

**B.Tech. MECHANICAL ENGINEERING
(COMPUTER INTEGRATED
MANUFACTURING)**

00382

**Term-End Examination
December, 2017**

BME-029 : ROBOTICS

Time : 3 hours

Maximum Marks : 70

Note : Answer any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted.

1. (a) State few typical applications of an industrial robot.
(b) Describe the classification of robots on the basis of physical configurations. 5+5
2. (a) Describe in brief, the various types of actuators.
(b) Why are DC motors generally used in robotics? 5+5
3. (a) What are the characteristics of spray painting robots?
(b) Discuss in brief, the safety issues in robotics.

5+5

4. (a) The co-ordinates of a point p_{abc} in the mobile frame OABC is given by $[5, 4, 3]^T$. If the frame OABC is rotated 30° about OZ-axis of the OXYZ frame, find the co-ordinates of the point p_{xyz} with respect to the base frame.
- (b) For the following rotation matrix, determine the axis of rotation and the angle of rotation about the same :

$$R = \begin{bmatrix} \frac{\sqrt{3}}{2} & 0 & 0.5 \\ 0 & 1 & 0 \\ -0.5 & 0 & \frac{\sqrt{3}}{2} \end{bmatrix}$$

5+5

5. (a) Discuss the forward and inverse kinematics in industrial robots.
- (b) When are hydraulic actuators preferred in robots ? What are the differences between a stepper motor and a DC servo motor ? 5+5
6. Discuss Lagrange-Euler formulations for a robotic manipulator with the help of an example. 10
7. (a) Explain trajectory planning and show how trajectory planning is done in case of Point-to-Point (PTP) robot having constant maximum velocity and finite acceleration and deceleration.

- (b) The revolute joint of an articulated PTP robot traverses from an initial position of 10° to 40° final position in 3 seconds. Assuming a third degree polynomial and start-off acceleration 3 deg/sec^2 , determine the deceleration at the end of 3 seconds. 5+5

8. A certain robot manipulator has a mechanical joint described by the differential equation specifying the position of the output link as a function of time

$$2.2 \frac{d^2y}{dt^2} + 17.6 \frac{dy}{dt} + 35.2y = X(t),$$

where y gives the output response and X is the function describing the force applied.

- (a) Write the characteristic equation.
- (b) What are the roots of the characteristic equation ?
- (c) Determine the types of response.
- (d) Compute the natural frequency and the resonant frequency. 10
9. (a) What is the critical information required for task programming of a robot ?
- (b) Discuss the advantages and disadvantages of online programming. 5+5

10. Write short notes on any **four** of the following : $4 \times 2 \frac{1}{2} = 10$

- (a) PID Control
 - (b) Forward Kinematics
 - (c) Simulation Environment
 - (d) Serial Chain Robot
 - (e) Robot Economics
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