Core VI

Mathematical Physics-III

Course Outcomes

- Understanding and application of Complex function variables.
- Understanding the concept of Fourier Integral transform.
- To Understand the properties and application of Fourier integral transformation.
- To Understand the properties and application of Laplace integral transformation.
- To Apply the acquired knowledge to solve problems.

Unit I

- **Complex Analysis:** Brief Revision of Complex Numbers and their Graphical Representation Euler's
- formula, De Moivres theorem, Roots of complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions: poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchys Inequality, Cauchys Integral formula, Simply and multiply connected region, Laurent and Taylors expansion, Residues and Residue Theorem, Application in solving Definite Integrals.

Unit II

- **Integral Transforms-I:** Fourier Transforms: Fourier Integral theorem, Fourier Transform, Examples, Fourier Transform of trigonometric, Gaussian, finite wave train and other functions, Representation of Dirac delta function as a Fourier Integral, Fourier transform of derivatives, Inverse Fourier Transform.

Unit III

- **Integral Transforms-II:** Convolution theorem, Properties of Fourier Trans- forms (translation, change of scale, complex conjugation), Three dimensional Fourier transforms with examples, Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat flow Equations.

Unit IV

- **Laplace Transforms:** Laplace Transforms (LT) of Elementary functions,
- **Properties of Laplace Transforms:** Change of Scale Theorem, Shifting Theorem, LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions, Inverse LT, Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Text Books:

- ✓ *Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris (2013,7thEdn.,Elsevier)*
- ✓ *Advanced Engineering Mathematics, ErwinKreyszig (WileyIndia)*

Reference Books:

- ✓ *Mathematical Physics and Special Relativity– M.Das, P.K.Jena and B.K. Dash (Srikrishna Prakashan)*
- ✓ *Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. Chand Publishing)*
- ✓ *Mathematical Physics C. Harper (Prentice Hall India)*
- ✓ *Complex• Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , Mc- Graw Hill Education)*
- ✓ *Complex variables and applications J.W.Brown and R.V.Churchill*
- ✓ *Mathematical Physics, Satya Prakash (Sultan Chand)*
- ✓ *Mathematical Physics B.D.Gupta (4thedition,VikasPublication)*
- ✓ *Mathematical Physics B.S.Rajput, Pragati Prakashan*
- ✓ *Mathematical physics-III,(University Physics), Dr. Ranjan Kumar Bhuyan, Himalaya Publishing House*

LAB: Credit-1

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like

. Solve simple differential equations like:

$\frac{dy}{dx} = e^{-x}$ with $y(x = 0) = 0$

$\frac{dy}{dx} + e^{-x} = x^2$ with $y(x = 0) = 0$

$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y$ with $y(x = 0) = 0,\ y'(x = 0) = 1$

$\frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = -y$ with $y(x = 0) = 0,\ y'(x = 0) = 1$

. Direct Delta Function:

Evaluate $\int_{-3}^{3} dx \frac{x=3}{\sqrt{2\pi a^2}}\ e^{-\frac{(x-2)^2}{2\sigma^2}}$, for $\sigma = 0.1,\ 0.01,\ 0.001$ and show that it tends to 5.

. Fourier Series:

Program to sum; evaluate the Fourier Coefficients of a given periodic function (Square Wave)

. Frobenius Method and Special Functions:

$$\int_{-1}^{1} d\mu \; P_n\mu \, P_m\mu = \frac{2}{2n+1}\delta_{m,n}$$

Plot Pn(x), Legendre polynomial of degree n, and Jn(x), Bessel function of first kind. Show Recursion relation.

- Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two)
- Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer Programme.
- Evaluation of trigonometric functions e.g. SinΘ, Given Bessel's function at N points, find its value at an intermediate point.

Complex analysis: Calculate $\int \frac{dx}{x^2+2}$ and check it with computer integration.

Integral transform: FFT of e^{-x^2}

Reference Books:

- ✓ *Mathematical Methods for Physics and Engineers, K.FRiley, M.P.Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.*
- ✓ *Mathematics for Physicists, P.Denneryand A.Krzywicki, 1967, Dover Publications.*
- ✓ *Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernndez. 2014 Springer ISBN: 978-3319067896*
- ✓ *Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444*
- ✓ *Scilab (AfreesoftwaretoMatlab): H.Ramchandran, A.S.Nair.2011 S.Chand And Company, Scilab Image Processing: Lambert M. Surhone. 2010 Betas cript Publis*hing.