Question bank robotics

Mechanical Engineering (Madras Institute of Technology, Anna University)

CHENNAI INSTITUTE OF TECHNOLOGY
(Autonomous)

(An Autonomous Institution, Affiliated to Anna University, Chennai)

QUESTION BANK FORMAT

(Questions Should Not Repeat)

NAME OF THE DEPARTMENT	**Mechatronic Engineering**		
YEAR / SEMESTER	**III Year /VI Semester**		
REGULATION	**R2021**		
SUBJECT CODE	**MR3691**		
SUBJECT NAME	**ROBOTICS**		
FACULTY NAME	**Dr. B. Selvam**	**Contact Number**	**9790527337**
REVISED BLOOMS TAXONOMY(RBT) :			

UNIT-I:

UNIT – I BASICS OF ROBOTICS

Introduction- Basic components of robot-Laws of robotics- classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.

PART-A (2-Marks)

S.NO	QUESTIONS	CO	RBT LEVEL
1.	Define a robot	C310.1	L1
1.	Define first and second law of robotics.	C310.1	L1
1.	What is end-effector in robot?	C310.1	L1
1.	Enumerate the types of robots based on configuration.	C310.1	L2
1.	What are the types of industrial robots?	C310.1	L2
1.	What are the essential components that make up the mechanical structure of a robot?	C310.1	L2
1.	Explain the role of sensors in the basic components of a robot.	C310.1	L2
1.	How do actuators contribute to the functionality of a robot?	C310.1	L2
1.	Differentiate between industrial and service robots, providing examples of each.	C310.1	L3
1.	Explain the criteria used to classify robots based on their mobility	C310.1	L2

1.	What are the four configurations of robot?	C310.1	L1	
1.	What are the types of joints used in a robot?	C310.1	L1	
1.	Differentiate between twisting and revolving joints	C310.1	L2	
1.	Define actuators in robots.	C310.1	L1	
1.	Differentiate between accuracy and precision in robot.	C310.1	L2	
1.	Differentiate between repeatability and reliability in robot.	C310.1	L2	
1.	Define accuracy in robot.	C310.1	L1	
1.	Define work envelope in robot.	C310.1	L1	
1.	What is repeatability in robot?	C310.1	L1	
1.	Differentiate between resolution and spatial resolution.	C310.1	L1	
	PART-B (13- Marks Or 16-Marks or 8-Marks)	**CO**	**BT Level**	**Marks**
1.	Describe briefly the robot anatomy and basic movements involved in industrial robots.	C310.1	L2	13
1.	Define degrees of freedom and explain briefly various motions involved in a robot.	C310.1	L2	13
1.	Describe briefly the types of joints used in a robot with neat sketches.	C310.1	L3	13

1.	Explain with neat diagrams polar and cylindrical configurations of robot and their merits and demerits.	C310.1	L2	13
1.	Explain with neat diagrams cartesian and revolute configurations of robot and their merits and demerits.	C310.1	L1	13
1.	What is work envelope in robot? and explain it briefly with diagrams for four configurations of robot.	C310.1	L1	13
1.	Describe briefly the basic motions of robots with neat diagram and explain the following terms i) Payload, ii) Pitch, iii)Yaw, iv) Roll, v) Duty cycle, vi) offset.	C310.1	L2	13
1.	Describe briefly the robot control and explain with block diagrams the types of robot control techniques.	C310.1	L2	13
	PART-C (15-Marks)	**CO**	**BT Level**	**Marks**
1.	Describe briefly the specifications or parameters involved in a robot	C310.1	**L2**	**15**
1.	Explain the following terms in robotics briefly i) Accuracy, ii) Repeatability, iii) Reliability, iv) Resolution, v) Spatial resolution.	C310.1	**L2**	**15**
1.	Define end effector in a robot. Explain briefly the design considerations of end effector and the classification of end of arm tooling	C310.1	**L2**	**15**

UNIT-II: ROBOT KINMEATICS

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms

PART-A (2-Marks)

S.NO	QUESTIONS	CO	RBT LEVEL
1.	Define kinematics in robot manipulator	C310.2	L1
1.	Differentiate between kinematics and differential kinematics	C310.2	L2
1.	Give short description on position and orientation of robot	C310.2	L1
1.	With block diagram explain forward kinematics	C310.2	L1
1.	With block diagram explain inverse kinematics	C310.2	L1
1.	Describe shortly kinematic relationship between two frames	C310.2	L1
1.	Define transformation matrix	C310.2	L2
1.	What is singularity and when it occurs in robot?	C310.2	L2
1.	What are the two kinds of problems in kinematic analysis?	C310.2	L2
1.	Give short description on redundancy in robot.	C310.2	L2

1.	What is Denavit Hartenberg parameters?	C310.2	L1	
1.	What are the two modes of control in robot?	C310.2	L2	
1.	Define forward kinematics for a 2-degree-of-freedom (2DOF) planar mechanism.	C310.2	L2	
1.	Explain the concept of inverse kinematics for a 2DOF planar robot.	C310.2	L2	
1.	Discuss the challenges and solutions associated with solving the inverse kinematics problem for a 2DOF planar mechanism.	C310.2	L2	
1.	Extend the concept of forward kinematics to a 3-degree-of-freedom (3DOF) planar mechanism.	C310.2	L3	
1.	How does the transformation matrix change when dealing with a 3DOF planar robot?	C310.2	L3	
1.	Elaborate on the steps involved in solving the inverse kinematics problem for a 3DOF planar robot.	C310.2	L3	
1.	Discuss the importance of singularity in the context of inverse kinematics for 3DOF planar mechanisms.	C310.2	L3	
1.	Define the forward kinematics equations for a 2DOF spatial mechanism.	C310.2	L2	
	PART-B (13- Marks Or 16-Marks or 8-Marks)	**CO**	**BT Level**	**Marks**
1.	Describe briefly the forward and inverse kinematics of robot manipulator with a block diagram	C310.2	L1	13
	Explain rotation matrices for three axes in robot			

1.	manipulator with neat diagram	C310.2	L2	13
1.	Explain briefly the composite rotation matrix rotated about x, y and z axes in robot manipulator	C310.2	L2	13
1.	Explain briefly the homogeneous transformation matrix and its components	C310.2	L2	13
1.	What is composite homogeneous transformation matrix and explain with an exmaple?	C310.2	L3	13
1.	A transformation matrix T is to be determined that represents a rotation of angle about the OX axis, followed by a translation of b units along the rotated OV axis. Solve it using both orthodox and unorthodox method.	C310.2	L3	13
1.	Find a homogeneous transformation matrix T that represents a rotation of a angle about the OX axis, followed by a translation of a units along the OX axis, followed by a translation of d units along the OZ axis, followed by a rotation of 0 angle about the OZ axis.	C310.2	L3	13
1.	Explain briefly i) Composite Homogeneous Transformation Matrix, ii) Composite rotation matrix, iii) Manipulator kinematics in joint space and task space.	C310.2	L2	13

	PART-C (15-Marks)	**CO**	**BT Level**	**Marks**
1	Derive the forward kinematics of manipulator with revolute joints with diagram, i)Two link planar manipulator , ii) Three link planar manipulator	C310.2	L3	15
2	i)Given two points auvw=(4 3 2)T and buvw=(6 2 4)T with respect to the rotated OUVW coordinate system, determine the corresponding points axyz, bxyz, with respect to the reference coordinate system if it has been rotated 60° about the OZ axis, ii) If axyz = (4, 3, 2)T and bxyz = (6, 2, 4)T are the coordinates with respect to the reference coordinate system, determine the corresponding points auvw, buvw with respect to the rotated OUVW	C310.2	L3	15

	coordinate system if it has been rotated 60° about the OZ axis.			
3	Derive the inverse kinematics solution for three link planar manipulator	C310.2	L3	15

UNIT-III: ROBOT DYNAMICS

Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

PART-A (2-Marks)

S.NO	QUESTIONS	CO	RBT LEVEL
1.	Define robot dynamics.	C310.3	L1
1.	What is forward and inverse dynamics?	C310.3	L2
1.	What is the role of Newton - Euler or Lageange's equation of motion in dynamics of robot?	C310.3	L2
1.	Why dynamics is crucial for implementing control algorithm?	C310.3	L1
1.	Write the structure of lagrange's equation of motion.	C310.3	L2
1.	Describe shortly 4X4 homogeneous coordinate transformation matrix.	C310.3	L2
1.	Why generalized coordinates are used in the derivation of equation of motion of robot system?	C310.3	L3
1.	Define kinetic energy of the robot manipulator.	C310.3	L2
1.	Write the formulation of linear and angular momentum	C310.3	L2
1.	Define potential energy of the manipulator	C310.3	L2
	Define manipulator dynamics and explain its		

1.	significance in robotic systems.	C310.3	L1	
1.	What is the Lagrange formulation in the context of manipulator dynamics?	C310.3	L1	
1.	Briefly describe the key steps involved in deriving the Lagrange equations for manipulator dynamics.	C310.3	L2	
1.	How does Lagrange-Euler formulation differ from Newton-Euler formulation in manipulator dynamics?	C310.3	L2	
1.	Explain the concept of generalized coordinates in the Lagrange formulation.	C310.3	L1	
1.	What role do kinetic and potential energy play in Lagrange's equations for manipulator dynamics?	C310.3	L2	
1.	Compare and contrast the advantages of Lagrange-Euler formulation over Newton-Euler formulation.	C310.3	L3	
1.	Define inertia matrix in the context of manipulator dynamics.	C310.3	L3	
1.	Explain how the Lagrange equations account for the effects of external forces and torques on a manipulator.	C310.3	L3	
1.	What are the key advantages of using Lagrange's equations for dynamic modeling of robotic manipulators?	C310.3	L3	
	PART-B (13- Marks Or 16-Marks or 8-Marks)	**CO**	**BT Level**	**Marks**
1.	Describe briefly the dynamic parameters involved in robot manipulator and also the differences between dynamics and kinematics.	C310.3	L1	13
	Explain the procedure involved in deriving			

1.	equation of motion using Lagrange - Euler formulation.	C310.3	L2	13
1.	Explain briefly the potential energy in general and derive it for two link robot manipulator	C310.3	L2	13
1.	Explain briefly the kinetic energy in general and derive it for two link robot manipulator	C310.3	L1	13
1.	Describe briefly the dynamics and equation of motion of TRR robot	C310.3	L2	13
1.	Derive equation of motion of two degree of freedom system using Newton -Euler approach.	C310.3	L3	13
1.	Derive equation of motion of single degree of freedom spring mass system with free body diagram using newton's second law of motion.	C310.3	L2	13
1.	Describe Newton-Euler formulation for a mechanical system and explain briefly the steps involved in it.	C310.3	L2	13
	PART-C (15-Marks)	**CO**	**BT Level**	**Marks**
1.	Derive inertia matrix for two link planar robot manipulator involving mass, length and angular motion of links	C310.3	L3	15
1.	Derive the equation of motion of two link robot manipulator using Lagrange -Euler formulation involving gravity terms.	C310.3	L3	15
1.	Describe briefly the static analysis of joints and links involved in robot manipulator dynamics	C310.3	L2	15

UNIT-IV: TRAJCTORY, PATH PLANNING AND PROGRAMMING

Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages- Introduction to ROS

PART-A (2-Marks)

S.NO	QUESTIONS	CO	RBT LEVEL
1.	What are the basic classifications of sensors?	C310.4	L1
1.	What is a tactile sensor?	C310.4	L1
1.	Define servo control robots?	C310.4	L2
1.	What are the methods of robot programming?	C310.4	L1
1.	What is manual lead through programming?	C310.4	L2
1.	What is trajectory planning in the context of robotics?	C310.4	L2
1.	Define joint space and Cartesian space in the context of robot motion.	C310.4	L1
1.	How does joint space differ from Cartesian space in trajectory planning?	C310.4	L2
1.	Explain the importance of trajectory planning in robotic systems.	C310.4	L2
1.	What are the primary challenges in joint space trajectory planning?	C310.4	L2
1.	Describe the advantages of Cartesian space		

	trajectory planning.	C310.4	L1	
1.	How does joint space trajectory planning contribute to robot motion control?	C310.4	L3	
1.	Discuss the role of kinematics in trajectory planning.	C310.4	L2	
1.	Explain the concept of forward kinematics and its relevance to trajectory planning.	C310.4	L2	
1.	What is trajectory planning in the context of robotics?	C310.4	L2	
1.	How are topics published in ROS?	C310.4	L2	
1.	What is the difference between message and topic in ROS?	C310.4	L2	
1.	What is the role of ROS master?	C310.4	L3	
1.	What are services in ROS?	C310.4	L2	
1.	What are dependencies in ROS?	C310.4	L1	
	PART-B (13- Marks Or 16-Marks or 8-Marks)	**CO**	**BT Level**	**Marks**
1.	What are the two common methods of robot programming and explain it briefly.	C310.4	L2	13
1.	Discuss in detail the processes involved in creating a new package in ROS	C310.4	L2	13
1.	Write the advantages of ROS and why it is preferred over other software platforms	C310.4	L2	13

1.	Enumerate and discuss briefly the disadvantages of ROS	C310.4	L2	13
1.	Discuss briefly with block diagram the ROS file system level	C310.4	L2	13
1.	Explain with neat diagram the structure of ROS package and its components.	C310.4	L3	13
1.	Describe briefly the role of ROS Master with block diagram.	C310.4	L2	13
1.	Describe briefly ROS nodes and the role and working mechanism of ROS topics	C310.4	L2	13
	PART-C (15-Marks)	**CO**	**BT Level**	**Marks**
1.	A single-link robot with a rotary joint is motionless at $\theta = 15$ degrees. It is desired to move the joint in a smooth manner to $\theta = 75$ degrees in 3 seconds. Find the coefficients of a cubic that accomplishes this motion and brings the manipulator to rest at the goal. Plot the position of the joint as a function of time	C310.4	**L3**	15
1.	Describe with block diagram the components involved in ROS computation graph	C310.4	**L2**	15
1.	What is the ROS computation graph, and how does it facilitate communication between nodes?	C310.4	**L2**	15

UNIT-V: ROBOT AND ROBOT APPLICATIONS

Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors & Grippers: Introduction- types & classification- Mechanical gripper- gripper force analysis- other types & special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.

PART-A (2-Marks)

S.NO	QUESTIONS	CO	RBT LEVEL
1.	What is the primary function of a sensor in a robot system?	C310.5	L1
1.	Name two common types of sensors used in robotics.	C310.5	L2
1.	Define actuator and provide an example used in robotics.	C310.5	L1
1.	Name three types of power transmission systems used in robotics.	C310.5	L2
1.	Differentiate between open-loop and closed-loop power transmission.	C310.5	L2
1.	How is rotary motion defined in robotics?	C310.5	L2
1.	Provide an example of a robot application that requires rotary motion.	C310.5	L2
1.	What are the advantages of rotary motion in certain robotic tasks?	C310.5	L2
1.	Explain the concept of converting rotary motion to linear motion in robots.	C310.5	L2

1.	Name a mechanism commonly used for converting rotary to linear motion.	C310.5	L2	
1.	Discuss one application where linear motion is crucial in robotics.	C310.5	L2	
1.	Define harmonic drives and their role in robotics.	C310.5	L2	
1.	Compare and contrast gear systems and belt drives in terms of robotic applications.	C310.5	L3	
1.	Discuss one advantage and one disadvantage of using harmonic drives in robots.	C310.5	L2	
1.	What is the function of an end effector in a robot system?	C310.5	L2	
1.	List three types of end effectors used in robotics.	C310.5	L2	
1.	Provide an example of a special-purpose gripper and its application.	C310.5	L2	
1.	Explain the basic principles behind mechanical grippers.	C310.5	L2	
1.	Name two factors influencing the selection of a mechanical gripper for a specific task.	C310.5	L2	
1.	Discuss one limitation of mechanical grippers in certain applications.	C310.5	L2	
	PART-B (13- Marks Or 16-Marks or 8-Marks)	**CO**	**BT Level**	**Marks**
1.	Write the types of tactile sensors, and explain any one in detail with neat sketch.	C310.5	L2	13
	Give basic definitions and operations involved			

1.	in mechanical grippers with neat diagram.	C310.5	L2	13
1.	Describe briefly the types of gripper mechanisms and explain with diagram gear and rack method of actuating the gripper	C310.5	L2	13
1.	Explain briefly the mechanisms involved in cam actuated gripper and screw type gripper actuation.	C310.5	L2	13
1.	Explain briefly the vacuum cups gripper with neat diagram.	C310.5	L2	13
1.	Explain briefly the magnetic grippers with neat diagram.	C310.5	L2	13
1.	Explain the following in detail with neat sketches a) Internal gripper, b) External gripper, c) Collect gripper.	C310.5	L2	13
1.	Explain the following in detail with neat sketches a) Gripper with a rotary actuator, b) Translation gripper mechanisms.	C310.5	L2	13
	PART-C (15-Marks)	**CO**	**BT- Level**	**Marks**
1.	What are the basic concepts in robot control and explain briefly servo and non-servo controlled robot with diagrams?	C310.5	L2	15
1.	Explain briefly about the types of robot drive systems, and its influence in the speed of motion and load carrying capacity of robot manipulator.	C310.5	L2	15
1.	Explain in detail mechanical gripers with two fingers with diagrams.	C310.5	L2	15