

Physics 480, Experimental Modern Physics

Dr. Greg Severn

MWF 11:15-12:00pm ST292, ST282 (Lectures & Tutorials) Th: 9:15-11:55 am
ST291 & ST 287 (Laboratory experiments)

(Dated: Fall 2020 Draft Version 1.5)

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Office Hours: T,Th 2:30-4pm, W 1:30-2:30, F 12:15-1:30,
& by appointment! If you need me for any reason,
please shoot me an email and let's figure out an ap-
pointment!

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 our website or placed in the filing cabinet in ST290.

Web pages: Our course has a public web page, see <http://www.sandiego.edu/~severn/p480W>, as well as a Blackboard site. \LaTeX will be used online for writing assignments, at www.sharelatex.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 new 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%, Tutorial & participation assignments 20%. Roughly speaking, I assign letter grades according to the scale, 85/75/65/50/0.

The writing (& reviewing) process: Mastery of experimental and theoretical ideas will be demonstrated through well written research papers. There are 4 experiments for the semester (see table 1) and each student will go through the submission process individually, for each experiment. The submission 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, 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 guides of the American Physical Society and the American Institute of Physics. This is writing intensive course in the physics major program.

Note: Due dates for each of the 3 papers are shown in table II, which give the tentative schedule for all experiments.

TABLE I. List of Experiments

Experiment Code	Topic & Laboratory
OP	High resolution optical spectroscopy, Zeeman effect and Hyperfine structure (hfs) in <i>Rb</i>
NMR	Pulsed nuclear magnetic resonance techniques, Nuclear Spin Echoes and estimating spin-spin relaxation times.
PW	Plasma physics, the Langmuir Probe, and Ion Acoustic Waves in laboratory plasmas
LS	High resolution laser spectroscopy and <i>Rb</i> hfs

TABLE II. Tentative schedule of Lab (zoom) meetings. The dates for submissions for the 3 papers (two per paper) are given in footnotes. **NB: date is the Lab day of the week: Thursday, Lab meets (synchronously) beginning at 9:15am.** NL-no lab, OP-optical pumping, NMR, PW-plasma waves, LS-laser spectroscopy

Week	Date	Group I	Group II	Friday Topic
I	20 Aug.	NL	NL	Orientation to the writing process, L ^A T _E X
II	27 Aug.	OP	NMR	Writing & reviewing, More on Mathematical Prose
III	3 Sept.			Examples, good and bad
IV	10 Sept. ^{ab}	Labor day^c		Quantum Mechanics of two state systems I
V	17 Sept. ^d			QM 2 state systems II
VI	24 Sept.	NMR	OP	QM 2 state systems III
VII	1 Oct.			QM 2 state systems IV
VIII	8 Oct. ^e	GEC2020 ^f	GEC2020	Diagnostics & Design
IX	15 Oct. ^g	PW	LS	Intro to Plasma Physics I
X	22 Oct.			Plasma Physics II
XI	29 Oct.			Saturation Spectroscopy I
XII	5 Nov. ^h			Saturation Spectroscopy II
XIII	12 Nov. ⁱ			Design a New Experiment?
XIV	19 Nov.	Finals	Week	

^a First submission, Paper #1, **midnight, Sat. 12 Sept.**; also submit reviewers comments.

^b Makeup day from Labor Day Holiday, Saturday 12 May

^c Labor Day Holiday, Makeup tutorial for Group I on following Saturday!

^d Final submission, Paper #1, midnight, Sat. 19 Sept.

^e First submission, Paper #2 this week, midnight, Sat. 10 Oct. ; also submit reviewers comments.

^f The APS-GEC research conference is Oct.5-8, and I will be doing lots of virtual running around that week!

^g Final submission, Paper #2, midnight, Sat. 17 Oct.

^h First submission, Paper #3 this week, midnight, Sat. 14 Nov.; also submit reviewers comments.

ⁱ Final submission, Paper #3, midnight, Sat. 21 Nov.

Tutorials: with the exception of the first week of classes, teaching in PHYS 480, for two of the 3 weekly lecture meetings occurs as tutorial sessions in small groups meetings (small group defined as those students performing a given experiment) **with the the instructor (who is also the tyrant journal editor) assuming the role of Tutor.** A list of questions is prepared to which students respond with written out solutions (note, tutorial questions are posted on the public course website), delivered discursively as well as algebraically, often festooned with cartoon figures as aids for ones understanding of the solution to the prompt. During tutorial sessions, the tutor and students discuss their work on the current experiment with a view toward mutual critical evaluation and deep down understanding. Please see the public course website for more details.

Class meeting schedule, & Calendar: Typical large group lecture topics include but are not limited to a) writing mathematical prose, b) professional standards for writing in physics c) L^AT_EX and mathematical composition d) the peer review process in physics, with practice at revising patches of papers taken from student and profession submissions, e) advanced concepts in quantum theory and plasma physics f) historical examples of experimental design problems in experimental physics as illustrative of the process of design. See tables II and III for more detail.

TABLE III. Each section will meet together as a large group (lg) only once a week, **except for the week with the random Saturday class, on 12 Sept.** and the other two meetings will be tutorial (t) meetings (see public course website for description). There are multiple rooms for the class meetings and lab meetings.

Course and Time	Room	M	W	Th	F
EMP Laboratory (9:15-11:55)	ST292, ST 287			Lab (Groups I & II)	
Experimental Modern Physics (EMP) 480-01 (11:15-12:00pm)	ST292(1,t)	Tutorial Group I	Tutorial Group I		Large group meeting (Groups I&II)