

**K. J. Somaiya Institute of Technology, Sion, Mumbai-22**  
(Autonomous College Affiliated to University of Mumbai)

|                                                             |                      |                |
|-------------------------------------------------------------|----------------------|----------------|
| May-June 2026                                               |                      |                |
| (B. Tech) Program: EXTC Scheme III                          |                      |                |
| Regular :LY Semester: VIII                                  |                      |                |
| Course Code: EXDLC 8043 and Course Name: Autonomous Vehicle |                      |                |
| Date of Exam: <b>23-05-26</b>                               | Duration: 02.5 Hours | Max. Marks: 60 |

EXDLC8033

**Instructions:**

- (1) All questions are compulsory.
- (2) Draw neat diagrams wherever applicable.
- (3) Assume suitable data, if necessary.

| Q. No.                | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Max. Marks | CO               | BT level               |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
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| Q 1                   | Solve any <b>two</b> questions out of three: (05 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 10         |                  |                        |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| a)                    | State Baye's formula for estimating the robot/system state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            | 1                | U                      |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| b)                    | Differentiate between CAN bus protocol and I2C protocol.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            | 3                | Ap                     |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| c)                    | Write a short note on HD map.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            | 2                | U                      |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| Q 2                   | Solve any <b>two</b> questions out of three: (05 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 10         |                  |                        |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| a)                    | Draw chirp signal graph of amplitude respect to time and frequency with respect to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            | 4                | U                      |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| b)                    | Explain angle measurement using Automotive Radar system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            | 5                | U                      |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| c)                    | Analyze the deviations between the ideal pinhole camera model and real-world camera models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            | 6                | An                     |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| Q.3                   | Solve any <b>two</b> questions out of three. (10 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20         |                  |                        |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| a)                    | <p>In a modern vehicle, several Electronic Control Units (ECUs) communicate using a <b>500 kbps CAN bus</b>. Consider <b>3 nodes (ECUs)</b> trying to transmit messages simultaneously:</p> <table><thead><tr><th>Node (ECU)</th><th>Function</th><th>Identifier (Hex)</th><th>Data Length</th><th>Data to Transmit (Hex)</th></tr></thead><tbody><tr><td>ECU A: Engine Control</td><td>Engine RPM data</td><td>0x0C0</td><td>2 bytes</td><td>0x1F, 0xA4 (RPM Data)</td></tr><tr><td>ECU B: ABS Control</td><td>Wheel Speed data</td><td>0x120</td><td>4 bytes</td><td>0x3C, 0x10, 0x00, 0x05</td></tr><tr><td>ECU C: Airbag Control</td><td>Crash detection alert</td><td>0x040</td><td>1 byte</td><td>0xFF (Crash Alert)</td></tr></tbody></table> <p>Explain the CAN data frame and transmission on CAN Bus. Calculate the total time of CAN bus transmission for ECUA.</p> |            | Node (ECU)       | Function               | Identifier (Hex)       | Data Length | Data to Transmit (Hex) | ECU A: Engine Control | Engine RPM data | 0x0C0 | 2 bytes | 0x1F, 0xA4 (RPM Data) | ECU B: ABS Control | Wheel Speed data | 0x120 | 4 bytes | 0x3C, 0x10, 0x00, 0x05 | ECU C: Airbag Control | Crash detection alert | 0x040 | 1 byte | 0xFF (Crash Alert) | 3 | Ap |
| Node (ECU)            | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            | Identifier (Hex) | Data Length            | Data to Transmit (Hex) |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| ECU A: Engine Control | Engine RPM data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            | 0x0C0            | 2 bytes                | 0x1F, 0xA4 (RPM Data)  |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| ECU B: ABS Control    | Wheel Speed data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0x120      | 4 bytes          | 0x3C, 0x10, 0x00, 0x05 |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| ECU C: Airbag Control | Crash detection alert                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0x040      | 1 byte           | 0xFF (Crash Alert)     |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
| b)                    | Explain all the Layers of CNN with explanation of hyper parameter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2          | U                |                        |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |
|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1          | U                |                        |                        |             |                        |                       |                 |       |         |                       |                    |                  |       |         |                        |                       |                       |       |        |                    |   |    |

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| c)    | Explain the object based vehicle environmental model.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |            |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|-------|-------|----|---|---|------------|----|---|---|------------|----|---|---|---------|----|---|---|---------|----|---|---|---------|--|---|---|
| Q.4   | Solve any <b>two</b> questions out of three. (10 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20    |            |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| a)    | <p>A LiDAR sensor in an autonomous vehicle detects object points represented by two features: <math>X_1</math> = Height of point (m) , <math>X_2</math> = Reflectivity intensity . The following labelled training points are available: A new LiDAR point <math>Q=(3,4)</math>, is detected. Using the K-Nearest Neighbors (KNN) algorithm with <math>k=3</math> and Euclidean distance metric.</p> <table><tr><th>Point</th><th><math>X_1</math></th><th><math>X_2</math></th><th>Class</th></tr><tr><td>P1</td><td>1</td><td>2</td><td>Pedestrian</td></tr><tr><td>P2</td><td>2</td><td>3</td><td>Pedestrian</td></tr><tr><td>P3</td><td>3</td><td>3</td><td>Vehicle</td></tr><tr><td>P4</td><td>6</td><td>5</td><td>Vehicle</td></tr><tr><td>P5</td><td>7</td><td>7</td><td>Vehicle</td></tr></table> <p>1. Calculate the distance of point Q from all training points.<br/>2. Identify the three nearest neighbors.<br/>3. Determine the class of the new LiDAR point.</p> | Point | $X_1$      | $X_2$ | Class | P1 | 1 | 2 | Pedestrian | P2 | 2 | 3 | Pedestrian | P3 | 3 | 3 | Vehicle | P4 | 6 | 5 | Vehicle | P5 | 7 | 7 | Vehicle |  | 4 | U |
| Point | $X_1$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | $X_2$ | Class      |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| P1    | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2     | Pedestrian |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| P2    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3     | Pedestrian |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| P3    | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3     | Vehicle    |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| P4    | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5     | Vehicle    |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| P5    | 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 7     | Vehicle    |       |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| b)    | Calibration of Camera does NOT require to already know intrinsic/extrinsic parameters. Justify this statement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       | 5          | An    |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |
| c)    | Explain the key use cases of autonomous vehicle across different sectors as such as transportation, logistic and public safety.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       | 6          | U     |       |    |   |   |            |    |   |   |            |    |   |   |         |    |   |   |         |    |   |   |         |  |   |   |

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