENGINEERING 1ST YEAR 1ST SEMESTER EXAMINATION – 2024
Subject : ROBOTICS (PT)

Time: 3 hours **Full Marks: 100**

Answer any 10 questions

1. 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 robot controller. 10

2. What do you mean by the working envelope of a robot? Draw the working envelopes & also the configurations for cartesian type & cylindrical type robot configurations. 2+4+4

3. Classify end effectors. 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. 2+8

4. Can a revolute joint of a robot be actuated using a piston & cylinder type prismatic actuator? If answer is 'yes' show a figure for that. Compare the advantages & disadvantages of different drive systems used for robots. 4+6

5. How many degrees of freedom (minimum) are required to position the end-effector at any point within the working envelope of a robot? How many additional degrees of freedom are required at the robot wrist & for what purpose? Show how this can be achieved, using a neat sketch of a robot wrist. 1+3+6

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

7. A cube of weight 5 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, $\mu = 0.2$. 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/10
   (g = acceleration due to gravity) 10

8. Show the various robot configurations using neat sketches, stating their co-ordinate systems. 10

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9.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. 2+4

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

10. Write a robot program in VAL-II language for a de-palletizing operation. The robot has to pick up 20 objects from a pallet, and to place them in a fixed location. The objects, to be picked up, are arranged in an array of 4 rows and 5 columns, where the rows and columns are parallel to x and y axes respectively, and are 200 mm & 150 mm apart respectively. 10

11. Discuss 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 from the basic homogeneous transformation matrices (indicating the joint variables and the link parameters). Also, discuss its use in solving direct kinematic problems in robotic. 3+7

12. What are the reasons for employing sensors in robots? Distinguish between internal and external sensors with suitable examples. 5+5

13. Explain briefly the working principle of an optical incremental encoder used for the measurement of joint displacement in robots. How can they be used for measurement of angular velocity? 8+2

14. What are meant by range and proximity sensors, and what are they used for? Explain briefly the working principle of an inductive proximity sensor. 4+6