MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Thomas College, Kozhenchery					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Job Mathai					
Contributors	Dr Arun Aniyan, Ms Susan George, Dr Priya Mathews					
Course Name	Introduction to Python Programming for Artificial Intelligence					
Type of Course	DSE					
Specialization title	Artificial Intelligence					
Course Code	MG3DSEMATA00					
Course Level	200					
Course Summary	This course covers Python programming fundamentals with a focus on Artificial Intelligence. Students learn variables, control structures, data structures, and array computations using NumPy, along with data visualization using Matplotlib. Emphasis is placed on building practical skills essential for data analysis and visualization in artificial intelligence contexts.					
Semester	3	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic Algebra, understanding of data types and familiarity with basic logical operations.					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To write basic Python programs using variables, control flow, functions, and data structures with an understanding of Python's core features and errors.	U, S	PO1, PO2, PO3
2	To use Python's built-in and user-defined modules, and apply lists, tuples, and dictionaries for effective data handling.	A, S	PO1, PO2, PO3, PO10
3	To perform data analysis using NumPy by working with arrays, applying computations, aggregations, broadcasting, sorting, and handling structured data.	C, S	PO1, PO2, PO3, PO9, PO10
4	To create and customize visualizations using Matplotlib, including line plots, scatter plots, density plots, and legends.	C, 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)*

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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	1	-	-	-	-	-	-	-
CO 2	2	3	2	-	-	-	-	-	-	2
CO 3	2	3	2	-	-	-	-	-	1	2
CO 4	2	3	2	-	-	-	-	-	1	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	Module 1 : Introduction to Python and Control Flow Statements			
	1.1	Features of Python, Installation of Python, Variables in Python	5	["1"]
	1.2	Input and Output in Python, Operators	6	["1"]
	1.3	Core Modules in Python, Core Libraries in Python, Decision-Making Structures	5	["1"]
	1.4	Loops, Nesting of Conditional Statements and Loops, Abnormal Loop Termination, Errors and Exception Handling	4	["1"]
2	Module 2 : Data Structures and Modules			
	2.1	Lists, Tuples	6	["2"]
	2.2	Dictionary, User-Defined Functions	5	["2"]
	2.3	In-Built Modules in Python, User-Defined Module.	4	["2"]
3	Module 3 : Introduction to NumPy			
	3.1	Understanding Data Types in Python, The Basics of NumPy Arrays	5	["3"]
	3.2	Computation on NumPy Arrays: Universal Functions, Aggregations: min, max, and Everything in Between	4	["3"]
	3.3	Computation on Arrays: Broadcasting, Sorting Arrays, Structured Data: NumPy's Structured Arrays	6	["3"]
4	Module 4 : Visualization with Matplotlib			
	4.1	General Matplotlib Tips	2	["4"]
	4.2	Simple Line Plots, Simple Scatter Plots	4	["4"]
	4.3	Density and Contour Plots, Customizing Plot Legends	4	["4"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, seminars, interactive instructions using ICT tools, and hands-on training

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Practical **A. Continuous Comprehensive Assessment (CCA)** **• Practical – 30 Marks** CCA for Practical: 30 Marks. Written tests, Practical Assignments, Viva, Group Activity etc **B. End Semester Evaluation (ESE)** **• Practical – 70 Marks** Assessment Methods – Practical Examination: 40 Marks (A total of 8 questions will be asked:(2 questions from each module). Each question will carry 10 marks. Candidates must attempt 1 out of 2 from each module. . Viva: 20 Marks . Record: 10 Marks Duration of Examination – 2.00 Hrs

References

- Bharti Motwani, Data Analytics using Python, First edition, Wiley India Pvt. Ltd., 2020. (Module 1 - Chapters 1, 2.1 - 2.5; Module 2 - Chapters 2.6, 3 - 4)
- Jake VanderPlas, Python Data Science Handbook, Second edition, O'Reilly Media, Inc., 2023. (Module 3 - Chapters 4 - 8, 11 - 12; Module 4 - Chapters 25 - 29)

Suggested Readings

- Ajith Kumar B.P., Python for Education, Inter University Accelerator Centre - New Delhi, 2010.
- Joel Grus, Data Science from Scratch, First Edition, O'Reilly Media, Inc., 2015.
- Wes McKinney, Python for Data Analysis, O'Reilly Media, Inc., 2022.
- Ben Root, Python Plotting with Matplotlib, Ben Root: Packt Publishing Ltd., 2017.
- SymPy Documentation (https://docs.sympy.org/latest/index.html), 2003.

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Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Thomas College, Kozhenchery					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Job Mathai					
Contributors	Dr Arun Aniyan, Mr Thomas Mathew, Dr Ann Susa Thomas					
Course Name	Introduction to Machine Learning					
Type of Course	DSE					
Specialization title	Artificial Intelligence					
Course Code	MG4DSEMATA00					
Course Level	200					
Course Summary	This course provides a foundational understanding of machine learning, starting with its key concepts, types (supervised, unsupervised, reinforcement), and real-world applications. It emphasizes the importance of data, covering types of data, data quality issues, and preprocessing techniques essential for effective model development. The course then moves into model training and evaluation, focusing on supervised learning models, their interpretability, and performance metrics. Feature engineering is introduced as a way to enhance model outcomes. Common regression algorithms and practical examples are also discussed.					
Semester	4	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic programming knowledge in Python, Fundamentals of calculus and statistics.					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand various types of machine learning algorithms and their applications.	U	PO1, PO2, PO3
2	To apply data preprocessing techniques to prepare data for modelling.	A	PO1, PO2, PO3, PO10
3	To understand modelling and evaluation methods for machine learning algorithms.	E	PO1, PO2, PO3, PO10
4	To apply feature transformation techniques and feature subset selection methods to preprocess datasets and optimize machine learning model accuracy.	A, S	PO1, PO2, PO3, PO10

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Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	To build and evaluate regression models for forecasting and prediction tasks.	A, S	PO1, PO2, PO3, 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	1	3	3	-	-	-	-	-	-	-
CO 2	2	3	2	-	-	-	-	-	-	2
CO 3	2	3	2	-	-	-	-	-	-	3
CO 4	2	3	2	-	-	-	-	-	-	3
CO 5	3	2	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	Module 1: Machine Learning Basics and Data Preparation			
	1.1	Introduction to Machine Learning, Types of Machine Learning	5	["1"]
	1.2	Applications of Machine Learning, Basic Types of Data in Machine Learning	5	["1"]
	1.3	Exploring the Structure of Data, Data Quality and Remediation, Data Pre-Processing	5	["2"]
2	Module 2: Modelling and Evaluation			
	2.1	Selecting a Model, Training a Model	5	["3"]
	2.2	Model Representation and Interpretability, Evaluating Performance of a Model	5	["3"]
	2.3	Improving Performance of a Model	5	["3"]
3	Module 3: Basics of Feature Engineering			
	3.1	What is feature engineering	5	["4"]
	3.2	Feature Transformation	5	["4"]
	3.3	Feature subset selection	5	["4"]
4	Module 4: Regression			
	4.1	Examples of Regression, Simple linear regression, Multiple linear regression	5	["5"]
	4.2	Assumptions and Main Problems in Regression Analysis, Improving Accuracy of the Linear Regression Model	5	["5"]
	4.3	Logistic Regression	5	["5"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, seminars, interactive instructions using ICT tools, group assignments and hands-on training

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Assessment Methods - Module Tests, Assignment, Quiz **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 ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

References

- Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, First Edition, Pearson India, 2020.(Module 1 - Chapters 1, 2; Module 2 - Chapter 3; Module 3 - Chapter 4; Module 4 - Chapter 8)

Suggested Readings

- Bharti Motwani, Data Analytics using Python, First edition, Wiley India Pvt. Ltd., 2020.
- Joel Grus, Data Science from Scratch, First Edition, O'Reilly Media, Inc., 2015.
- Jake VanderPlas, Python Data Science Handbook, Second edition, O'Reilly Media, Inc., 2023.
- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
- Reema Thareja, Data Science and Machine Learning using Python, Oxford University Press, 2020.
- Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, First edition, Cambridge University Press, 2020.

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2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Thomas College, Kozhenchery					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Job Mathai					
Contributors	Dr Arun Aniyan, Ms Preethi Elsi Thomas, Mr Ligin P Mathew					
Course Name	Supervised Machine Learning: Algorithms and Applications					
Type of Course	DSE					
Specialization title	Artificial Intelligence					
Course Code	MG5DSEMATA00					
Course Level	300					
Course Summary	This course provides a comprehensive introduction to supervised machine learning techniques with a strong focus on practical Python implementation. It begins with fundamental algorithms like k-Nearest Neighbors and Naive Bayes, emphasizing their application in classification problems. Learners then explore Support Vector Machines (SVM), focusing on margin optimization and kernel methods, including advanced optimization using the SMO algorithm. The course continues with Decision Trees, teaching students how to construct, visualize, and evaluate them using Python tools. Advanced ensemble methods such as Bagging, Random Forests, Extra Trees, and AdaBoost are covered to enhance model performance and robustness. Throughout the course, learners use real-world datasets and Python-based libraries to build, test, and refine machine learning models. By the end, students will be equipped to apply multiple supervised learning techniques and critically assess their suitability for different data problems.						
Semester	5	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic programming knowledge in Python, Fundamentals of Machine Learning.					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Apply k-Nearest Neighbors and Naive Bayes algorithms for classification tasks.	A, S	PO1, PO2, PO3
2	Build decision tree classifiers, visualize their structure using Matplotlib, analyze their decision boundaries, and evaluate their performance on various datasets.	E, S	PO1, PO2, PO3, PO10
3	Design and optimize Support Vector Machine models.	A, S	PO1, PO2, PO3, PO10

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Number of COs		4	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
4	Compare and contrast different ensemble techniques including Bagging, Random Forest, Extra Trees, AdaBoost, and apply them to improve prediction accuracy over single models.	AN	PO1, PO2, PO3, 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	1	2	1	-	-	-	-	-	-	-
CO 2	2	3	2	-	-	-	-	-	-	3
CO 3	2	3	2	-	-	-	-	-	-	3
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	Module 1: Classification Algorithms k-NN and Naive Bayes			
	1.1	k-Nearest Neighbors	7	["1"]
	1.2	Naive Bayes	8	["1"]
2	Module 2: Decision Trees			
	2.1	Decision Trees - Tree construction	5	["2"]
	2.2	Plotting trees in Python with Matplotlib annotations	5	["2"]
	2.3	Testing and storing the classifier	5	["2"]
3	Module 3: Support Vector Machines: Theory, Optimization, and Kernel Methods			
	3.1	Support Vector Machines - Separating data with the maximum margin, Finding the maximum margin	5	["3"]
	3.2	Efficient optimization with the SMO algorithm	5	["3"]
	3.3	Speeding up optimization with the full Platt SMO, using kernels for more complex data	5	["3"]
4	4 Module 4: Ensemble Methods			
	4.1	Bagging and boosting	7	["4"]
	4.2	Random Forest, Extra Trees, Ada Boosting	8	["4"]

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Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lectures, seminars, interactive instructions using ICT tools, and hands-on training

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Assessment Methods - Module Tests, Assignment, Quiz **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 ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

References

- Peter Harrington, Machine Learning in Action, Manning Publications, 2012.(Module 1 - Chapters 2 and 4; Module 2 - Chapter 3; Module 3 - Chapter 6)
- Bharti Motwani, Data Analytics using Python, First edition, Wiley India Pvt. Ltd., 2020.(Module 4 - Chapter 15)

Suggested Readings

- John P Mueller, Luca Massaro, Machine Learning for dummies, John Wiley & Sons, Inc., 2016.
- Joel Grus, Data Science from Scratch: First Principles with Python, 2nd edition, O'Reilly Media, 2019.
- Jake VanderPlas, Python Data Science Handbook, Second edition, O'Reilly Media, Inc., 2023.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second edition, Springer, 2009.
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R, Second edition, Springer, 2021.
- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
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Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Job Mathai					
Contributors	Dr Arun Aniyan, Mr Thomas Mathew, Dr Priya Mathews					
Course Name	Unsupervised Learning in Artificial Intelligence					
Type of Course	DSE					
Specialization title	Artificial Intelligence					
Course Code	MG6DSEMATA00					
Course Level	300					
Course Summary	This course introduces key unsupervised learning and deep learning techniques, focusing on both theory and implementation using Python. It begins with k-means clustering and its variants, then explores dimensionality reduction through Principal Component Analysis and Singular Value Decomposition with practical applications like recommendation systems. The third module covers foundational neural network concepts and deep learning models for complex data analysis tasks. The fourth module explores the fundamentals of computer vision, the workings of convolutional neural networks (CNNs) for solving complex visual recognition tasks.					
Semester	6	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic programming knowledge in Python, Fundamentals of Machine Learning					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand and implement the k-means clustering algorithm, including its enhancements like bisecting k-means and postprocessing techniques for unsupervised data segmentation.	A	PO1, PO2, PO3
2	To apply dimensionality reduction techniques such as Principal Component Analysis (PCA) and Singular Value Decomposition (SVD) to transform and analyze high-dimensional datasets.	AN	PO1, PO2, PO3, PO10
3	To understand the foundational concepts of neural networks and apply basic deep learning models to real-world data problems.	A	PO1, PO2, PO3, PO10
4	To apply convolutional neural networks to perform image classification and object detection tasks in computer vision.	A, S	PO1, PO2, PO3, PO10

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

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Module 1: k-Means Clustering			
	1.1	The k-means clustering algorithm	5	["1"]
	1.2	Improving cluster performance with postprocessing, Bisecting k-means	5	["1"]
2	Module 2: Dimensionality Reduction and Matrix Factorization for Recommendation Systems			
	2.1	Dimensionality reduction techniques, Principal component analysis	7	["2"]
	2.2	Applications of the SVD, Matrix factorization	7	["2"]
	2.3	SVD in Python, Collaborative filtering–based recommendation engines	6	["2"]
3	Module 3: Foundations of Deep Learning			
	3.1	Computer Vision, Applications of Computer vision, Image preprocessing, Feature extraction, Classifier Learning Algorithm	5	["3"]
	3.2	Deep learning and neural networks, Understanding perceptrons, Activations functions, The feedforward process	5	["3"]
	3.3	Error functions, Optimization algorithms, Backpropogation	5	["3"]
4	Module 4: Convolutional neural networks			
	4.1	Image classification using MLP	5	["4"]
	4.2	CNN architecture	5	["4"]
	4.3	Basic components of a CNN, Image classification using CNNs	5	["4"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, seminars, interactive instructions using ICT tools, and hands-on training.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Assessment Methods - Module Tests, Assignment, Quiz **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 ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

References

- Peter Harrington, Machine Learning in Action, Manning Publications, First Edition, 2012.(Module 1 - Chapters 10; Module 2 - Chapter 13, 14)
- Mohamed Elgendy, Deep Learning for vision systems, Manning Publications, First Edition, 2020.(Module 3 - Chapter 1,2; Module 4 - Chapter 3(3.1,3.2,3.3,3.4))

Suggested Readings

- Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018.
- Bharti Motwani, Data Analytics using Python, First edition, Wiley India Pvt. Ltd., 2020.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second edition, Springer, 2009.
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R, Second edition, Springer, 2021.
- Simon Haykin, Neural Networks and Learning Machines, Third Edition, Pearson, 2008.

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