MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHATRONICS

VI SEMESTER B.TECH. (MECHATRONICS)

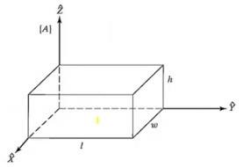
END SEMESTER EXAMINATION, 21th June 2022

SUBJECT: ROBOT DYBAMICS & CONTROL (MTE4060)

Instructions to Candidates:

- Answer **ALL** the questions.
- MISSING DATA MAY BE SUITABLY ASSUMED AND JUSTIFIED.
- Write your Name, Registration Number at top of every page of the answer sheet.
- Sign on every page of the answer sheet.
- Answers should be handwritten, and scanned copy of the answer should be uploaded (PDF Format).

Q. No.	QUESTIONS	M	CO	PO	LO	BL
1A	Solve a homogeneous transformation matrix between the base and tool frames for a 3-link planar robot with revolute joints with link lengths l_1, l_2 and l_3.	3	2	1	1	3
1B	Define the Jacobian for the function Y=F(X), where Y is an n×1 vector and X is an m×1 vector?	2	3	2	2	4
1C	Illustrate forward and inverse kinematics of a manipulator? For a two link planar robot with revolute joints, derive forward and inverse kinematic relationship.	5	4	1	1	2
2A	With a schematic sketch, illustrate interactive and net forces and moments acting on a link. Demonstrate on how to obtain an expression for net force and moment acting on an intermediate (i-th) link. Define the Newton-Euler equation for the (i-th) link	5	2,3	2	2	4
2B	Demonstrate the Lagrangian and how one can obtain the equation of motion of a dynamical system using it?	2	2	1	1	3
2C	Derive the transfer function of an armature controlled DC servo motor and develop its block diagram.	3	4	1	1	2

3A	Determine the inertia tensor for the rectangular body of uniform density ρ with respect to the co-ordinate system shown in figure  Figure No. 1	5	4	1	1	3
3B	Illustrate Coriolis force with a proper sketch	2	3	2	2	4
3C	Enumerate differences in Newton-Euler and Lagrange-Euler formulations	3	5	1	1	3
4A	Explain the Routh Hurwitz Criteria for determining the stability of a system.	2	5	1	1	3
4B	Compare P, PI and PID controllers. Also, plot the expense of these controllers to a unit step change in error	5	3	1	1	2
4C	What are closed-loop, open-loop, regulator, and servo (tracking) controls?	3	5	1	1	3
5A	Derive an expression for the linear, and angular velocity of point P in frame {B} with respect to frame {A} when two frames are undergoing relative translational and rotational motion ad P is moving with a velocity ${}^{B}V_{P}$ relative to frame {B}.	5	5	2	1	4
5B	Frame {B} is obtained from frame {A} by Z-Y-Z Euler rotation of angles α, β, and γ. Derive the relationship between individual rotation matrices and the ${}^{A}\boldsymbol{R}_{B}$.	3	5	1	1	3
5C	Define the purpose of determining dynamics of a manipulator and state its pre-requisites?	2	5	1	1	3