Physics 480, Experimental Modern Physics
Fall 2024

Dr. Greg Severn

MWF 11:15am-12:05pm ST 261 (Class time) W: 2:30-5:20pm (Lab)
ST287 & ST 292 (Laboratory experiments)

(Dated: Fall 2024 **Draft Version 1.5**)

Professor: Dr. Greg Severn, **ST282** x6845, **severn@sandiego.edu** I did my thesis work in fusion relevant experimental plasma physics in grad school at UW-Madison, having gotten interested in plasma physics at UCLA as undergraduate physics major there. I was hired at USD to create advanced labs, and this course is one them!

Office Hours: M 1:30-3pm, T 2:00-3:30 R 1:30-3:30 (also lab times of course are super good times to discuss anything pertaining to the course), and of course by appt; but stay tuned for announcements on Canvas, as these may change during the semester.

Catalog listing: `EXPERIMENTAL MODERN PHYSICS Units: 4, Core Attributes: CADW, Prerequisites: PHYS 330 (Quantum Mechanics), A laboratory-based course focused on the introduction to principles of research techniques with an emphasis on modern physics. Experiments illustrate physical phenomena pertaining to core areas of physics: quantum mechanics, atomic and nuclear physics, laser physics and plasma physics. Analog and digital data acquisition instrumentation, high-resolution optical and laser technology, and phase sensitive detection technology will be explored. This course is the required writing-intensive course for physics majors and fulfills the upper-division core writing requirement. Students write papers up to professional standards required of publication in physics research journals, learn to write mathematical prose, engage in the peer review process, and learn to code LaTeX`

Required Text: *Experiments in Modern Physics* 2nd Ed., A.C. Melissinos and J. Napolitano, Academic Press, 2003. **Note: a lab notebook is required also**.

Lab Manual(s): Reprints, lab handouts, and supporting documentation for each experiment will be posted to Canvas and maybe a Google drive too, but that's to be determined.

Web pages: Our course has a public web page, see `http://www.sandiego.edu/~severn/p480W`, as well as on Canvas (`canvas.sandiego.edu`). LaTeX will be used for writing assignments, at `www.overleaf.com`. Please register forthwith for a free account.

Learning outcomes: By the course's end, the student will be able, principally through writing,

1. to demonstrate a thorough knowledge and comprehension of core concepts of classical and modern physics, especially in the specific areas of quantum mechanics and plasma physics.
2. to write mathematical prose well.
3. to explain the process of experimental research in the physical sciences, and articulate specific things that make experimental work in physics convincing.
4. to code manuscripts using the programming language, LaTeX proficiently.
5. to exhibit competency (as set forth in rubrics) in writing research papers up to the standards of the physics profession as formulated and maintained by the course rubric, and the American Physical Society and the American Institute of Physics (not redundant: this includes use of sources for citation, how to cite and why, the first essential engagement with the physics research literature in a physics course, etc.,etc.,etc....).
6. to become proficient in reviewing, refereeing research papers up to the professional standards maintained by our rubric and those same societies.
7. exhibit proficiency in designing experiments, and understanding experimental designs, that among other things, enhance signal relative to noise through a variety of contemporary techniques, which include electronic low, high, and band-pass filters, digital storage oscilloscopes, Lock-in amplifiers, and Data Acquisition technology.
8. finish the course with a recognition of the need for, and an ability to engage in life-long learning.

Grades: The breakdown of the final grade will be as follows: **3 Papers - 80%**, class participation assignments (LaTeX writing prompts, worksheets, *peer reviews*) 20%. Roughly speaking, I assign letter grades for final grades according to the scale, 85(A-)/75(B-)/65(C-)/50(D-).

The writing (& reviewing) process: Mastery of experimental and theoretical ideas will be demonstrated through well written research papers. There are 3 experiments for the semester (see table 1 for due dates) and each student will go through the submission process *individually, for each experiment.* Each paper is the product of what is sometimes called 'process-oriented writing'. The process adopted in PHYS 480 is one that attempts *not only to help the student to write up to professional standards, but also to simulate the*

actual experience of submitting a research paper to a journal, and to engage, as professional physicists do, with the reviewing process. As a result, the process includes,

- submission of a complete manuscript on Blackboard by the time of posted submission date (see table 2 for dates),
- performance of a peer review using rubrics; submit peer review by the time of the posted submission date, typically 48hrs. after submitting ones own manuscript for review, then
- receipt of 2 reviews: 1) peer review and 2) TJE review ("Tyrant Journal Editor") to use in making revisions to submitted manuscript,
- submission of revision of manuscript along with a cover letter ('rebuttal letter', visit 'information for authors' on the public course website), by the time of the posted submission date.

Class and Lab meetings: Groups I and II meet for lab on Wednesday afternoons. Class time topics include but are not limited to

- professional standards for writing in physics, including notes on LaTeX and mathematical prose and composition, the writing cycle (process) for papers in 480, and the submission process for research papers in physics, including the peer review process, plus, practice with revising patches of papers taken from student and profession submissions, and so on. These dominate class meetings at the beginning of the semester after which these topics are relegated mostly to Friday class times.
- advanced concepts in quantum theory and plasma physics,
- tutorial discussions of experimental design and diagnostics, experimental approaches to solving problems in physics, driven by the tutorial questions posted for each experiment,
- student led discussions of intermediate results, much like what happens in research group meeting, where students report their progress and understanding of things,
- historical examples of experimental design problems in experimental physics.

Accommodation of Disability: Students with verified physical or academic disability are entitled to appropriate academic accommodations. Please self-identify to me and to the Director of Disability Services, and/or the Learning Disabilities Specialist in Saints Hall, Room 300, (619) 260-4655.

TABLE I. Tentative schedule of meetings and topics. The dates for all 3 paper submissions, cover letters, Peer reviews, and *some* of the ad hoc assignments are given in the footnotes. **NB: 'Date' give is for Monday of the week**. Groups I and II meet in lab W afternoons. **NL-no lab, PW-ion acoustic waves in plasmas, OP-measuring quantum numbers in Rb I with optical pumping, LS-saturated absorption laser spectroscopy to measure hyperfine energy gaps in Rb I**

Week	Date	M W	Friday topics
I	2 Sep.	NL NL	Orientation to the writing process, LaTeX
II	9 Sep.	PW	Writing & reviewing, More on Mathematical Prose, Intro to Plasma Physics I + tutorial questions (TQs)
III	16 Sep.		Plasma Physics II + TQs, Writing Examples, good and bad,
IV	23 Sep.		Plasma Physics III + Theory presentations[a]
V	30 Sep.		Plasma Physics IV [**APS GEC 2024**][b]
VI	7 Oct. [c]	LS OP	New Experiment Orientation (LS & OP) TQ's [**APS DPP 2024**][d]
VII	14 Oct.[e]		Quantum Mechanics of two state systems I
VIII	21 Oct.		QM of 2 state systems II + TQs
IX	28 Oct.		QM of 2 state systems III + TQs
X	4 Nov.[f]	OP LS	New Experiment Orientation (OP & LS)
XI	11 Nov.[g]		QM of 2 state systems IV + TQs
XII	18 Nov.		QM of 2 state systems V + TQs
XIII	25 Nov.	NL	Exp. Design & diagnostic Issues I **Thanksgiving Break Woohoo! 27-29 Nov.**
XIV	2 Dec.		Exp. Design & diagnostic Issues II + TQs.[h]
XV	9 Dec		Exp. Design & diagnostic Issues III TQs
XVI	16 - 20 Dec. [i]		**Finals Week**

[a] Theory presentations on Friday 27 Sep.
[b] APS GEC 2024, San Diego, 9/30-10/4
[c] First submission Paper #1 (P_s^1) is M. **midnight** 7 Oct., + Peer Review of Paper #1 (PR^1) Th. **midnight** 10 Oct.
[d] APS DPP 2024, Atlanta GA, 10/7-10/11
[e] Final submission, Paper #1, P_{FS}^1 + cover letter, W **midnight** 16 Oct.
[f] P_s^2, M. **midnight** 4 Nov. + Peer Review, PR^2, W. **midnight**, 6 Nov.
[g] Final submission, Paper #2, P_{FS}^2 + cover letter M. **midnight** 11 Nov.
[h] P_s^3, Sat. **HIGH NOON**, 7 Dec. **Note: no Peer reviews required for the third paper.**
[i] P_{FS}^3 + cover letter F. **midnight** 20 Dec.

Academic Integrity: It is expected that you understand and adhere to USD's Academic Integrity Policy. Plagiarism for example, strictly prohibited by the policy, is the falsification and, or the invention of data, and the outsourcing of writing assignments, including text written by artificial intelligence such as ChatGPT, essentially uncitable, etc., etc..