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

Subject: Robot Dynamics and Control

Time: 3 Hour

## Subject Code: MTE 4060

## Date: 1-6-2023

Exam Time: AM- AM

## Max Marks: 50

Q. No	Question	Μ	СО	РО	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	1, 2, 3	3
1B	Appraise the concept of control law partitioning in the context of position regulation (Linear Control).	4	4	1, 2, 3, 4, 5, 12	1, 2, 4	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	1, 2, 4	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 $W = 45N$ , $\mu = 0.5$ , $L1 = 72mm$ , $L2 = 48mm$ , $L3 = 18mm$ , $L4 =$ 54mm, Dp (diameter of piston cylinder) = 78mm, $z = 1.2$ , Q = 0.018 m3/s, a(accelerating down) = 9.81 m/s2.	4	2	1, 2, 3, 4, 5, 9,12	1, 2, 3, 5, 12	5

28	Analyse the relationship between the desired joint position ( $\theta$ d) and the actual joint position ( $\theta$ ) of a 3-joint robotic arm, with the base motor controlled by a PI controller.	3	3	1, 2, 3, 4, 5, 12	1, 2, 3	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	1, 2, 3, 5, 12	3
3A	Determine the forward and inverse kinematics of a spherical robotic arm.	4	1	1, 2, 3, 4, 5, 12	1, 2, 5, 8	5
зВ	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	1, 2, 3, 5, 12	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 70cm, 15cm respectively and the lengths of the two links are 11 to be 50cm, 12 to be 40cm.	3	1	1, 2, 3, 4, 5, 12	1, 2, 5, 8	3
4A	Deconstruct how Lyapunov stability theorem can be used to explain robot stability.	4	5	1, 2, 3, 4, 5	1, 2	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	1, 2	5
4C	Explain and distinguish between force/hybrid position control and compliance control.	3	5	1, 2, 3, 4, 5	1, 2	4

5A	Determine the DH parameters for a given configuration	3	1	1, 2, 3,	1, 2, 5,	5
	of a robot in the figure below.	_		4, 5,	8	-
	$y_1 \qquad y_2 \\ frightarrow y_2 $			12		
5B	Conclude the velocity propagation matrix and parameters- for the same 2R planar robot given in Fig. 5A.	5	2	1, 2, 3, 4, 5, 9,12	1, 2, 3, 5, 12	5
5C	Demonstrate your knowledge of controllers to determine 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	1	1, 2, 3, 4, 5, 12	1, 2, 5, 8	3