Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

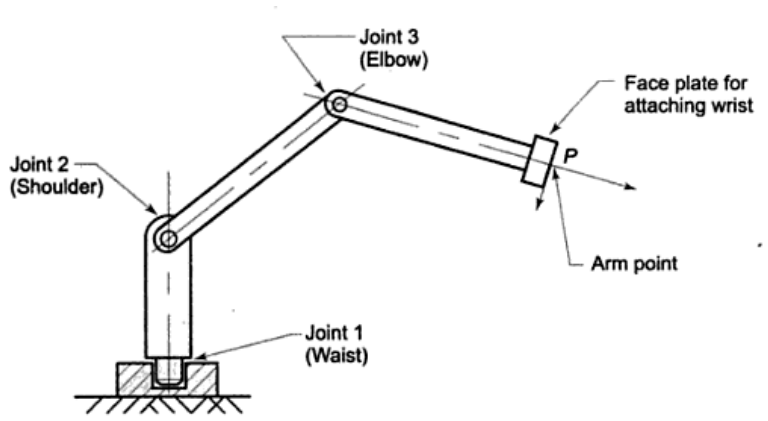
Course: Robotics & Mechatronics **Semester: VIII**
Program: B.Tech ADE **Time : 03 hrs.**
Course Code: MEPD4013 **Max. Marks: 100**

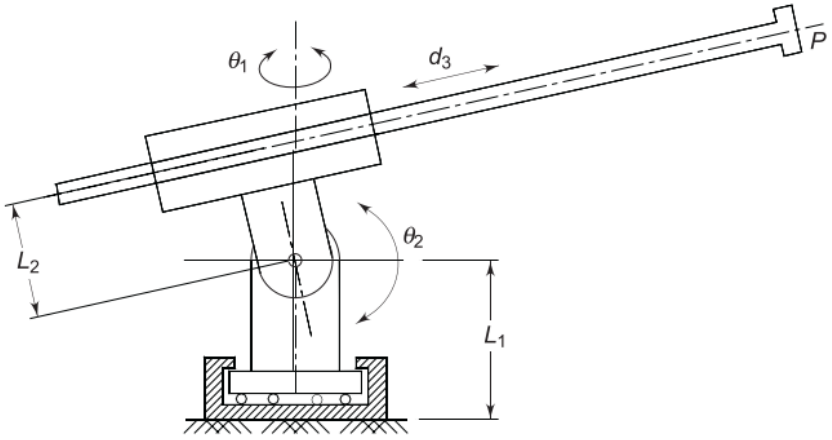
Instructions:

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	List the design and control issues in the robotics system.	**4**	**CO1**
Q 2	Define the term work envelope.	**4**	**CO1**
Q 3	Identify the parameters in Denavit-Hartenberg notation scheme.	**4**	**CO2**
Q 4	Define the term interior singularity and boundary singularity.	**4**	**CO2**
Q 5	Discuss the integrated issues in mechatronics.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	An articulated arm is a 3-DOF manipulator with three revolute joints that is an RRR arm configuration as shown in figure 1. Determine the arm point transformation matrix.  Figure 1	**10**	**CO3**

Q 7	Explain the mechatronics key elements.	**10**	**CO3**
Q 8	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 the rotated ***z-axis.*** ***OR*** Frame {2} is rotated with respect to frame {1} about the x-axis by an angle of 45 °. The position of the origin of frame {2} as seen from frame {1} is $^{1}D_{2} = [7 \quad 5 \quad 7]^{T}$ .Obtain the transformation matrix $^{1}T_{2,}$ which describes frame {2} relative to frame {1}. Also find the descriptions of point P in frame {1}, if $^{2}P = [2 \quad 5 \quad 6]^{T.}$	**10** **10**	**CO3** **CO3**
Q 9	Explain the function of a sensor and actuator in a mechatronic system. List the different types of sensor and actuator.	**10**	**CO4**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	For the 3-DOF (RRP) configuration manipulator shown in figure 2.  Figure 1 The positions and orientation of point P in Cartesian space is given by $T = \begin{bmatrix} 0.354 & 0.866 & 0.354 & 0.106 \\ -0.612 & 0.500 & -0.612 & -0.184 \\ 0.707 & 0 & 0.707 & 0.212 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ Determine all values of all joint variables that is, all solutions to the inverse kinematic problem.	**20**	**CO4**
Q 11	Determine the manipulator Jacobian matrix for the 3-DOF articulated arm shown in figure 2.	**20**	**CO4**

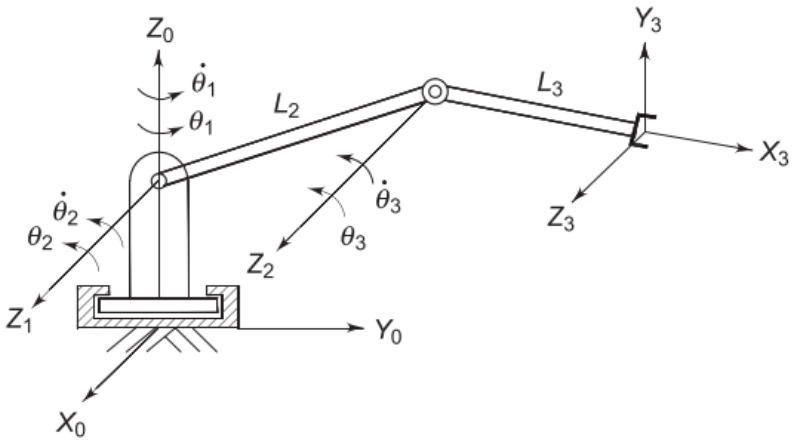


Figure 2

OR

Determine the singularities of 3-DOF articulated arm configuration as shown in figure 2.