Physics 480, Experimental Modern Physics

Dr. Greg Severn

MWF 10:10-11:05 ST 261 (Class time) W: 2:30-5:20 pm

ST287 & ST 291 (Laboratory experiments)

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Professor: Dr. Greg Severn, **ST282** x6845, **severn@sandiego.edu**

Office Hours: M 1:20-3pm, T 2:30-4 R 2:30-5:30, and by appt; but stay tuned and watch for links on Canvas! If you need me for any reason, please shoot me an email and let's figure out an appointment! Please include PHYS480 in subject line.

Catalog listing: `EXPERIMENTAL MODERN PHYSICS Units: 4, 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`

Text: *Experiments in Modern Physics* 2nd Ed., A.C. Melissinos and J. Napolitano, Academic Press, 2003.

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

1. *through writing,* 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. write mathematical prose well
3. to code manuscripts using LaTeX proficiently
4. to exhibit competency (as set forth in rubrics) in
   (a) writing research papers up to the standards of the physics profession as formulated and maintained by the American Physical Society and the American Institute of Physics
   (b) reviewing, refereeing research papers up to the professional standards maintained by those same societies
   (c) designing experiments that enhance signal relative to noise through a variety of contemporary techniques, among other laboratory skills
5. to articulate the logic of modern physics experiments related to advanced topics in quantum mechanics and plasma physics
6. 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: Papers - 80%, ad-hoc, class participation assignments (LaTeX writing prompts, worksheets, etc.) 20%. Roughly speaking, I assign letter 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) 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),
- receipt of a peer manuscript and performance of a peer review using rubrics; submit peer review by the time of the posted submission date,
- receipt of 2 reviews: 1) peer review and 2) TJE review ("Tyrant Journal Editor") to use in making revisions to submitted manuscript,
- submit revision of manuscript, with cover letter ('rebuttal letter', visit 'information for authors' on the public course website), by the time of the posted submission date,

and conforms to current practice in scientific research in physics. The rubric responds to current standards for research papers in Physics as captured in the style

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' is first day of the week**. Groups I and II meet in lab on different afternoons. **NL-no lab, OP-optical pumping, NMR, PW-plasma waves, LS-laser spectroscopy.**

Week	Date	Group I	Group II	Large group topic
I	29 Jan.	NL	NL	Orientation to the writing process, LaTeX
II	5 Feb.	PW	PW	Writing & reviewing, More on Mathematical Prose, Intro to Plasma Physics I
III	12 Feb.			Examples, good and bad, Plasma Physics II
IV	19 Feb.			Plasma Physics III
V	26 Feb.[a]			Plasma Physics IV + Theory presentations[b]
VI	4 Mar.[c]			New Experiment Orientation (LS & OP)
VII	11 Mar.	LS	OP	Quantum Mechanics of two state systems I + tutorial questions (TQs)
VIII	18 Mar.			QM of 2 state systems II + TQs
IX	25 Mar.	NL	NL	**Spring Break Woohoo!**
X	1 Apr.			QM of 2 state systems III + TQs
XI	8 Apr.[d]			Plasma Physics II
XII	15 Apr.[e]	OP	LS	New Experiment Orientation (OP & LS)
XIII	22 Apr.			QM of 2 state systems IV + TQs
XIV	29 Apr.			Exp. Design & diagnostic Issues I + TQs
XV	6 May			Exp. Design & diagnostic Issues II TQs
XVI	13 May[f]			Exp. Design & diagnostic Issues III TQs
XVII	20 May[g]			

[a] First submission, Paper #1, P_s^1, this coming weekend, Sat. **noon** 2 March + Peer Review of Paper #1, RP^1, Mon. **midnight**, 4 March.

[b] This is an ad hoc assignment and not the first!

[c] Final submission, Paper #1, P_{FS}^1 + cover letter this coming weekend, Sat. **noon** 9 Mar.

[d] P_s^2, this coming weekend, Sat. **noon** 13 April + Peer Review, RP^2, Mon. **midnight**, 15 April.

[e] Final submission, Paper #2, P_{FS}^2 + cover letter this coming weekend, Sat. **noon** 20 April.

[f] P_s^3, this coming weekend, Sat. **noon** 18 May, no review req.

[g] P_{FS}^3 + cover letter coming weekend, Wed. **midnight** 22 May.

guides of the American Physical Society and the American Institute of Physics. This class is the writing intensive course in the physics major program.

Class and Lab meetings: Groups I and II meet for lab on different 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,
- 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,
- advanced concepts in quantum theory and plasma physics,
- discussions of experimental design and diagnostics, experimental approaches to solving problems in physics,
- historical examples of experimental design problems in experimental physics as illustrative of the process of design.

These are common themes for both groups. However, later in the semester when two different experiments are happening at the same time, class time will be continue the common themes on the Friday meeting, but will have group meetings devoted especially to theory, experiment design, diagnostics, and so forth specially devoted one of the particular experiments.

TABLE II. List of Experiments

Experiment Code	**Topic & Laboratory**
PW	Plasma physics, the Langmuir Probe, and Ion Acoustic Waves in laboratory plasmas
OP	High resolution optical spectroscopy, Zeeman effect and Hyperfine structure (hfs) in *Rb*
LS	High resolution laser spectroscopy and *Rb* hfs