VECTOR CALCULUS & PARTIAL DIFFERENTIAL EQUATIONS
(MECHANICAL Engg.)

23MA1105 **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40
End Exam : 3 Hours End Exam Marks:60

Prerequisites: Differentiation, integration and functions.

Course Objectives:

The aim of this course is to introduce basic fundamentals of vector calculus, formulate and solve first order partial differential equations, and study of Fourier transforms and its applications.

Course Outcomes: By the end of the course, students will be able to

1.	Explain the characteristics of scalar and vector valued functions and provide a physical interpretation of the gradient, divergence, curl and related concepts.
2.	Transform line integral to surface integral, surface to volume integral and vice versa using Green's theorem, Stoke's theorem and Gauss's divergence theorem.
3.	Construct partial differential equation of a given equation and solve first order partial differential equations and their applications.
4.	Find different Fourier transforms of non-periodic functions and also use them to evaluate boundary value problems.
5.	Evaluate simple correlation between the two variables and fit curves by the method of least square approximation.

CO-PO –PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2										1			
CO2	3	2										1			
CO3	3	2										1			
CO4	3	2										1			
CO5	3	2										1			

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

CO-PO-PSO Justification	
1	CO1 deals with finding the gradient, div and curl of a given vector point functions and these fundamental concepts in vector calculus are widely used in many areas of engineering.
2	CO2 deals with vector integration like line, surface and volume integrals and these are widely used in various fields of engineering.
3	CO3 deals with formation, finding solution and applications of PDE and these are widely used various fields of engineering.
4	CO4 deals with properties of Fourier transforms, and their applications, these are widely used in various field of engineering.
5	CO5 deals with the process of constructing a curve that has the best fit to a series of data points and it is widely used in various fields of engineering.

SYLLABUS

UNIT I **10 Periods**

VECTOR DIFFERENTIATION

Scalar and vector point functions – Del applied to scalar point functions – Directional derivative – Del applied to vector point functions – Physical interpretation of divergence and curl – Del applied twice to point functions – Del applied to products of point functions.

UNIT II **10 Periods**

VECTOR INTEGRATION

Integration of vectors – Line integral , circulation, work done – Surface integral , flux – Green's theorem in the plane – Stoke's theorem – Volume integral – Gauss divergence theorem (all theorems without proofs) – Irrotational and solenoidal fields.

UNIT III **10 Periods**

FIRST ORDER PARTIAL DIFFERENTIAL EQUATIONS

Introduction – Formation of partial differential equations by eliminating arbitrary constants and functions – Solutions of a partial differential equations by direct Integration – Linear equations of th first order (Lagrange's linear equations).

APPLICATIONS : Method of separation of variables – Vibrations of a stretched string: Wave equation – One dimensional heat flow equation ($\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$), and two dimensional heat flow equation. (i.e. Laplace equation : $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$).

UNIT IV **10 Periods**

FOURIER TRANSFORMS

Introduction – Definition – Fourier integral theorem(without proof) – Fourier sine and cosine integrals – Fourier transforms – Properties of Fourier transforms(without proof) – Convolution theorem – Parseval's identity for Fourier transforms – Relation between Fourier and Laplace transforms – Fourier transforms of the derivatives of a function – Applications of transforms to boundary value problems.

UNIT V **10 Periods**

CORRELATION, REGRESSION ANALYSIS AND CURVE FITTING

Correlation : Definition – Karl pearson's coefficient of correlation – Measures of correlation – Rank correlation coefficients.

Regression : Simple linear regression – Regression lines and properties.

Curve Fitting : Principle of least squares – Method of least squares – Fitting of straight lines – Fitting of second degree curves and exponential curves.

TEXT BOOKS:

B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.

2. N. P. Bali, Engineering Mathematics, Lakshmi Publications.

3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas, Calculus, 13/e, Pearson Publishers, 2013.

4. H. K. Dass, Advanced Engineering Mathematics, S. Chand and complany Pvt. Ltd.

5. Michael Greenberg, Advanced Engineering Mathematics, Pearson, Second Edition.