VECTOR CALCULUS, PARTIAL DIFFERENTIAL EQUATIONS and FOURIER ANALYSIS

[ENGINEERING MATHEMATICS – III]

[R – 20 Regulation]

[Common to EEE, MECHANICAL, CIVIL and CHEMICAL]

	Credits:3
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Course Outcomes: At the end of the course, the student will be able to do

CO1: Explain the characteristics of scalar and vector valued functions and provide a physical interpretation of the gradient, divergence, curl and related concepts.

CO2: 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.

CO3: Explain analytical methods for solving PDE's like applying separation of variables to solve elementary problems in linear second order partial differential equations (heat and wave equations).

CO4: Understand the need for a function or its approximation as an infinite Fourier series to represent discontinuous function which occurs in signal processing and electrical circuits.

CO5: Find different Fourier transforms of non-periodic functions and also use them to evaluate boundary value problems.

CO – PO Mapping :

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2										1
CO-2	3	2										1
CO-3	3	2										1
CO-4	3	2										1
CO-5	3	2										1

SYLLABUS

UNIT - I: VECTOR DIFFERENTIATION **[12 Lectures]**

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.

Sections: 8.4, 8.5, 8.6, 8.7, 8.8 and 8.9.

UNIT - II: VECTOR INTEGRATION **[12 Lectures]**

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.

Sections: 8.10, 8.11, 8.12, 8.13, 8.14, 8.15, 8.16 and 8.18.

UNIT-III: PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS **[12 Lectures]**

Introduction – Formation of partial differential equations by eliminating arbitrary constants and functions – Solutions of a partial differential equations by direct Integration – Linear equations of the 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 : $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$).

Sections: 17.1, 17.2, 17.4, 17.5, 18.2, 18.4, 18.5, 18. 6 and 18. 7.

UNIT – IV: FOURIER SERIES **[12 Lectures]**

Introduction – Euler's formulae – Conditions for a Fourier expansion – Functions having points of discontinuity – Change of interval – Even and odd functions – Half range series – Parseval's formula.

Sections: 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 and 10.9.

UNIT – V: FOURIER TRANSFORMS **[12 Lectures]**

Introduction – Definition – Fourier integral theorem(without proof) - Fourier sine and cosine integrals – Fourier transforms – Properties of Fourier transforms – 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.

Sections: 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9 and 22.11.

TEXT BOOK:

B. S. Grewal, *Higher Engineering Mathematics*, 43rd edition, Khanna publishers, 2017.

REFERENCE BOOKS:

1, **N P. Bali and Manish Goyal**, *A text book of Engineering mathematics*, Laxmi publications, Latest edition.

2. **Erwin Kreyszig**, *Advanced Engineering Mathematics*, 10th edition, John Wiley & Sons, 2011.

3. **R. K. Jain and S. R. K. Iyengar**, *Advanced Engineering Mathematics*, 3rd edition, Alpha Science International Ltd., 2002.

4. **George B. Thomas, Maurice D. Weir and Joel Hass, Thomas,** *Calculus*, 13th edition, Pearson Publishers.