Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2021

Subject Code:3154102 Date:17/12/2021

Subject Name:Principles of Robotics

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	(a)	List various classifications of Robot.	03
	(b)	Show the various types of Manipulator.	04
	(c)	State and derive Asimov's laws of robotics. Also give its features and its limitations	07
Q.2	(a)	Differentiate between the kinematics and dynamics.	03
	(b)	Write down a homogeneous transformation matrix, used in robotics, and explain its components.	04
	(c)	Consider the two frames {A} and {B}. The frame {B} is rotated with respect to frame {A} by 30° around z-axis and origin of {B} is shifted with respect to the origin of {A} by [5, 10, 15].The Z_A and Z_B axis are parallel. A point P is described in {B} by (4, 2, 3). Evaluate the same point with respect to {A} using transformation matrix $\{T_{BA}\}$.	07
		OR	
	(c)	What are the different types of kinematic pair? Draw representative symbol of any it.	07
Q.3	(a)	Define Linear velocity.	03
	(b)	Differentiate Joint space and Cartesian space.	04
	(c)	Write the expressions for linear and angular velocity of a rigid body and also the linear velocity due to angular motion and combined angular and linear motion	07
		OR	
Q.3	(a)	Show the non-singularity of a matrix.	03
	(b)	Give an expression relating R, the rotation matrix, and the angular velocity.	04
	(c)	The jacobian of a robot at particular time is given. Calculate the linear and angular differential motions of the robot's hand frame for the given joint differential motions.	07

$$J=\begin{bmatrix} 2 & 0 & 0 & 0 & 1 & 0 \\ -1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \qquad D\theta=\begin{bmatrix} 0 \\ 0.1 \\ -0.1 \\ 0 \\ 0 \\ 0.2 \end{bmatrix}$$

Q.4	(a)	List out the advantages of recursive Newton Euler	03

formulation

	(b)	Design the steps in orientation planning.	**04**
	(c)	It is desired to have the first joint of a six-axis robot go from initial angle of 35° to a final angle of 70° in 6 seconds. Using a third order polynomial, calculate the joint angle at 1, 2 and 3 seconds.	**07**

OR

Q.4	**(a)**	Give four constraints on the planned trajectory.	**03**
	(b)	Discuss Joint Space Trajectory planning.	**04**
	(c)	Express the time history of position velocity and acceleration for blended trajectory for point-to-point motion with via points.	**07**
Q.5	**(a)**	Develop the block diagram of a manipulator control syatem.	**03**
	(b)	Give the differential equation for a second order under damped system and show typical step response.	**04**
	(c)	Explain the following **(i)** Lagrange Euler Formulation. **(ii)** Force control of robotic manipulator.	**07**

OR

Q.5	**(a)**	Analyze the PID control schemes.	**03**
	(b)	Classify the different linear control strategies.	**04**
	(c)	Discuss the influencing parameters that are involved in developing inverse dynamic model of 2 DOF robots.	**07**

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