Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NMED531	Introduction to Machine Learning	3	0	0	3

Course Objective
• The course will familiarize students with the basics of machine learning, the various regression and classification methods involved, reduced order modelling, etc. • The subject provides students with a practical and theoretical approach to machine learning which can be applied in any field of engineering which involves data (quantitative or images) reduction and classification.
Learning Outcomes
Upon successful completion of this course, the student is intended to understand the following: • Reducing dimensionality of a problem (SVD, PCA, ROM) • Various regression strategies and how to implement these for experimental/numerical data. • How to classify and cluster data for supervised and unsupervised learning. • Applying artificial neural networks to model various physical processes and identifying patterns. • Data compaction and reduction using the governing ODEs/ PDEs representing the physics of the problem

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Machine learning classification, matrix algebra, linear algebra	2	To introduce the various machine learning strategies and revise basic mathematics that will be used in the course
2	SVD, Fourier transforms, Wavelet transforms, PCA	5	To explore the tools for dimensionality reduction like SVD, PCA, tensor decomposition and for transforms like DFT, FFT
3	Curve fitting, nonlinear regression, gradient descent, Pareto optimization	5	To understand the basics of regression modelling viz. curve fitting, nonlinear regression, gradient descent
4	Feature selection, data mining, supervised learning and linear discriminants	7	To understand how features are selected for classification of data sets and to explore supervised learning through examples
5	k-means clustering, supervised versus unsupervised learning, hierarchical clustering	7	To understand how features are selected for clustering of data sets and to explore unsupervised learning through examples
5	single-layer and multi-layer networks, activation functions, backpropagation algorithms, deep convolution neural networks	8	To understand the single-layer, multi-layer neural networks, backpropagation algorithm, convolution neural networks
6	POD for PDEs, POD expansion, POD with symmetries, Gappy POD	8	To explore various methods for reduced order modelling viz. PODs for PDEs, POD with symmetries, machine learning ROMs
	Total	42 hrs	

Text books

1. Steven L. Brunton and J. Nathan Kuntz, Data-driven science and engineering: Machine learning, dynamical systems and control. Cambridge University Press (2019).

Reference books

1. N. J. Nilsson, Introduction to Machine Learning, 1996.

2. T. M. Mitchell, Machine Learning, McGraw Hill Science, 1997.

3. Steven L. Brunton, Bernd Noack, and PetrosKoumoutsakos, Machine Learning for Fluid Mechanics, Annual Review of Fluid Mechanics, 2020.