

Course Code	Course Name	Credits
26PH006	ARTIFICIAL INTELLIGENCE IN PHYSICS	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 physics problems

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Understand the fundamentals of Artificial Intelligence, Machine Learning, and their key algorithms.
- Apply data analysis techniques to process and interpret large and noisy physics datasets.
- Implement machine learning algorithms such as regression, classification, decision trees, SVM, and clustering for physics-related problems.
- Analyze physical data using neural networks and deep learning techniques for image, time-series, and predictive modeling.
- Evaluate the role of AI and machine learning in solving problems in material science, condensed matter physics, and astrophysics.

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/106106226>
2. <https://youtu.be/GiIxJ5tqGoE?si=h1x3WEX49-DiTBBO>
3. https://youtu.be/QIXUTsdj_oA?si=6LeGm-qP2Zy7U6ft

COs and Bloom's Taxonomy Mapping – 26PH006

Course Outcomes	On successful completion of this course, students will be able to	BTL
CO1	Recall and explain fundamental concepts of artificial intelligence and machine learning relevant to physics.	K1, K2
CO2	Apply data analysis techniques to process and interpret physics datasets.	K3
CO3	Analyze physical systems using machine learning algorithms and computational models.	K4
CO4	Evaluate the effectiveness of AI models in solving physics-related problems.	K5
CO5	Develop and implement AI-based solutions for modeling and predicting physical phenomena.	K6

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

Relationship Matrix – 26PH006

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

