CBCS SCHEME

USN | | | | | | | | | | |

20MCM/MAR21

Second Semester M.Tech. Degree Examination, July/August 2022
Design of Robotic Systems

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define a robot and briefly discuss anatomy of a robot. **(10 Marks)**

b. Give the chronology of development in the area of robotics. **(10 Marks)**

OR

2 a. With a neat sketch explain working principle of vacuum cup grippers. **(10 Marks)**

b. Explain the following types of control of a robotic system.
i) Proportional ii) Derivative iii) PID control. **(10 Marks)**

Module-2

3 a. Explain Denavit – Hardenberg convention briefly. **(10 Marks)**

b. A robotic workcell has a camera within the setup. The origin of the six joint robot fixed to a base can be seen by the camera. A cube placed on the work cell table is also seen by the camera. The homogeneous transformation matrix H_1 maps the camera with the cub centre, the origin of the base coordinate system as seen from the camera is represented by the homogeneous transformation matrix H_2.

$$H_1 = \begin{bmatrix} 0 & 1 & 0 & 2 \\ 1 & 0 & 0 & 8 \\ 0 & 0 & -1 & 7 \\ 0 & 0 & 0 & 1 \end{bmatrix} \text{ and } H_2 = \begin{bmatrix} 1 & 0 & 0 & -8 \\ 0 & -1 & 0 & 15 \\ 0 & 0 & -1 & 6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

i) What is the position and orientation of the cube with respect to the base coordinate system?

ii) After the system has been setup, if camera is rotated by 90° about z-axis of the camera what is the position and orientation of the camera with respect to robots base coordinate system. **(10 Marks)**

OR

4 a. Describe composite homogeneous transformation and explain the rules applied in the formation of the same. **(08 Marks)**

b. Sketch the configuration of a SCARA robot and obtain the kinematic parameters using D-H algorithm. **(12 Marks)**

Module-3

5 a. Compute the effective inertia, coupling inertia centripetal and coriolis component and the gravity terms for a single link manipulator of mass 'm' and length 'a_1' as shown in Fig Q5(a).

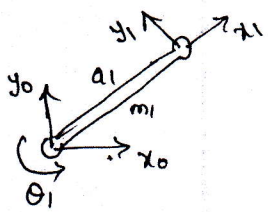

Fig Q5(a) Signal link manipulator **(14 Marks)**

b. The end effector of a manipulator exert a force of f = 0i + 0j + 10k and a moment of m = 0i + 0j – 100k. The position of the end effectors is described by

$$A = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine the equivalent moment and force at the wrist. **(06 Marks)**

OR

6 a. Derive Lagrange – Euler formulation for a robot manipulator. **(12 Marks)**

b. Explain following with respect to robot arm dynamic analysis
i) Kinetic energy ii) Potential energy. **(08 Marks)**

Module-4

7 a. Describe the significance of motion interpolation in robot programming **(10 Marks)**

b. Explain the use of Branching in robot programming with an example. **(10 Marks)**

OR

8 a. Discuss the important features of the following programming languages
i) VAL II ii) RAIL. **(10 Marks)**

b. Discuss the significance of WAIT, SIGNAL and DELAY commands in robot programming for a typical punch press application. **(10 Marks)**

Module-5

9 a. Describe the working principle of following types of proximity sensors, i) Inductive sensor ii) Hall effect sensor. **(10 Marks)**

b. Discuss the Robotic application of machine vision in brief. **(10 Marks)**

OR

10 a. Explain the general characteristics of industrial work situation that tend to promote the substitution of robots for human labour. **(12 Marks)**

b. Describe three phases of robot task planning. **(08 Marks)**

* * * * *