UNIVERSITY OF MADRAS
M.SC DEGREE PROGRAMME IN PHYSICS
SYLLABUS WITH EFFECT FROM 2023-2024.

529S4A

Professional Competency Skill - PHYSICS SIMULATIONS WITH PYTHON

Unit 1: Introduction to Computational Physics

Role of simulations in physics-Advantages and limitations of computational methods-Overview of Python for scientific computing.

Unit 2: Python Basics for Physics Simulations

Data types, loops, and functions-NumPy for numerical computations-Matplotlib for data visualization-SymPy for symbolic computation.

Unit 3: Solving Ordinary Differential Equations (ODEs) in Physics

Solving first- and second-order differential equations- Euler's method, Runge-Kutta methods, projectile motion with air resistance, and simple harmonic motion (damped and forced oscillations).

Unit 4: Electromagnetism & Fields Simulations

Charge distribution and electric field visualization, solving Laplace's equation using relaxation methods, magnetic field visualization for current loops, and numerically solving Maxwell's equations

Unit 5: Quantum Mechanics Simulations

Solving Schrödinger's time-independent and time-dependent equations numerically-simulating a particle in a 1D, 2D, and 3D box - modeling quantum tunneling through a potential barrier and well."

Books for study

1. Rubin H. Landau, Manuel J. Páez, & Cristian C. Bordeianu (2015). Computational Physics: Problem Solving with Python. Wiley.
2. Giuseppe Moruzzi (2021). Python for Physics: A Practical Introduction to Computational Physics with Python. Springe
3. Gupta, S. C. (2019). *Fundamentals of Mathematical Physics*. New Age International Publishers (Indian Author).
4. Jake VanderPlas (2016). Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media.Rajaraman, V. (2014). *Computer Programming in Python*. PHI Learning (Indian Author).

References

1. Landau, R. H., Páez, M. J., & Bordeianu, C. C. (2015). *A Survey of Computational Physics: Introductory Co*
2. *mputational Science*. Princeton University Press
3. Newman, M. (2013). *Computational Physics*. CreateSpace Independent Publishing Platform.
4. Koonin, S. E., & Meredith, D. C. (2018). *Computational Physics: Fortran Version*. Westview Press.

Web Links

Computational Physics with Python - MIT OpenCourseWare

Numerical Methods for Physics - University of Colorado Boulder

SciPy and NumPy for Scientific Computing

NPTEL Course on Computational Physics

IIT Bombay - Python for Scientific Computing