GUJARAT TECHNOLOGICAL UNIVERSITY

VECTOR CALCULUS AND LINEAR ALGEBRA
SUBJECT CODE: 2110015
B.E. 1ST YEAR

Type of course: Engineering Mathematics

Prerequisite: Determinants and their Properties. Matrices, Types of Matrices, Algebraic Operations on Matrices, Transpose of a Matrix, Symmetric and Skew Symmetric Matrices, Elementary Operation (Transformation) of a Matrix, Minors and Cofactors of matrices, Adjoint and Inverse of a Matrix. Vector Algebra, Types of Vectors, Addition of Vectors, Multiplication of a Vector by a Scalar, Scalar and Vector Products of Vectors, Three Dimensional Geometry, Equation of a Line in Space, Angle between Two Lines, Shortest Distance between Two Lines, Plane, Co planarity of Two Lines, Angle between Two Planes, Distance of a Point from a Plane, Angle between a Line and a Plane.

Rationale: Mathematics is a language of Science and Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE /Viva (V)	PA (I)	
3	2	0	5	70	30*	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Systems of Linear Equations and Matrices** • Systems of Linear Equations • Matrices and Elementary Row Operations • The Inverse of a Square Matrix • Matrix Equations • Applications of Systems of Linear Equations	5	14-16%
2	**Linear Combinations and Linear Independence** • Vectors in R^n. • Linear Combinations • Linear Independence **Vector Spaces** • Definition of a Vector Space • Subspaces • Basis and Dimension • Coordinates and Change of Basis	7	20-22%
3	**Linear Transformations**	7	20-22%

	• Linear Transformations • The Null Space and Range • Isomorphisms • Matrix Representation of Linear Transformations • Similarity **Eigenvalues and Eigenvectors** • Eigen values and Eigen vectors • Diagonalization		
4	**Inner Product Spaces** • The Dot Product on R^n and Inner Product Spaces • Orthonormal Bases • Orthogonal Complements • Application: Least Squares Approximation • Diagonalization of Symmetric Matrices • Application: Quadratic Forms	6	18-20%
5	**Vector Functions** • Vector & Scalar Functions and Fields, Derivatives • Curve, Arc length, Curvature & Torsion • Gradient of Scalar Field, Directional Derivative • Divergence of a Vector Field • Curl of a Vector Field	5	14-16%
6	**Vector Calculus** • Line Integrals • Path Independence of Line Integrals • Green`s Theorem in the plane • Surface Integrals • Divergence Theorem of Gauss • Stokes`s Theorem	6	18-20%

Note: Teachers are advised to encourage students to perform the projects in group of 4 students for conceptual understanding by geometrically, numerically and algebraically.

Reference Books:

1. Introduction to Linear Algebra with Application, Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill
2. Elementary Linear Algebra, Applications version, Anton and Rorres, Wiley India Edition.
3. Advanced Engineering Mathematics, Erwin Kreysig, Wiley Publication.
4. Elementary Linear Algebra, Ron Larson, Cengage Learning
5. Calculus, Volumes 2, T. M. Apostol, Wiley Eastern.
6. Linear Algebra and its Applications, David C. Lay, Pearson Education

Course Outcome:

On successful completion of the course, students will be able following points:

1. System of linear equations in solving the problems of electrical engineering, mechanical engineering, applied mechanics etc.

2. Use of matrix in graph theory, linear combinations of quantum state in physics, computer graphics and cryptography etc.
3. Students will be able to apply vectors in higher dimensional space in experimental data, storage and warehousing, electrical circuits, graphical images, economics, mechanical systems and in physics.
4. Students will able to use eigen values and eigen vector in Control theory, vibration analysis, electric circuits, advanced dynamics and quantum mechanics.
5. Students will be able to apply linear transformation in computer graphics, cryptography, thermodynamics etc.
6. Students will able to use the techniques and theory of linear algebra to model various real world problems. (Possible applications include: curve fitting, computer graphics, networks, discrete dynamical systems, systems of differential equations, and least squares solutions.
7. Modeling of heat flow, heat equation.
8. Understand fluid mechanics problem such as conservation of momentum, conservation of mass etc.

List of Open Source Software/learning website:

The syllabus is roughly covered by:
Massachusetts Institute of Technology, MIT Open Course Ware

1. **Instructor(s) Prof**. Gilbert Strang **MIT Course Number 18.06**
   Link:http://ocw.mit.edu/courses/mathematics/18-06-linear-algebraspring2010/videolectures/

2. **Instructor(s)** Prof. Denis Auroux **MIT Course Number 18.02**
   Link:http://ocw.mit.edu/courses/mathematics/18-02-multivariable-calculus-fall- 2007/video-lectures/

*PA (M): 10 marks for Active Learning Assignments, 20 marks for other methods of PA

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding the applications of Linear Algebra and Vector Calculus to engineering applications – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Linear Algebra and Vector Calculus is covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be sent to achievements@gtu.edu.in.