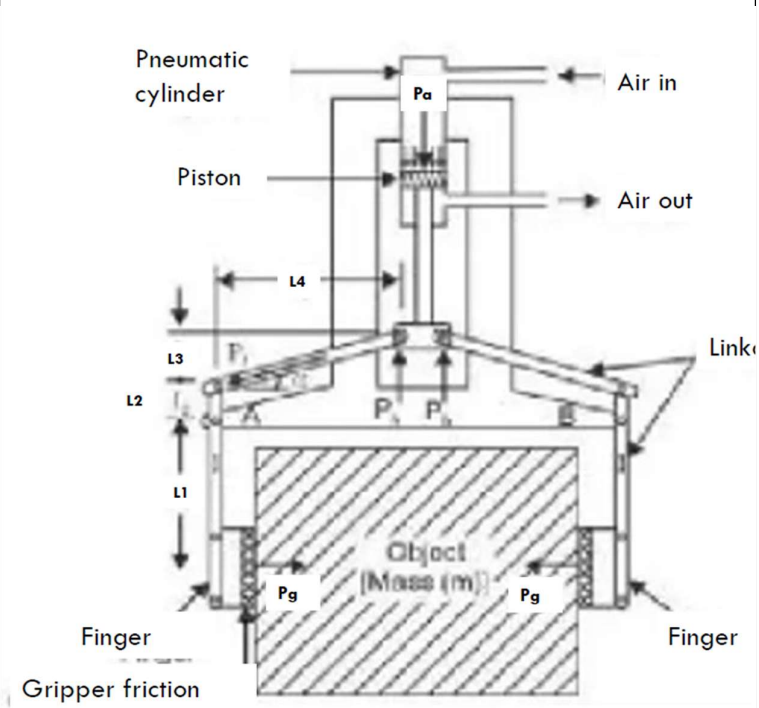
DEPARTMENT OF MECHATRONICS
VI SEMESTER B. TECH (MECHATRONICS)
END-SEMESTER, [May] [2023]

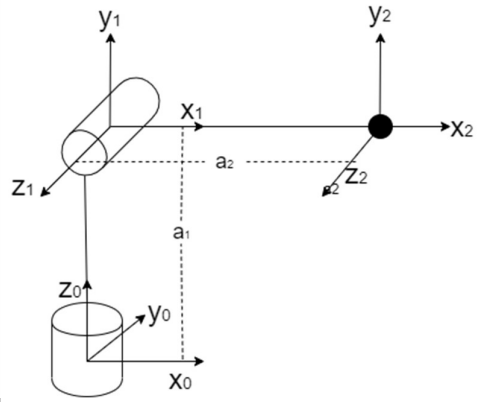
Subject: Robot Dynamics and Control **Subject Code: MTE 4060**

Date: -06-2023

Time: 3 Hour **Exam Time: AM- AM** **Max Marks: 50**

Q. No	Question	M	CO	PO	LO	BL
1A	Model the Zigler - Nichols method to design P, PI, and PID controllers for the transfer function 1/(S+1)(S+2)(S+3).	4	3	1, 2, 3, 4, 9	1, 2, 3, 16	3
1B	Appraise the concept of control law partitioning in the context of position regulation (Linear control).	4	3	1, 2, 3, 4, 9	1, 2, 3, 16	5
1C	Examine the concept of set point tracking to explain how a controller can be designed to make a system follow a desired trajectory.	2	4	1, 2, 3, 4, 9	1, 2, 16	3
2A	Evaluate the a. gripping force and b. actuation force required to retain and obtain a part respectively, as well as the c. pressure and power required to operate the piston cylinder of a mechanical gripper (Fig. 2A) that uses friction to grasp an object. Where the parameters are given below W = 45N, μ = 0.5, L1 = 72mm, L2 = 48mm, L3 = 18mm, L4 = 54mm, Dp (diameter of piston cylinder) = 78mm, z = 1.2, Q = 0.018 m^3/s, a(accelerating down) = 9.81 m/s^2.	4	2	1, 2, 3, 4	1, 2, 3	5

	 Fig. 2A					
2B	Analyze and break down the components of a 2R planar robotic arm in order to derive and explain the Legrangian equation of single arm.	3	3	1, 2, 3, 4, 9	1, 2, 3, 16	4
2C	Identify the concept of Newton-Euler and Lagrange-Euler formulations to enumerate their differences.	3	2	1, 2, 3, 4	1, 2, 3	3
3A	Determine the forward and inverse kinematics of a RPY robotic arm.	4	1	1, 2, 3, 4	1, 2, 3	5
3B	In a robotic system the location of an object with respect to base of the robot is given by ${}^{b}T_{o} = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & -1 & 0 & 8 \\ 0 & 0 & -1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$, also the gripper is defined with respect to base as given by ${}^{b}T_{g} = \begin{bmatrix} 0 & -1 & 0 & 6 \\ 1 & 0 & 0 & -12 \\ 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$. Appraise the location of object with respect to gripper. Pictorially represent the frames of object and gripper with respect to base.	3	2	1, 2, 3, 4	1, 2, 3	4

3C	Illustrate the selective compliance assembly robotic arm with its work volume and joint notations, also highlight its applications.	3	1	1, 2, 3, 4	1, 2, 3	3
4A	Analyse how Lyapunov stability theorem can be used to explain robot stability.	4	4	1, 2, 3, 4, 9	1, 2, 16	4
4B	Justify the behavior of a nonlinear mechanical spring-damper system described by the equation $X'' + b(X') + k(X) = 0$. Using appropriate stability theorem. Energy Function => $V(X,X') = \frac{1}{2} X'^2 + \int_0^k k(\lambda)\, d\lambda$	3	4	1, 2, 3, 4, 9	1, 2, 16	5
4C	Compare and Classify between force/hybrid position control and compliance control.	3	4	1, 2, 3, 4, 9	1, 2, 16	4
5A	Determine the DH parameters for a given configuration of a robot.  Fig. 5A	3	1	1, 2, 3, 4	1, 2, 3	5
5B	Evaluate the trapezoidal profile equations of trajectory planning.	5	1	1, 2, 3, 4	1, 2, 3	5
5C	Identify the required bit storage capacity for the controllers of a Cartesian coordinate robot, when a given control resolution and total range is motion of 0.25mm and 750mm respectively.	2	2	1, 2, 3, 4	1, 2, 3	3