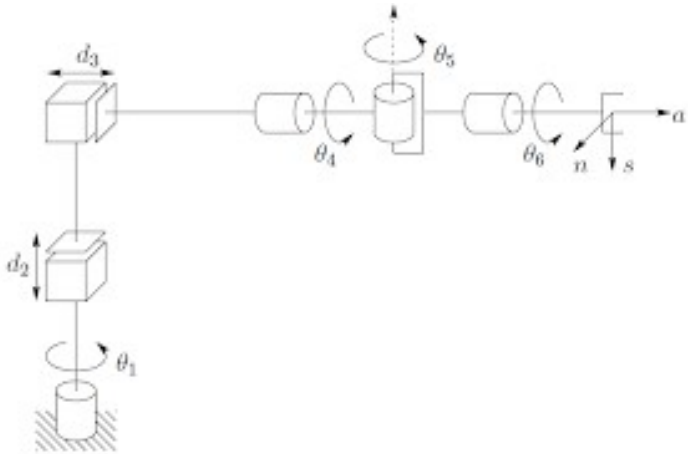
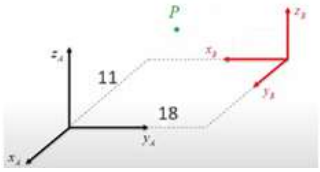
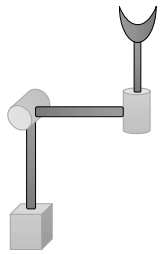
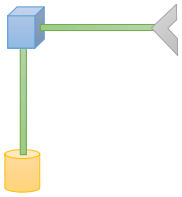
DEPARTMENT OF MECHATRONICS
VI SEMESTER B. TECH (MECHATRONICS)
END-SEMESTER, [November] [2023]

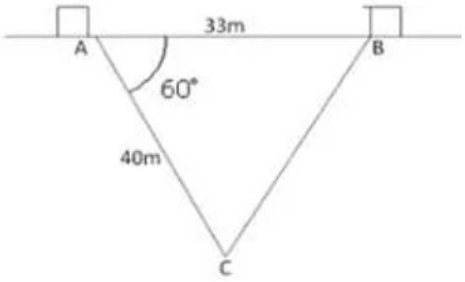
Subject: Mechanics of Robotics Systems **Subject Code: MTE 2124**

Date: 7-12-2023

Time: 3 Hour **Exam Time: 9:30AM - 12:30 AM** **Max Marks: 50**

Q. No	Question	M	CO	PO	LO	BL
1A	Apprise the DH-Parameter Table for the manipulator below in Fig.1A by assigning frames for it. S  Figure: 1A	5	3	3	3	5
1B	Consider frame {A} and {B}, and point P in frame {B} is given by (12,3,5), compute its coordinates with respect to frame {A} using a Homogeneous Transformation Matrix for Fig.1B R  Figure: 1B	3	2	2	1	3
1C	Demonstrate the format of HTM matrix and the different types of Rotation matrices for the 3 axis of rotation. R	2	**2**	2	1	3
2A	Construct the forward and inverse kinematics of a spherical robotic arm. R	4	**3**	3	3	6

2B	By applying graphical approach, support the inverse kinematics of the given Fig.2B PRR robotic arm. S  Figure: 2B	3	**3**	2	3	5
2C	For the below shown RP robotic arm in Fig.2C conclude the angular velocity and rotational velocity in X,Y,Z directions, by applying velocity propagation method in matrix form. S  Figure: 2C	3	**4**	**3**	2	5
3A	Compile the movement analysis in space, using Lagrangian dynamics approach of 1R link. S	4	**4**	2	2	6
3B	Elaborate on 2R robot's "Work space singularities" & its types. Also, with an suitable example emphasize when the singularities occurs. S	3	**4**	1	2	3
3C	From the equation found in Q.3A constitute the Torque equations of the same 1R robot S	3	4	2	2	6
4A	Sketch the screw type gripper actuation mechanism under mechanical grippers, with suitable labelling. Also highlight the usage of fanners in magnetic grippers application. Distinguish between internal and external grippers, highlight on two main differences. R	4	**1**	1	1,12	3
4B	Relate that $j^2 = -1$ Through quaternion matrix multiplication method. When q = a+bi+cj+dk . S	4	**2**	2	1	4
4C	If a cylindrical robot is given 5 units of displacement along x axis, 25° twist about z axis and 12 units linear displacement along y axis. Identify the corresponding end-effector co-ordinates for it. R	2	**3**	2	3	4

5A	If x and y are functions of two independent variables r and θ, when x=rcosθ, y=rsinθ. Predict the Jacobian of x & y by applying any differentiation method. R	3	**4**	3	2	3
5B	Elucidate on the Trapezoidal velocity profile with expected displacement, velocity, and acceleration by plotting graph of all possible segments. By considering the general displacement equation $S = ut + [(1/2)\ at^2]$, for the segments I and II profile under Trajectory planning concept obtain the variations of displacement, velocity and acceleration. R	5	**5**	2	2	5
5C	Two ships A and B , lies 33m apart on the sea surface as in figure below. There is submarine "C" on the sea-bed as shown in the Fig. 5C. The angle of depression of C from A is 60° and the distance AC is 40m. Infer the distance BC. R  Figure: 5C	2	**3**	2	3	3