

<b>Course Title:</b> Applied Machine Learning				
<b>Course Code:</b> NRE 182	<b>No. of credits:</b> 4	<b>L-T-P:</b> 30-15-30	<b>Learning hours:</b> 60	
<b>L:</b> Lectures; <b>T:</b> Tutorials; <b>P:</b> Practical				
<b>Pre-requisite Course Code and Title (if any):</b>				
<b>Department:</b> Natural and Applied Sciences				
<b>Course Coordinator:</b> Dr. Priyanka Singh		<b>Course Instructors:</b> Dr. Priyanka Singh and Dr. Adwitiya Sinha		
<b>Contact Details:</b> priyanka.singh@terisas.ac.in				
<b>Course Type:</b> Elective		<b>Course Offered in:</b> Semester 3		
<b>Course Description</b> The course bridges that gap by emphasizing applied, intuitive, and tool-based learning, with gradual exposure to coding (Python). The focus is on practical applications, conceptual understanding, and low-code/no-code tools, progressing gradually to basic coding with Python.				
<b>Course Objectives</b>				
<ul style="list-style-type: none"> <li>• Understand the basic concepts of machine learning (ML) and data science</li> <li>• Apply ML techniques to solve real-world problems in climate, environment, and resource management</li> <li>• Use data visualization and basic analytics to inform policy and decision-making</li> <li>• Work with real environmental datasets (e.g., climate data)</li> <li>• Build and interpret simple ML models using no-code/low-code tools and Python</li> </ul>				
<b>Course Content</b>				
<b>Module</b>	<b>Topic</b>	<b>L</b>	<b>T</b>	<b>P</b>
1	<b>Introduction to Machine Learning (ML) and Artificial Intelligence (AI)</b>			
	This module introduces the basic concepts of machine learning (ML) and data science and application of ML techniques to solve real-world problems in climate, environment, and resource management. Following topics are as follows:  Introduction to ML and AI in Environmental and Climatic Sciences – Definitions of AI, ML, Data Science, Big Data, Historical evolution of ML in climate studies, Importance of ML in environmental and climate studies; Case studies: ML for predicting floods, air pollution, crop yield, etc.	6	2	2
2	<b>Introduction to Python</b>			
	This module helps students in learning in performing basic coding tasks and data visualization using Python in Google Colab or Jupyter Notebooks. The major topics will include:  Introduction to Jupyter Notebooks and Google Colab; Python basics: variables, loops, data structures; Using pandas for data manipulation, Visual analytics: Line plots, histograms, scatter plots	8	3	8

3	<b>Understanding Machine Learning: Supervised vs Unsupervised</b>			
	<p>This module focuses to build and interpret simple ML models and applying machine learning models (regression, classification, clustering) to real environmental datasets. The topics as follows:</p> <p>Core concepts: features, labels, training, testing; Conceptual understanding of regression and classification; Supervised - Regression, Classification, and Unsupervised - Clustering, Dimensionality Reduction; Confusion matrix and model evaluation</p>	8	8	12
4	<b>Applications of Machine Learning</b>			
	<p>This module provides a comprehensive introduction to deep learning and neural networks, along with its application in environmental and climate science. Following topics will be covered in course delivery:</p> <p>Real-world applications: Image recognition for environmental monitoring; Teachable Machine demo: Train your own image classifier; Meteostat &amp; CliMetLab; OceanParcels; TorchGeo; Air Temperature Downscaling; ClimaX; Case-based Discussion: Can AI and ML replace environmental scientists?</p>	8	2	8
	<b>Total</b>	<b>30</b>	<b>15</b>	<b>30</b>

<b>Practical Sessions</b>	Tools Overview; Data handling and pre-processing	-	-	6
	Data Visualization; Regression and Classification Modelling			8
	Unsupervised ML modelling	-	-	8
	Real-world case studies	-	-	8
	<b>Total Practical Sessions</b>	-	-	<b>30</b>

### Evaluation Criteria

- Minor Test: Written test [at the end of teaching of modules 1 and 2] -- 20%
- Practical Test: Practical test [including modules 2 and 3] -- 20%
- Project-based learning: Project presentation [at end of teaching of module 1,2, 3 and 4] – 30%
- Major Test: Written test [end of semester, full syllabus, modules 1, 2, 3, and 4] -- 30%

### Learning Outcomes

By the end of the course, students will be able to:

- Explain the basic principles of machine learning and data science.
- Use tools for data analysis and visualization.
- Apply machine learning models (regression, classification, clustering) to real environmental datasets.
- Perform basic coding tasks using Python in Google Colab or Jupyter Notebooks.

**Pedagogical Approach**

- The course will provide blended learning approach - lecture-based instruction, hands-on labs & coding assignments, flipped classroom and Project-Based Learning (PBL)
- The course is dedicated to Concept-first, code-later approach
- This course will have formative assessments (mini-projects, coding exercises), summative assessments (Mid-term and final project evaluations), and continuous evaluation.

**Reading Resources (\* = compulsory readings)**

- \*Andreas C. Muller and Sarah Guido. (2016). *Introduction to Machine Learning with Python*. O'Reilly Media
- \*Jerry D. Davis. (2023). *Introduction to Environmental Data Science*. CRC Press.
- \*Julian, David. (2016). *Designing Machine Learning Systems with Python*. Packt Publishing
- Jung, Alexander. (2022). *Machine Learning: The Basics*. Springer
- Kelleher, J.D., Mac Namee, B., & D'arcy, A. (2020). *Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies*. MIT Press.

**Coding Practice & Interactive Platforms**

- Free platforms: Google Colab, Teachable Machine

**Student Responsibilities:** The students are required:

- To be regular and attentive in theory classes and lab sessions
- To come prepared with readings that would be given in the theory class
- To come prepared in lab with readings from respective theory concepts taught in class
- To sincerely participate in the day-to-day lab activities
- To incorporate real-world datasets as case-studies in project-based learning
- To submit assignments and project works on or before the deadlines

**Course Designed by:**

- Dr. Priyanka Singh, Assistant Professor, Department of Natural and Applied Sciences, TERI School of Advanced Studies, New Delhi

**Course Reviewers:**

The course is reviewed by following reviewers:

- Dr. Dharmveer Singh Rajpoot, Professor, School of Engineering and Technology, Central University of Punjab, Punjab.
- Dr. Tanupriya Choudhury, Professor, School of Computer Science, UPES, Uttarakhand