Course Code	Course Name	Credits
26PH502	AI AND DATA SCIENCE FOR PHYSICS APPLICATIONS	04

Course Objectives

- To identify AI and ML in physics
- To understand AI algorithms to solve physics problems
- To apply AI to model and predict physics experiments
- To conclude AI to enhance physics results
- To plan and develop AI system to solve physic problems

Learning Outcomes

After completion of the course, students will be able to:

- Understand the basic concepts of Artificial Intelligence and Machine Learning and their evolution.
- Apply data analysis techniques for handling and processing physics datasets.
- Use basic machine learning algorithms such as regression, classification, and decision trees for physics data.
- Explain the fundamentals of neural networks and deep learning and their applications in physics.
- Describe the applications of AI and machine learning in modern physics and material science**.**

Unit 1 - Artificial Intelligence and Machine Learning (12 Hrs.)

History and evolution of AI - Types of AI: Narrow AI - General AI - Machine Learning - Deep Learning - Supervised and unsupervised learning - Neural networks - Key algorithms: Linear regression, decision trees, clustering, and classification.

Unit 2 – Data Analysis in Physics (12 Hrs.)

Experimental physics and large data sets - particle accelerators - astronomical observatories - noisy data - filtering - cleaning and normalizing data - dimensionality reduction.

Unit 3 - Machine Learning Algorithms for Physics Data (12 Hrs.)

Regression and classification in physical systems - decision trees - random forests - support vector machines (SVM) - Cross-validation, bias-variance – trade off - overfitting - Loss functions and optimization techniques.

Unit 4 – Neural Networks and Deep Learning for Physics (12 Hrs.)

Introduction to Convolutional Neural Networks (CNN) - Recurrent Neural Networks (RNN) - Training deep networks using backpropagation - deep learning in image analysis, time-series data, and physics-based predictions - Particle collision prediction in high-energy physics - Image recognition in astrophysics.

Unit 5 - Material Science and Condensed Matter Physics (12 Hrs.)

Predicting material properties using machine learning - High-throughput screening of new materials - Spin models, phase transitions, and AI approaches - AI for simulating electron interactions and lattice dynamics - black hole imaging - quantum simulations.

Reference Books:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning,
2. YoshuaBengio, and Aaron Courville, Deep Learning by Ian Goodfellow,
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective,
4. Ray LaFlamme, Introduction to Quantum Computing,
5. R. C. V. K. Rao, Computational Physics: Fortran and C.

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/106106179
2. https://youtu.be/mSd9nmPM7Vg?si=gZ64-h0kpBQfX641
3. https://youtu.be/qYNweeDHiyU?si=XzmCPWchTivWSosK

COs and Bloom's Taxonomy Mapping – 26PH502		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain AI, ML concepts and algorithms used in physics.	K1, K2
CO2	Apply data analysis and machine learning techniques to physics datasets.	K3
CO3	Analyze physical systems using regression, classification, and ML models.	K4
CO4	Evaluate AI-based models for prediction and optimization in physics.	K5
CO5	Develop AI-driven solutions for modeling and simulation of physical phenomena.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH502													
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**						**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	2	2	1	1	3	1	2	2	1	1	3	1	1.75
CO2	2	3	2	2	3	1	2	3	3	2	3	2	2.33
CO3	2	3	3	2	3	1	2	3	3	2	3	3	2.50
CO4	2	2	3	2	3	2	2	2	3	2	3	3	2.42
CO5	2	2	3	3	3	3	2	2	3	3	3	3	2.67
												Total	2.33

Mean Score: 3- High, 2- Medium/Moderate, 1-Low