APPLIED MATHEMATICS

Semester I (Computer Engineering)

SUB CODE: MECE104

Teaching Scheme (Credits and Hours):

Teaching scheme				**Total Credit**	**Evaluation Scheme**					
L	**T**	**P**	**Total**		**Theory**		**Mid Sem Exam**	**CIA**	**Pract.**	**Total**
Hrs	**Hrs**	**Hrs**	**Hrs**		**Hrs**	**Marks**	**Marks**	**Marks**	**Marks**	**Marks**
04	**00**	**02**	**06**	**05**	**3**	**70**	**30**	**20**	**30**	**150**

LEARNING OBJECTIVES:

The objective of this course is to introduce students to the following concepts.

- To introduce the fundamentals of probability theory and random processes and illustrate these concepts with engineering applications. This course will present the basic principles of random variables and random processes needed in applications such as signal processing, digital communications, speech processing, data modeling, etc. MATLAB will be used as a software tool for bringing probability theory and real-world applications closer together.
- To understand several important concepts in linear algebra, including systems of linear equations and their solutions; matrices and their properties; determinants and their properties; vector spaces; linear independence of vectors; subspaces, bases, and dimension of vector spaces; inner product spaces; linear transformations; and eigenvalues and eigenvectors;
- To apply these concepts to such real world phenomena as electrical networks, traffic flow, archeological dating, economic interdependencies, population movement, communication networks, and weather prediction;
- To learn to use the computer package MATLAB to perform matrix computations and to explore and analyze linear algebra concepts;
- To improve the ability (or to learn!) to prove mathematical theorems;
- To improve the ability to think logically, analytically, and abstractly; and
- To improve the ability to communicate mathematics, both orally and in writing.

OUTLINE OF THE COURSE:

Unit No	Topics
1	Combinatorial Analysis
2	Random Variables
3	Continuous Random Variable
4	Introduction to Statistics
5	Introduction to Vectors
6	Vector Spaces and Subspaces
7	Orthogonality
8	Determinants
9	Eigenvalues and Eigenvectors
10	Linear Transformations
11	Applications

Total hours (Theory): 60

Total hours (Practical): 30

Total hours: 90

DETAILED SYLLABUS:

Part I : Introduction to Probability				
Sr. No	**Topic**		**Lecture Hours**	**Weightage (%)**
1	Combinatorial Analysis		3	3
	1.1	The Basic Principal of Counting		
	1.2	Permutation and Combination		
	1.3	Multinomial Coefficients		
	1.4	Sample Space and Events		
	1.5	Axioms of Probability		
2	Random Variables		7	7
	2.1	Distribution function		
	2.2	Discrete Random Variables		
	2.3	Expectation of a Function of Random Variable		
	2.4	The Bernoulli & Binomial Random variable		
	2.5	The Poison Random Variable		
	2.6	Discrete Probability Distribution		
3	Continuous Random Variable		7	7
	3.1	Expectation and Variance of Continuous Random Variable		
	3.2	The Uniform Random Variable		
	3.3	Normal Random Variable		
	3.4	Exponential Random Variable		
	3.5	The Gamma Distribution		

	3.6	The Cauchy Distribution		
	3.7	The Beta Distribution		
4	Introduction to Statistics			
	4.1	Introduction to Population, Mean, Variance, Deviation	7	7
	4.2	Point Estimation		
	4.3	Tests of Hypotheses		
	4.4	Regression		
Part II : Linear Algebra				
5	Introduction to Vectors		4	5
	5.1	Vectors and Linear Combinations		
	5.2	Lengths and Dot Products		
	5.3	Matrices		
	5.4	Solving Linear Equation		
6	Vector Spaces and Subspaces		7	7
	6.1	Spaces of Vectors		
	6.2	The Nullspace of A: Solving Ax = 0		
	6.3	The Rank and the Row Reduced Form		
	6.4	The Complete Solution to Ax = b		
	6.5	Independence, Basis and Dimension		
	6.6	Dimensions of the Four Subspaces		
7	Orthogonality		5	6
	7.1	Orthogonality of the Four Subspaces		
	7.2	Projections		
	7.3	Least Squares Approximations		
	7.4	Orthogonal Bases and Gram-Schmidt		
8	Determinants		4	6
	8.1	The Properties of Determinants		
	8.2	Permutations and Cofactors		
	8.3	Cramer's Rule, Inverses, and Volumes		
9	Eigenvalues and Eigenvectors		5	7
	9.1	Introduction to Eigenvalues		
	9.2	Diagonalizing a Matrix		
	9.3	Applications to Differential Equations		
	9.4	Symmetric Matrices		
	9.5	Positive Definite Matrices		
	9.6	Similar Matrices		
	9.7	Singular Value Decomposition (SVD)		
10	Linear Transformations		5	6
	10.1	The Idea of a Linear Transformation		
	10.2	The Matrix of a Linear Transformation		
	10.3	Diagonalization and the Pseudoinverse		
11	Applications		6	9
	11.1	Matrices in Engineering		
	11.2	Graphs and Networks		

	11.3	Markov Matrices, Population, and Economics		
	11.4	Linear Programming		
	11.5	Fourier Series: Linear Algebra for Functions		
	11.6	Linear Algebra for Statistics and Probability		
	11.7	Image Processing		

Text Book:

1. A First Course in Probability, Sheldon Ross, Fifth Edition
2. Introduction to Linear Algebra, Gilbert Strang, Fourth Edition

References:

1. Linear Algebra Done Right, Sheldon Axler
2. Linear Algebra, Kenneth Hoffman
3. Linear Algebra with Applications, Steven J Leon
4. Vector Calculus, 5th edition, Jerrold E. Marsden, Anthony Tromba

INSTRUCTIONAL METHOD AND PEDAGOGY (Continuous Internal Assessment (CIA) Scheme)

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lecture and laboratory which carries 10 marks in overall evaluation.
- One internal exam will be conducted as a part of internal theory evaluation.
- Assignments based on the course content will be given to the students for each unit and will be evaluated at regular interval evaluation.
- Surprise tests/Quizzes/Seminar/tutorial will be conducted having a share of five marks in the overall internal evaluation.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Experiments shall be performed in the laboratory related to course contents.

STUDENTS LEARNING OUTCOMES:

On successful completion of the course, the student will be able to:

- demonstrate an understand the basic principles of probability, conditional probability, independence, Bayes rule, discrete distributions, continuous distributions, etc.
- solve systems of linear equations, manipulate matrix algebra and determinants, apply row operations and elementary matrices;
- understand the concept and basic structure of vector spaces, give examples and non-examples, explain the concept of dimension, apply the dimension theorem (for the sum of two subspaces);
- elucidate the nullspace, row space and column space of a matrix, apply the rank-nullity theorem;

- give examples and non-examples of linear transformations, evaluate the matrix representations of a linear transformation;
- evaluate eigenvalues and eigenvectors, evaluate algebraic multiplicity and geometric multiplicity, diagonalize a matrix.

LIST OF PRACTICALS:

Sr. No	Name of Experiment
1	Matlab Introduction
2	Vectors in n-dimensional space
3	Matrix Algebra
4	System of Linear Equation
5	Vector and Matrix Differentiation