

## **SEC: Computational Physics Skills (32223902)**

**Credit:04 (Theory-02, Practical-02)**

**Theory: 30 Hours**

**Practical : 60 Hours**

### **Course Objectives**

This course is intended to give an insight to computer hardware and computer applications. Students will familiarize with use of computer to solve physics problems. They will learn a programming language namely fortran and data visualization using GNU plot. Further they will also learn to prepare long formatted document using latex.

### **Course Learning Outcomes**

Students will be able to

- Use computers for solving problems in Physics.
- Prepare algorithms and flowcharts for solving a problem.
- Use Linux commands on terminal
- Use an unformatted editor to write sources codes.
- Learn “Scientific Word Processing”, in particular, using LaTeX for preparing articles, papers etc. which include mathematical equations, picture and tables.
- Learn the basic commands of Gnuplot.

### **Unit 1**

**Introduction:** Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor.

**Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of  $\sin(x)$  as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

**(4 Lectures)**

**Scientific Programming:** Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

**(5 Lectures)**

## **Unit 2**

Control Statements: Types of Logic(Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO- CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using  $\exp(x)$  series evaluated at  $x=1$

**(6 Lectures)**

## **Unit 3**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

**(6 Lectures)**

## **Unit 4**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

**(9 Lectures)**

### **Practicals/Hands on exercises:**

#### **PRACTICALS-SEC LAB: Computational Physics Skills Lab**

Teacher may give long duration project based on this paper.

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

### **References**

1. Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
2. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
3. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
4. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
5. Elementary Numerical Analysis, K.E.Atkinson,3<sup>rd</sup> Edn., 2007, Wiley India Edition.

**SEC: Electrical circuits and Network Skills (32223903)**  
**Credit:04 (Theory-02, Practical-02)**  
**Theory: 30 Hours**  
**Practical : 60 Hours**

### **Course Objectives**

To develop an understanding of basic principles of electricity and its household applications. To impart basic knowledge of solid state devices and their applications, understanding of electrical wiring and installation.