Course code	Course Title	L	T	P	C
VAC2318	**Mathematics for Machine Learning**	**2**	**0**	**0**	**2**
		Syllabus version			

Course Objectives

1. To provide the basic concepts of linear algebra to illustrate its power and utility.
2. To perceive the concepts of calculus in optimization techniques.
3. To understand the essence of probability theory and regression in analysing, interpreting experimental data
4. To provide students with a framework of the concepts that will help them to understand mathematics behind machine learning.

Course Outcomes

At the end of the course the student should be able to

1. Understand basic linear algebra, calculus and probability theory behind the machine learning
2. Apply the Principle component analysis (PCA) to reduce the dimension
3. Construct the Neural Network for classification.
4. Understand the clustering techniques and to apply into the data.
5. Do the practical examples, programming and applications using python and other open-source ML tools.

Module: 1	**Vector Space**	**4 hours**
System of linear equation – vector space – subspace; linear combination – span – linearly dependent – Independent – bases- dimensions – Support Vector machine (SVM)		
Module: 2	**Matrices**	**4 hours**
Matrices – Basic properties; Row-echelon form - Invertiblity; Matrices as linear transformations; Similarity; Eigenvalues and Eigenvectors - Perceptron; Single layer and Multilayer Neural Network		
Module: 3	**Inner Product Space**	**4 hours**
Dot products and inner products **–** the lengths and angles of vectors – Gram-Schmidt orthogonalisation – Least Square solutions - Principle component analysis (PCA)		
Module: 4	**Calculus**	**4 hours**
Basics concepts of Calculus – gradient – Jacobian – Chain rule – Change of variables – Maxima and Minima of two variable function – contraint maxima and minima - Lagrangian Multiplier method – Gradient Decent Algorithm		
Module: 5	**Probability and Random Variables**	**4 hours**
Probability – The axioms of probability – Conditional probability – Baye‘s theorem – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Clustering: density based clustering, k-means clustering		
Module: 6	**Regression**	**4 hours**
Correlation and Regression – Partial and Multiple correlation – Linear and Multiple Regression - Logistic Regression – Practical Examples of regressions		
Module: 7	**Graphs and Networks**	**4 hours**
Graphs – Adjacency and Incidence Matrix – Tree – Properties - distance and centres in Trees - Binary Tree – Binary Search Tree – Tree Traversals – Decision Tree		
Module: 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**30 hours**

Text Book(s)				
1	Jin Ho Kwak, Sungpyo Hong, Linear Algebra, 2004, 2nd, Springer.			
2	George B.Thomas, D.Weir and J. Hass, Thomas Calculus, 2014, 13th edition, Pearson			
3	R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, Probability and Statistics for engineers and scientists, 2012, 9th Edition, Pearson Education.			
4	S. Shalev-Shwartz, S.Ben-David, Understanding Machine Learning: From Theory to Algorithms, 2014, Cambridge University Press.			
5	Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, 2017, Dover Publications			
Reference Books				
1	Gilbert Strang, Introduction to Linear Algebra, 2015, 5th Edition, Cengage Learning			
2	Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley & Sons (Wiley student Edition).			
3	Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6th Edition, John Wiley & Sons.			
4	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.			
Mode of Evaluation: Assignment, Quiz and FAT				
Recommended by Board of Studies				
Approved by Academic Council		No.	Date	