SEMESTER-IV

PHYDSC251

MATHEMATICAL PHYSICS-II

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The emphasis of this course is on applications in solving problems of interest to physicists. The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during this course will prepare them not only for carrying out fundamental and applied research but also for a wide variety of careers.*

Unit 1: Fourier Series

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Summing of Infinite Series. Even and odd functions and their Fourier expansions. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Term-by-Term differentiation and integration of Fourier Series. **(14 Lectures)**

Unit 2: Frobenius Method

Regular and Singular Points of Second Order Linear Differential Equations. Frobenius method and its applications to find the solution of Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre, Hermite and Laguerre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. **(12 Lectures)**

Unit 3: Special Functions & Partial Differential Equations

Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions [$J_0(x)$ and $J_1(x)$] and Orthogonality.

Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular symmetry. **(10 Lectures)**

Unit 4: Laplace Transform (LT)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1^{st} and 2^{nd} order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Periodic Functions. **(12 Lectures)**

Unit 5: Inverse LT and Application of LT

Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2^{nd} order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1^{st} order. Solution of heat flow along infinite bar using Laplace transform. **(12 Lectures)**

Expected learning outcomes: *At the end of this course, the students will be able to represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems. Students are also expected to, obtain power series solution of differential equation of second order with variable coefficient using Frobenius method, understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations, recurrence relations, learn about Laplace transform and inverse transform along with their applications.*

Reference Books:

i. Ordinary and Partial Differential Equations by M.D. Raisinghania, S Chand Publisher.
ii. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
iii. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
iv. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
v. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
vi. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
vii. Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press.
viii. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.

PHYDSC252T

ELECTRONICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The emphasis of course is on building basic concepts of electronics covering both analog and digital parts. The course will also expose students to fundamental concepts of semiconductor devices and their wide range of applications. The topics covered in this course will also give flavours of digital electronics connecting both arithmetic and sequential circuits.*

Unit 1:

Semiconductor Diodes: Conductivity and Mobility, Concept of Drift velocity. Formation & V-I characteristics of p-n junction diode. Current Flow Mechanism in Forward and Reverse Biased Diode. Static & Dynamic resistance of p-n junction diode. Half-wave and Full-wave Rectifiers, Calculation of Ripple Factor and efficiency. C & π -filter. Zener and avalanche breakdown, Zener Diode and Voltage Regulation. LED & Solar cell (Principle and working).

(10 Lectures)