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10MAR13

# First Semester M.Tech. Degree Examination, January 2011

## Robotics for Industrial Automation

Time: 3 hrs. Max. Marks:100

**Note: 1.** ***Answer any FIVE full questions.***
**2.** ***Missing data may be suitably assumed.***



1 a. Define robots in various ways and justify any one of the definition as applicable to modem robots. **(06 Marks)**

b. Discuss the different classifications of robots. **(06 Marks)**

c. Discuss the merits and demerits of four basic robotic structures, with symbolic sketches. **(08 Marks)**

2 a. Briefly discuss the factors that are used for evaluating the performance of robotic systems. **(06 Marks)**

b. Explain any five basic controllers along with their transfer functions. **(07 Marks)**

c. With a neat sketch, derive the composite matrix for rotation about an arbitrary axis. **(07 Marks)**

3 a. A six joint robotic manipulator is equipped with a digital T.V. camera capable of monitoring the position and orientation of an object. The position and orientation of the object with respect to the camera is expressed by a matrix $[T_1]$, the origin of the robot base coordinate with respect to the camera is given by $[T_2]$ and the position and orientation of the gripper with respect to the base coordinate frame is given by $[T_3]$.

$$[T_1]=\begin{bmatrix}0 & 1 & 0 & 5\\ 1 & 0 & 0 & 6\\ 0 & 0 & -1 & 10\\ 0 & 0 & 0 & 1\end{bmatrix} \quad [T_2]=\begin{bmatrix}1 & 0 & 0 & -20\\ 0 & -1 & 0 & 10\\ 0 & 0 & -1 & 12\\ 0 & 0 & 0 & 1\end{bmatrix} \quad [T_3]=\begin{bmatrix}1 & 0 & 0 & 8\\ 0 & 1 & 0 & 6\\ 0 & 0 & 1 & 6\\ 0 & 0 & 0 & 1\end{bmatrix}$$

Determine :

i) The position and orientation of the object with respect to the base coordinate frame.

ii) The position and orientation of the object with respect to the gripper. **(12 Marks)**

b. Discuss with a neat sketch, D.H. representation and method with usual notations. **(08 Marks)**

4 Apply D.H. method with usual notations for the typical following robotic arms assuming usual conventions and configurations and obtain the displacement matrices :

i) Cartesian robot ii) Anthromorphic robot **(20 Marks)**

5 a. Explain inverse kinematics for a 3-axis robotic system with proper illustration. **(08 Marks)**

b. Discuss the trajectory planning with respect to a PTP robot considering a modified constant velocity motion of the joint and illustrate by suitable sketches and also obtain switching timings. **(12 Marks)**

6 a. In its usual form, discuss the Lagrange-Euler dynamic modeling of robotic arms. **(06 Marks)**

b. For a two axis articulated planar robot, derive the dynamic equations with distributed masses. Use the notations of $l_1$, $l_2$, $m_1$, $m_2$, $\theta_1$, $\theta_2$, $\tau_1$ and $\tau_2$ for link length, mass, displacement and torques respectively. **(14 Marks)**

7 a. Discuss various programming methods used in robot teaching and give clearly the typical applications of each of them. **(10 Marks)**

b. With a neat sketch, explain the components and their functions in a robot vision system. **(10 Marks)**

8 Write short notes on : **(20 Marks)**

a. General features of RPL's

b. Task planning and AI related problems

c. Robotics sensors

d. Present and future robotic industrial applications.

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