



# PRESIDENCY UNIVERSITY

BENGALURU

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## End - Term Examinations – May / June 2026

Date: 25-05-2026

Time: 01:00pm – 04:00pm

|                      |                                       |                |
|----------------------|---------------------------------------|----------------|
| School: SOE          | Program: B.Tech                       |                |
| Course Code: MEC3099 | Course Name: Autonomous Mobile Robots |                |
| Semester: VI         | Max Marks: 100                        | Weightage: 50% |

| CO - Levels | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|-------------|-----|-----|-----|-----|-----|-----|
| Marks       | 12  | 19  | 12  | 16  | 22  | 19  |

### Instructions:

- Read all questions carefully and answer accordingly.
- Do not write anything on the question paper other than roll number.

### Part A

Answer ALL the Questions. Each question carries 2marks.

10Q x 2M=20M

|     |                                                                                          |         |    |     |
|-----|------------------------------------------------------------------------------------------|---------|----|-----|
| 1.  | How do you express the relationship between global and body coordinates of mobile robot? | 2 Marks | L2 | CO1 |
| 2.  | Define proprioceptive and exteroceptive sensors.                                         | 2 Marks | L2 | CO2 |
| 3.  | What is heading sensor used in wheel robots?                                             | 2 Marks | L2 | CO2 |
| 4.  | List various proprioceptive sensors used in autonomous mobile robots.                    | 2 Marks | L2 | CO3 |
| 5.  | State the Markov Assumption used during Markov Localization.                             | 2 Marks | L2 | CO4 |
| 6.  | Explain in brief about the Kidnapped Robot Problem of Markov Localization.               | 2 Marks | L2 | CO4 |
| 7.  | How do you write the wheel displacement in Odometric position estimation?                | 2 Marks | L2 | CO4 |
| 8.  | Define Markov Decision process.                                                          | 2 Marks | L2 | CO5 |
| 9.  | Write the expansion strategy used in rapidly exploring random trees?                     | 2 Marks | L2 | CO6 |
| 10. | Define Voronoi diagrams.                                                                 | 2 Marks | L2 | CO6 |

## Part B

**Answer the Questions.**

**Total Marks 80M**

|            |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------|------------|
| <b>11.</b> | Elucidate 5 differences between holonomic and non-holonomic mobile robots.                                                                                                                                                                                                                                                                         | <b>10 Marks</b> | <b>L3</b> | <b>CO1</b> |
| <b>Or</b>  |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
| <b>12.</b> | Derive the forward kinematics equations for Autonomous wheel mobile robot with 2 wheels and differential drive system by considering the global and body coordinate systems.                                                                                                                                                                       | <b>10 Marks</b> | <b>L3</b> | <b>CO1</b> |
| <b>13.</b> | What is doppler effect-based sensor? Elucidate the working of such sensors with neat sketch and applications of it.                                                                                                                                                                                                                                | <b>10 Marks</b> | <b>L3</b> | <b>CO3</b> |
| <b>Or</b>  |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
| <b>14.</b> | Elucidate the working of vision-based sensors deployed in autonomous mobile robots.                                                                                                                                                                                                                                                                | <b>10 Marks</b> | <b>L3</b> | <b>CO3</b> |
| <b>15.</b> | Identify the parameters that are considered in performance measure of sensors in mobile robots. Explain each of them in brief.                                                                                                                                                                                                                     | <b>10 Marks</b> | <b>L3</b> | <b>CO4</b> |
| <b>Or</b>  |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
| <b>16.</b> | List the sensors used in Autonomous Mobile Robots and elucidate the working Compass sensors and Gyroscopes sensors.                                                                                                                                                                                                                                | <b>10 Marks</b> | <b>L3</b> | <b>CO4</b> |
| <b>17.</b> | List and explain the components of Probabilistic Mapping used in mobile robots localization.                                                                                                                                                                                                                                                       | <b>10 Marks</b> | <b>L4</b> | <b>CO5</b> |
| <b>Or</b>  |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
| <b>18.</b> | Explain the working of Markov Localization method used in mobile robots for localization.                                                                                                                                                                                                                                                          | <b>10 Marks</b> | <b>L4</b> | <b>CO5</b> |
| <b>19.</b> | Explain in detail the concept of belief representation used in Autonomous Mobile Robots.                                                                                                                                                                                                                                                           | <b>10 Marks</b> | <b>L3</b> | <b>CO5</b> |
| <b>Or</b>  |                                                                                                                                                                                                                                                                                                                                                    |                 |           |            |
| <b>20.</b> | Discuss the working and components Markov Decision Processes used in the path planning of mobile robots.                                                                                                                                                                                                                                           | <b>10 Marks</b> | <b>L3</b> | <b>CO5</b> |
| <b>21.</b> | A differential drive mobile robot has the following parameters: Radius of each wheel is 0.1 m and robot base is 0.30 m. Initial pose is again $x = 0, y = 0, \theta = 30 \text{ deg}$ . The mobile robot moves with angular velocities as $\omega_L = 3 \text{ rad/s}, \omega_R = 7 \text{ rad/s}$ . Ignore the wheel inertia and friction losses. | <b>15 Marks</b> | <b>L4</b> | <b>CO2</b> |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |           |            |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------|------------|
|            | Robot moves in a horizontal plane. Determine linear velocity components of velocity in x-direction, y-direction and $\dot{\theta}$ of mobile robot with respect to global coordinate system.                                                                                                                                                                                                                                                                                        |                 |           |            |
|            | <b>Or</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |           |            |
| <b>22.</b> | A differential drive mobile robot has the following parameters: Mass of robot body (excluding wheels): 25 kg, moment of inertia about vertical axis is 3.0 kg-m <sup>2</sup> . Radius of each wheel is 0.15 m and robot base is 0.65 m. Torques applied to left and right wheel is 7 N-m and 3 N-m respectively. Ignore the wheel inertia and friction losses. Robot moves in a horizontal plane. Solve for linear acceleration of the robot and angular acceleration of the robot. | <b>15 Marks</b> | <b>L4</b> | <b>CO2</b> |
| <b>23.</b> | Analyze the working Stochastic Dynamic Programming applied in path planning process of robots.                                                                                                                                                                                                                                                                                                                                                                                      | <b>15 Marks</b> | <b>L4</b> | <b>CO6</b> |
|            | <b>Or</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |           |            |
| <b>24.</b> | Explain the Configuration space and configuration space components of Rapidly Exploring Random Trees algorithm.                                                                                                                                                                                                                                                                                                                                                                     | <b>15 Marks</b> | <b>L4</b> | <b>CO6</b> |