PPH305: COMPUTATIONAL METHODS IN PHYSICS

L	T	P	Cr
3	1	3	5.0

Course Objectives: To give exposure about various computational techniques to solve physics using advance computer programming languages.

Fortran 90 Programming: Operating systems, Flow charts, Integer and Floating point arithmetic, built-in functions, Executable and non-executable statements, Assignment, Control and input/output commands, Subroutines and functions, Operation with files, Debugging and testing.

Numerical Algebraic and Transcendental Equations: Methods for determination of zeroes of linear and nonlinear algebraic and transcendental equations, Convergence of solutions, Solution of simultaneous linear equations.

Interpolation and Approximation: Introduction to interpolation, Lagrange approximation, Newton polynomials, Curve fitting by least squares, Polynomial least squares and cubic splines fitting.

Numerical Differentiation and Integration: Numerical differentiation, Quadrature, Simpson's rule, Gauss's quadrature formula, Newton – Cotes formula.

Random Variables and Monte Carlo Methods: Random numbers, Pseudo-random numbers, Monte Carlo integration: Moment of inertia, Monte Carlo Simulations: Buffen's needle experiment, Importance of sampling.

Differential Equations: Euler's method, RungeKutta methods, Finite difference method, Finite difference equations for partial differential equations and their solution.

Laboratory Assignments:
1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. To determine Wien's constant using bisection method and false position method.
3. To solve Kepler's equation by Newton-Raphson method.
4. To solve van der Waals gas equation for volume of a real gas by the method of successive approximation.
5. To interpolate a real data set from an experiment using the Lagrange's method, and Newton's method of forward differences and cubic splines.
6. To fit the Einstein's photoelectric equation to a realistic data set and hence calculate Planck's constant.
7. To find the area of a unit circle by Monte Carlo integration.
8. To simulate the random walk.
9. To study the motion of an artificial satellite by solving Newton's equation for its orbit using Euler method.

10. To study the growth and decay of current in RL circuit containing (a) DC source and (b) AC using RungeKutta method, and to draw graphs between current and time in each case.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. various computational methods like Euler, Newton-Raphson and RangaKutta useful to solve research problems.
2. various simulation techniques which can be used in future by students to analyse the data.

Recommended Books:

1. *Mathews, J.H., Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall, (2000).*
2. *Rajaraman, V., Computer programming in Fortran 90 and 95, Prentice-Hall of India, (2008).*
3. *Salaria, R.S., Programming in Fortran, Khanna Publishing, (2008).*