PHY473/473A/617: Computational Physics

Academic Year: 2023-2024; Semester II, 3-0-3-0 (12)

Objective: This course is intended to introduce details of numerical computation used in many fields of physics. Students will be acquainted with techniques to solve physics-based problem using numerical computation.

Details of the Course-Content:

Introduction to computers-bash scripts, Python basics, Error Analysis, Interpolation - Lagrange, Splines, Numerical Integration- Newton-Cotes, Gaussian Quadrature, Monte Carlo, Numerical differentiation, Ordinary differential equation solvers – stability accuracy issues, Explicit vs Implicit Schemes, Predictor-corrector methods (Euler, Runge-Kutta), Multistep methods (Adam-Bashforth), Stiff Equations, Leapfrog and Verlet methods, PDE (partial differential equation) – Spectral method, Finite difference method to solve parabolic equations – Diffusion equation, Schrodinger equation, stiff equations, CFL Condition, Laplace and Poisson's equations, Nonlinear equations -- Iterative procedure, Newton's method, Secant method, Linear Algebra -- Solve Ax = b, Eigenvalues and eigenvectors

***Students will use Linux based computers for assignments and programming part of the exams.*

Textbooks:

1. Computational Physics with Python, 2nd Ed., Mark Newmann
2. An Introduction to Computational Physics by Tao Pang, Cambridge University press (2006)
3. A Primer on Scientific Programming with Python, Springer (2016), H. P. Langtangen
4. Computational Physics, Problem Solving With Computers, Rubin H. Landau and M. J. Paez, John Wiley (1997)
5. Practical Numerical Methods using Python (2022), M. K. Verma

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Lectures: 11:00 am-12:00 pm on Monday, 10.00-11.00 am Thursday and Friday, **Venue:** L15
Practical: Thursday 3.00 PM- 6.00 PM, **Venue:** Math Linux Lab

Student TA: Arijit Halder (harijit@iitk.ac.in), Debojyoti Garain (dgarain@iitk.ac.in), Rohit Kumar (rohit20@iitk.ac.in)

Evaluation Scheme: Lab Assignments (20%), Quiz (15%), Mid-Sem Examination (30%), End-Sem Examination (35%). Taking End-Sem examination is mandatory.

Attendance is mandatory for this course.

Course Policy:

1. Only SUGC sanctioned leaves will be considered as valid reasons for absences during lectures/quizzes/exams.

2. DOAA guidelines on use of unfair means will be strictly followed.