Proposal for New Course		
Course Number	:	MB512
Course Name	:	Mathematical Foundations for DS and AI
Credits	:	2-0-0-2 (L-T-P-C)[1]
Prerequisites	:	None
Intended for	:	MBA
Distribution	:	Compulsory
Semester	:	Q1-Semester 1

Preamble

Mathematics is said to be the queen of sciences and so without mathematics the evolving field of data science and artificial intelligence (DSAI) will remain quite incomplete. The DSAI is increasingly involved in making important decisions in the modern era industry and society. Further, this field is becoming an integral part of our live and directly or indirectly influencing multiple aspects of it.
To understand this complex and rapidly changing field of DSAI, this course is focused on all basic mathematical concepts like vectors, matrices, dimensions, calculus and optimization. These mathematical understanding is essential in understanding data-driven decision making that makes use of advanced analytics. This course is emphasizing on understanding of the most useful mathematical concepts for DSAI implementation. Additionally, this is also ascertained here that one need not be an expert in this topic in order to succeed in the field of DSAI. Rather, one need to have a deeper understanding of certain useful topics drawn from the big gamut of mathematical field.

Objective

On completion of this course, the student should be able to:

- understand mathematical concepts more intuitively.
- visualize applications of math in DSAI-based problem solving and decision making.
- comprehend the link between mathematics and business.
- appreciate the use of complex mathematical concepts to handle business scenarios.
- Transform and visualize business problems in mathematical form.

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Introduction**	**(2 hours)**
Why mathematics for machine learning and artificial intelligence, concepts of models; constants, parameters and variables; mathematical models, simple and deterministic models.		
Module 2	**Linear Algebra**	**(8 hours)**
Linear equations and solutions, Scalars and Vectors, vector arithmetic and operations, orthogonality; Linear Independence, basis vectors; Matrices, basic matrix arithmetic and operations, rank of a matrix, matrix types, sparse matrix, matrix factorization, soft introduction to concepts of Tensors; Concepts of linearity and nonlinearity, linear Mappings, Vector and matrix norms; Eigenvectors and eigenvalues, singular value decomposition (SVD).		
Module 3	**Calculus**	**(6 hours)**
Limits and Functions, nature of Functions, univariate and multivariate functions, continuity of a function; basic functions like exponential, logarithmic, trigonometric, hyperbolic, modulus, greatest integer etc; squashing functions and activation functions; composite functions, Derivative, derivative of basic functions and activation functions, Chain rule, concepts of partial differentiation; Integrals, substitution rule, areas between curves.		
Module 4	**Dimensions**	**(4 hours)**
Concepts of dimensions-zero dimension to multiple dimensions, hyperspace, Euclidean space and dimensions, Euclidean distance between points, soft introduction to non-Euclidean space; vectors and matrices in dimensional space; Dimensions and analysis space; Business concepts and dimensions, mapping business problems into dimensional representation, multidimensional analysis.		
Module 5	**Optimization**	**(8 hours)**
Concepts of single and multiple attributes, objectives and criteria; Concepts of constraints and constraint satisfaction problems; Maximum and minimum of univariate and multivariate functions, Saddle Points, local and global optimum, concepts of linear and nonlinear optimization, constrained and unconstrained optimization, soft introduction to linear programming; search space, feasible and infeasible solution space, single agent and multi-agent search problems, search domain exploration and exploitation; Least squares method, Concept of gradient, gradient of vector valued functions, gradient of matrices; loss functions, gradient descent method.		

Lab Exercises (If applicable):
Nil

Textbooks:	
1.	Nil
2.	
Reference Book:	
1.	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong (2020), Mathematics for Machine Learning, Cambridge University Press (https://mml-book.com)
2.	Thomas Nield (2022), Essential Math for Data Science: Take Control of Your Data with Fundamental Linear Algebra, Probability, and Statistics, Shroff Publishers & Distributors Pvt. Ltd., Mumbai
3.	Charu C. Aggarwal (2020), Linear Algebra and Optimization for Machine Learning, Springer Nature Switzerland AG.
4	MS Excel 2019 (2020), Data Analysis & Business Modeling, Wayne Winston, Microsoft Press (PHI).