Shri Shivaji Science College, Amravati

Department of Physics

Add On Course

"*Physics with SCILAB*"

Introduction and Background:

SCILAB is a scientific software package for numerical computations providing a powerful computing environment for scientific applications. It was developed in 1990 by researchers from INRIA (French National Institute for Research in Computer Science and Control) and ENPC (National School of Bridges and Roads). It is now maintained and developed by SCILAB Consortium joined to Digiteo Foundation from 2008. The current version is 6.1.0 released on Tue, 25 Feb 2020.

It is an open source, cross-platform numerical computational software and also a high-level, numerically oriented programming language. Due to the open source nature of the software, some user contributions (define new data types and operations) have been integrated into the main program. Using SCILAB many numerical problems may be expressed in a reduced number of code lines, as compared to similar solutions using traditional languages, such as FORTRAN, C, or C++. This allows users to rapidly construct models for a range of mathematical problems.

SCILAB also includes a free package called **Xcos** for modeling and simulation of explicit and implicit dynamical systems, including both continuous and discrete sub-systems.

SCILAB is fully compatible with Linux, Mac OS X, and Windows operating systems.

This course is designed for introducing the Physics students to SCILAB and its effective use in solving the problems and simulating the concepts in Physics.

Who should take this course:

Any student of physics or mathematics (UG/PG) wishing to discover SCILAB software, its environment and its capabilities.

Prerequisites:

Be able to use computers and know college physics and mathematics concepts.

Duration of the Course:

FOUR WEEKS (32 Hours)

Course is divided into four modules each of 08 hours including 02 hours for assessments.

Module 1: (Week 1)

INTRODUCTION TO SCILAB

- Scilab environment
- Scilab datatypes, variables and constants

MATRICES AND VECTOR SPACES

- Introduction
- Creation of a Matrix
- Nature of the Matrix
- Matrix Operation
- Vector Algebra
- Applications
    - Coordinate Conversion
    - Orthogonal Vectors
    - Centre of mass of a system
    - Electrical Circuits
    - Force on a Test Charge
    - Principal Axes of Moment of Inertia
    - Matrix representation of Differential Operator
    - Matrix representation of Laplace operator
    - Wave function for stationary states

PLOTTING AND GRAPHICS DESIGN

- Introduction
- Formatting of the coordinate axes
- Formatting of the line styles
- Formatting of the markers
- Formatting of the title

- Formatting of the legend
- Applications
    - Trajectory of a Projectile
    - Superposition of Collinear Harmonic Oscillations
    - Beats
    - R-L-C Circuit
    - Maximum Power Transfer Theorem
    - Diode Characteristics
    - Specific Heat of Solids
    - Spectral Radiance of a Blackbody Radiation
    - Miller Indices
    - Linear Interpolation
    - Gradient of a Scalar Field

Module 2: (Week 2)

LEAST SQUARE CURVE FITTING

- Introduction
- Fitting of Linear Data
- Fitting of Non-Linear Data
- Polynomial Fitting
- Fitting with in-built SciLab function
- Applications
    - Refractive Index of Water
    - Spring Constant
    - Cauchy's Constant of a Prism
    - Coefficient of Electronic Heat Capacity and Debye's Temperature
    - Lennard-Jones Potential
    - Spectral Radiance of Blackbody Radiation

ORDINARY DIFFERENTIAL EQUATION

- Introduction
- Euler's Method
- Modified Euler's Method
- Second order Runge-Kutta Method
- Fourth order Runge-Kutta method
- Finite Difference Method

- Applications
    - Radioactive Decay
    - Orthogonal Trajectory
    - Square Wave ↔ Triangular Wave
    - Sinusoidal Wave
    - Freely Falling Object
    - Atwood's Machine
    - Simple Pendulum
    - Mass-spring system
    - Schrödinger Equation
    - Lagrangian Dynamics

Module 3: (Week 3)

INTEGRATION AND DIFFERENTIATION

- Introduction
- In-built SciLab functions for integration
- Trapezoidal Rule
- Simpson's 1/3 – Rule 5.5 Simpson's 3/8 – Rule
- Differentiation
- Applications
    - Integration in Cylindrical Coordinates
    - Total Charge
    - Planck's Law for Blackbody Radiation
    - Specific Heat of Solids
    - Dirac Delta Function (Shifting Property)
    - Cornu's Spiral and Fresnel's Diffraction Pattern
    - Arc Length

SPECIAL FUNCTIONS

- Introduction
- Bessel Function
- Legendre Polynomial
- Laguerre Polynomial
- Hermite Polynomial
- Improper integrals – Quadrature methods
- Applications

Module 4: (Week 4)

FOURIER ANALYSIS

- Introduction
- Periodic Functions
- Fourier series
- Harmonics
- Fourier series expansion of periodic functions
- Fast Fourier Transform

X-COS MODELLER AND SIMULATOR

- Introduction to X-Cos
- Making simulations for Physical systems using Xcos