PHYS 503 Dr. Edward J. Brash
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Office: Luter 304 594-7451
Office Hours: Mon/Wed/Fri 11:00am-12:00pm, and by appointment

System Design Laboratory/Advanced Analysis and Simulation Course

Texts: There is not a required text for this course.

Course Overview:

This course has two principal overarching goals:

1. To provide an introduction to the methodology of investigating advanced physics in an experimental laboratory.

2. To provide an introduction to the advanced analysis and simulation techniques used by physicists in graduate research and industry.

Laboratory Component:

Students will carry out an introductory experiment, followed by several more in-depth experiments over the course of the term.

Instead of formal (typed up) lab reports, results from these experiments will be presented to the class as a whole via some of the avenues used for scientific communication: the scientific poster, wiki pages, the scientific manuscript/paper, and/or the scientific talk (the specific format will be specified for each experiment before it begins). In addition, students will keep an experimental lab notebook – more details on the format of this logbook are given below and will be discussed during the first class.

Students will work in small groups. We will determine the specific groups during the first week of class. The groups may change over the course of the semester.

For each experiment, the scientific communication vehicle will be submitted in two stages – a draft version (including a formal outline), and a final version.

Finally, there will be an individual graduate lab project that will be due at the end of the semester. Projects will be assigned on an individual basis, with the hope that this project will complement your graduate research and/or personal goals for the course in some way.

Analysis and Simulation Component:

The main sub-goals for this portion of the course are:

A) To study and understand some of the most basic and useful techniques in numerical analysis.

B) To develop a suite of useful programs, methods, and libraries which you will be able to apply to a host of problems going forward.

C) To develop an appreciation for and understanding of some of the applications of numerical analysis, in particular in modeling and simulation of non-linear physical processes.

We will be using the Python and Jupyter Notebooks, together with many very useful Python modules, including SciPy, NumPy, Matplotlib, Seaborn, Statsmodels, Scikit-Learn, and SimPy, for the data analysis and simulation frameworks, for the development of analysis scripts and programs, and also importantly for visualization. Over the last several years, I have developed a lot of useful pieces of analysis and simulation code in Python. I will make at least some of these programs available to you at points throughout the course, as a starting point for the assignments.

I have found that Anaconda (http://www.anaconda.com) is an incredibly useful and easy to install data science platform, if you want to have the software on a local machine.

There will be assignments given periodically, and in most cases will be due one week later. Homework is due by 5:00 pm on the due date. No extensions will be given, except in the case of a valid DOCUMENTED reason.

Significant Difference Statement:

This course is cross-listed with PHYS421, and differs from that course in the following ways:

1. The graduate lab project that is assigned is, of course, only for the graduate students in the course, i.e. only those students enrolled in PHYS 503.
2. As a graduate students, the expectation is that you should take on more of a leadership role in the group that you are working in. The evaluation of the overall performance/attendance/effort portion of the grade in this course, as explained in more detail below, will reflect, in part, an evaluation of this leadership component.

Safety:

Physics research presents a variety of technical situations involving a wide spectrum of potential hazards. Laboratory work, therefore, may involve tasks that are potentially hazardous.

Do not perform hazardous experimental work in any research or teaching laboratory, day or night, when you are entirely alone. Make sure that someone is aware of your activity and is available to assist you in case of emergency.

Make yourself familiar with potentially dangerous situations associated with each experiment.

Lab Notebook:

Keeping a detailed and organized lab notebook is critical skill for both engineers and scientists.

You should always write your data, observations, and calculations directly into your notebooks, and never onto scrap pieces of paper. If you are recording data and make a mistake, simply cross it out. If you make a big mistake and have an entire page of useless calculations, just draw a line through it and write OMIT and explain why you believe it's flawed. Don't tear out the page. If the data turn out to be correct after all, they are easily resurrected. Remember, this is intended to be a working lab notebook. It will hopefully be relatively neat and fairly easy to follow, but it need not be perfect. We require you to record your data in pen, and white-out is forbidden. A lab notebook is a legal document, and there can be no evidence of tampering.

A working lab book evolves as your work progresses; you can move backward in the book to fill in details or augment explanations as you go, and forward to lay out a logical plan of work to be done, and how, and what mode of display of results you will use. You are strongly advised to plan and explore the experiment before the time you will actually do it. You can then come to the lab with your notebook already containing a plan of what you will do, and how. Your book could already contain tables laid out for data entry, algorithms specified for reducing the data, graph pages designed, and a checklist to ensure all experimental work has been done. If you record things in your book which you later decide to be wrong or otherwise to be ignored, that's OK — indicate this, and leave it there. Data and analysis in the logbook need to have a date associated with them, particularly if parts of the report are out of sequence.

Your notebook should be understandable in the absence of any other material. You don't need to reproduce derivations of equations, but the important equations should be presented with references. A diagram of the experimental set-up that includes details like model numbers of equipment is essential. At any time, a colleague (or especially one of your group members!!!) should be able to pick up your notebook and understand what you've done so far.

You will only be writing a formal report for one of the four experiments, but your lab book should contain most of the elements of a formal report within it: every experiment in your book should contain some statement of objective, what you are doing and why. It should explain clearly how the experiment is done, and should have some discussion of the results and should clearly state your conclusions.

I would also like you to get experience in writing scientific abstracts, and so I ask you to write an abstract in your book when you have completed the experiment and analysis.

Computer data files: Every raw data file you create in an experiment should be noted in your lab book with some explanation of what data are in it, and other relevant experimental details. Imagine coming back to your notebook two years from now – make it easy to figure out what data you have, and how to find it. In a working lab, you will eventually find that trying to encode all the details about the file in the file name is a losing proposition when you start repeating measurements with slightly different combinations of parameters. You are much better to give files names according to some simple scheme, e.g. ejb20140920-1 [my initials, followed by the date and a sequence number]. Then the contents of the file are described fully in your lab notebook. This protocol makes it easy to find the information about the file because the file points to the date which can be quickly located in the lab book.

Grading:	Scientific communications/reports	30%
	Homework Assignments	30%
	Lab Notebook	10%
	Overall performance/attendance/effort	30%

Scientific communications/reports, at each stage, will be due at the beginning of class on the specified due date. No extensions will be given, except in the case of a valid DOCUMENTED reason.

Final grades will be assigned as follows:

A = 87-100%; A^- = 80-86 %
B^+ = 77-89 %; B = 73 –77 %; B^- = 70 – 73 %
C^+ = 67-79%; C = 63 –67 %; C^- = 60 – 63 %
D^+ = 57-69%; D = 53 –57 %; D^- = 50 – 53 %: F < 50%

Hints:

Do not labor over something for hours. Try to figure it out yourself and if you can't, then ask for help.

Generally, you are expected to attend the course (whether it is a lecture or a lab period) during the allotted time for PHYS 421. You MUST attend on weeks where you are to give a presentation and the week before where will we discuss a draft of your presentation. However, if you do end up having 3 midterms and 6 assignments due in one week, I don't mind if you do your lab work at some other time the week before or after.

Honor Code, Plagiarism, and All That:

Students are encouraged to talk with each other and help each other where appropriate, but copying from current or pre-existing lab reports, marked or unmarked, is strictly prohibited. If you are thinking about it, don't. I can tell.

While it is obvious what constitutes academic misconduct during exams, in the past there has been some confusion regarding misconduct when working together on lab reports and other presentation formats. In the interest of being crystal clear on this topic below I have

provided some specific examples detailing what is and what isn't acceptable behavior. This list is meant only as a guide and it is by no means exhaustive. Moreover, the final determination of what is and isn't academic misconduct shall always follow official CNU policy.

Examples of academic misconduct in the context of laboratory work:

1. Directly copying any portion of another student's presentation/report/poster/lab notebook (whether in final form or not) and hands them is as his/her own solutions.

2. Copying from current or pre-existing lab reports whether they are marked or unmarked.

3. Using data taken by anyone other than yourself or members of your group.

4. Presenting the work of another student (such as a computer program, etc.) as your own work (even if it is a student in your group).

Examples of acceptable conduct in the context of laboratory work:

1. Two or more students sit down and discuss a laboratory analysis to see if their understanding of the problem(s) and/or their solution(s) are consistent and then SEPERATELY go their own way and write their own solutions WITHOUT reference to a either a common document or another student's solutions (whether the latter is in final form or not).

2. Using a computer program or other utility written by another student to analyze your data, and giving appropriate credit to that student in the final presentation product.

Additional Information, provided by the CNU Administration, which you may find useful (and with which I happen to agree):

University Statement on Diversity and Inclusion:
The Christopher Newport University community engages and respects different viewpoints, understands the cultural and structural context in which those viewpoints emerge, and questions the development of our own perspectives and values, as these are among the fundamental tenets of a liberal arts education.

Accordingly, we affirm our commitment to a campus culture that embraces the full spectrum of human attributes, perspectives, and disciplines, and offers every member of the University the opportunity to become their best self.

Understanding and respecting differences can best develop in a community where members learn, live, work, and serve among individuals with diverse worldviews, identities, and values. We are dedicated to upholding the dignity and worth of all members of this academic community such that all may engage effectively and compassionately in a pluralistic society.

If you have specific questions, suggestions, or concerns regarding diversity on campus please contact Diversity.Inclusion@CNU.edu

Disabilities/Accessibility:
For a student to receive an accommodation due to a disability, that disability must be on record in the Office of Student Affairs, 3rd Floor, David Student Union (DSU). If you have a diagnosed disability, please contact Jacquelyn Barnes, Student Disability Support Specialist in Student Affairs (594-7160) to discuss your needs.

Students with documented disabilities are to notify the instructor at least seven days prior to the point at which they require an accommodation (the first day of class is recommended), in private, if accommodation is needed. The instructor will provide students with disabilities with the reasonable accommodations approved and directed by the Office of Student Affairs. Work completed before the student notifies the instructor of his/her disability may be counted toward the final grade at the sole discretion of the instructor.

Success:
I want you to succeed in this course and at Christopher Newport University. I encourage you to contact me during office hours or to schedule an appointment to discuss course content or to answer questions you have. If I become concerned about your course performance, attendance, engagement, or well-being, I will contact you first. I also may submit a referral through our Captains Care Program. The referral will be received by the Center for Academic Success as well as other departments when appropriate (Counseling Services, Office of Student Engagement). If you are an athlete, the Manager of Athletic Academic Success Programs will be notified. Someone will contact you to help determine what will help you succeed. Please remember that this is a means for me to support you and help foster your success at Christopher Newport University.

Public Health

The university will provide guidance on public health issues and students will be expected to comply with university protocols.

Academic Support:

The Center for Academic Success offers free tutoring assistance for Christopher Newport students in several academic areas. Center staff offer individual assistance and/or workshops on various study strategies to help you perform your best in your courses. The center also houses the Alice F. Randall Writing Center. Writing consultants can help you at any stage of the writing process, from invention, to development of ideas, to polishing a final draft. The Center is not a proofreading service, but consultants can help you to recognize and find grammar and punctuation errors in your work as well as provide assistance with global tasks. Contact them as early in the writing process as you can!

You may contact the Center for Academic Success to request a tutor, confer with a writing consultant, obtain a schedule of workshops, or make an appointment to talk with a staff member about study skills and strategies. The Center is located in Christopher Newport Hall, first floor, room 123. You may email academicsuccess@cnu.edu or call (757) 594-7684.

Course Materials:
All content created and assembled by the faculty member and used in this course is to be considered intellectual property owned by the faculty member and Christopher Newport University. It is provided solely for the private use of the students currently enrolled in this course. To ensure the free and open discussion of ideas, students may not make available any of the original course content, including but not limited to lectures, discussions, videos, handouts, and/or activities, to anyone not currently enrolled in the

course without the advance written permission of the instructor. This means that students may not record, download, screenshot, or in any way copy original course material for the purpose of distribution beyond this course. A violation may be considered theft. It is the student's responsibility to protect course material when accessing it outside of the physical classroom space.

Textbook and Reference List

Data Analysis and Error Propagation

Bevington, Phillip, and D. Keith Robinson. Data Reduction and Error Analysis for the Physical Sciences.: The McGraw-Hill Companies, 2002. ISBN: 9780072472271

Taylor, John R. Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements.: University Science Press, 1997. ISBN: 9780935702750

Design of Experiments

Montgomery, Douglas C. Design and Analysis of Experiments, 6th Edition,: John Wiley & Sons, Incorporated, 2004. ISBN: 9780471487357

Baird, D.C. Experimentation: An Introduction to Measurement Theory and Experiment Design, 3rd Edition.: Prentice Hall, 1995. ISBN: 0133032981

Canavos, George C., and Koutrouvelis, Ioannis A. An Introduction to the Design and Analysis of Experiments.: Prentice Hall, 2008. ISBN: 9780136158639

Cobb, George W. Introduction to Design and Analysis of Experiments.: Key College Publishing, 2002. ISBN: 9781931914079

Probability and Statistics

Devore, Jay L. Probability and Statistics for Engineering and the Sciences.: Duxbury Resource Center, 2008. ISBN: 9780495557449