

PHYS 640 Computational Physics

TIME AND LOCATION:

Tuesday 11:30 - 12:45 Mathematics and Psychology Building., Room 010
Thursday 11:30 - 12:45 Mathematics and Psychology Building., Room 010

INSTRUCTOR:

Dr. Tamás Várnai

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OFFICE HOURS:

Tuesday afternoon, exact hours & location TBD

TEXTS:

“Computational Physics: Problem Solving with Computers” By R. H. Landau et al.
Published by WILEY-VCH

GRADING:

Homework (30%), Midterm Project (20%), Final Project (30%),
Participation/Discussion (20%)

COURSE OUTLINE:

❖ **Computer Setup and Programming Warm-Up (Weeks 1~2)** (this part is taught by Dr. Zhibo Zhang)

- Computer Setup
- Python programming basics
- Numpy and Matplotlib

❖ **Understanding Errors and Uncertainties In Numerical Computations**

- Type of Errors
- Tricks to control errors

❖ **Monte Carlo method**

- 2-D random walk
- 3-D random walk
- Real-world Problem: Photon scattering in cloud

❖ Numerical Integration

- Quadrature methods
- Monte Carlo method
- Real-world Problem: Integrate Radiance to Flux

❖ Numerical Differentiation and Root Searching

- Bisection method
- Newton-Raphson method
- Real-world Problem: Cloud property remote sensing

❖ Midterm Projects

❖ Linear algebra and matrix computing

- Matrix inversion and Eigenvalue
- Singular value decomposition
- Real-world problem: Greenhouse effect and atmospheric temperature profile

❖ Data fitting

- Quadrature fitting
- Least-square fitting
- Real-world problem: Satellite data analysis

❖ Differential Equations: ODE and PDE (if time permits)

- Trajectory
- Wave equation
- Real-world problem: Maxwell Eq. and E&M wave propagation

❖ Final Projects