VIT®
Vellore Institute of Technology

Reg. No. :

Final Assessment Test(FAT) - Nov/Dec 2024

Programme	B.Tech.	Semester	Fall Semester 2024-25
Course Code	BCSE421L	Faculty Name	Prof. Arunkumar
Course Title	Robotics: Kinematics, Dynamics and Motion Control	Slot	C1+TC1
		Class Nbr	CH2024250101394
Time	3 hours	Max. Marks	100

General Instructions

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

Course Outcomes

1. Comprehend, classify and analyze the fundamentals of robotics.
2. Analyze the inverse manipulator kinematics and dynamics.
3. Gain the knowledge about the manipulator design and mechanism.
4. Elucidate the role of actuators, drive systems and sensors in robotics.

Section - I

Answer all Questions (4 × 10 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
01.	Industrial manipulators are widely used in different manufacturing industrial applications, each application requires some specific type of industrial robots, a) Classify the types of industrial manipulators (3 Marks) b) Describe the essential components of an industrial manipulator with a block diagram. (7 Marks)	10	1	1
02.	Effective operation of industrial robots in performing multi-tasking applications relies heavily on assigning appropriate frames throughout their workspace. Discuss the importance and functions of standard frames, explaining how each frame contributes to the robot's kinematic modeling and control. Include a diagram with clear labels indicating different frames to support your discussion.	10	1	
03.	Robotic manipulators used in the automobile manufacturing industry handling heavy loads are ensured with the essential characteristics called stiffness and deflection. Explain the concept of stiffness and deflection in an industrial manipulator using the required diagram. List out the importance of stiffness and deflection from a robotics point of view.	10	3	
04.	The precise operation of the industrial manipulators in pharmaceutical industries for packing applications requires continuous closed-loop feedback system inputs. Illustrate a block diagram and describe in detail each block and the functions of a closed-loop control system used in industrial manipulators. List out its advantages.	10	4	

Section - II

Answer all Questions (3 × 20 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
05.	A) Consider the robotic arm with three degrees of freedom, as shown in Figure 1. Note that there is a 90-degree twist between axes 1 and 2. Derive the link parameters for the robotic arm and the forward kinematic equations for the configuration from the base to the wrist, ${}^{B}{}_{W}T$. Note that L_3 does not need to be defined for this problem., (12 Marks)	20	2	3

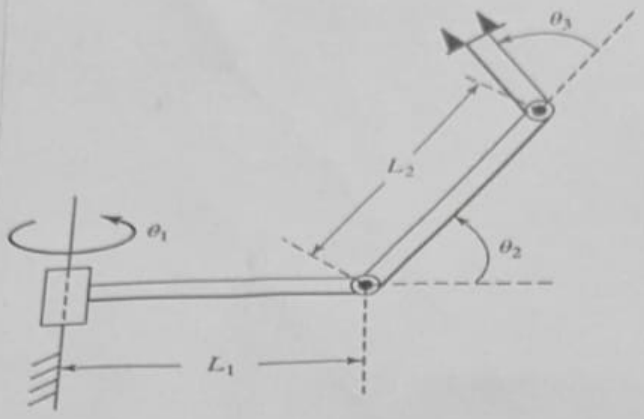

Figure-1

B) Derive the inverse kinematics for the three-link manipulator arm shown in above Figure-1 (8 Marks)

06.	A) Derive the Jacobian equations for a robot manipulator with six functions and six independent variables. Define the condition for singularity in a robot manipulator and provide a detailed classification of singularity types (14 Marks) B) Identify the singularities of the simple two-link arm shown in below Figure -2. What is the physical explanation of the singularities for the given robot. Are they workspace-boundary singularities or workspace-interior singularities. (6 Marks)	20	3	

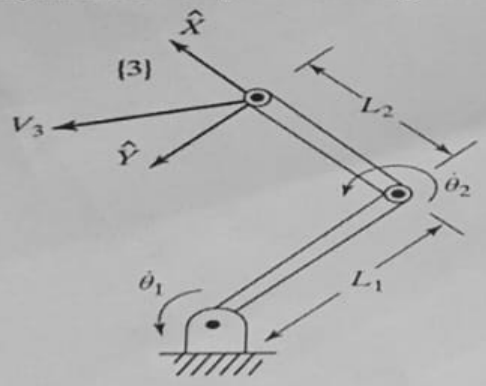

Figure-2

07.	A) Define the terms kinetic energy and potential energy in a lagrangian equation. Derive the force-acceleration relationship for the 2-DOF system shown in following Figure -3 using lagrangian mechanics equation. (14 Marks)	20	3	3

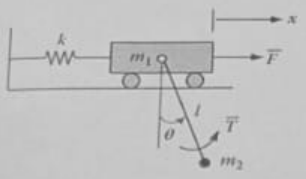

Figure -3

B) Give the important equations and explain about the non rigid body effects for calculating the dynamics of robot manipulator arm (6 Marks)

BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)

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