

Enrollment No.....



Faculty of Engineering
End Sem (Odd) Examination Dec-2022
RA3CO19 Principle of Robotics

Programme: B.Tech.

Branch/Specialisation: RA

Duration: 3 Hrs.**Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

- Q.1 i. Which of the following is not the functionality of Robot? **1**
 (a) Reprogramability (b) Multifunctionality
 (c) Responsibility (d) Efficient Performance
- ii. A Robot is- **1**
 (a) Programmable (b) Multi-functional manipulator
 (c) Both (a) and (b) (d) None of these
- iii. Homogeneous Transformation takes care of _____. **1**
 (a) Translation only (b) Rotation only
 (c) Both (a) and (b) (d) None of these
- iv. Angle between Z_{i-1} and Z_i along X axis is called- **1**
 (a) Theta (b) Alpha (c) Gamma (d) None of these
- v. Types of singularities is/are- **1**
 (a) Boundary singularities (b) Interior Singularities
 (c) Both (a) and (b) (d) None of these
- vi. The Jacobian for the rotary joint is- **1**
 (a) $J_i(q) = [P_{i-1} ; 0]$ (b) $J_i(q) = [P_{i-1} * i-1P_i ; 0]$
 (c) $J_i(q) = [i-1P_i ; 0]$ (d) $J_i(q) = [P_{i-1} * i-1P_i ; P_{i-1}]$
- vii. Once I have defined the path I want the end-effector to follow, how do I find the end-effector velocity (the trajectory)? **1**
 (a) Take the derivative (b) Take the inverse
 (c) Take the integral (d) Take the transpose
- viii. Path with specified qualities of motion, that is, a path on which a time law is specified in terms of velocities and / or accelerations at each point is known as _____. **1**
 (a) Path (b) Trajectory (c) Spline (d) None of these

P.T.O.


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ix.	Euler equation is used to determine-	1
	(a) Velocity and acceleration	
	(b) Force and torque	
	(c) Both (a) and (b)	
	(d) None of these	
x.	Langrange function is-	1
	(a) Sum of all kinetic energy	
	(b) Difference between total kinetic energy and potential energy	
	(c) Sum of total kinetic energy and potential energy	
	(d) None of these	
Q.2	i. Define the gripper and end effector.	2
	ii. State and explain the laws of robotics.	3
	iii. Explain the types of end effector with suitable examples.	5
OR	iv. Explain the cartesian robot with neat sketch and application.	5
Q.3	i. Write short note on D-H parameters.	4
	ii. Explain the importance of forward kinematic and inverse kinematic analysis of robot manipulator.	6
OR	iii. Derive the homogeneous transformation matrix.	6
Q.4	i. What do you mean by Jacobian?	2
	ii. Define the term “Singularities”. Explain why it is important for robot analysis.	8
OR	iii. Derive the expression for prismatic joint Jacobian.	8
Q.5	Attempt any two:	
	i. Explain the joint space techniques.	5
	ii. Explain the cartesian space techniques.	5
	iii. Define the following terms	5
	(a) Path	
	(b) Trajectory	
	(c) Knot points	
	(d) Joint space trajectory planning	
	(e) Cartesian space trajectory planning	

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Q.6	Attempt any two:	
	i. Explain Euler-Lagrange formulation.	5
	ii. Write the advantages of Newton-Euler formulation.	5
	iii. Derive the inertia tensor of a rectangular box.	5

Scheme of Marking

	Faculty of Engineering	
	End Sem (Odd) Examination Dec-2022	
	Principle of Robotics-RA3CO19	
	Programme: B.Tech.	Branch/Specialisation:

Note: The Paper Setter should provide the answer wise splitting of the marks in the scheme below.

Q.1	i) Which of the following is not the functionality of Robot?	1
	Responsibility	
	ii) A Robot is a	1
	Both (A) and (B)	
	iii) Homogeneous Transformation takes care of ---	1
	Both translation and rotation	
	iv) Angle between Z_{i-1} and Z_i along X axis is called	1
	Alpha	
	v) Types of singularities is/are	1
	Both A and B	
	vi) The Jacobian for the rotary joint is	1
	$J_i(q) = [P_{i-1}^{T-1} P_{i-1}^{T-1}]$	
	vii) Once I have defined the path I want the end-effector to follow,	1
	how do I find the end-effector velocity (the trajectory)?	
	Take the derivative	
	viii) Path with specified qualities of motion, that is, a path on which a time law	1
	is specified in terms of velocities and / or accelerations at each point is	
	known as	
	Trajectory	
	ix) Euler equation is used to determine	1
	Force and torque	
	x) Lagrange function is	1
	Difference between total kinetic energy and potential energy	
Q.2	I. Define the gripper and end effector.	2
	Gripper definition	1 Mark
	End-effector definition	1 Mark
	II. State and explain the laws of robotics?	3
	3 Laws of robotics	1 Mark each
	III. Explain the types of end effector with suitable examples.	5

	End effector Types	1 Mark
	Explain of 3 type	1 Mark each
	3 Diagrams	2 marks
OR	IV. Explain the Cartesian robot with neat sketch and application.	5
	Explanation	2 marks
	Application	2 Marks
	Diagram	1 mark
Q.3	I. Write short note on D-H parameters	4
	4 parameters	1 mark each
	II. Explain the importance of forward kinematic and inverse	6
	kinematic analysis of robot manipulator.	
	Importance of forward kinematic analysis	3 marks
	Importance of inverse kinematic analysis	3 marks
OR	III. Derive the homogeneous transformation matrix.	6
	Rotation matrix	3 marks
	Formation of final Transformation matrix	3 marks
Q.4	I. What do you mean by Jacobian?	2
	Definition of Jacobian	2 marks
	II. Define the term "Singularities", and explain why it is important	8
	for robot analysis.	
	Definition	2 marks
	Explanation of min 3 importance	6 marks
OR	III. Derive the expression for prismatic joint Jacobian.	8
	Diagram	2 marks
	Definition	2 marks
	Derivation	4 marks
Q.5	Attempt any two:	
	I. Explain the joint space Techniques.	5
	Explanation <i>① Introduction ② types of methods</i>	5 marks
	II. Explain the Cartesian space techniques.	5
	Explanation <i>① Introduction ② types of methods</i>	5 marks
OR	III. Define the following terms	5
	a) Path	
	b) Trajectory	
	c) Knot points	
	d) Joint space trajectory planning	

		e) Cartesian space trajectory planning	
		Definition 1 mark each	
Q.6		Attempt any two:	
	I.	Explain Euler-Lagrange formulation. Explanation <u>Formulation - 2</u> 5 marks	5
	II.	Write the advantages of Newton-Euler formulation. Advantages <u>(any five)</u> 5 marks	5
	III.	Derive the inertia tensor of a rectangular box. Diagram with labelling 2 marks Derivation 3 marks	5