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

DEPARTMENT OF MECHATRONICS ENGINEERING

III SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, JANUARY 2022

SUBJECT: ROBOTICS I **SUBJECT CODE: MTE 2154**

Time: 09:00 AM to 01:00 PM **Date:29/01/2022**

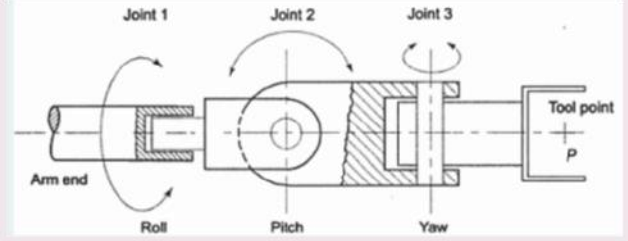
Time: 45 + 10 Min **MAX. MARKS: 30**

Instructions to Candidates:

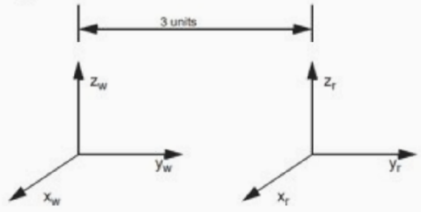
- Answer **ALL** the questions.

PART A		**30 Marks**				
		Marks	**CO**	**PO**	**LO**	**BL**
1	Newton Euler Method depends upon the recursive algorithm for calculating subsequent linkages and joint calculation for deriving the dynamics a. None b. False c. True d. Statement is wrong	**1**	**CO4**	**1,2**	**1,2**	**1**
2	What is the return value angle in the range of arc tangent function normally having two arguments x and y? a. -90 Deg to 90 Deg b. -180 Deg to 180 Deg c. 0 to 90 Deg **d.** 0 to 180 Deg	**1**	**CO3**	**1,2**	**1,2**	**1**
3	In assembling of integrated chips which of the following robot is used? a. Parallel Manipulator b. Serial Manipulator c. None of the above d. All of the above	**1**	**CO3**	**1,2**	**1,2**	**1**
4	In the matrix given here, what will be the guideline you will be using for equating joint variable1? a. Guideline 2 b. None of the above c. Guideline 1 d. Guideline 3	**1**	**CO3**	**1,2**	**1,2**	**1**
5	The full Jacobian is an nxm matrix where n is the number of joints, and m is the number of variables describing motion? a. Statement is wrong b. None c. True	**1**	**CO4**	**1,2**	**1,2**	**1**

	d. False					
6	In a homogeneous transformation matrix, one of the parts is the displacement vector. Which of the homogeneous transformation matrices shown here has the displacement vector in red and bold- a) $\begin{bmatrix}1&0&0&5\\0&1&0&4\\0&0&1&0\\0&0&0&2\end{bmatrix}$ b) $\begin{bmatrix}1&0&0&3\\0&1&0&4\\0&0&1&2\\0&0&0&1\end{bmatrix}$ c) $\begin{bmatrix}1&0&0&5\\0&1&0&4\\0&0&1&3\\0&0&0&0.5\end{bmatrix}$ d) $\begin{bmatrix}1&0&0&5\\0&1&0&4\\0&0&1&0\\0&0&0&1\end{bmatrix}$ a. d b. b c. a d. c	**1**	**CO2**	**1,2**	**1,2**	**1**
7	Select all relevant applications of forward dynamics a. None of the above b. Surgical robot c. Welding d. Pick and Place operation	**1**	**CO4**	**1,2**	**1,2**	**1**
8	Inverse dynamics maps motion to torque a. False b. Statement is wrong c. True d. None	**1**	**CO4**	**1,2**	**1,2**	**1**
9	Does path generation and trajectory generation of a robot for its movement from one location to another location are same? a. No b. Maybe c. None d. Yes	**1**	**CO5**	**1,2**	**1,2**	**1**
10	According to the guidelines of inverse kinematics we can use the arc sine function to calculate the joint variables of the given robot. Sampling-based algorithms a. None b. True c. Statement is wrong d. False	**1**	**CO3**	**1,2**	**1,2**	**1**
11	From the given figure if you apply inverse kinematics, how many solutions in real-time you can calculate?	**1**	**CO3**	**1,2**	**1,2**	**1**

	 a. None of the above b. Unique Solution c. No Solution d. Many Solutions					
12	Consider a 3x3 matrix, $M = \begin{bmatrix} 3 & -4 & 1 \\ 5 & 3 & -7 \\ -9 & 2 & 6 \end{bmatrix}$ It- a. Has determinant +1 and its orthogonal hence represents a rotation matrix b. Has determinant +1 and its orthogonal hence does not represents a rotation matrix c. Has determinant +1 and its not orthogonal hence does not represents a rotation matrix d. Can not say whether the given matrix M is a rotation matrix or not based on the determinant and orthogonality	**1**	**CO2**	**1,2**	**1,2**	**1**
13	Parallel robot is used for Automobile simulator a. None b. True c. Statement is wrong d. False	**1**	**CO3**	**1,2**	**1,2**	**1**
14	Differential motions are small movements of mechanisms (e.g., robots) that can be used to derive velocity relationships between different parts of the mechanism a. False b. Statement is wrong c. None d. True	**1**	**CO4**	**1,2**	**1,2**	**1**
15	According to the inverse homogeneous transformation function the transpose is equivalent to the inverse of the matrix?	**1**	**CO2**	**1,2**	**1,2**	**1**

	a. True b. False c. None d. Statement is wrong					
16	Using the guideline 'e', in inverse transform approach to isolate the joint variable, we can use post multiplication method a. True b. Statement is wrong c. False d. None	**1**	**CO3**	**1,2**	**1,2**	**1**
17	The kinematic chain subsquently connected with open ended end dffector is called as _____? a. Serial Manipulator b. Parallel Manipulator c. None d. Hybrid Manipulator	**1**	**CO1**	**1,2**	**1,2**	**1**
18	A Path is the locus of points to be traversed by the manipulator to execute the required task? a. Yes b. Maybe c. No	**1**	**CO5**	**1,2**	**1,2**	**1**
19	What are the applications of trajectory planning? a. None of the above b. Both of the above c. Obstacle Avoidance d. Kinematic Chain Analysis	**1**	**CO5**	**1,2**	**1,2**	**1**
20	Rot(q,dx) is represented as small rotations of the frame with angle dx about q axis . a. None b. False c. Statement is wrong d. True	**1**	**CO2**	**1,2**	**1,2**	**1**
21	Displacement Vector between two frames depends? a. On joint variable of prismatic joint only b. Only on the scalar distance between two frames c. It depends on the angle of rotation of the first frame if it's a revolute joint and the scalar distance between two frames d. None of the above	**1**	**CO2**	**1,2**	**1,2**	**1**
22	Legragian dynamics methodology depends upon the total kinetic energy and potential energy of the system? a. None b. Statement is wrong c. True d. False	**1**	**CO4**	**1,2**	**1,2**	**1**
23	Jacobian is calculated by taking the derivatives of each position equation with respect to all joint variables. a. True	**1**	**CO4**	**1,2**	**1,2**	**1**

	b. False c. None d. Statement is wrong					
24	The characteristic of a parallel robot is that it should have at least three degrees of freedom actuators a. None b. True c. Statement is wrong d. False	**1**	**CO3**	**1,2**	**1,2**	**1**
25	Two coordinate frames, world (w) and robot (r) as shown in the figure.  The two x axes are parallel, as are the two y and the two z axes. the origin of the world coordinate axes in robot frame can be represented as-. a) $\begin{bmatrix}3\\0\\0\\1\end{bmatrix}$ b) $\begin{bmatrix}0\\-3\\0\\1\end{bmatrix}$ c) $\begin{bmatrix}0\\0\\3\\1\end{bmatrix}$ d) $\begin{bmatrix}-3\\0\\0\\1\end{bmatrix}$ a. d b. b c. a d. c	**1**	**CO2**	**1,2**	**1,2**	**1**
26	The full Jacobian is an nxm matrix where n is the number of joints, and m is the number of variables describing motion. a. Statement is wrong b. False c. None d. True	**1**	**CO2**	**1,2**	**1,2**	**1**
27	Rotation matrix between two frames depends. a. on both no joint motion and joint motion matrices b. on no joint motion matrix only c. None of the above e. on joint motion matrix only	**1**	**CO2**	**1,2**	**1,2**	**1**
28	$[D] = [J][D_\theta]$ In the given equation, what is D representing?	**1**	**CO4**	**1,2**	**1,2**	**1**

	a. Differential motion of joints b. None of the above c. Differential motions along respective axis d. Differential rotations					
29	In a homogeneous transformation matrix, one of the parts is the rotation matrix. Which of the homogeneous transformation matrices shown here has the rotation matrix marked in red and bold a) $\begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix}$ b) $\begin{bmatrix} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ c) $\begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 0.5 \end{bmatrix}$ d) $\begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ a. d b. b c. a d. c	**1**	**CO2**	**1,2**	**1,2**	**1**
30	What is the term added for cubic polynomial function of a trajectory to fifth order polynomial ? a. None of the above b. Angular Acceleration c. Angular Distance d. Angular Velocity	**1**	**CO5**	**1,2**	**1,2**	**1**

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DEPARTMENT OF MECHATRONICS

V SEMESTER B.TECH. (MECHATRONICS)

END SEMESTER EXAMINATIONS, [Jan] [2022]

SUBJECT: ROBOTICS I

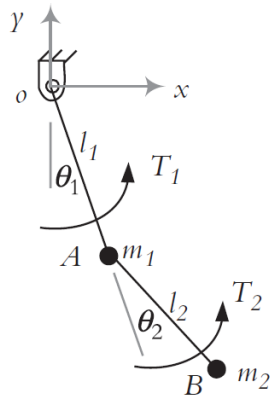
SUBJECT CODE: MTE 2154 **DATE:29/01/2022**

Time: 75+10 MINUTES **MAX. MARKS: 20**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any can be suitably assumed.

Part B

Q. No	Question	M	CO	PO	LO	BL
1	Illustrate Trajectory Planning? Demonstrate the third-order polynomial trajectory planning?	5	5	1,2	1,2	3,4
2	Develop equations of motions of 2-degree of freedom manipulator shown in Fig.Q using Lagrangian formulation. Calculate the kinetic and potential energy of links 1 and 2.  Fig. Q	5	4	1,2	1,2	4,5

3	Determine the new location of the robot after the differential motion, if the hand frame of the 2RP2R manipulator with its numerical Jacobian (J) is given for this instance, and a set of differential motions are provided. $T_6 = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 0 & -1 & 3 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ $J = \begin{bmatrix} 3 & 0 & 0 & 0 & 0 \\ -2 & 0 & 1 & 0 & 0 \\ 0 & 4 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} d\theta_1 \\ d\theta_2 \\ ds_1 \\ d\theta_4 \\ d\theta_5 \end{bmatrix} = \begin{bmatrix} 0.1 \\ -0.1 \\ 0.05 \\ 0.1 \\ 0 \end{bmatrix}$	5	4	1,2	1,2	3,4
4	Determine the joint variables (θ_1, θ_2, d_3, and θ_4) for the 4-DOF SCARA manipulator. When: $^0T_4 = \begin{bmatrix} C_{124} & S_{124} & 0 & L_2C_{12} + L_{11}C_1 \\ S_{124} & -C_{124} & 0 & L_2S_{12} + L_{11}S_1 \\ 0 & 0 & -1 & L_{12} + d_3 - L_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ $T_E = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ r_{31} & r_{32} & r_{33} & r_{34} \\ 0 & 0 & 0 & 1 \end{bmatrix}$ Where, $\text{Cos}(\theta_1) = C_1$ $\text{Sin}(\theta_1) = S_1$ $\text{Cos}(\theta_{1+}\theta_2) = C_{12}$ $\text{Sin}(\theta_{1+}\theta_2) = S_{12}$ $\text{Cos}(\theta_2) = C_2$ $\text{Sin}(\theta_2) = S_2$ $\text{Cos}(\theta_1 + \theta_2 - \theta_4) = C_{124}$ $\text{Sin}(\theta_1 + \theta_2 - \theta_4) = S_{124}$	5	4	1,2	1,2,3	4,5