# Physics 401/801 — Computational Physics

Spring 2024

## Synopsis

This course is an introduction to using numerical methods to solve physical problems.

## Meeting Time

2:00 – 3:15 PM Tuesday, Jorgensen 245 (lecture)
2:00 – 3:15 PM Thursday, Jorgensen 211 (lab)

## Instructor

Brad Shadwick, Jorgensen 310N, 472-3578, shadwick@unl.edu
Office Hours: Drop by or by appointment.

## Course Description

Computational physics is the solving of physical problems by numerical (as opposed to analytical) means. We will study some basic elements of numerical analysis and their application to the solution of physical problems. We will follow the text by Acton (see below) closely with some supplemental material on solving differential equations. We will focus on computational methods, not on programming. Our class time will be split (approximately 50–50) between lecture and computing labs. There will be weekly reading assignments that must be completed before class. Typically, I will post material for each class on the preceding Wednesday. All of our computing will be done using python. Homework will be generally assigned weekly and **due by noon** each Tuesday.

Topics to be covered (tentative):

- Evaluating functions
- Approximation & Interpolation
- Roots of equations
- Quadrature (integration)
- Roots of polynomials
- Solution systems of linear equations
- ODEs: initial value problems, boundary value problems, & symplectic integrators
- PDEs: elliptic & hyperbolic problems
- Spectral analysis and Fourier transforms

## Text & References

### Required

- *Numerical Methods that Work*, Forman S. Acton, American Mathematical Society, 1990. The paper version of this book is out of print but is available used. An electronic version of book can be purchased from the American Mathematical Society.

### Optional (if you already know python)

- *Learning Python*, Mark Lutz, O'Reilly, 5th Ed., 2013. ISBN-13: 978-1449355739.
- *A Primer on Scientific Programming with Python*, Hans Petter Langtangen, 2016

### Additional references (on reserve in the Engineering Library)

- "Numerical Methods," Robert W. Hornbeck, Quantum Publishers, 1975.
- "Numerical Methods for Scientists and Engineers," R. W. Hamming, 2nd Ed., McGraw–Hill, 1973.

### Online documentation

- Python: `https://docs.python.org/3.9/`
- Numpy: `https://numpy.org/doc/stable`
- Scipy: `https://scipy.github.io/devdocs/tutorial/`
- Matplotlib: `https://matplotlib.org/stable`
- Matplotlib examples: `https://matplotlib.org/stable/gallery`

## Computers

We will be using `jupyter` notebooks for all examples and home problems. The systems is accessed from `https://ml-mgt.unl.edu:8000`.

## Final Project

Each student will complete a final project, in lieu of a final exam, on a subject chosen in consultation with the instructor. (Those registered for 801 should pick a topic related to their research.) The project will involve: the computational solution of some physics problem, a written report, and a 20 minute oral presentation. A one paragraph abstract describing the your project is **due no later than Tuesday, March 5**. The presentations will take place during the last week of classes (both Tuesday and Thursday) and at the time of our scheduled exam, **1:00 PM to 3:00 PM, Wednesday, May 15**.

## Grading (approximate)

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|---|---|
| 2/3 | Homework |
| 1/3 | Project |

## Web Pages

Course materials will be available through the Canvas system.

## UNL Course Policies

Students are responsible for knowing the university policies found at `https://go.unl.edu/coursepolicies`.