PHY-313 Mathematical Methods of Physics II

Credit Hours: 3-0

Pre-requisite: Mathematical Methods of Physics I

Course Objectives: This course treats two important topics that are important for physicists – functional basis in linear algebra and partial differential equations. Course starts with Fourier series and moves on to strum-Liouville equations and associated polynomials. Then partial differential equations are solved using these polynomial solutions.

Core Contents: Functional basis and partial differential equations.

Detailed Course Contents: Discontinuous functions, non-periodic functions, integration and differentiation, complex Fourier series, Parseval's theorem, Fourier transforms, Adjoint and Hermitian operators and their properties, eigenfunctions of Hermitian operators, Sturm-Leoville equations, superposition of eigenfunctions – Green's functions, Legendre and associated Legendre functions, spherical harmonics, Spherical Bessel functions, Laguerre functions, Introduction to partial differential equations (brief description of the wave, diffusion, Poisson's and Schrodinger's equations), general form of solution, general and particular solutions – first-order equations, inhomogeneous equations and problems, second-order equations, the wave and diffusion equations – general solutions, existence and uniqueness of solutions, separation of variables, superposition of separated solutions, separation of variables in polar coordinates and examples, integral.

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

- understand fully Fourier series and transform
- solve strum Liouville equations and associated eigen functions
- solve linear first order and second order partial differential equations via separation of variables
- understand the properties of solutions of partial differential equations.

Textbook: Ken F. Riley, Michael P. Hobson, Stephen J. Bence, Mathematical Methods for Physics and Engineering, 3rd ed. Cambridge University Press, 2006.

Reference Books:

- Mary L. Boas, Mathematical Methods in the Physical Sciences, 3rd ed. John Wiley, 2005.

- Peter V. O'Neil, Advanced Engineering Mathematics, 7th ed. Cengage Learning, 2011.
- Dennis G. Zill, Michael R. Cullen, Differential equations with boundary value problems, 7th ed. Cengage Learning, 2008.
- E. Kreyszig, Advanced Engineering Mathematics, 10th ed. John Wiley, 2011.

Weekly Breakdown		
Week	Section	Topics
1	RHB 12.4-12.8	Discontinuous functions, non-periodic functions, integration and differentiation, complex Fourier series, Parseval's theorem
2	RHB 13.1	Fourier transforms
3	RHB 17.1-17.3	Adjoint and Hermitian operators and their properties, eigenfunctions of Hermitian operators
4	RHB 17.4-17.6	Sturm-Liouville equations, superposition of eigenfunctions – Green's functions
5	RHB 18.1-18.3	Legendre and associated Legendre functions, spherical harmonics
6	RHB 18.6-18.7	Spherical Bessel functions, Laguerre functions
7	RHB 20.1-20.2	Introduction to partial differential equations (brief description of the wave, diffusion, Poisson's and Schrodinger's equations), general form of solution
8	RHB 20.3	General and solutions – first-order equations, inhomogeneous equations and problems
		Midterm Exam
9	RHB 20.3	General and particular solutions - second-order equations
10	RHB 20.4-20.5	The wave and diffusion equations – general solutions
11	RHB 20.6-20.7	Existence and uniqueness of solutions
12	RHB 21.1-21.2	Separation of variables, superposition of separated solutions
13	RHB 21.3	Separation of variables in polar coordinates and examples
14	RHB 21.4	Integral transform methods
	RHB 21.5	Green's functions