PHYS 235
Applied Electronics
Spring 2019

Instructors:

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Course Website: http://www.eg.bucknell.edu/~mligare/ph235/

Office Hours: TBA

Synopsis

This course will introduce you to both analog and digital electronics, and also provide an introduction the interfacing of lab equipment and to micro-controllers. The heart of this course is the lab work you will do; there is one lecture for every lab, and in much of the time the lectures will be specifically designed to give you the background necessary for the upcoming lab session. The topics will include the following:

- Analog Electronics I: circuits with passive elements — mostly linear. (Kirchoff's laws, DC circuits, AC circuits and filters, equivalent circuits).
- Analog Electronics II: Circuits with active elements. (transistors, op-amps, and feedback).
- Introduction to Digital Electronics: logic gates, timers, counters, shift registers.
- Analog Meets Digital: A-to-D conversion, D-to-A conversion.
- Electronics and Micro-Controllers: using an Arduino.
- Return to Analog (while you are beginning work on projects): Fourier analysis, noise & interference.

Texts and Resources

Required: *PHYS 235 Applied Electronics Laboratory Manual* (2019), available in the bookstore.

Optional: *Basic Electronics for Scientists and Engineers*, Dennis L. Eggleston (Cambridge Univ. Press, 2011)

Supplementary: (available in lab room)

- *Introductory Electronics for Scientists and Engineers*, R. E. Simpson, 2nd ed., (Allyn and Bacon, 1987)
- *Practical Electronics for Inventors*, 3rd ed., Paul Scherz (McGraw-Hill, 2013)
- *Electronics: Circuits, Amplifiers and Gates*, D. V. Bugg, 2nd ed., (Taylor and Francis, 2006)
- *The Art of Electronics*, P. Horowitz and W. Hill, 1st, 2nd, or 3rd ed., (Cambridge Univ. Press, 1989)
- *Schaum's Outline of Basic Circuit Analysis*, J. O'Malley, 2nd ed., (McGraw-Hill, 1992)
- *Schaum's Outline of Electric Circuits*, M. Nahvi and J. Edminster, 4th ed., (McGraw-Hill, 2002)
- *Schaum's Outline of Digital Principles*, R. Tokheim, 3rd ed., (McGraw-Hill, 1994)

Labs

Because the labs are the heart of the course, completion of all lab exercises is mandatory. Your lab book will be graded after every lab.

Homework

I will assign problems to accompany each lecture/lab. Once a week I will collect selected problems from this list for grading. Although not all problems will be graded, , you are responsible for the material covered in all of the assigned problems. I encourage collaboration in working on homework, but all submitted problems must represent your own articulation of the work and your understanding. You may test your understanding and study for exams using problems in Eggleston.

Exams

There will be three in-class exams and a comprehensive final. The tentative in-class exam dates are:

- Tuesday February 12,
- Thursday March 7 (last class before spring break), and
- Tuesday April 9.

Final Project

During the last three weeks of the semester (or so) you will work on a comprehensive project that should integrate many aspects of the course. You can choose a project from a list of suggestions, or you can come up with your own idea. You will design the circuit, build and troubleshoot it, and demonstrate that it performs the intended function. You will also write a "manual" that includes operating instructions, a discussion of design principles, and a schematic diagram.

Grading

- Final Project: 20%
- Lab Work: 15%
- Homework: 15%
- In-class Exams: 30%
- Final Exam: 20%

Bucknell Honor Code

As a student and citizen of the Bucknell University community:

1. I will not lie, cheat, or steal in my academic endeavors.
2. I will forthrightly oppose each and every instance of academic dishonesty.
3. I will let my conscience guide my decision to communicate directly with any person or persons I believe to have been dishonest in academic work.
4. I will let my conscience guide my decision on reporting breaches of academic integrity to the appropriate faculty or deans.

Learning Goals

Students completing the course will

- demonstrate proficiency in the methods of scientific inquiry in laboratory projects, and
- present well-organized, logical and scientifically sound oral and written scientific reports

as called for in our department learning objectives.

University Expectations for Academic Engagement

Courses at Bucknell that receive one unit of academic credit have a minimum expectation of 12 hours per week of student academic engagement. Student academic engagement includes both the hours of direct faculty instruction (or its equivalent) and the hours spent on out of class student work. Half and quarter unit courses at Bucknell should have proportionate expectations for student engagement.

Access Statement

Any student who may need an accommodation based on the impact of a disability should contact one of us privately to discuss the specific needs. Please contact Heather Fowler, Director of the Office of Accessibility Resources at 570-577-1188 or `hf007@bucknell.edu` who will help coordinate reasonable accommodations for those students with documented disabilities.

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Schedule for Unit 1: Passive Linear Circuits (and diodes)

Date	Topic	Suggested Problems
Jan. 15	Lecture 1 — Charge/Current/Voltage; Ohm's Law Lab 1 — Orientation & Test Equipment	1–5
Jan. 17	Lecture 2 — Intro to DC Circuits & Kirchoff's Laws Lab 2 — *I-V* curves (Ohm's Law and Not Ohm's Law)	6–17
Jan. 22	Lecture 3 — More on DC circuits; Power Lab 3 — Kirchoff's Laws & Wheatstone Bridge	18–24
Jan. 24	Lecture 4 — Equivalent Circuits Lab 4 — Voltage Dividers; Equivalent Circuits	25–30
Jan. 29	Lecture 5 — Capacitors; Simple *RC* Circuits Lab 5 — *RC* Circuits: Transient Response	31–39
Jan. 31	Lecture 6 — AC Circuits; Two-Port Networks Lab 6 — *RC* Circuits: Low- and High-Pass Filters	45–52
Feb. 5	Lecture 7 — Intro. to semiconductors; Diodes Lab 7 Diodes; DC Power Supplies	
Feb. 7 Feb. 10	Lecture 8 — Intro. to Transistors (not on exam) **Exam I**	

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Schedule for Unit 2: Analog Circuits with Active Elements & Introduction to Digital Electronics

Date	Topic	Suggested Problems
Feb. 11-12	Lab 8 — Electronic Switches & LEDs Lecture 8 — Intro. to Transistors & Amplifiers	53–56
Feb. 16–17	Lab 9 — Transistor Amplifiers Lecture 9 — Transistors & Intro. to Op-Amps	57–63
Feb. 18–19	Lab 10 — Introduction to Op-Amps (Simple Amplifiers) Lecture 10 — Op-amps; Negative Feedback	64–77
Feb. 23–24	Lab 11 — Op-Amp Applications I Lecture 11 — General Amplifier Theory; Non-ideal Op-Amps	64-77
Feb. 25–26	Lab 12 — Op-Amp Applications II Lecture 12 — Introduction to Digital Electronics	59–74
Mar. 2–3	Lab 13 — Intro. to Digital Electronics; Gates & Flip-flops Lecture 13 —	75–84
Mar. 4–5	Lab 14 — 555 Timer and Counters (Abbreviated) **Exam II**	

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Schedule for Unit 3: Digital Electronics

Date	Topic	Suggested Problems
Mar. 17	Lecture 14 — 555 Timer; Clocked Flip-Flops; Counters Lab 14 — 555 Clock/Timer, Type-D Flip-Flops, Counters	 75–84
Mar. 19	Lecture 15 — More Logic, Algebra, and Gates Lab 15 — Decade Counter	85-94
Mar. 24	Lecture 16 — One-shots; Intro. to A/D Conversion Lab 16 — One-Shots and Shift Registers	95-98
Mar. 26	Lecture 17 — Analog-to-Digital Conversion Lab 17 — Analog-to-Digital Conversion	99
Mar. 31	Lecture 18 — Digital-to-Analog Conversion Lab 17 — Analog-to-Digital Conversion (cont'd)	100
Apr. 2	Lecture 19 — Intro. to Fourier Analysis Lab 18 — Introduction to LabView	101–107
Apr. 7	Lecture 20 — Fourier Analysis Lab 20 — Computer Interfacing: Analog I/O	
Apr. 9	Lecture 21 — FFTs, Power Spectrum, and Scopes Lab: Start Projects	
Apr. 14	**Exam III** Lab X — Transducers	

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Schedule for Unit 4: Special Topics and Projects

Date	Topic	Suggested Problems
Apr. 16	Lecture 22 — Digital Signals: Sampling, Aliasing, Nyquist Frequency Lab — Work on Projects	
Apr. 21	Lecture 23 — Interference: Detection and Measurement Lab — Work on Projects	
Apr. 23	Lecture 24 — Noise and Interference Sources Lab — Work on Projects	
Apr. 28	Lecture 25 — ??? Lab — Demonstrate Projects	
May 6	**Final Exam**	