Course: Ph291 - Fall semester - Introductory Physics Laboratory

Credits and Contact hours: 1.5 credits, 2 contact hours per week

Objectives and Goals: In this course you will gain a physical and mathematical understanding of measurement, its statistical and error analysis, geometric optics, index of refraction, optics of individual and multiple lenses and mirrors, rays and ray tracing, wave fronts and image formation, diffraction and interference sufficient to solve new quantitative problems, to design, setup and execute related laboratory experiments, to analyze and interpret error of such experiments and to present experimental data, error analysis, physical analysis of results as a coherent and complete lab report including figures (with *Python)* and lab reports (using *LaTeX* & *OverLeaf*) -- a central goal of this course is to improve your scientific writing and the lab reports are assessed both individually and for evidence of improvement.

Course Topics:
(i) Theory and application of measurement techniques and the analysis, quantification and propagation of experimental error, statistical tests, properties of random functions and Gaussian distributions.

(ii) Snell's law and the principles and analysis of refraction and reflection, index of refraction, Huygens and Fermat's (least time) principles, variational methods, setting up and finding extrema of functioanls.

(iii) Geometric optics, coherence, including mirror, thick and thin lens formulae, lensmakers equation, ray tracing and images, principles of microscopes and telescopes and aberrations (spherical, chromatic).

(iv) Optics and history of the pinhole camera; design, construction and iterative improvement of simple pinhole cameras; pinhole photography techniques and chemical film development techniques.

(v) Interference, coherence, Young's double slit experiment and single slit interference; analysis using trigonometric, exponential and/or phasor methods.

(vi) Diffraction and gratings, the grating equation, connection to the Fourier transform and Fourier optics. resolution (diffraction) limit in optics, Airy disk.

Specific Course Information: The course addresses ABET outcomes Criteria 1-7.

Instructor: Philip Yecko**, Office:** 41 CSq room 515, **Telephone:** 212.353.4314**, e-mail:** philip.yecko@cooper.edu
Office Hours: Please check the Ph291 Moodle site or my office (515 CSq) for my office hours.

Prerequisites & credit: Ph212 plus Ph213 concurrent; familiarity with complex variables may improve your experience.

Textbook: There is no required textbook beyond your Physics text (HRW). Recommended and supplemental readings will be given in PDF for throughout the semester, starting in Week 2 (see Moodle) and includes material from the following: J.R. Taylor *Introduction to Error Analysis* and L. Lyons *A Practical Guide to Data Analysis for Physical Science Students*, among others.

Moodle: Check Moodle frequently for handouts, solutions, updates, news, urgent messages, office hours ... everything, really, so just check often. I will also post links to online resources and supplemental material.

Attendance: You cannot miss either the Lab meeting or the preceding Lecture meeting. If you miss a session for an excused absence (medical, religious, valid emergency) see your instructor (not TA) to schedule a make-up immediately.

Lab Reports: Each Lab requires a written Lab Report to be handed in 7 days (1 week) after that lab ends **before or at** the start of your regular lab meeting. Late labs will incur point penalties as found on the course Moodle page.

Grading policies: Your grade will be computed according to the following scheme:

80% Lab Reports + 20% Final Exam

Accommodations:

I value and uphold an environment that meets the needs of every student. Should you need accommodations please reach out to the Dean of Students who will issue a letter detailing the accommodations. You must meet with me to discuss how I can meet the accommodations you are eligible for. It is the student's responsibility to inform me of all accommodations they qualify for in accordance with the Dean's letter. This means that accommodations (e.g., grading accommodations) will not be applied unless I am notified accordingly by the student.
A complete description of student disability support services is in this link: https://cooper.edu/students/student-affairs

/disability.

Academic Integrity & Standards:

You are encouraged and expected to work on labs together, however you must write the lab report by yourself. In other words, each student must submit their own reports. Academic dishonesty of any kind (including plagiarism) is not acceptable and will result in a zero on that assignment. You should be aware of The Cooper Union School of Engineering Policy on Academic Standards: https://cooper.edu/engineering/curriculum/academic-standards-regulations.

Generative AI, ChatGPT, etc.:
A significant goal of this course is for you to learn or improve your scientific communication skills. Part of this is working with lab partners but another part is putting scientific and/or quantitative concepts and results into written and graphical form. This work must be your own without the use of AI tools.

Recordings, Zoom, etc.:
Some class sessions may be recorded for use by other students, possibly not in your section. Student consent to being recorded during class is a condition of class participation. If class is being taught online and you do not consent you must deactivate your video camera and remain muted at all times; you may participate via the chat feature or during period when the recording is paused.
Students are not permitted to record class sessions on their own (unless of course such recordings are mandated as a learning Accommodation). Students are not permitted to share or distribute in any way any recordings of this class.

Other important information:

The Cooper Union Title IX policy on sexual misconduct can be found in this link: https://cooper.edu/sites/default/files/uploads/assets/site/files/2020/Cooper-Union-Policy-Upholding-Human-Rights-Title-IX-Protections.pdf

Counseling Services at The Cooper Union are coordinated through the Office of Student Affairs. The Cooper Union counseling and mental health services website can be found here: https://cooper.edu/students/student-affairs/health/counseling

Tentative Weekly Schedule (may vary based on circumstances including weather):

Week	Topic	Assignment / Reading
0:		
1:	LECTURE 1: Error analysis	Taylor and Lyons handouts (Moodle)
2:	**LAB 1: Measurement and Error**	ALL Lab 1 Documents (Moodle)
3:	LECTURE 2: Reflection & Refraction	Lec 2 Notes, Handouts (Moodle)
4:	**LAB 2: Refraction & Pfund**	ALL Lab 2 Documents (Moodle)
5:	LECTURE 3: Geometric Optics	Lec 3 Notes, Handouts (Moodle)
6:	**LAB 3: Pinhole Photography**	Build your camera BEFORE Lab
7:	**LAB 3 continued**	
8:	LECTURE: Geometric Optics (cont.)	
9:	**LAB 4: Geometric Optics**	ALL Lab 4 Documents (Moodle)
10:	LECTURE: Interference	
11:	Thanksgiving week: NO MEETINGS	
12:	**LAB 5: Interference & Diffraction**	All Lab 5 Documents (Moodle)
13:	review	
14:	**LAB 6: Plotting in Python**	(Lab 6 cannot be handed in before graded Lab 1 report is returned)
15:	**FINAL EXAM:** (optional)	cumulative