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|  | <p style="text-align: center;"><b>MAHATMA GANDHI UNIVERSITY</b><br/>Kottayam, Kerala</p> <p style="text-align: center;"><b>Undergraduate Programmes (HONOURS)</b><br/><b>2025 Admission Onwards</b></p> |
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| SYLLABUS               |                                                                                                                                                                                                                                                                                                                                                                                                       |         |             |                   |         |             |         |   |    |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------|-------------------|---------|-------------|---------|---|----|
| SIGNATURE COURSE       |                                                                                                                                                                                                                                                                                                                                                                                                       |         |             |                   |         |             |         |   |    |
| Name of the College    | Sree Narayana Trusts Arts & Science College, Pampanar, Idukki                                                                                                                                                                                                                                                                                                                                         |         |             |                   |         |             |         |   |    |
| Faculty/ Discipline    | Mathematics                                                                                                                                                                                                                                                                                                                                                                                           |         |             |                   |         |             |         |   |    |
| Programme              | BSc (Hons) Mathematics                                                                                                                                                                                                                                                                                                                                                                                |         |             |                   |         |             |         |   |    |
| Course Coordinator     | Anupriya C S                                                                                                                                                                                                                                                                                                                                                                                          |         |             |                   |         |             |         |   |    |
| Contributors           | Aadya D                                                                                                                                                                                                                                                                                                                                                                                               |         |             |                   |         |             |         |   |    |
| Course Name            | Statistical Computing for Data Science                                                                                                                                                                                                                                                                                                                                                                |         |             |                   |         |             |         |   |    |
| Type of Course         | DSE                                                                                                                                                                                                                                                                                                                                                                                                   |         |             |                   |         |             |         |   |    |
| Specialization title   | Machine Learning and Data Science                                                                                                                                                                                                                                                                                                                                                                     |         |             |                   |         |             |         |   |    |
| Course Code            | MG3DSEMATA11                                                                                                                                                                                                                                                                                                                                                                                          |         |             |                   |         |             |         |   |    |
| Course Level           | 200                                                                                                                                                                                                                                                                                                                                                                                                   |         |             |                   |         |             |         |   |    |
| Course Summary         | This course functions as a beginner-level entry point into the specialization. It introduces the computational software stack while reinforcing descriptive and inferential statistics through an applied, data-driven lens. The course emphasizes data wrangling, the exploratory analysis of raw information, and the translation of statistical theory into programmable logic using Python and R. |         |             |                   |         |             |         |   |    |
| Semester               | 3                                                                                                                                                                                                                                                                                                                                                                                                     | Credits | 4           |                   |         |             |         |   |    |
| Course Details         | <table><tr><td>Learning Approach</td><td>Lecture</td><td>Total Hours</td></tr><tr><td>Credits</td><td>4</td><td>60</td></tr></table>                                                                                                                                                                                                                                                                  |         |             | Learning Approach | Lecture | Total Hours | Credits | 4 | 60 |
|                        | Learning Approach                                                                                                                                                                                                                                                                                                                                                                                     | Lecture | Total Hours |                   |         |             |         |   |    |
| Credits                | 4                                                                                                                                                                                                                                                                                                                                                                                                     | 60      |             |                   |         |             |         |   |    |
| Pre-requisites, if any | Foundation in basic calculus and theoretical statistics.                                                                                                                                                                                                                                                                                                                                              |         |             |                   |         |             |         |   |    |

#### Course Outcomes (CO)

| Number of COs |                                                                                                                                                    | 4                  |          |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------|
| CO No.        | Expected Course Outcome                                                                                                                            | Learning Domains * | PO No    |
| 1             | Recall fundamental statistical distributions, measures of central tendency, and the syntax of data manipulation libraries in Python and R.         | K                  | PO1      |
| 2             | Comprehend the assumptions underlying descriptive statistics and the geometric interpretations of variance, covariance, and standard deviation.    | U                  | PO2      |
| 3             | Utilize Python and R to clean, wrangle, parse, and visualize noisy, real-world datasets, preparing them for downstream mathematical modeling.      | A, An              | PO3, PO4 |
| 4             | Critically evaluate raw datasets to identify outliers, underlying distribution shapes, and significant correlations between independent variables. | An, E              | PO4, PO5 |

\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

## CO-PO Articulation Matrix

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-------|------|------|------|------|------|------|------|------|------|-------|
| CO 1  | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 2  | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 3  | -    | -    | 3    | 3    | -    | -    | -    | -    | -    | -     |
| CO 4  | -    | -    | -    | 3    | 3    | -    | -    | -    | -    | -     |

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

## Course Content

Content for Classroom transaction (Units)

| Module | Units | Course Description                                                                                                                                                                                            | Hrs | CO No.               |
|--------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------|
| 1      |       | Introduction to Data Science & Python Basics                                                                                                                                                                  |     |                      |
|        | 1.1   | Ecosystem of Data Science. Python fundamentals: variables, data types, lists, dictionaries, control structures, and functions.                                                                                | 17  | ["1", "2", "3", "4"] |
| 2      |       | Mathematical Computing with Python                                                                                                                                                                            |     |                      |
|        | 2.1   | Introduction to 'NumPy' for vectorized mathematical operations and linear array manipulation. Introduction to 'Pandas': Series, Data Frames, indexing, filtering, and handling missing values mathematically. | 16  | ["1", "2", "3"]      |
| 3      |       | Measures of Central Tendency                                                                                                                                                                                  |     |                      |
|        | 3.1   | Measures of Central Tendency (Mean, Median, Mode) and Dispersion (Variance, Standard Deviation, IQR). Skewness and Kurtosis (Moments). Mathematical formulation of correlation vs. causation.                 | 10  | ["1", "2"]           |
| 4      |       | lab using 'Matplotlib' and 'Seaborn'                                                                                                                                                                          |     |                      |
|        | 4.1   | Hands-on lab using 'Matplotlib' and 'Seaborn'. Plotting histograms, scatter plots, and box plots. List of Practical assignments: Minimum 15 problems using real-world datasets.                               | 17  | ["3", "4"]           |

| Teaching and Learning Approach | Classroom Procedure (Mode of transaction)<br>Lecture, Tutorial and Activity oriented. |
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|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assessment Types | <b>MODE OF ASSESSMENT</b><br>Mode of Assessment: Theory                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                  | <b>A. Continuous Comprehensive Assessment (CCA)</b><br>• <b>Theory - 30 Marks</b><br>Quiz, Assignments, Written Tests                                                                                                                                                                                                                                                                                                                                                                           |
|                  | <b>B. End Semester Evaluation (ESE)</b><br>• <b>Theory - 70 Marks</b><br>Assessment Methods – End Semester Evaluation<br>Duration of Examination – 2.00 Hrs<br>Pattern of examination for Theory – Non-MCQ<br>Different parts of written examination – Part - A , B , C<br>Answer Type:<br>◦ PART - A<br>◦ Short answer - (8 out of 10 ) - $8 \times 2 = 16$<br>◦ PART - B<br>◦ Short Essays - (4 out of 7 ) - $4 \times 6 = 24$<br>◦ PART - C<br>◦ Essays - (3 out of 5 ) - $3 \times 10 = 30$ |

## References

- Python for Data Analysis, Wes McKinney (International).
- The Book of R: A First Course in Programming and Statistics, Tilman M. Davies (International).
- Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor (Indian).

## Affidavit

- We, Sree Narayana Trusts Arts & Science College, Pampanar, Idukki and Anupriya C S, retain the copyright of this syllabus and expressly prohibit its distribution in complete form to any institution outside our own.
- We, Sree Narayana Trusts Arts & Science College, Pampanar, Idukki, agree to appoint a new course coordinator for the proposed Machine Learning and Data Science in the event of the unavailability of the currently nominated coordinator. This appointment will ensure the continued coordination of course delivery, assessments, and all related academic responsibilities necessary for the successful implementation of the specialization, for as long as the college offers this programme.
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| SYLLABUS               |                                                                                                                                                                                                                                                                                                                                                                                                       |         |             |                   |         |             |         |   |    |
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| Name of the College    | Sree Narayana Trusts Arts & Science College, Pampanar, Idukki                                                                                                                                                                                                                                                                                                                                         |         |             |                   |         |             |         |   |    |
| Faculty/ Discipline    | Mathematics                                                                                                                                                                                                                                                                                                                                                                                           |         |             |                   |         |             |         |   |    |
| Programme              | BSc (Hons) Mathematics                                                                                                                                                                                                                                                                                                                                                                                |         |             |                   |         |             |         |   |    |
| Course Coordinator     | Anupriya C S                                                                                                                                                                                                                                                                                                                                                                                          |         |             |                   |         |             |         |   |    |
| Contributors           | Aadya D                                                                                                                                                                                                                                                                                                                                                                                               |         |             |                   |         |             |         |   |    |
| Course Name            | Exploratory Data Analysis and Inference                                                                                                                                                                                                                                                                                                                                                               |         |             |                   |         |             |         |   |    |
| Type of Course         | DSE                                                                                                                                                                                                                                                                                                                                                                                                   |         |             |                   |         |             |         |   |    |
| Specialization title   | Machine Learning and Data Science                                                                                                                                                                                                                                                                                                                                                                     |         |             |                   |         |             |         |   |    |
| Course Code            | MG4DSEMATA11                                                                                                                                                                                                                                                                                                                                                                                          |         |             |                   |         |             |         |   |    |
| Course Level           | 200                                                                                                                                                                                                                                                                                                                                                                                                   |         |             |                   |         |             |         |   |    |
| Course Summary         | This course functions as a beginner-level entry point into the specialization. It introduces the computational software stack while reinforcing descriptive and inferential statistics through an applied, data-driven lens. The course emphasizes data wrangling, the exploratory analysis of raw information, and the translation of statistical theory into programmable logic using Python and R. |         |             |                   |         |             |         |   |    |
| Semester               | 4                                                                                                                                                                                                                                                                                                                                                                                                     | Credits | 4           |                   |         |             |         |   |    |
| Course Details         | <table><tr><td>Learning Approach</td><td>Lecture</td><td>Total Hours</td></tr><tr><td>Credits</td><td>4</td><td>60</td></tr></table>                                                                                                                                                                                                                                                                  |         |             | Learning Approach | Lecture | Total Hours | Credits | 4 | 60 |
|                        | Learning Approach                                                                                                                                                                                                                                                                                                                                                                                     | Lecture | Total Hours |                   |         |             |         |   |    |
| Credits                | 4                                                                                                                                                                                                                                                                                                                                                                                                     | 60      |             |                   |         |             |         |   |    |
| Pre-requisites, if any | Foundation in basic calculus and theoretical statistics.                                                                                                                                                                                                                                                                                                                                              |         |             |                   |         |             |         |   |    |

#### Course Outcomes (CO)

| Number of COs |                                                                                                                                             | 4                  |          |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------|
| CO No.        | Expected Course Outcome                                                                                                                     | Learning Domains * | PO No    |
| 1             | Recall fundamental statistical distributions, measures of central tendency, and the syntax of data manipulation libraries in Python and R.  | K                  | PO1      |
| 2             | Apply Python and R to organize and visualize complex, real-world data, preparing it for mathematical modeling.                              | U, A               | PO2, PO3 |
| 3             | Understand the foundational assumptions of descriptive statistics and interpret variance, standard deviation, and covariance geometrically. | U                  | PO3      |
| 4             | Analyze raw data to detect outliers, determine data distributions, and identify meaningful relationships between independent variables.     | An, E              | PO3, PO4 |

\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

**CO-PO Articulation Matrix**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-------|------|------|------|------|------|------|------|------|------|-------|
| CO 1  | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 2  | -    | 3    | 3    | -    | -    | -    | -    | -    | -    | -     |
| CO 3  | -    | -    | 3    | -    | -    | -    | -    | -    | -    | -     |
| CO 4  | -    | -    | 3    | 3    | -    | -    | -    | -    | -    | -     |

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

**Course Content**

Content for Classroom transaction (Units)

| Module | Units                                                | Course Description                                                                                                                                                                      | Hrs | CO No.               |
|--------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------|
| 1      | Data Wrangling and Exploratory Data Analysis         |                                                                                                                                                                                         | 18  | ["1", "2"]           |
|        | 1.1                                                  | Data structures, vectorization, and data cleaning mathematics. Data Wrangling and Exploratory Data Analysis: Pandas manipulation, variance, standard deviation, skewness, and kurtosis. |     |                      |
| 2      | Descriptive Statistics and Geometric Interpretations |                                                                                                                                                                                         | 10  | ["2", "3"]           |
|        | 2.1                                                  | Descriptive Statistics and Geometric Interpretations: Covariance and correlation matrices, Pearson's correlation, collinearity.                                                         |     |                      |
| 3      | Probability Distributions in Computational Contexts  |                                                                                                                                                                                         | 10  | ["1", "2", "3", "4"] |
|        | 3.1                                                  | Probability Distributions in Computational Contexts: Binomial, Poisson, Uniform, Normal. Law of Large Numbers and Monte Carlo.                                                          |     |                      |
| 4      | Introduction to Inferential Statistics via R         |                                                                                                                                                                                         | 22  | ["3", "4"]           |
|        | 4.1                                                  | Introduction to Inferential Statistics via R: Null/alternative hypotheses, p-values, ttests, Chi-square tests, and ANOVA.                                                               |     |                      |

|                                       |                                                                                              |
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| <b>Teaching and Learning Approach</b> | <b>Classroom Procedure (Mode of transaction)</b><br>Lecture, Tutorial and Activity oriented. |
|---------------------------------------|----------------------------------------------------------------------------------------------|

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Assessment Types</b> | <b>MODE OF ASSESSMENT</b><br>Mode of Assessment: Theory                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                         | <b>A. Continuous Comprehensive Assessment (CCA)</b><br>• <b>Theory - 30 Marks</b><br>Quiz, Assignments, Written Tests                                                                                                                                                                                                                                                                                                                                                                |
|                         | <b>B. End Semester Evaluation (ESE)</b><br>• <b>Theory - 70 Marks</b><br>Assessment Methods - Written Exam<br>Duration of Examination - 2.00 Hrs<br>Pattern of examination for Theory - Non-MCQ<br>Different parts of written examination - Part - A , B , C<br>Answer Type:<br>◦ PART - A<br>◦ Short answer - (8 out of 10 ) - $8 \times 2 = 16$<br>◦ PART - B<br>◦ Short Essays - (4 out of 7 ) - $4 \times 6 = 24$<br>◦ PART - C<br>◦ Essays - (3 out of 5 ) - $3 \times 10 = 30$ |

## References

- Python for Data Analysis, Wes McKinney (International).
- The Book of R: A First Course in Programming and Statistics, Tilman M. Davies (International).
- Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor (Indian).

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| SYLLABUS               |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |             |                   |         |             |         |   |    |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------|-------------------|---------|-------------|---------|---|----|
| SIGNATURE COURSE       |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |             |                   |         |             |         |   |    |
| Name of the College    | Sree Narayana Trusts Arts & Science College, Pampanar, Idukki                                                                                                                                                                                                                                                                                                                                                                                       |         |             |                   |         |             |         |   |    |
| Faculty/ Discipline    | Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |             |                   |         |             |         |   |    |
| Programme              | BSc (Hons) Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                              |         |             |                   |         |             |         |   |    |
| Course Coordinator     | Anupriya C S                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |             |                   |         |             |         |   |    |
| Contributors           | Aadya D                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |             |                   |         |             |         |   |    |
| Course Name            | Linear Algebra & Optimization for Machine Learning                                                                                                                                                                                                                                                                                                                                                                                                  |         |             |                   |         |             |         |   |    |
| Type of Course         | DSE                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |             |                   |         |             |         |   |    |
| Specialization title   | Machine Learning and Data Science                                                                                                                                                                                                                                                                                                                                                                                                                   |         |             |                   |         |             |         |   |    |
| Course Code            | MG5DSEMATA11                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |             |                   |         |             |         |   |    |
| Course Level           | 300                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |             |                   |         |             |         |   |    |
| Course Summary         | This course contextualizes linear algebra and multivariable calculus specifically for machine learning applications. By viewing massive datasets as high-dimensional matrices and loss functions as topological landscapes, students learn the mathematical engines that drive algorithmic optimization. The course heavily applies the ``Bridge Concept," transitioning from pure vector spaces to applied gradient descent and simple regression. |         |             |                   |         |             |         |   |    |
| Semester               | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Credits | 4           |                   |         |             |         |   |    |
| Course Details         | <table><tr><td>Learning Approach</td><td>Lecture</td><td>Total Hours</td></tr><tr><td>Credits</td><td>4</td><td>60</td></tr></table>                                                                                                                                                                                                                                                                                                                |         |             | Learning Approach | Lecture | Total Hours | Credits | 4 | 60 |
|                        | Learning Approach                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lecture | Total Hours |                   |         |             |         |   |    |
| Credits                | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 60      |             |                   |         |             |         |   |    |
| Pre-requisites, if any | Vector spaces , matrix operations and basic calculus.                                                                                                                                                                                                                                                                                                                                                                                               |         |             |                   |         |             |         |   |    |

#### Course Outcomes (CO)

| Number of COs |                                                                                                                                  | 4                  |          |
|---------------|----------------------------------------------------------------------------------------------------------------------------------|--------------------|----------|
| CO No.        | Expected Course Outcome                                                                                                          | Learning Domains * | PO No    |
| 1             | Define vector spaces, matrix norms, eigenvalues, eigenvectors, and the chain rule for multivariate continuous functions.         | K                  | PO1      |
| 2             | Grasp the geometric interpretation of matrix transformations and the topological nature of convex optimization landscapes.       | U                  | PO2      |
| 3             | Implement Singular Value Decomposition (SVD) for data compression and execute gradient descent for mathematical optimization.    | A, An              | PO3, PO4 |
| 4             | Deconstruct iterative optimization algorithms, analyzing convergence rates, saddle points, and the impact of the Hessian matrix. | An, E              | PO4, PO5 |

\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

## CO-PO Articulation Matrix

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-------|------|------|------|------|------|------|------|------|------|-------|
| CO 1  | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 2  | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 3  | -    | -    | 3    | 3    | -    | -    | -    | -    | -    | -     |
| CO 4  | -    | -    | -    | 3    | 2    | -    | -    | -    | -    | -     |

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

## Course Content

Content for Classroom transaction (Units)

| Module | Units | Course Description                                                                                                               | Hrs | CO No.     |
|--------|-------|----------------------------------------------------------------------------------------------------------------------------------|-----|------------|
| 1      |       | Fundamentals of Vector Spaces and Matrix Theory                                                                                  |     |            |
|        | 1.1   | Vectors, matrices, dot/cross products, eigenvalues/eigenvectors, matrix factorization, Singular Value Decomposition (SVD)        | 15  | ["1", "2"] |
| 2      |       | Geometric and Topological Foundations of Optimization                                                                            |     |            |
|        | 2.1   | Grasp the geometric interpretation of matrix transformations and the topological nature of convex optimization landscapes.       | 15  | ["2", "3"] |
| 3      |       | Singular Value Decomposition and Gradient-Based Optimization Methods                                                             |     |            |
|        | 3.1   | Implement Singular Value Decomposition (SVD) for data compression and execute gradient descent for mathematical optimization.    | 16  | ["1", "2"] |
| 4      |       | Advanced Iterative Optimization Algorithms and Convergence Analysis                                                              |     |            |
|        | 4.1   | Deconstruct iterative optimization algorithms, analyzing convergence rates, saddle points, and the impact of the Hessian matrix. | 14  | ["3", "4"] |

|                                |                                                                                       |
|--------------------------------|---------------------------------------------------------------------------------------|
| Teaching and Learning Approach | Classroom Procedure (Mode of transaction)<br>Lecture, Tutorial and Activity oriented. |
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|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assessment Types | <b>MODE OF ASSESSMENT</b><br>Mode of Assessment: Theory                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                  | <b>A. Continuous Comprehensive Assessment (CCA)</b><br><b>• Theory - 30 Marks</b><br>Module Test -I, Module Test -II, Module Test -III, Module Test -IV, Assignment/Seminar, Quiz/ Viva voce.                                                                                                                                                                                                                                                                                                   |
|                  | <b>B. End Semester Evaluation (ESE)</b><br><b>• Theory - 70 Marks</b><br>Assessment Methods – End Semester Evaluation<br>Duration of Examination – 2.00 Hrs<br>Pattern of examination for Theory – Non-MCQ<br>Different parts of written examination – Part - A , B , C<br>Answer Type:<br>◦ PART - A<br>◦ Short answer - (8 out of 10 ) - $8 \times 2 = 16$<br>◦ PART - B<br>◦ Short Essays - (4 out of 7 ) - $4 \times 6 = 24$<br>◦ PART - C<br>◦ Essays - (3 out of 5 ) - $3 \times 10 = 30$ |

## References

- Linear Algebra and Learning from Data, Gilbert Strang (International).
- Mathematics for Machine Learning, Marc Peter Deisenroth et al. (International).
- Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal (Indian).

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| SYLLABUS               |                                                                                                                                                                                                                                                                                                                                                                                                                      |         |         |             |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|-------------|
| SIGNATURE COURSE       |                                                                                                                                                                                                                                                                                                                                                                                                                      |         |         |             |
| Name of the College    | Sree Narayana Trusts Arts & Science College, Pampanar, Idukki                                                                                                                                                                                                                                                                                                                                                        |         |         |             |
| Faculty/ Discipline    | Mathematics                                                                                                                                                                                                                                                                                                                                                                                                          |         |         |             |
| Programme              | BSc (Hons) Mathematics                                                                                                                                                                                                                                                                                                                                                                                               |         |         |             |
| Course Coordinator     | Anupriya C S                                                                                                                                                                                                                                                                                                                                                                                                         |         |         |             |
| Contributors           | Aadya D                                                                                                                                                                                                                                                                                                                                                                                                              |         |         |             |
| Course Name            | Neural Networks and Algorithms of Machine Learning                                                                                                                                                                                                                                                                                                                                                                   |         |         |             |
| Type of Course         | DSE                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |             |
| Specialization title   | Machine Learning and Data Science                                                                                                                                                                                                                                                                                                                                                                                    |         |         |             |
| Course Code            | MG6DSEMATA11                                                                                                                                                                                                                                                                                                                                                                                                         |         |         |             |
| Course Level           | 300                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |             |
| Course Summary         | With a firm grounding in data wrangling and linear optimization, this course shifts the focus from internal mathematical mechanics to external predictive application. It teaches students how to select, deploy, mathematically tune, and rigorously evaluate supervised and unsupervised models using the Scikit-Learn library, bridging raw mathematical coding and industry-standard machine learning pipelines. |         |         |             |
| Semester               | 6                                                                                                                                                                                                                                                                                                                                                                                                                    | Credits | 4       |             |
| Course Details         | Learning Approach                                                                                                                                                                                                                                                                                                                                                                                                    |         | Lecture | Total Hours |
|                        | Credits                                                                                                                                                                                                                                                                                                                                                                                                              |         | 4       | 60          |
| Pre-requisites, if any | Introductory optimization, descriptive statistics, and linear algebra.                                                                                                                                                                                                                                                                                                                                               |         |         |             |

#### Course Outcomes (CO)

| Number of COs |                                                                                                                                                   | 4                  |               |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|
| CO No.        | Expected Course Outcome                                                                                                                           | Learning Domains * | PO No         |
| 1             | Identify the defining mathematical characteristics, statistical assumptions, and primary use-cases of core machine learning algorithms.           | K                  | PO1, PO2      |
| 2             | Comprehend the theoretical framework of the bias-variance tradeoff and the mathematical differences between generative and discriminative models. | U                  | PO1, PO2, PO3 |
| 3             | Train, test, and mathematically tune regression and classification models using Python's Scikit-Learn library.                                    | A                  | PO2, PO3, PO4 |
| 4             | Evaluate model performance using advanced statistical metrics and diagnose complex issues such as data overfitting and feature collinearity.      | An, E              | PO1, PO2      |

\*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

## CO-PO Articulation Matrix

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-------|------|------|------|------|------|------|------|------|------|-------|
| CO 1  | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -     |
| CO 2  | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -     |
| CO 3  | -    | 3    | 3    | 3    | -    | -    | -    | -    | -    | -     |
| CO 4  | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -     |

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

## Course Content

Content for Classroom transaction (Units)

| Module | Units | Course Description                                                                                                                                                                   | Hrs | CO No.               |
|--------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------|
| 1      |       | Neural Networks ,Perceptron and Back-Propogation Algorithm                                                                                                                           |     |                      |
|        | 1.1   | Neural Networks, Perceptron,Multilayer Perceptron,Back Proagation Algorithm.                                                                                                         | 15  | ["1", "2", "3", "4"] |
| 2      |       | Classification,Clustering and Regession                                                                                                                                              |     |                      |
|        | 2.1   | Data and Patterns,Classification and a simple binary classifier,Classification,Clustering Techniques,Linaer Regression: Line of best fit,Logistic Regression                         | 15  | ["1", "2", "3"]      |
| 3      |       | Mathematical intuition of Logistic Regression                                                                                                                                        |     |                      |
|        | 3.1   | Mathematical intuition of Logistic Regression( Sigmoid function,log loss), K-nearest neighbors(Distance metrics: Eucledian/Manhattan).Naive Bayes Classified(Applying Bayes Theorem) | 15  | ["1", "2", "3", "4"] |
| 4      |       | Implementing Classification models using Python                                                                                                                                      |     |                      |
|        | 4.1   | Implementing Classification models using Python(scikit-learn).Evaluating models using confusion matrices,ROC-AUC curves,precision,recall and F1 -score.                              | 15  | ["2", "3", "4"]      |

|                                       |                                                                                              |
|---------------------------------------|----------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Approach</b> | <b>Classroom Procedure (Mode of transaction)</b><br>Lecture, Tutorial and Activity oriented. |
|---------------------------------------|----------------------------------------------------------------------------------------------|

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Assessment Types</b> | <b>MODE OF ASSESSMENT</b><br>Mode of Assessment: Theory                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                         | <b>A. Continuous Comprehensive Assessment (CCA)</b><br>• <b>Theory - 30 Marks</b><br>Module Test- I , II ,III , IV , Assignment/Seminar , Quiz/Viva voce                                                                                                                                                                                                                                                                                                                                    |
|                         | <b>B. End Semester Evaluation (ESE)</b><br>• <b>Theory - 70 Marks</b><br>Assessment Methods - Written Examination<br>Duration of Examination - 2.00 Hrs<br>Pattern of examination for Theory - Non-MCQ<br>Different parts of written examination - Part - A , B , C<br>Answer Type:<br>◦ PART - A<br>◦ Short answer - (8 out of 10 ) - $8 \times 2 = 16$<br>◦ PART - B<br>◦ Short Essays - (4 out of 7 ) - $4 \times 6 = 24$<br>◦ PART - C<br>◦ Essays - (3 out of 5 ) - $3 \times 10 = 30$ |

## References

- An Introduction to Statistical Learning, Gareth James, Daniela Witten, et al. (International).
- Machine Learning: A Probabilistic Perspective, Kevin P. Murphy (International).
- Machine Learning for Undergraduate Students, Dr. A.J.K. Prasad (Indian).

## Affidavit

- We, Sree Narayana Trusts Arts & Science College, Pampanar, Idukki and Anupriya C S, retain the copyright of this syllabus and expressly prohibit its distribution in complete form to any institution outside our own.
- We, Sree Narayana Trusts Arts & Science College, Pampanar, Idukki, agree to appoint a new course coordinator for the proposed Machine Learning and Data Science in the event of the unavailability of the currently nominated coordinator. This appointment will ensure the continued coordination of course delivery, assessments, and all related academic responsibilities necessary for the successful implementation of the specialization, for as long as the college offers this programme.
- We, Sree Narayana Trusts Arts & Science College, Pampanar, Idukki and Anupriya C S, declare that no part of this signature course submitted here for approval has been taken from the course content developed by, or from any of the course titles prepared by, the BoS/expert committee in the same discipline under our University.