

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

- Jan 2026

( M. Tech.) Program: AI Scheme: II

Regular Examination: FY Semester: I

Course Code: PCEC102 and Course Name: Machine Learning and Pattern Recognition

Date of Exam: 19/01/2026

Duration: 02.5 Hours

Max. Marks: 60

**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 |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|----------|----|--------|---------|------|---|------|----|----|---|------|----|----|---|--------|----|-----|---|-----|-----|-----|---|-----|-----|-----|---|-----|----|----|---|--------|-----|-----|---|------|-----|-----|---|
| Q 1    | Solve any <b>two</b> questions out of three: (05 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10         |      |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| a)     | Define the curse of dimensionality. List and briefly explain any four feature extraction methods used to reduce dimensionality in pattern recognition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            | CO2  | U        |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| b)     | Define supervised and unsupervised learning. List and explain examples of algorithms used in each category.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            | CO4  | U        |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| c)     | Explain the concept of Classification and Regression Trees (CART). Describe how overfitting and underfitting can occur in decision trees, and mention one method to address each problem.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            | CO3  | U        |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| Q 2    | Solve any <b>two</b> questions out of three: (05 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10         | CO3  | Ap       |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| a)     | <p>A company wants to decide whether to approve a loan based on two attributes: Income and Student. The dataset is:</p> <table><tr><th>ID</th><th>Income</th><th>Student</th><th>Loan</th></tr><tr><td>1</td><td>HIGH</td><td>NO</td><td>NO</td></tr><tr><td>2</td><td>HIGH</td><td>NO</td><td>NO</td></tr><tr><td>3</td><td>MEDIUM</td><td>NO</td><td>YES</td></tr><tr><td>4</td><td>LOW</td><td>YES</td><td>YES</td></tr><tr><td>5</td><td>LOW</td><td>YES</td><td>YES</td></tr><tr><td>6</td><td>LOW</td><td>NO</td><td>NO</td></tr><tr><td>7</td><td>MEDIUM</td><td>YES</td><td>YES</td></tr><tr><td>8</td><td>HIGH</td><td>YES</td><td>YES</td></tr><tr><td>9</td><td>HIGH</td><td>NO</td><td>NO</td></tr></table> <p>Use ID3 algorithm to construct a decision tree (Solve upto one iteration only). Determine the root attribute.</p> |            |      |          | ID | Income | Student | Loan | 1 | HIGH | NO | NO | 2 | HIGH | NO | NO | 3 | MEDIUM | NO | YES | 4 | LOW | YES | YES | 5 | LOW | YES | YES | 6 | LOW | NO | NO | 7 | MEDIUM | YES | YES | 8 | HIGH | YES | YES | 9 |
| ID     | Income                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Student    | Loan |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 1      | HIGH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | NO         | NO   |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 2      | HIGH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | NO         | NO   |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 3      | MEDIUM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | NO         | YES  |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 4      | LOW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | YES        | YES  |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 5      | LOW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | YES        | YES  |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 6      | LOW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | NO         | NO   |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 7      | MEDIUM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | YES        | YES  |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 8      | HIGH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | YES        | YES  |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |
| 9      | HIGH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | NO         | NO   |          |    |        |         |      |   |      |    |    |   |      |    |    |   |        |    |     |   |     |     |     |   |     |     |     |   |     |    |    |   |        |     |     |   |      |     |     |   |

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| Jan 2026                                                                       |
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| Regular Examination: FY Semester: I                                            |
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| Date of Exam:19/01/2026                                                        |
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| Max. Marks: 60                                                                 |

| b)      | Use the K-means clustering algorithm to cluster the following one-dimensional data into two clusters.<br>Data points: {1,3,6,8,10,15,18,20}. Initial cluster centroids: M1=3, M2=10                                                                                                                                                                                                                                                                                                                                                                                                                      |          | CO4      | U        |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----|---|---|----|---|----|----|---|---|----|--|-----|----|
| c)      | Explain the Random Forest Ensemble method and compare with other ML algorithms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          | CO5      | U        |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| Q.3     | Solve any <b>two</b> questions out of three. (10 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 20       |          |          |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| a)      | i) Explain Support Vector Machine with the help of suitable diagram and mathematical equations. (5 mk)<br>ii) Define hierarchical clustering. Distinguish between agglomerative and divisive clustering. (5mk)                                                                                                                                                                                                                                                                                                                                                                                           |          | CO4      | U        |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| b)      | Given the data in Table, reduce the dimension from 2 to 1 using the Principal Component Analysis (PCA) algorithm;<br><table border="1" style="margin: 10px auto;"> <thead> <tr> <th>Feature</th><th>Example1</th><th>Example2</th><th>Example3</th><th>Example4</th></tr> </thead> <tbody> <tr> <td>X1</td><td>4</td><td>8</td><td>13</td><td>7</td></tr> <tr> <td>X2</td><td>11</td><td>4</td><td>5</td><td>14</td></tr> </tbody> </table>                                                                                                                                                              | Feature  | Example1 | Example2 | Example3 | Example4 | X1 | 4 | 8 | 13 | 7 | X2 | 11 | 4 | 5 | 14 |  | CO2 | Ap |
| Feature | Example1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Example2 | Example3 | Example4 |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| X1      | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 8        | 13       | 7        |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| X2      | 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 4        | 5        | 14       |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| c)      | i) A company wants to analyze customer data to improve sales. The dataset contains customer demographics, purchase history, and browsing behavior. Identify which machine learning algorithms you would apply for the following tasks and justify your choice:<br>i) Predict whether a customer will buy a product.<br>ii) Group customers with similar buying behavior<br>iii) Forecast sales for the next month<br>iv) Identify frequently bought items together<br>For one of the chosen algorithms, suggest two hyperparameters that can be tuned and describe a suitable parameter tuning approach. |          | CO6      | Ap       |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| Q.4     | Solve any <b>two</b> questions out of three. (10 marks each)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |          |          |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |
| a)      | A company wants to predict sales (in units) based on advertising expenditure (in \$1000s). The dataset is:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20       | CO3      | Ap       |          |          |    |   |   |    |   |    |    |   |   |    |  |     |    |

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|                | <table><tr><th>Advertising(X)</th><th>Sales(Y)</th></tr><tr><td>1</td><td>1.5</td></tr><tr><td>2</td><td>1.7</td></tr><tr><td>3</td><td>3.2</td></tr><tr><td>4</td><td>3.8</td></tr><tr><td>5</td><td>5.1</td></tr></table> <p>Find the <b>linear regression equation</b> <math>Y=b_0+b_1X</math><br/>Predict <b>sales</b> when advertising = 6</p> | Advertising(X) | Sales(Y) | 1 | 1.5 | 2 | 1.7 | 3 | 3.2 | 4 | 3.8 | 5 | 5.1 |  |  |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------|---|-----|---|-----|---|-----|---|-----|---|-----|--|--|
| Advertising(X) | Sales(Y)                                                                                                                                                                                                                                                                                                                                            |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| 1              | 1.5                                                                                                                                                                                                                                                                                                                                                 |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| 2              | 1.7                                                                                                                                                                                                                                                                                                                                                 |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| 3              | 3.2                                                                                                                                                                                                                                                                                                                                                 |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| 4              | 3.8                                                                                                                                                                                                                                                                                                                                                 |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| 5              | 5.1                                                                                                                                                                                                                                                                                                                                                 |                |          |   |     |   |     |   |     |   |     |   |     |  |  |
| b)             | What is the need of Data cleaning and Data transformation? Also explain model visualization in machine learning.                                                                                                                                                                                                                                    | CO1            | U        |   |     |   |     |   |     |   |     |   |     |  |  |
| c)             | Explain the concept of ensemble classifiers and discuss their need and usefulness in machine learning. Briefly describe any four ensemble methods and explain how each improves predictive performance.                                                                                                                                             | CO5            | U        |   |     |   |     |   |     |   |     |   |     |  |  |

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