PHA-307: Computational Physics

1. Introduction: Review of C++ and C programming language, Editing and typing the program, Debugging and testing, Conditions loops, Arrays, pointer and strings.
2. Solving Problem Using C/C++
   A. Solving Ordinary Differential Equation (ODE) with Initial Value: First Order ODE (Example: Euler Method for the Harmonic Oscillator), Second Order ODE (Example: Runge-Kutta Method for Harmonic Oscillator), Central Difference Method (Verlet Method for the Harmonic Oscillator).
   B. Root Finding and Optimization: Bisection and Newton-Raphson Method of Root Finding, Direct Optimization (Example Simulated annealing minimization of a function of many variables), Stochastic Optimization.
   C. Numerical Differentiation: Finite Difference Method, Two point formula, three point formula and five point formula.
   D. Numerical Integration Newton-Cotes Method (Using Discrete Planes to appropriate an integral), Trapezoidal rule, Simpson 1/3 and 3/8 rule for integration, Romberg Integration.
   E. The Integral Transformation: Theoretical Background, Discrete Fourier Transform, Fast Fourier Transform.
   F. Generation of Random Numbers: Pseudo Random number generators, Linear Congruential Generator, Non Uniform Random Numbers, Monte Carlo method.
   G. Solving Linear System : Gaussian Elimination, Gauss-Jordan Elimination, LU Decomposition, Eigenvalues and Eigenvectors. Inverse of a matrix and determinant, tridiagonal systems of linear equations
   H. Methods of data fitting, interpolation and extrapolation: Lagrange interpolation, Hermite interpolation, cubic spline interpolation, approximation of derivatives, Richardson extrapolation, curve fitting by least square fitting, least square and orthogonal polynomials, nonlinear least square
   I. Numerical Solution of partial differential equation: Classes of partial differential equations, finite difference equations, irregular physical boundary, Neumann boundary conditions, finite difference equations, diffusion equations
   J. Monte-Carlo Method: Probability distribution function, Monte Carlo integration, Monte-Carlo integration of multidimensional integral, random walk, Metropolis algorithm.

3. Concept of Object Oriented Language:
   Object oriented development themes, Modeling concepts, Modeling as a design technique, Object modeling, Dynamic modeling, Functional modeling.

Books:

1. Titus Adrian Beu, Introduction to numerical programming a practical guide for scientist and engineers using c++ and python. CRC press
2. Robin H. Landau, Manuel J. Paez, Computational Physics Problem Solving with Computers, John Wiley & Sons, (1997)
3. Paul L. DeVries, A First Course in Computational Physics, John Wiley & Sons, (1994)
4. Morten Hjorth-Jensen, Computational Physics.

Department of Physics
University of Dhaka
List of 3rd Year Laboratory Experiments

Nos.	Name of the Experiments
1.	To determine e/m of an electron using a Helmholtz coil
2.	a) To study the plateau curve of a given G.M. counter and hence to determine its operating voltage b) To determine the dead time of the G.M. tube by double source method
3.	b) To verify the inverse square law of gamma radiation emitted from a $137C_s$ radioactive source
4.	b) To find the linear absorption coefficient and mass absorption coefficient for lead using a $137C_s$ source
5.	b) To study the random nature of radioactive decay and hence to show that 68.3% of the measurements would fall within the limits bounded by one standard deviation from the mean value of measurements
6.	To study the frequency response characteristics of RC high pass, low pass, band pass and parallel T-filters
7.	To study the impedance characteristics of LCR circuit (both series and parallel)
8.	To study the characteristic curves of a field effect transistor (FET) and hence to determine the various parameters of this device
9.	To study the characteristic curves of an SCR and hence to find the different parameters of this device.
10.	To design and construct a full wave rectified power supply and hence to study the following: (a) I-V characteristic and maximum output power (b) Ripple factor as a function of load resistance at constant capacitance (c) Ripple factor as a function of capacitance at constant load resistance (d) Rectification efficiency as a function of load resistances
11.	To construct and experimentally verify the operation of the following voltage regulator circuit: b) Zener diode voltage regulator c) Emitter follower regulator d) A feedback regulator with current limiting circuit e) I-C controlled voltage regulator (at constant current source)
12.	To construct and experimentally verify the operation of the following voltage regulator circuits: a) A center tapped full wave rectifier circuit and to measure the ripple factor b) Voltage regulator circuit using 7805 IC as voltage regulator c) A variable output voltage regulated power supply circuit using the 7805 IC as a constant current source
13.	To study the frequency response characteristics of a single stage transistor amplifier with and without feedback and to determine the band-width in both cases
14.	To design and construct an inverting OPAMP, using discrete components, and hence to study the frequency response characteristics for it
15.	To design and construct a non-inverting OPAMP, using discrete components, and hence to study the frequency response characteristics for it
16.	To study the characteristics of different logic gates and to construct their respective truth tables for the verification of corresponding Boolean Algebra