

# PHYSICS 441

## FALL 2023

### COMPUTATIONAL PHYSICS

#### Instructor Information

Instructor: Dr. Yang Zhang, Assistant Professor in Physics & Astronomy, and EECS

Office: 217A Nielsen building

Email: [yangzhang@utk.edu](mailto:yangzhang@utk.edu), or via the Canvas message system

Zoom link: <https://tennessee.zoom.us/j/87464677446>

Communication: The majority of classroom communication will be conducted via Canvas for this class. To ensure a prompt response, please follow the email policy:

- Please put “**PHYS 441**” in the subject line of all course-related emails. This practice helps identify course-related emails.
- Before emailing, please ensure that the information is not already provided in the course syllabus or on Canvas.

#### General Course Information

Lecture Hours            12:55 – 02:10 pm Tue/Thu

Location                 NIELSEN 203

Office Hours            02:30 – 03:30 am Tuesday  
Nielsen 217A

Laboratory Hours        Thursday by schedule

TA                         Johnny Lawless        [jlawles4@vols.utk.edu](mailto:jlawles4@vols.utk.edu)

#### General Course Description

Physics 441 is a 3-credit-hour physics course with programming. This course covers the introduction to scientific computing, basic numerical programming with Python, computational modelling of physical problems, and basic machine learning.

After successfully completing this course, students should be able to: 1) Use computational techniques to solve and explore topics addressed through the undergraduate physics program; 2) Develop and use elementary computational methods to solve physics problems; 3) Develop experience to assess the appropriate computational technique and necessary precision for the particular physics application; 4) Explain computational approach and methods used for selected homework to class; 5) Develop an individual semester-long computational physics project with advice of instructor; 6) Present computational physics project to class at end of the semester with write-up.

#### Prerequisites

Familiarity with calculus and calculus concepts, as well as concepts in vector algebra. A background in mathematics up to the level of Math 141-142, or equivalent, is highly recommended and is probably necessary for success in the course. The course also assumes that you are familiar with concepts in classical mechanics such as force, acceleration, work, kinetic and potential energy, and Newton’s laws, as taught in PHYS 135 or PHYS 137. Basic Python programming skills are required.

## Textbooks

Recommended books for the course:

“Computational Physics”, Nicholas J. Giordano and Hisao Nakanishi

<http://www.physics.purdue.edu/~hisao/book/>

## Course Format

The course consists of two lectures per week, the Thursday class will be more hands-on programming. We will proceed using a mix of traditional lecturing, and problem-solving demonstrations/active-learning exercises.

## Announcements, Lecture Notes, Course Updates

This syllabus and other important information and announcements will be posted on Canvas, as well as copies of the slides used in the lecture. Your grades will be posted in the Canvas Gradebook, and your grades will be available for only you to see.

## Class Schedule

The following is a class schedule along with lecture topics, assignments, etc. This is a tentative schedule and might differ as our class speeds. We will be performing our computation locally and also remotely on UT’s supercomputer, ISAAC.

The main focus of this course will be to provide an introduction to modern numerical techniques with the goal of either simulating or solving real physical systems. We will study examples from classical mechanics, electricity and magnetism, chaos, and statistical mechanics with an emphasis on the graphical representation of results. We will use Python as the main programming language with libraries such as Matplotlib, Scipy, and Numpy being employed where appropriate. A rough breakdown of topics includes:

- Introduction to the Python and Linux system tools for HPC. (Class 2-5)
- Data structure, data storage, errors, and uncertainties in computation. (Class 6-7 )
- Finite difference methods (dissipation in classical mechanics, chaos, equation of motion, and N-body problems ) (Class 8-13 )
- Derivative and Integration (Exact and Monte Carlo methods for higher dimensional integrals) (Class 14-17)
- Statistical mechanics (classical many-body problem via Monte Carlo and molecular dynamics) ) (Class 18-23)
- Interpolation, splines, and Fourier Transforms (curve fitting and analysis of experimental or simulation data) (Class 24-25)
- Introduction to Machine Learning (Class 26)

## Class sessions:

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1.	Thu Aug. 24	Introduction to Phys 441
2.	Tue Aug. 29	Introduction to Python and Linux
3.	Thu Aug. 31	Hands on practice



**The Final Project is mandatory.** Missing the final project presentation is very serious and may result in the course's failure. The final project **presentation (20 mins)** will be given on Nov. 30 and Dec. 5 in class.

### Conversion to Letter Grades

A	85 – 105
B	75 - 85
C	60 - 75
D	50 - 60
F	0 - 50

### Questions and Appeals

I encourage you to ask questions during the lecture or/and talk to me during my office hours (Tuesday or by appointment – just ask after class) about the subject. You can discuss with me and/or complain to me about the grading of a given assignment, Mid Exams, or Final project. Any appeal will be entertained if it is raised no later than one week after the date on which the graded Exam/HW is made available for return to the class. After this “appeal period” of one week, exam grades will be considered final and will not be altered.

### Your Feedback/Suggestions on the course

You are encouraged to provide feedback on any aspect of the course all through the semester using any communication method you prefer. You will also have an opportunity to give feedback at the end of the semester through the Course Evaluation System. Your feedback is critical in improving the course!

### For students with disabilities

The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kinds of disability, or a temporary injury, you are encouraged to contact Student Disability Services (SDS) at 865-974-6087 or [sds@utk.edu](mailto:sds@utk.edu). An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing the accommodations included in your course access letter.

### Academic Honesty

*All work submitted by a student is expected to represent his/her own work. Students are expected to enter their own homework without assistance from others. Students are expected to perform all work in conformance with the University policies regarding Academic Honesty.*