Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

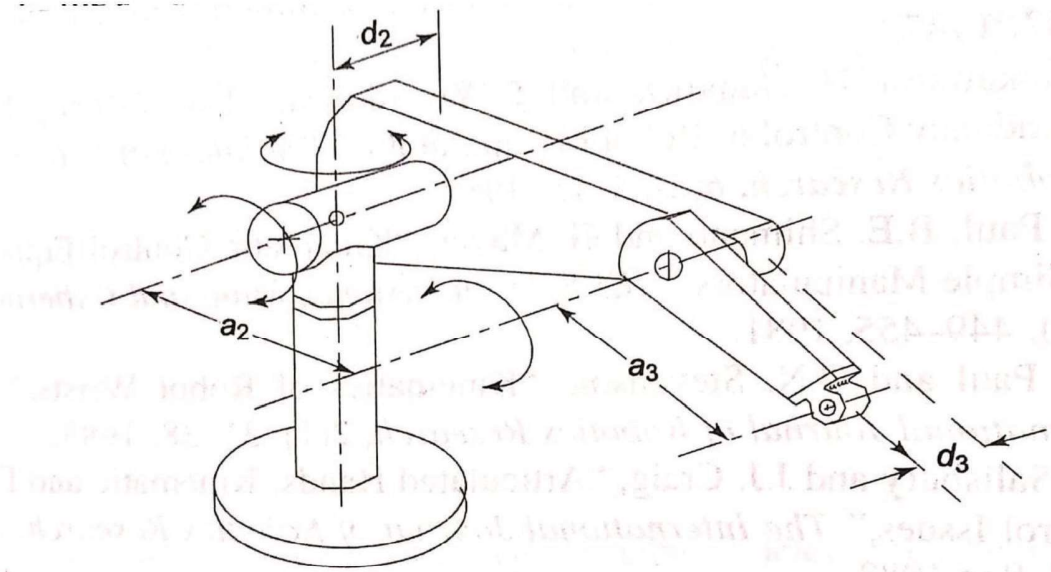
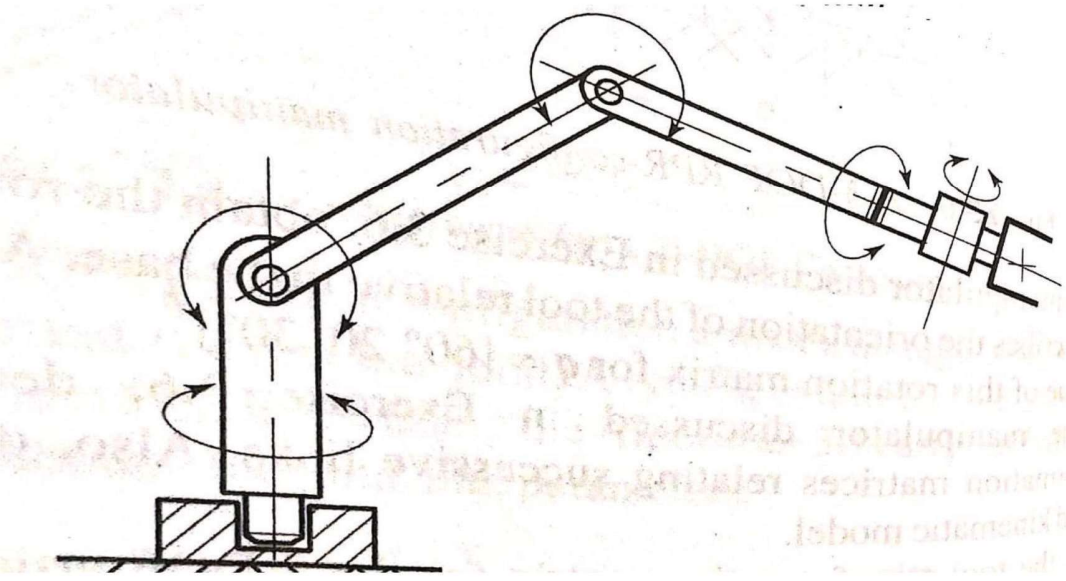
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

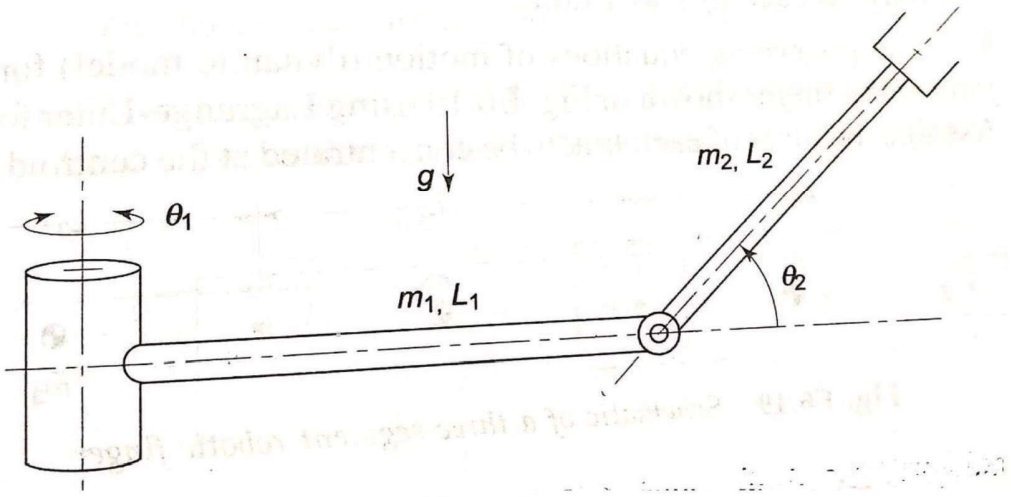
Course: Robotics **Semester: VII**
Program: B.Tech- Mechanical & Specialization **Time : 03 hrs.**
Course Code: ADEG481 **Max. Marks: 100**

Instructions:

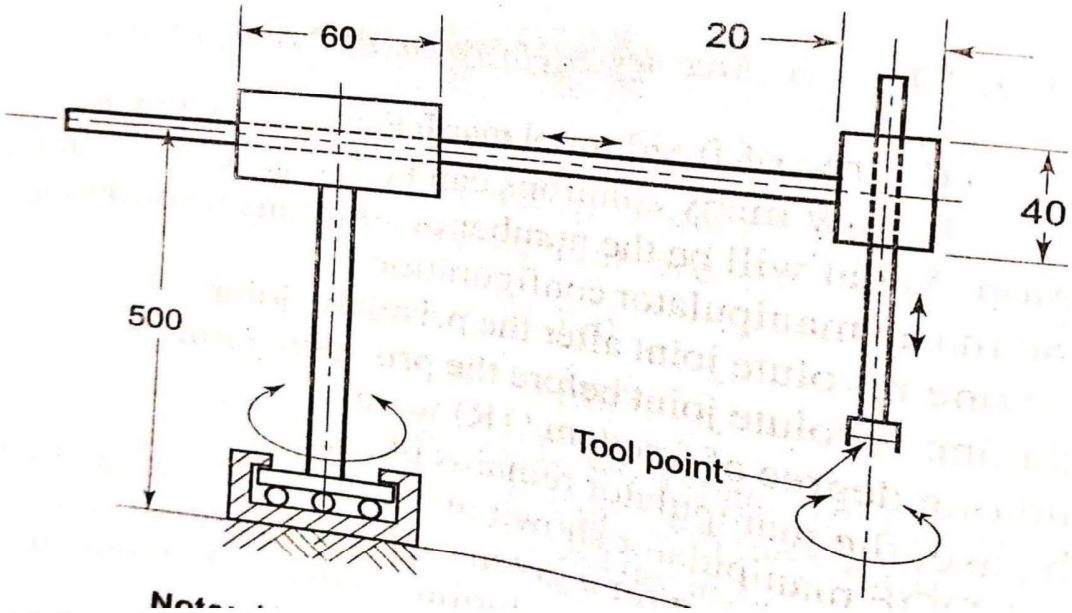
SECTION A

S. No.		Marks	CO
Q 1	A robot is required to perform an assembly of a shaft into a bearing placed in an arbitrary position. List the degrees of freedom are required for a manipulator to perform this task. If the bearing is placed in a horizontal plane, identifies the required degree of freedom.	5	CO1
Q 2	Determine the transformation matrix T that represents a translation of a unit along x-axis, followed by a rotation of an angle α about x-axis followed by a rotation of θ about rotated z-axis.	5	CO2
Q 3	Discuss the parameters for a link for kinematic modeling.	5	CO2
Q 4	Describe the workspace of a manipulator. Make a list of factors on which the workspace, the dexterous and reachable workspace, of a given manipulator depends.	5	CO2
	SECTION B		
Q 5	Jacobian of an ***n*-DOF** manipulator **is a 6X*n*** matrix. How can its inverse be determined to compute the kinematic singularities of the manipulator?	10	CO3
Q 6	If a manipulator is to be used in a gravity -free environment, say space, discuss the effect of this on the dynamic model. Predict the forces that will be the significant under these conditions.	10	CO3
Q 7	The motion of a joint from start to goal position is specified in terms of position, velocity and acceleration at the beginning and end of a path segment. Determine the coefficient the fifth-degree polynomial for interpolating the smooth trajectory in the segment.	10	CO4

Q 8	A 3-DOF articulated configuration arm of a manipulator has all three revolute joints. The design of joints in figure1 has joint offsets. Tabulate the joint-link parameters and obtain the forward kinematic model of the arm.  Figure1 **OR** For a 5-DOF articulated configuration manipulator shown in figure 2 obtain the forward kinematic model.  Figure 2	**10**	**CO3**

SECTION-C			
Q 9	For the nonplanar 2-DOF manipulator with two rotary joints, shown in figure 3,obtain the dynamic equation 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 3	**20**	**CO4**
Q 10	For the 4-ODF manipulator shown in figure4, determine the joint displacements required for the tool point position and orientation given by the following transformation matrix. $$T = \begin{bmatrix} 0.5 & -0.866 & 0 & -84 \\ 0.866 & -0.5 & 0 & -48.5 \\ 0 & 0 & -1 & 105 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$	**20**	**CO4**

The dimensions are shown in the figure.



All dimensions are in mm

Figure4

OR

Obtain the inverse kinematics equation of roll pitch yaw (RPY)wrist.