B.E (OPEN TO ALL PROGRAMMES OF ENGINERRING)

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

(Effective from the academic year 2022-2023)

SEMESTER – VI

MATHEMATICS FOR MACHINE LEARNING

Course Code	21MAT656	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning Objectives: This course will enable students to:

1. Improve the skills and knowledge in linear algebra to get more out of machine learning.
2. Understand the vector calculus required to build many common machine learning techniques.
3. Learn the probability and distribution in statistics to build machine learning applications.
4. Learn the basic theoretical properties of optimization problems, for applications in machine learning

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

Module – 1

Linear Algebra-Part1: Introduction, Matrices, System of Linear Equations, Vector Spaces, Linear Dependence and Independence, Gaussian Elimination, Basis and basis set, Rank, Norms, Inner Products, Lengths and Distances. **(Ch: 2.2-2.6, Ch:3-3.3) (8 Hours)**
(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 2

Linear Algebra-Part2: Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Rotations, Determinant and Trace, Eigenvalues and Eigenvectors – its

interpretations, Projections, Regression, Diagonalization, Singular Value Decomposition. **(Ch:3.4-3.6, 3.9, Ch:4-4.5)** **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning
Module – 3	
Vector Calculus: Introduction, Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation **(Ch:5-5.6)** **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning
Module – 4	
Probability and Distribution: Probability concepts, Conditional probability, Bayes' Theorem, Discrete and Continuous Random Variables and Distributions, Expectation and its Interpretations, Standard discrete and continuous distribution functions. **(Ch-6.2-6.5)** **(RBT Levels: L1, L2 and L3)** **(8 Hours)**	
Pedagogy	Chalk and Board, Problem based learning
Module – 5	
Optimization: Introduction, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization **(Ch-7)** **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Course Outcomes

- Improve the skills and knowledge in linear algebra to get more out of machine learning.
- Understand the vector calculus required to build many common machine learning techniques.
- Learn the probability and distribution in statistics to build machine learning applications.
- Learn the basic theoretical properties of optimization problems, for applications in machine learning

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE).

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**
(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**
1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Text Books:

1. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. "Mathematics for Machine Learning" ,Published by Cambridge University Press, Copyright 2020

Reference Books:

1. Sheldon Axler, "Linear Algebra Done Right" third edition, 2015, Springer
2. David C. Lay, "Linear Algebra and its Applications," 3rd edition, Pearson Education (Asia) Pte. Ltd,2005.
3. Gilbert Strang, "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia, 2003.
4. D. Chatterjee, "Analytical Geometry: Two and Three Dimensions", Alpha Science International Limited, 2009
5. Charles M. Grinstead, J. Laurie Snell, "Introduction to Probability".
6. DasGupta, Anirban, "Probability for Statistics and Machine Learning: Fundamentals and AdvancedTopics" , Springer, 2011
7. David Morin, "Probability: For the Enthusiastic Beginner", 2016
8. V. Jeyakumar, Alexander M. Rubinov, "Continuous Optimization: Current Trends and Modern Applications(Applied Optimization) 2005th Edition

Web links and Video Lectures (e-Resources):

http://www.class-central.com/subject/math(MOOCs)

http://academicearth.org/

http://www.bookstreet.in.

VTU EDUSAT PROGRAMME – 20

VTU e-Shikshana Program

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars