

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BACHELOR OF ENGINEERING – SEMESTER 6 – EXAMINATION – SUMMER 2026**

**Subject Code: 3164208**

**Date: 01/06/2026**

**Subject Name: Introduction to Robotics**

**Time: 10:30 AM TO 01:00 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.**

- Q.1**
- |     |                                                                              |           |
|-----|------------------------------------------------------------------------------|-----------|
| (a) | Explain degree of freedom with suitable example                              | <b>03</b> |
| (b) | List the type of robot joints along with notation, symbol and description.   | <b>04</b> |
| (c) | Explain four basic configuration according to work envelope and applications | <b>07</b> |

- Q.2**
- |     |                                                                                                                                                                                  |           |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | Describe Belt, Chain and Gear drives used in robotics.                                                                                                                           | <b>03</b> |
| (b) | Explain the following robot characteristics: Payload, Reach, Precision and Repeatability. Comment on how robots are superior on each of these aspects compared to a human being. | <b>04</b> |
| (c) | What is a gripper? How is it different from an end effector? Describe briefly all the different types of grippers that you are aware of.                                         | <b>07</b> |

OR

- Q.2**
- |     |                                                                                                                                                                                                                                    |           |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (c) | Perform a simple force requirement calculation for a mechanical jaw type gripper (working entirely on frictional grip) and a vacuum gripper (working on suction). What are the important variables that should be considered here? | <b>07</b> |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|

- Q.3**
- |     |                                                                                                                                                                                                                                             |           |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | What factors are typically considered when choosing an actuating mechanism for a robot?                                                                                                                                                     | <b>03</b> |
| (b) | What is a DC motor? What is the difference between a brushed and a brushless DC motor, and its advantages and disadvantages?                                                                                                                | <b>04</b> |
| (c) | What is forward and inverse kinematics? What is a coordinate transformation and why is it important? If a rotation is made about z axis followed by a rotation about y axis, all in current frame, what is the total transformation matrix? | <b>07</b> |

OR

- Q.3**
- |     |                                                                                                                                                                |           |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | What are actuators? Briefly explain the different types of actuators used in robotics.                                                                         | <b>03</b> |
| (b) | What is an AC motor? What are the typical AC motors that are used in robotics? Are they self-starting in nature?                                               | <b>04</b> |
| (c) | Explain roll, pitch, yaw and Euler angles using illustration and write down the total transformation matrix if all the rotations are made in the current axis. | <b>07</b> |

- Q.4**
- |     |                                                                                                                                       |           |
|-----|---------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | What are D-H parameters and why are they important?                                                                                   | <b>03</b> |
| (b) | Explain briefly the working principles of encoders (position sensor), tachometers (velocity sensor) and strain gauges (force sensor). | <b>04</b> |
| (c) | What are mobile robots? Explain the different types of mobile robots.                                                                 | <b>07</b> |

OR

|            |                                                                                                                                                                                              |           |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Q.4</b> | <b>(a)</b> What are World, Joint and Tool reference frames?                                                                                                                                  | <b>03</b> |
|            | <b>(b)</b> Briefly explain the principles involved and the essential elements of a vision sensor.                                                                                            | <b>04</b> |
|            | <b>(c)</b> What are controllers? Describe the different levels of control and the different types of control system used in mobile robots.                                                   | <b>07</b> |
| <b>Q.5</b> | <b>(a)</b> Explain WAIT, SIGNAL , DELAY command using a small code block.                                                                                                                    | <b>03</b> |
|            | <b>(b)</b> What are the different programming methods used in robotics?                                                                                                                      | <b>04</b> |
|            | <b>(c)</b> Explain the different learning methods in AI for robotics with examples.                                                                                                          | <b>07</b> |
|            | OR                                                                                                                                                                                           |           |
| <b>Q.5</b> | <b>(a)</b> Write a small program snippet to move a robot to three positions sequentially, wait for a sensor signal at each position, and then open the gripper. Use WAIT and DELAY commands. | <b>03</b> |
|            | <b>(b)</b> Explain VAL, RAIL, AML and Python languages used in robotics.                                                                                                                     | <b>04</b> |
|            | <b>(c)</b> Describe briefly some of the problem solving, searching and reasoning methods used in AI for robotics.                                                                            | <b>07</b> |

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