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
Phone:  301-614-6408
Email:  varnai@umbc.edu

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 Programing 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**
  - Bisect 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**