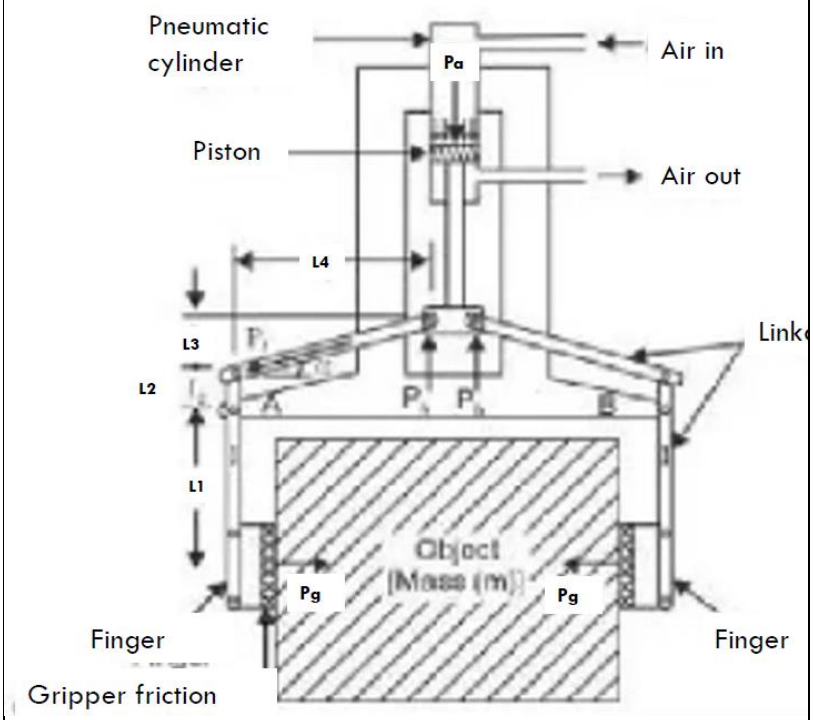
DEPARTMENT OF MECHATRONICS
VI SEMESTER B. TECH (MECHATRONICS)
END-SEMESTER, [may] [2023]

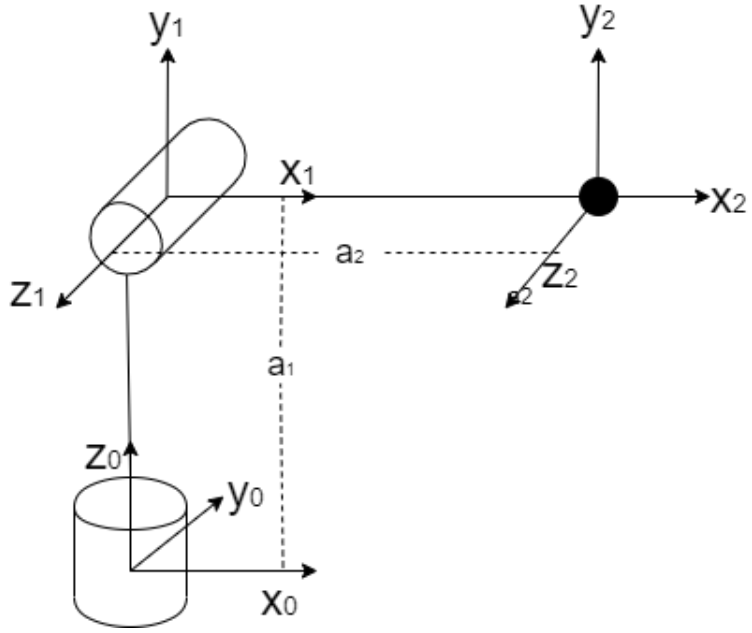
Subject: Robot Dynamics and Control **Subject Code: MTE 4060**

Date: -05-2023

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

Q. No	Question	M	CO	PO	LO	BL
1A	Employ 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, 5, 12	C1, C2, C3	3
1B	Appraise the concept of control law partitioning in the context of position regulation.	4	4	1, 2, 3, 4, 5, 12	C1, C2, C4	5
1C	Outline 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, 5, 12	C1, C2, C4	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 that uses friction to grasp an object. Where the parameters are given below W=30N, μ = 0.3, L1= 72mm, L2=48mm, L3= 18mm, L4=54mm, Dp(diameter of piston cylinder)=78mm, z=1.4, Q =0.018 m3/s, a(accelerating down)= 9.81 m/s2. Diagram  	4	**2**	1, 2, 3, 4, 5, 9,12	C1, C2, C3, C5, C12	5
2B	Analyse the relationship between the desired joint position (θd) and the actual joint position (θ) of a 3-joint robotic arm, with the base motor controlled by a PI controller.	3	**3**	1, 2, 3, 4, 5, 12	C1, C2, C3	4
2C	Implement your knowledge of Newton-Euler and Lagrange-Euler formulations to enumerate their differences.	3	**2**	1, 2, 3, 4, 5, 9,12	C1, C2, C3, C5, C12	3
3A	Determine the forward and inverse kinematics of a spherical robotic arm.	4	**1**	1, 2, 3, 4, 5, 12	C1, C2, C5, C8	5

3B	Categorize six factors and considerations that must be taken into account when designing an end effector for an industrial environment.	3	**2**	1, 2, 3, 4, 5, 9,12	C1, C2, C3, C5, C12	4
3C	Apply your knowledge of kinematics to determine the required joint displacement of a 2R planar robot, given the end effector's x and y positions are given by 70, 15 respectively and the lengths of the two links are l1 to be 50cm, l2 to be 40cm.	3	1	1, 2, 3, 4, 5, 12	C1, C2, C5, C8	3
4A	Deconstruct how Lyapunov stability theorem can be used to explain robot stability.	4	**5**	1, 2, 3, 4, 5	C1, C2	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.	3	**5**	1, 2, 3, 4, 5	C1, C2	5
4C	Explain and distinguish between force/hybrid position control and compliance control.	3	**5**	1, 2, 3, 4, 5	C1, C2	4
5A	Determine the DH parameters for a given configuration of a robot. 	3	**1**	1, 2, 3, 4, 5, 12	C1, C2, C5, C8	5

5B	Conclude the velocity propagation matrix and parameters- for the same 2R planar robot given in Fig 2	5	**2**	1, 2, 3, 4, 5, 9,12	C1, C2, C3, C5, C12	5
5C	Demonstrate your knowledge of controllers to determine the required bit storage capacity for the controllers of a Cartesian coordinate robot with a given control resolution and total range of motion of 0.25mm and 750mm respectively.	2	**1**	1, 2, 3, 4, 5, 12	C1, C2, C5, C8	3