PHYS 325
Intermediate University Physics Laboratory

Spring 2021
Lecture: Fridays 1:30 – 4:10 pm
Classroom: ONLINE

Instructor:

- Dr. Fernando E. Camelli
- E-mail: fcamelli@gmu.edu
- Office: Planetary Hall, Suite 103, #101C
- Office Hours: Friday from 10:00 am to 11:30 am, or by appointment.

Course Description:

Experiments in mechanics, electricity, and magnetism with emphasis on data analysis using state-of-the-art-tools.

Fulfills Mason Core requirement in information technology (all except ethics).

Prerequisite(s): C or higher in PHYS 251 and PHYS 260. Prerequisite enforced by registration system.

About this Class:

PHYS 325 will be offered as a synchronous online class this semester. The class will meet in a virtual Zoom room Fridays from 1:30 pm to 4:10 pm. You can access the Zoom virtual room in the PHYS 325 Black Board webpage:

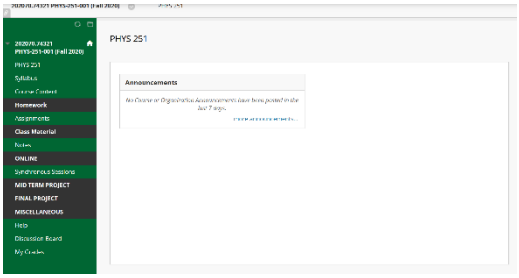

Figure 1: PHYS 251 Black Board web page.

Once you are in the PHYS 251 Black Board web page, you should click on “Synchronous Sessions”, on the left side of the page, and you will access the following page:

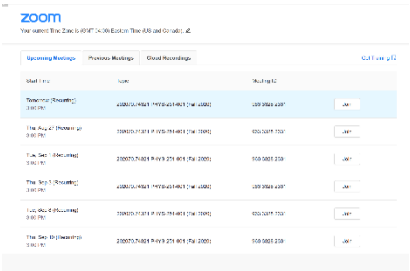

Figure 2: Access to Zoom from Black Board.

You should click on “Join” to access the virtual classroom.

Each class meeting will be split into two periods: new material will be presented in the first period of class, and students will work on problems in the second period of class. The problems introduced in the second period will be related to homework problems.

The material you need for this class is in the required textbook and in Blackboard. You are expected to review the material before each class. All the topics and problems for this class are covered in the textbook and in the lectures available on Blackboard. The lecture notes contain example problems and activities.

This is an activity-driven class; I will not be giving extensive lectures on each topic. Instead, I will give a brief overview of the topic and then provide activities that you will work through in-class. The homework assignments are typically based in part on the activities that you worked on in class.

You are encouraged to work with other students on the in-class activities.

Attendance to this class is required. If you miss a class, you will likely find the homework assignments to be difficult.

Objectives:

- To develop proficiency integrating laboratory work and computational techniques.
- To analyze data: uncertainties, plots and statistics.
- To model physical processes trough experiments and correlating them with a numerical model.
- To be proficient in developing ideas for ways to determine if a numerical solution is physically reasonable or correct and compare it to an experiment.
- To develop and analyze the results of numerical experiments of physical systems.

Schedule:

- Week 1: Python review.
- Week 2: Numbers.
- Week 3: Derivatives.
- Week 4: Linear algebra – Part I.
- Week 5: Linear algebra – Part II.
- Week 6: Roots, nonlinear equations.
- Week 7: Approximation, interpolation.
- Week 8: Integrals.
- Week 9: Differential Equations, initial value problems – Part I.
- Week 10: Differential Equations, initial value problems – Part II.
- Week 11: Differential Equations, initial value problems – Part III.
- Week 12: Differential Equations, boundary value problems – Part I.
- Week 13: Differential Equations, boundary value problems – Part II.
- Week 14: Differential Equations, boundary value problems – Part III.
- Week 15: Fast Fourier transform.

Textbooks:

There is not a required textbook for this course. The following list is a sample of the books available in the University Library. Some of these books are available online through the University. The course will not follow any specific book.

- **"Numerical Methods in Physics with Python", A. Gezerlis, 2020 (required).**
- **"Computational Physics", Newman, 2023 (recommended),**
- "University Physics", Young and Freeman,
- "Numerical Analysis", Richard L. Burden and J. Douglas Faires, 1993.
- "Python and Matplotlib Essentials for Scientists and Engineers", Matt A. Wood, 2015.
- "Mastering Matplotlib", Duncan M. McGreggor, 2015.
- "Introduction to Programming in Python: An Interdisciplinary Approach", Robert Sedgewick, Kevin Wayne and Robert Dondero, 2015.
- "Numerical Python: A Practical Techniques Approach for Industry", Robert Johansson, 2015.
- "NumPy: Beginner's Guide", Ivan Idris, 3rd Edition, 2015.
- "NumPy Essentials", Leo Chin and Tanmay Dutta, 2016.
- "SciPy and NumPy", Eli Bressert, 2012.
- "Python Data Analytics: Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language", Fabio Nelli, 2015,

References:

The following are additional references covering Computational Physics at the Junior/Senior undergraduate level.

- "Computational Physics", Nicholas Giordano and Hisao Nakanishi, 2nd Edition, 2006.
- "Basic Concepts in Computational Physics", Benjamin A. Stickler and Ewald Schachinger, 2014.
- "A Course on Mathematical Methods for Physicists", Russel L. Herman, 2013.
- "Introduction to Computational Science: Modeling and Simulation for the Sciences", Angela B. Shiflet George W. Shiflet, 2006.

Other links:

- Finding E-Books at Mason: [1]
- A list of computational physics books: [2]
- Instructor resources for undergraduate computational physics: [3]

Grading:

- Final and Midterm Projects: 50% - One midterm and one final projects, equally weighted.
- Homework: 40% - Usually one assignment per week. The lowest homework grade is dropped. I do not accept late homework assignments.
- Quizzes-Polls: 5%
- Attendance: 5%

Letter Grades:

- > 97: A+
- 93 to 96.9: A
- 90 to 92.9: A-

- 87 to 89.9: B+
- 83 to 86.9: B
- 80 to 82.9: B-
- 77 to 79.9: C+
- 73 to 76.9: C
- 70 to 72.9: C-
- 60 to 69.9: D
- < 60: F

Projects:

You will work on the midterm and final projects individually. You can discuss ideas with other students, and you can ask me questions about the projects during office hours. You must not use someone else computer code in any of the projects. You must write an original computer code for the projects. You must explore a scientific question that may not be easily answer without the help of a computer.

The midterm project will require to write a computer code to answer a scientific question and present your results in a written paper. The written paper only requires presenting and explaining your results with tables or plots and a conclusion section. You should expect that the midterm project will like slightly more difficult than some homework.

The final project encompasses the analysis and interpretation of the data produced by your computer code. The deliverable of the final project is the computer code, and a full paper describing the project, the numerical methods used in your code and the analysis of the data produced by your code.

The paper final project paper will be organized with the following sections: (a) introduction, (b) description of the problem, (c) results, and (d) conclusions. Examples of scientific papers will be introduced in the class to help you to write your final paper.

Email Communication:

Please send all your question to me via email. Here are a few thinks to remember to make email communication better.

- Please use your name in the salutation so that I don't have to look up your name given only your Mason email address. There is a way of setting up your email so your full name appears in the header - see below.
- If you have a question about a program, copy it inline in the email body, attach it (worst option), or (best option), send me a direct link to it on Bitbucket so I can place my comments directly in your program.
- Always tell me what you tried and read and be very specific about your point of confusion. Otherwise, I may guess incorrectly why you are confused. For example, if you say "I don't know where to start" I may guess that you don't know how to use a keyboard or that you need to be told "at the beginning". You will oftentimes find that if you write out a question, in the process of trying to make yourself clear about your point of confusion, you'll realize the answer to your question.

How to show your full name in MasonLive emails:

1. Log in to your MasonLive account.
2. Click on the 'Settings Gear' at the top right of your window, then select 'Options' from the drop-down list.

3. On the left-hand menu click 'General', then click on 'My Account'.
4. On the 'My Account' screen, type in your full name in the 'Display Name' area, then click 'Save'.

Collaboration Policy:

You may collaborate with other students on your homework. *However, the write-up and code that you turn in must be independent.* I suggest starting the homework prior to having any discussion with other students. Turning in a write-up or code that is similar to another student's will be treated as an honor code violation. The best way to avoid an honor code violation is to have someone look at your work when you are stuck and have them suggest modifications (rather than looking at someone else's work). ***Plagiarism will not be tolerated.*** If you collaborate with another student, you must indicate the name of the student on your write-up and/or code.

Referencing Policy:

It is quite unlikely that any homework problem will have a solution available on an external website, and you are encouraged to use other resources to help you with parts of a problem. If you used a website or a book while doing your homework, please reference it. This is a good habit to have when you do any programming or writing.

Software:

All software needed for this course is available to GMU students free of charge. Students will build on example code in Python; no prior experience with other languages is expected. We will also experiment with Python during the class.

Academic Calendar: GMU Academic Calendar

University Policy:

The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/ . All members of the university community are responsible for knowing and following established policies.

Disability Accommodations:

If you have a learning disability or other condition that may affect academic performance, please: a) make sure documentation is on file with Office of Disability Services (SUB I, Rm. 4205; 993-2474; http://ods.gmu.edu) to determine the accommodations you need; and b) talk with me to discuss your accommodation needs.

Counseling and Student Support:

- Counseling and Psychological Services provides confidential psychological services, including 24/7 crisis intervention and consultation to faculty and staff: http://caps.gmu.edu/

- Student Support helps students negotiate life situations by connecting them with appropriate on- and off-campus resources http://studentsupport.gmu.edu/referral-form/

Celebrating our Diversity:

The College of Science, an intentionally inclusive community, promotes and maintains an equitable and just work and learning environment. We welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age, and disability.

- We value our diverse student body and desire to increase the diversity of our faculty and staff.
- We commit to supporting students, faculty and staff who have been the victims of bias and discrimination.
- We promote continuous learning and improvement to create an environment that values diverse points of view and life experiences.
- We believe that faculty, staff, and students play a role in creating an environment that engages diverse points of view.
- We believe that by fostering their willingness to hear and learn from a variety of sources and viewpoints, our students will gain competence in communication, critical thinking and global understanding, aware of their biases and how they affect their interactions with others and the world.

Mason University Life religious holiday calendar:

https://ulife.gmu.edu/religious-holiday-calendar/

It is your responsibility, within the first two weeks of the semester, to let me know the dates of major religious holidays on which you will be absent or unavailable due to religious observances.

Student Privacy: https://registrar.gmu.edu/ferpa/

Student services:

- Keep Learning, Learning Services (learningservices.gmu.edu/keeplearning/)
- University Libraries (library.gmu.edu)
- Writing Center (writingcenter.gmu.edu)
- Counseling and Psychological Services (caps.gmu.edu)