Seat No: _____ **Enrollment No: _____**

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

B Tech. Summer 2021-22 Examination

Semester: 8th **Date: 04-04-2022**
Subject Code: 203109485 **Time: 10:30am to 1:00pm**
Subject Name: Industrial Robotics **Total Marks: 60**

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1 (a) Multiple Choice Questions: **(05)**

1. The term "robot" has come from the Czech word: robota, which means forced or slave laborer. The terms was first used by:
   a. John Engvenger b. Isaac Asimov
   c. Karel Capek d. George Devol
2. The locus of points (either in the joint space or in the Cartesian space) to be traversed by the manipulator to execute the specified task.:
   a. Path b. Trajectory
   c. Way d. None of the above
3. When the robot loses a degree of freedom, the event is known as-
   a. Dexterity b. Degeneracy
   c. Reachability d. None of the above
4. Jacobian is a representation of _____ of the mechanism.
   a. Geometry b. Motion
   c. Both of the above d. None of the above
5. The advantage of using robot in industries is:
   a. Increased Productivity b. Increased Flexibility
   c. Increased Accuracy d. All of the above

Q.1 (b) Write a short note on: **(05)**

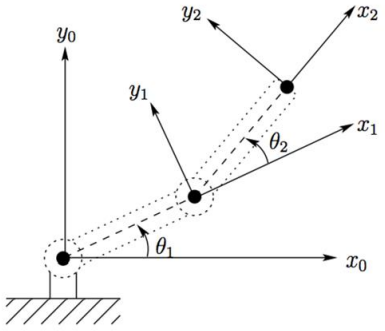
1. Dexterous Workspace
2. Homogeneous Representation of Matrices
3. Trajectory of the robot
4. Applications on Robots in Manufacturing
5. Non-industrial applications of Robots

Q.1 (c) Fill in the blanks: **(05)**

1. A cylindrical joint has _____ DOF.
2. The process of determining coordinates of the robot's end (hand), if all joint variables are known, is called _____
3. In RPY angles, RPY stands for _____.
4. The small movements of mechanisms (e.g., robots) that can be used to derive velocity relationships between different parts of the mechanism is known as _____.
5. If the determinant of a square Jacobian is zero, it is known as _____

Q.2 Answer the following questions. (Attempt any three) **(15)**

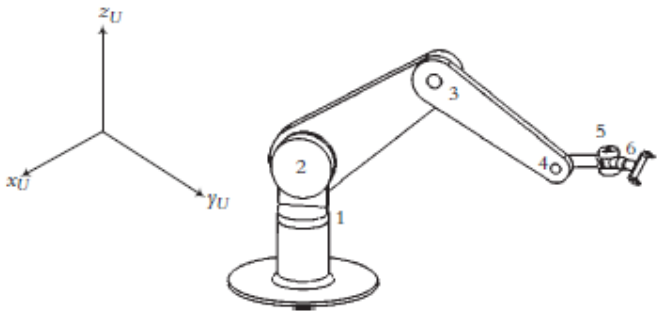
A) Find the Jacobian matrix for the 2-DOF planar manipulator as shown in the figure.



B) Explain forward dynamics and inverse dynamics along with the inputs and outputs in each case.

C) Explain Joint Space Trajectory Planning and Cartesian Space Trajectory Planning.
D) Describe D-H Parameters with the help of a neat sketch.

Q.3 A) Using a conventional D-H convention, identify the frames at the joints of the robots shown in the figure. Draw a table to represent the D-H parameters of the configuration shown. **(07)**



A) A point $P(7,3,1)^T$ is attached to a frame F and is subjected to the following transformations. Find the coordinates of the point relative to the reference frame at the conclusion of transformations. **(08)**

1. Rotation of 90^0 about the z-axis,
2. Followed by a rotation of 90^0 about the y-axis,
3. Followed by a translation of [4,-3,7].

OR

B) Classify the robots based on: **(08)**

1. Type of task performed
2. Configuration of the robot
3. Based on mobility of the robot
4. Type of control system

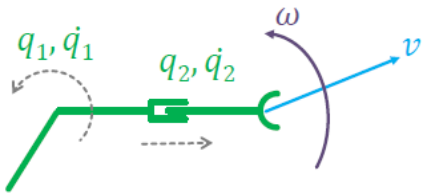
Q.4 A) Define the following terms related to the specifications of the sensors: **(07)**

1. Range
2. Response
3. Accuracy
4. Sensitivity
5. Linearity
6. Repeatability
7. Resolution

OR

A) The forward kinematic equation of a robot is given below. Find its elements of the Jacobian: **(07)**

$$x = q_2 \cos(q_1)$$
$$y = q_2 \sin(q_1)$$



B) Compare the Newton-Euler Formulation and Lagrange Formulation used for dynamic modeling of the robots. **(08)**