Name: Enrolment No:	UPES — UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

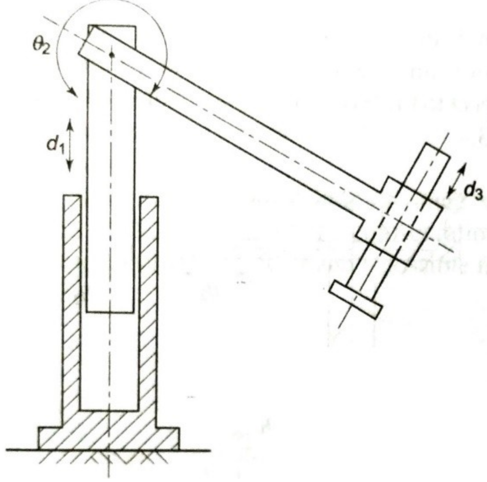
Course: Robots Simulation | **Semester: II**

Program: M.Tech. Automation and Robotics Engg. | **Time : 03 hrs.**

Course Code: ECEG7020 | **Max. Marks: 100**

Instructions: Assume any missing data.

SECTION A (5Qx4M=20Marks)			
S. No.		**Marks**	**CO**
Q 1	State the different types of robot coordinates.	**4**	**CO1**
Q 2	Discuss the various applications of robots.	**4**	**CO1**
Q 3	Differentiate between forward and inverse kinematic analyses of robots.	**4**	**CO1**
Q 4	Describe the procedure of assigning degrees of freedom to various joints of a robot. Show with reference to a 4-DOF articulated planar manipulator.	**4**	**CO1**
Q 5	Draw the block diagram for a typical closed-loop control system. Discuss the significance of transfer function.	**4**	**CO1**
SECTION B (4Qx10M= 40 Marks)			
Q 6	Develop a MATLAB code for performing inverse kinematic analysis of a spherical robot. **OR** Develop a MATLAB code for performing inverse kinematic analysis of a cylindrical robot.	**10**	**CO2**
Q 7	It is required to simulate a first-order system using SIMULINK. Draw the block diagram using the blocks available in SIMULINK library browser. Mention the location of each block within the library browser.	**10**	**CO2**
Q 8	Perform the state-space analysis of the differential equation provided below. $5\ddot{y}+8\dot{y}+100y=20x$	**10**	**CO4**
Q 9	Two consecutive frames describe the old (T_1) and new (T_2) positions and orientations of the end of a 3-DOF robot. The corresponding Jacobian, relating to *dz, δx, δz,* is also given. Find values of joint differential motions ds_1, $d\theta_2$, $d\theta_3$ of the robot that caused the given	**10**	**CO2**

	frame change. $T_1=\begin{bmatrix} 0 & 0 & 1 & 10 \\ 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$; $T_2=\begin{bmatrix} -0.05 & 0 & 1 & 9.75 \\ 1 & -0.1 & 0.05 & 5.2 \\ 0.1 & 1 & 0 & 3.7 \\ 0 & 0 & 0 & 1 \end{bmatrix}$; $J=\begin{bmatrix} 5 & 10 & 0 \\ 3 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix}$		
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	Derive the relationship between velocity of joint frame and velocity of hand frame for a two-link planar articulated robot.	**20**	**CO4**
Q 11	For the 3-DOF-manipulator arm shown in Fig. 1, assign frames and obtain the joint-link parameters. Perform the inverse kinematic analysis.  Fig. 1: A 3 DOF manipulator **OR** The dynamic equations for a 2-DoF manipulator are- $\tau_1=m_1 L_1^2\ddot{\theta}_1+m_2 L_1 L_2\dot{\theta}_1\dot{\theta}_2+B_1\dot{\theta}_1$ $\tau_2=m_2 L_2^2\left(\ddot{\theta}_1+\ddot{\theta}_2\right)+B_2\dot{\theta}_2+m_2 g L_1\cos\theta_1$ Design a proportional-derivative based closed-loop control system for the system.	**20**	**CO3**