



MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS

SIGNATURE COURSE

Name of the College	The Cochin College, Cochin					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Nancy Thomas					
Contributors	Lana Leanus, Ancy Antony					
Course Name	Foundations of Python Programming for Artificial Intelligence					
Type of Course	DSE					
Specialization title	Artificial Intelligence and Machine Learning					
Course Code	MG3DSEMATA04					
Course Level	200					
Course Summary	This course introduces the fundamentals of Artificial Intelligence and Machine Learning with a strong mathematical foundation and Python programming support. Students acquire essential programming skills including the use of variables, control flow, data structures, and numerical array operations through NumPy, along with graphical representation of results using Matplotlib. The course covers AI problem-solving techniques, search algorithms, logic, and inference methods, and provides exposure to key AI and ML domains such as Machine Learning models, Deep Neural Networks, Computer Vision, Natural Language Processing, Robotics, and Expert Systems. The course focuses on strengthening hands-on computational and analytical abilities necessary for applying AI and ML techniques.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic programming proficiency in Python and a foundational understanding of mathematical concepts such as algebra, functions, statistics, and matrices. Familiarity with basic data types and elementary logical operations is also expected.					

Course Outcomes (CO)

Number of COs		4	
CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To apply Python programming concepts such as variables, control structures, data structures, and array operations using NumPy for AI and ML-related computations.	A, S	PO1, PO2, PO3, PO10
2	To understand fundamental Artificial Intelligence concepts including problem formulation, uninformed and informed search techniques, logic, and inference methods..	A	PO1, PO2, PO3
3	To analyze core Machine Learning concepts and major AI application areas such as Machine Learning models, Deep Neural Networks, Computer Vision, Natural Language Processing, Robotics, and Expert Systems.	A	PO1, PO2, PO3, PO9

Number of COs		4	
CO No.	Expected Course Outcome	Learning Domains *	PO No
4	To create computational and analytical skills for implementing basic AI and ML solutions using Python and visualization tools such as Matplotlib.	A, S	PO1, PO2, PO3, PO9, PO10

*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	3	-	-	-	-	-	-	3
CO 2	3	3	3	-	-	-	-	-	-	-
CO 3	3	3	3	-	-	-	-	-	2	-
CO 4	3	3	3	-	-	-	-	-	2	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	Python Foundations for Artificial Intelligence & Machine Learning			
	1.1	Overview of Python for AI Applications, Key Features of Python, Python Installation and Environment Setup	5	["1"]
	1.2	Variables, Data Types, Input and Output Operations, and Operators in Python	6	["1"]
	1.3	Conditional Execution and Decision-Making Constructs in Python	5	["1"]
	1.4	Iterative Structures, Nested Control Flow, Loop Control Statements, and Exception Handling	6	["1"]
2	Python Data Structures and Functional Programming for AI and ML			
	2.1	Python Data Structures for AI Applications: Lists, Tuples, and Their Operations	5	["2"]
	2.2	Dictionary-Based Data Representation, Functions, and Functional Decomposition	5	["2"]
	2.3	Use of Built-in Python Libraries and Design of User-Defined Modules for Reusability	4	["2"]
3	Numerical Computing with NumPy for Machine Learning			
	3.1	Numerical Data Types, Introduction to NumPy, and Array-Based Computation	4	["3"]
	3.2	Vectorized Operations, Universal Functions, and Aggregation Techniques in NumPy	6	["3"]
	3.3	Advanced Array Processing: Broadcasting, Sorting, Indexing, and Structured Arrays	4	["3"]
4	Visualization Techniques for AI and ML Applications			
	4.1	Principles of Visual Representation and Introduction to Matplotlib	3	["4"]
	4.2	Visualization of Numerical Data using Line Plots, Scatter Plots, and Bar Charts	3	["4"]
	4.3	Advanced Visualization: Histograms, Density Plots, Contour Plots, Legends, and Annotations	4	["4"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Blended instruction through lectures, ICT-enabled demonstrations, seminars, group discussions, and hands-on practice sessions.
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Assessment Types	MODE OF ASSESSMENT Mode of Assessment: Theory
	A. Continuous Comprehensive Assessment (CCA) • Theory - 30 Marks Module Tests, Assignment, Quiz, Practical
	B. End Semester Evaluation (ESE) • Theory - 70 Marks Assessment Methods - Theory Examination Duration of Examination - 2.00 Hrs Pattern of examination for Theory - Non-MCQ Different parts of written examination - Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 15) - $10 \times 3 = 30$ ◦ PART - B ◦ One or two Sentences - (4 out of 6) - $4 \times 5 = 20$ ◦ PART - C ◦ Short Essays - (2 out of 4) - $2 \times 10 = 20$

References

- 1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson. 2. Reema Thareja, Artificial Intelligence and Machine Learning using Python, Oxford University Press. 3. Tom M. Mitchell, Machine Learning, McGraw Hill Education.

Suggested Readings

- 1. Elaine Rich and Kevin Knight, Artificial Intelligence, McGraw Hill Education. 2. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, Packt Publishing. 3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media

Affidavit

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SIGNATURE COURSE

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Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Nancy Thomas					
Contributors	Lana Leanus, Ancy Antony					
Course Name	Introduction to Artificial Intelligence and Machine Learning					
Type of Course	DSE					
Specialization title	Artificial Intelligence and Machine Learning					
Course Code	MG4DSEMATA04					
Course Level	200					
Course Summary	This course offers a comprehensive exploration of Artificial Intelligence and Machine Learning, with a heavy focus on mathematical argumentation and analytical skills. It explores the history of AI, its essential concepts, and the current trends, in addition to describing the underlying principles of model development and the assessment of these models. The course explores the essential machine learning paradigms, including supervised learning, unsupervised learning, and reinforcement learning, with a special focus on the representation of features, interpretation of models, and assessment of performance. The entire course is designed to develop a robust algorithmic foundation, improve problem-solving skills, and learn how to apply AI and ML effectively to real-world problems.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Foundational knowledge of mathematics, including algebra, calculus, and statistics, along with analytical and logical reasoning skills, and basic familiarity with programming concepts.					

Course Outcomes (CO)

Number of COs		4	
CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the core concepts of Artificial Intelligence and Machine Learning, including their evolution, classifications, emerging developments, and societal relevance.	U	PO1, PO2, PO3
2	Use foundational AI and ML tools, libraries, and datasets, and perform essential data preparation tasks to make datasets suitable for machine learning processes.	A	PO1, PO2, PO3, PO10
3	Examine the working principles of selected machine learning algorithms and implement appropriate training and evaluation strategies for predictive models.	A	PO1, PO2, PO3, PO10
4	Employ feature engineering and feature selection techniques to enhance model performance, and develop simple AI/ML solutions addressing practical problems.	A, S	PO1, PO2, PO3, PO10

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	2	2	-	-	-	-	-	-	-
CO 2	3	3	2	-	-	-	-	-	-	2
CO 3	3	3	3	-	-	-	-	-	-	2
CO 4	3	3	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	Foundations and Evolution of Artificial Intelligence			
	1.1	Concept of Artificial Intelligence, scope of AI, comparison between human intelligence and machine intelligence, domains influenced by AI	5	["1"]
	1.2	Origins of AI, early research efforts, key developments, landmark achievements, and present-day research challenges	5	["1"]
	1.3	Phases of AI growth and decline, causes of AI enthusiasm and setbacks, impact of AI hype cycles on research and applications	5	["1"]
2	Types, Trends, and AI Infrastructure			
	2.1	Categories of AI systems including task-oriented intelligence, general intelligence concepts, and advanced autonomous intelligence with real-world relevance	5	["1"]
	2.2	Current trends in AI development, edge AI systems, cloud AI platforms, and deployment of AI in smart and connected environments	5	["2"]
	2.3	Role of data in AI systems, introduction to AI libraries and frameworks, hardware accelerators, and software environments supporting AI applications	5	["2"]
3	Machine Learning Concepts and Data Preparation			
	3.1	Definition and objectives of machine learning, supervised, unsupervised, and reinforcement learning paradigms, applications of machine learning	5	["2"]
	3.2	Types of data used in machine learning, data structure, data quality issues, consistency, and reliability	5	["3"]
	3.3	Data preprocessing techniques including data cleaning, handling missing and noisy data, scaling, normalization, and encoding methods	5	["3"]
4	Modeling, Feature Engineering, and Regression Techniques			
	4.1	Model selection strategies, training processes, model representation, interpretability, performance metrics, and validation techniques	5	["3"]
	4.2	Concepts of overfitting and underfitting, methods for improving model performance, parameter tuning, and optimization approaches	5	["3"]
	4.3	Feature engineering concepts, feature transformation and selection, simple and multiple linear regression, assumptions and limitations of regression, logistic regression and its applications	5	["4"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Blended instruction through lectures, ICT-enabled demonstrations, seminars, group discussions, and hands-on practice sessions.
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Assessment Types	MODE OF ASSESSMENT Mode of Assessment: Theory
	A. Continuous Comprehensive Assessment (CCA) • Theory - 30 Marks Module Tests, Assignment, Quiz. Practical.
	B. End Semester Evaluation (ESE) • Theory - 70 Marks Assessment Methods - Theory Examination Duration of Examination - 2.00 Hrs Pattern of examination for Theory - Non-MCQ Different parts of written examination - Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 15) - $10 \times 3 = 30$ ◦ PART - B ◦ One or two Sentences - (4 out of 6) - $4 \times 5 = 20$ ◦ PART - C ◦ Short Essays - (2 out of 4) - $2 \times 10 = 20$

References

- 1. Russell, S. J., and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson. 2. Ertel, W., Introduction to Artificial Intelligence, Springer. 3. Alpaydin, E., Introduction to Machine Learning, Pearson Education. 4. Géron, A., Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media.

Suggested Readings

- 1. Aggarwal, C. C., Artificial Intelligence, Springer. 2. Bishop, C. M., Pattern Recognition and Machine Learning, Springer. 3. Grus, J., Data Science from Scratch, O'Reilly Media. 4. Deisenroth, M. P., Faisal, A. A., and Ong, C. S., Mathematics for Machine Learning, Cambridge University Press.

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SIGNATURE COURSE

Name of the College	The Cochin College, Cochin					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Nancy Thomas					
Contributors	Lana Leanus, Ancy Antony					
Course Name	Algorithmic Methods and Practical Applications of Machine Learning					
Type of Course	DSE					
Specialization title	Artificial Intelligence and Machine Learning					
Course Code	MG5DSEMATA04					
Course Level	300					
Course Summary	This course develops a foundational understanding of supervised machine learning by integrating algorithmic concepts with practical implementation using Python. It introduces essential classification models and gradually progresses to advanced learning techniques, emphasizing both theoretical insight and applied relevance. Students work with tree-based, margin-based, and ensemble methods to enhance model accuracy and reliability through hands-on analysis of real datasets. By the end of the course, learners will be able to choose suitable supervised learning algorithms, implement them effectively, and interpret their results in data-driven contexts.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic knowledge of Python programming along with elementary concepts of statistics, linear algebra, and introductory machine learning.					

Course Outcomes (CO)

Number of COs		4	
CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply fundamental concepts of Artificial Intelligence and supervised Machine Learning to formulate data-driven solutions using appropriate computational techniques.	A	PO1, PO2, PO3
2	Implement and evaluate core supervised learning algorithms, including distance-based, probabilistic, and margin-based classifiers, using Python programming tools.	A, S	PO1, PO2, PO3, PO10
3	Examine the working principles of selected machine learning algorithms and implement appropriate training and evaluation strategies for predictive models.	An, S	PO1, PO2, PO3, PO10
4	Compare and apply ensemble learning techniques to improve predictive accuracy, robustness, and reliability of supervised Machine Learning models.	An	PO1, PO2, PO3, PO10

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	2	-	-	-	-	-	-	-
CO 2	3	3	3	-	-	-	-	-	-	2
CO 3	3	3	3	-	-	-	-	-	-	2
CO 4	3	3	3	-	-	-	-	-	-	2

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Supervised Classification Techniques			
	1.1	Introduces instance-based supervised learning through k-Nearest Neighbors by explaining similarity measures, distance metrics, selection of optimal k, algorithmic workflow, strengths and limitations, and its use in real-world classification tasks using Python.	7	["1"]
	1.2	Covers probabilistic classification using the Naive Bayes framework, focusing on Bayesian reasoning, conditional probability, independence assumptions, major variants of Naive Bayes classifiers, and practical implementation for text and data classification problems.	8	["1"]
2	Tree-Based Learning Models			
	2.1	Explains the construction of decision tree classifiers, including attribute selection measures, recursive tree growth, stopping criteria, and strategies to control overfitting in supervised learning models.	7	["2"]
	2.2	Focuses on visual representation and interpretation of decision trees using Python libraries, enabling learners to analyze decision paths, node splits, and model transparency.	4	["2"]
	2.3	Emphasizes evaluation of decision tree models through testing and performance metrics, along with techniques for saving, loading, and reusing trained models in applied machine learning environments.	4	["2"]
3	Support Vector Machines and Optimization Techniques			
	3.1	Introduces margin-based classification using Support Vector Machines by discussing linear separability, optimal hyperplane formulation, margin maximization, and classification decision rules.	6	["3"]
	3.2	Explores optimization concepts underlying SVMs with emphasis on quadratic optimization and the Sequential Minimal Optimization (SMO) algorithm, highlighting computational efficiency in large datasets.	4	["3"]
	3.3	Examines kernel-based learning for non-linear classification, including commonly used kernel functions and advanced optimization using the full Platt SMO algorithm to enhance model performance.	5	["3"]

Module	Units	Course Description	Hrs	CO No.
4	Ensemble Learning Approaches			
	4.1	Introduces ensemble learning principles such as bagging and boosting, explaining how combining multiple learners reduces variance and improves predictive stability.	7	["4"]
	4.2	Covers advanced ensemble algorithms including Random Forests, Extra Trees, and AdaBoost, with comparative analysis against single classifiers and applications in improving accuracy and robustness of machine learning models.	8	["4"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Blended instruction through lectures, ICT-enabled demonstrations, seminars, group discussions, and hands-on practice sessions.
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Assessment Types	MODE OF ASSESSMENT Mode of Assessment: Theory
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References

- 1. James, G., Witten, D., Hastie, T., & Tibshirani, R. An Introduction to Statistical Learning: With Applications in Python. Springer, 2021.
- 2. Bishop, C. M. Pattern Recognition and Machine Learning. Springer, 2006.
- 3. Murphy, K. P. Machine Learning: A Probabilistic Perspective. MIT Press, 2012.
- 4. Alpaydin, E. Introduction to Machine Learning (4th Edition). MIT Press, 2020.

Suggested Readings

- 1. Géron, A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition). O'Reilly Media, 2023.
- 2. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press, 2016.
- 3. Kuhn, M., & Johnson, K. Applied Predictive Modeling. Springer, 2019.
- 4. VanderPlas, J. Python Data Science Handbook. O'Reilly Media, 2016.

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SYLLABUS

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Name of the College	The Cochin College, Cochin					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Dr. Nancy Thomas					
Contributors	Lana Leanus, Ancy Antony					
Course Name	Advanced Pattern Discovery in AI and ML					
Type of Course	DSE					
Specialization title	Artificial Intelligence and Machine Learning					
Course Code	MG6DSEMATA04					
Course Level	300					
Course Summary	This course develops a foundational understanding of supervised machine learning by integrating algorithmic concepts with practical implementation using Python. It introduces essential classification models and gradually progresses to advanced learning techniques, emphasizing both theoretical insight and applied relevance. Students work with tree-based, margin-based, and ensemble methods to enhance model accuracy and reliability through hands-on analysis of real datasets. By the end of the course, learners will be able to choose suitable supervised learning algorithms, implement them effectively, and interpret their results in data-driven contexts.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic knowledge of Python programming along with elementary concepts of statistics, linear algebra, and introductory machine learning.					

Course Outcomes (CO)

Number of COs		4	
CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explore methods for grouping unlabeled data, implementing clustering algorithms such as k-means and its advanced variants, to discover inherent patterns.	A	PO1, PO2, PO3
2	Transform high-dimensional datasets into meaningful representations using techniques like PCA and SVD to support efficient analysis and interpretation.	An	PO1, PO2, PO3, PO10
3	Build and evaluate basic neural network models to address real-world data challenges, demonstrating understanding of deep learning principles.	A	PO1, PO2, PO3, PO10
4	Apply convolutional neural networks for practical computer vision applications, including object detection, image recognition, and feature extraction.	A, S	PO1, PO2, PO3, PO10

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CO 2	3	3	3	-	-	-	-	-	-	2
CO 3	3	3	3	-	-	-	-	-	-	2
CO 4	3	3	3	-	-	-	-	-	-	2

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Cluster Analysis for Unlabeled Data			
	1.1	Introductory concepts in cluster analysis and data structuring	6	["1"]
	1.2	Implementation and optimization of k means and hierarchical enhancements	5	["1"]
	1.3	Practical exercises on cluster assessment and interpretation using Python libraries	4	["1"]
2	Feature Compression and Representation			
	2.1	Fundamentals of feature space reduction	5	["2"]
	2.2	Principal Component Analysis and latent factor decomposition	5	["2"]
	2.3	Matrix factorization and building recommendation logic exploratory systems	5	["2"]
3	Neural Models for Data Modeling			
	3.1	Architecture of feedforward networks and activation mappings	5	["3"]
	3.2	Learning optimization, loss surfaces, and gradient based methods	5	["3"]
	3.3	Training pipelines and evaluation of neural learners	4	["3"]
4	Deep Visual Learning Systems			
	4.1	Digital image representation and pre learning transformations	6	["4"]
	4.2	Design and interpretation of convolutional layers	5	["4"]
	4.3	Building and testing CNN architectures for visual pattern tasks	5	["4"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Blended instruction through lectures, ICT-enabled demonstrations, seminars, group discussions, and hands-on practice sessions.
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- 1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall; 3rd/4th Edition. 2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 3. P. Harrington, Machine Learning in Action, Manning Publications, First Edition, 2012. 4. M. Elgendy, Deep Learning for Vision Systems, Manning Publications, First Edition, 2020.

Suggested Readings

- 1. Richard O. Duda, Peter E. Hart & David G. Stork - Pattern Classification, Wiley 2. Simon O. Haykin - Neural Networks and Learning Machines, Pearson. 3. Trevor Hastie, Robert Tibshirani & Jerome Friedman, The Elements of Statistical Learning, 2nd Edition, Springer 4. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018.

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