Name:

Enrolment No:

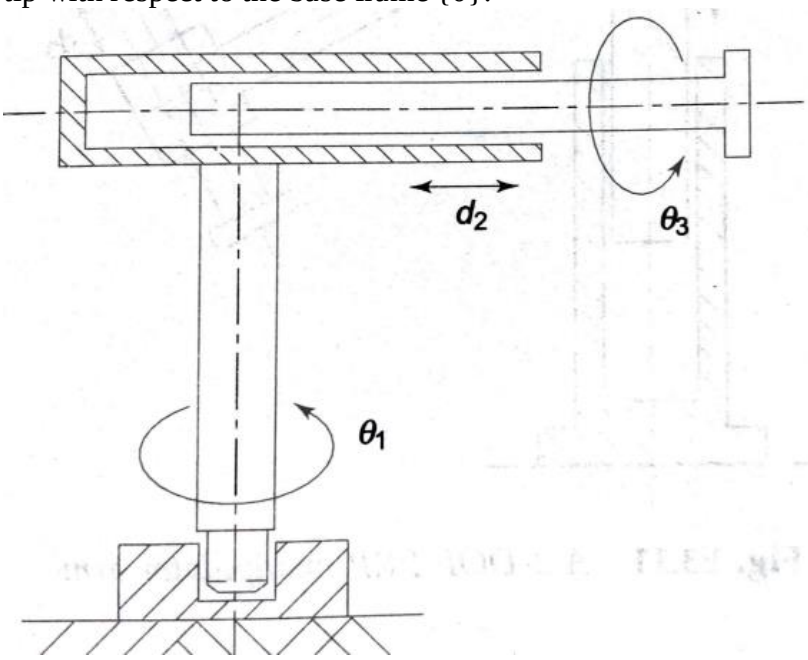
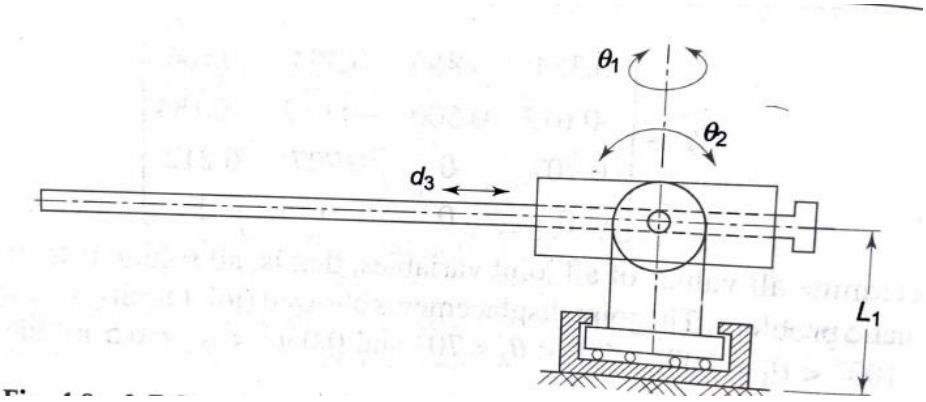
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2023

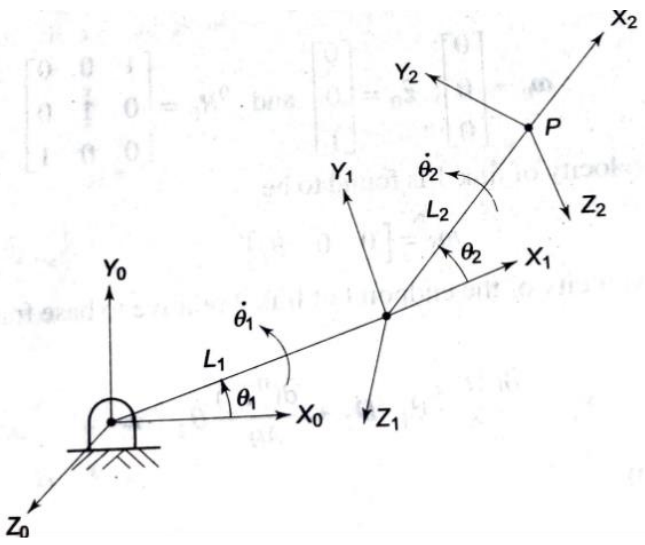
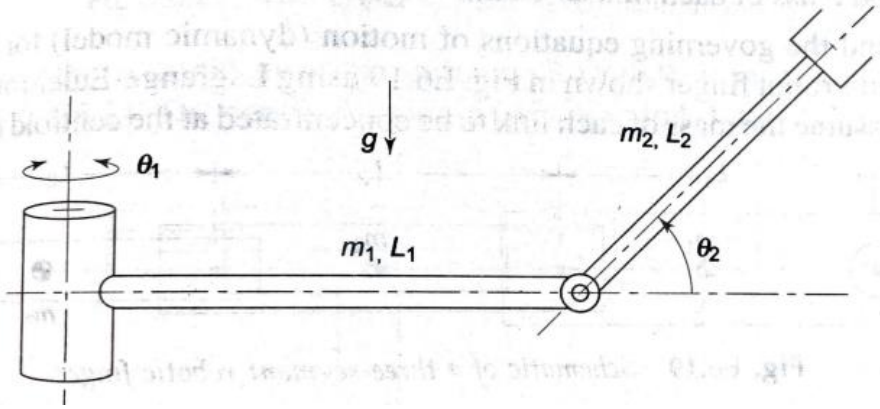
Course: Introduction to Robotics **Semester : I**
Program: M.Tech Robotics **Time : 03 hrs.**
Course Code: ECEG7035 **Max. Marks: 100**

Instructions:

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	For each of the following tasks, state whether a gripper or an end of arm tooling is appropriate: (a) Welding (b)Scrapping pint from a glass pane (c) Drilling a hole (d) Tightening a nut of automobile engine	**4**	**CO1**
Q 2	Describe the role of arm and wrist of a robotic manipulator.	**4**	**CO1**
Q 3	State the requirement of homogeneous transformation in modeling of robotic manipulator,	**4**	**CO2**
Q 4	List the different parameters for a link for kinematic modeling. State which of these parameters are variable and which are constant for (a) a revolute joint and (b) a prismatic joint	**4**	**CO2**
Q 5	Using the DH notation for frame assignment, is it possible to have the a link with zero link length whereas the physical link on the manipulator will have a finite link length.	**4**	**CO2**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Two frames, {A} and {B} , are initially coincident . Frame {B} undergoes the following four motions in sequence with respect to axes of frame {A}: (i) A rotation of θ about z-axis (ii) A translation of $\boldsymbol{d}$ along z-axis (iii) A translation of $\boldsymbol{a}$ along x-axis , and finally (iv) A rotation of $\boldsymbol{\alpha}$ about x-axis Determine the final homogeneous transformation matrix to describe frame {B}, after the transformations , with respect to the frame {A}	**10**	**CO3**

Q 7	For the 3-DOF manipulator arm shown in figure1. Assign frames and obtain the joint-link parameters. Also, determine the positions of the tool tip with respect to the base frame $\{0\}$.  Figure 1	**10**	**CO3**
Q 8	Describe the singularity in robotics manipulator.	**10**	**CO3**
Q 9	For the 3-DOF arm shown in figure 2 , obtain the general solution for the inverse kinematics.  Figure 2 OR Sketch the approximate reachable workspace of the tip of a two link planar arm with revolute joints. For this arm the first link is thrice as long as the second link, that is, $L_1 = 3L_2$ and the joints limits are $-100° < \theta_2 < 160°$.	**10**	**CO4**

	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	Calculate the velocity of the tip of the two link, planar, RR-manipulator arm shown in figure 3.  Figure 3	**20**	**CO4**
Q 11	Obtain the equations to determine the joint torques using Lagrange-Euler formulation for the SCARA manipulator. OR For the non-planar 2-DOF manipulator with two rotary joints, shown in figure 4, find the dynamic equations of motion using Lagrange-Euler formulation. Assume link masses, m_1 and m_2 to be unity and concentrated at the distal ends of the respective links.  Figure 4	**20**	**CO4**