California State University, Monterey Bay

Phys 330
Electronics for Ecological Research
with Lab

Syllabus for Fall 2014
(Covers CRN 41972 & 41973)

Welcome to this fun and useful course!

A small, battery-powered, remotely-operated vehicle (ROV) explores marine life growing on pilings under the Monterey Commercial Wharf. Photo © Steven W. Moore.

CLASS MEETING TIMES
For hybrid lecture/lab/discussion
Chapman Science Center, Room E140
Tu 6:00-9:50 PM and Th 6:00-7:50 pm

Instructor: Steve Moore, Ph.D.
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- Office: Chapman Science Academic Center, Room E-209
- Office Hours: Th 1-3pm, or by appointment.

1. Course Description:
This is a hands-on, outcomes-based course emphasizing practical skills in modern electronics, which you can use to design, build, select, or repair a wide variety of simple electronic devices. These include fun underwater robots, scientific instruments, and interactive educational displays. This one-semester course won't make you an electrical engineer, but it can give you marketable skills that many CSUMB alumni have already found helpful in getting into graduate schools or landing excellent jobs soon after graduation.

2. Prerequisites:
[(MATH 150) AND (PHYS 121 OR PHYS 150 OR PHYS 220 OR CST 231 OR CST 232)]

3. Required Text and Supplies:

- Text: Scherz, Paul and Simon Monk. *Practical Electronics for Inventors*, 3rd ed. McGraw-Hill © 2014. (Paperback; ISBN-13: 978-0-07-177133-7). Retails for approximately $40 new. This popular book is available at the CSUMB bookstore and many other sources.
- You will also need a notebook of some form to record lecture and lab notes, circuit diagrams, project data, etc.

4. Additional Recommended Items:

- Scientific Calculator.
- Laptop computer (PC or Mac) with USB port, WiFi, and BASIC Stamp 2 programming software installed. (This software is available for free download from www.parallax.com. Macs may require additional or alternative software. Details will be provided in class)

5. Learning Outcomes
The learning outcomes (bulleted list below) are designed around three broad goals:

1) You will develop a basic understanding of electronics and robotics,
2) You will have completed at least one reasonably complex electronics / robotics project, and
3) You will know how to stay active in electronics beyond the end of this course, designing and building your own increasingly advanced projects, if you choose to do so.

More specifically, your grade in this course will be based on a series of self-paced modules through which you will have an opportunity to demonstrate that you have achieved each of the following **course learning outcomes**:

- Explain and apply theoretical fundamentals of electronics to the design, construction, testing, and repair of simple electronic and robotic circuits.
- Work safely around low voltage electrical circuits.
- Identify, select, and use appropriate electronic components for specific applications.
- Create and interpret schematic diagrams, component datasheets, and technical reports.
- Program simple microcontrollers to perform a variety of useful tasks.
- Interface microcontrollers with analog sensors, digital sensors, and a variety of output devices, including high-power lights and motors.
- Explain and use a variety of protocols for storing and transmitting digital data electronically.

- Select and use appropriate batteries or other power supplies for field electronic projects.
- Build real circuits and protect them from weather, immersion in seawater, or other exposure to harsh environments.
- Use a systematic and efficient approach to troubleshoot (i.e., diagnose and repair) problems in circuits that are not working properly.
- Locate good retail and on-line sources for electronic parts, supplies, tools, and circuit building/programming information.
- Work collaboratively and effectively as a team member.

6. Assessment and Grading

You will learn and demonstrate the course learning outcomes by completing a series of **self-paced modules**. Most of the modules will provide extensive hands-on experience with designing, building, programming, and testing electronic or robotic circuits. Each module will have associated instructions, lecture content, reading materials, links to videos, and other learning resources.

The modules must be completed in sequence. The more modules you complete by the end of the semester, the higher your grade. A tentative list of modules and associated grade levels is summarized in **Table 1** (below). Note that students who complete the early modules soon enough in the semester will work as a team on an advanced project, called the EEL Challenge, near the end of the semester. The EEL Challenge will be selected by the instructor based on the number of students reaching that stage, their interests, available parts/supplies, and the amount of time remaining in the semester.

To progress through the modules, you must pass an "**assessment**" at the end of each module to demonstrate that you have mastered the knowledge and skill for that module. Assessments will take various forms, depending on the module. They may include written quizzes, hands-on skills tests, simple instructor observation of your circuit building and troubleshooting skills, or things like programming your robot to negotiate an obstacle course.

Assessments come in two styles: **summative** and **formative**. Summative assessments are "real" assessments conducted by your instructor to determine whether or not you can progress to the next module. Formative assessments are "practice" assessments conducted by "trainers". A trainer is a student who has already passed the summative assessment for the module in question. Here's how it works in more detail:

When you think you have mastered a module and are ready for a *summative* assessment to demonstrate your skill, you must first find another student who has already passed that module (and thereby achieved "trainer" status) for that module. Once you have located a trainer, you ask the trainer to give you a *formative* assessment. If, after your formative assessment, the trainer thinks you are ready, s/he will recommend that you schedule a summative assessment with

the instructor. If not, s/he will help you learn the material until s/he believes you are ready for a summative assessment. [Note: If no other student has yet achieved trainer status for that module, you have no choice but to proceed directly to a summative assessment with the instructor, but not until you think you are ready.]

To “pass” a module and move onto the next module, you must earn a score of at least 80% of the possible points on that module during a summative assessment with the instructor. If you attempt a summative assessment for a module, but do not pass it, *you must wait until the next lab session* (usually one week later) to attempt passing it again; thus, there is a time penalty if you attempt a module before you are ready. On the other hand, your grade is determined by how may modules you pass, so there is also a cost if you delay assessment beyond when you are ready. A trainer can help you gauge when you are ready.

When you pass a module, you can immediately begin work on the next module; however, you also become a “trainer” for the module you just passed and are obligated to help any classmate who asks you for a formative assessment and/or help on that module. The act of teaching others will help cement your newfound knowledge and skill, but it also takes time away from your progress toward your next module. Fortunately, your work as a trainer accomplishes two things: first, it reinforces your skills, providing a stronger foundation for you as you move into more advanced modules. Second, once you have successfully helped someone else achieve “trainer” status on a given module, that new trainer takes over training duties for that module, and you can move on!

To guarantee that everyone can make steady progress, the instructor will make an effort to balance student workload so trainers don’t get too bogged down with training. You can help by keeping track of how many students you have helped and how much time you have spent with them. If you feel you are doing more than your fair share of training and/or formative assessments, present your case to the instructor.

You may take summative assessments for more than one module per day, but the instructor reserves the right to prioritize who is next in line for assessment, so each person in the class gets roughly the same number of summative assessment attempts per day.

Please note that the modules differ dramatically in length and conceptual difficulty. Some can be completed in a matter of minutes. Others may take days. The assessments also vary in time and complexity, ranging from less than 1 minute to over 30 minutes.

Table 1
TENTATIVE Sequence of Self-Paced Modules and Grade Thresholds

#	Description or Title	Assessment
1	Getting Started	You will check out the contents of two kits in your lab locker: a "BOE Bot robot kit," and an "Electronics Kit." You must inventory the parts in both kits, notify you instructor of any missing parts, and turn in a signed form promising to return the kits and all parts in good, working order at the end of the semester.
2	Build a BOE-Bot	This is a very long, but otherwise straightforward module, because the book in your BOE-Bot kit will walk you through the steps of how to build and program a real robot. Be sure to tell your instructor as you complete each chapter.
3	BOE-Bot Challenge	You must program your BOE Bot robot to navigate through a maze or obstacle course (designed by your evil instructor) until it reaches the dance platform, whereupon it must perform a beautifully choreographed dance routine set to music – one that will impress the socks off your instructor.
4	DC Foundations & Safety	The assessment for for this module takes the form of a written (or on-line) quiz. You'll need to answer correctly several questions about DC electricity and electrical safety. You must score 100% on the safety portion to be allowed to move on beyond this module.
Reaching this threshold earns you a "D" in the course.		
5	DC Tools	For this assessment, you'll need a triple DC power supply, a multimeter, and a resistor. You'll connect them in various ways to demonstrate that you know how to use the features of the power supply and the multimeter. If you blow a fuse, you automatically fail this assessment and have to replace the fuse yourself.
6	Simple Light Meter	You'll be asked to build a simple light meter based on a voltage divider and a CdS photoresistor. You'll provide power to the circuit from a 9V battery and use a digital multimeter for the display. Your light meter must work properly. You must also be able to answer correctly a set of questions about your circuit and how it works.
7	AC Foundations	Written (or on-line) quiz: You must answer correctly several questions about AC electricity and RLC circuits.
8	AC Tools	You'll need to demonstrate the various features of a signal generator and a dual-channel oscilloscope.
Reaching this threshold earns you a "C" in the course.		

9	555 Timer	Practical Skills Demo: You will be given some components and asked to build an LED flasher using a 555 timer chip, some capacitors, and a trimpot or two. You must use your O-scope to adjust the LED flash timing precisely. You will be asked to explain how your circuit works demonstrate how you adjust the timing of the pulses it produces.
10	Digital Sensor and LCD	You must program your BS2 to read data from a GPS unit or other digital sensor correctly and display it on a 2x16 (or similar) LCD screen.
Reaching this threshold earns you a "C+" in the course.		
11	Light and DC motor control	Practical Skills Demo: You will program your BS2 to control the brightness of lights and/or the speed of motors more powerful than the BS2 can control directly. To do this you will need to use transistor amplifiers, motor controllers, or similar devices.
12	A/D Converter	Practical Skills Demo: You will use an A/D converter to translate at least two different analog voltage signals into digital data your BS2 can read.
Reaching this threshold earns you a "B-" in the course.		
13	Op-Amps	Practical Skills Demo: You will build a signal conditioning circuit out of op-amps and other components to convert the tiny current output from an AD590 temperature sensor into a 0-5VDC signal to feed into an A/D converter.
14	Components	Quiz (sort of): You'll be handed a box full of LOTS of different electrical components. From the assortment, you'll need to select ones that match items in a list of names, descriptions, and/or schematic symbols. In addition, you will need to answer some questions about some of the components, such as what they are used for or what properties or features you would need to specify when ordering them.
Reaching this threshold earns you a "B" in the course.		
15a	Datalogger	You must program your BS2 to store data from your light and temperature sensors in a separate 24LCXXX EEPROM chip using the I^2C protocol. You will program it to record data for 24 hours, place it in a watertight container, and leave it with Steve for its "mystery voyage". Upon its return, you must recover and analyze the recorded data to figure out what temperatures and light levels it was exposed to while on its voyage.

15b	Simple SeaBot	To complete this module, you must design and build simple robot that can be tossed off the Monterey Wharf into the water, go to the bottom, wait there for an amount of time specified by your instructor (which will range between 5 minutes and 24 hours), then return to the surface for recovery by your instructor on a kayak, all without human intervention.
Completing EITHER 15a or 15b earns you a "B+" in the course. *If you want an A-, you can EITHER complete the other option under Module 15 (possibly by combining them into a datalogging SeaBot), OR you can proceed to Module 16 and attempt success there.*		
16	EEL Challenge	Advanced Project with Technical Report: Students who have successfully completed all prior modules with at least 3 weeks remaining in the semester will be assigned to work as a team to solve a challenging real-world electronics or robotics project. The instructor will select the project based on how many students reach this level and how much time is left in the semester when they get there. Most candidate projects are sub-projects of larger existing EEL projects. Likely candidates include developing circuits and/or microcontroller programs that provide new features for underwater cameras or ROVs. To complete this module, students will need to write up a professional-quality technical report summarizing their project.
Reaching this threshold earns you: • *the grade of "*A-" if your collaborative project was successful. • *the grade of "*A" if the project succeeded AND is well-documented. • *The grade of "A+" if and only if the project, the teamwork, and the documentation are all truly exemplary!*		

Comment regarding teamwork on modules:
You are encouraged to work together in informal teams to learn what you need to learn to complete each module. It's more fun and effective that way. However, skills will be assessed *individually*, so make sure that YOU are doing the learning along with your teammates.

7. Strategic Advice:
If you are striving for a high grade (A or B) in this course, it may be tempting to skip reading material, do sloppy wiring, neglect to enter detailed comments into your robot programs, or otherwise "save time" while working on modules. This is short-sighted and likely to backfire. The modules get progressively more challenging as you advance through the series, so it's important to build a strong foundation at each level before you move on. The more difficult modules have been known to stump students for 4-5 *weeks*, usually because those students

had skimmed too quickly through earlier modules and missed some key points. This is one race where the tortoise, who moves steadily and carefully, usually beats the hare who races through the early modules, but then trips and gets stuck on the later modules. If you are concerned about your grade, check with me regularly to see if you are on track to achieve the grade you want.

8. Support for Learning

There are a number of resources available to help you be successful in this challenging course. Please use them as needed.

- **iLearn.** CSUMB has an on-line course management system called "iLearn." You can get to it by going to http://ilearn.csumb.edu and logging in with your Otter ID and password. Once you are logged in, you should see course listed among your iLearn courses. You should visit this iLearn site several times each week to check for new or updated class announcements, lecture notes, videos, field trip information, and other supplemental learning resources. For Fall 2014, the iLearn course identifier is: **PHYS330-01_FA14: Robotics for Ecol Research**
- **Office hours.** I hold regular weekly office hours, so you can meet with me for help in this class. You can also chat with me about science careers and other academic matters. My office hours and locations appear at the top of this syllabus and/or will be announced in class**.**
- **Center for Student Success.** The CSS, located on the third floor of the Tanimura and Antle Memorial Library, is a great resource for all CSUMB students. Among other services, they provide free on-line video tutorials covering student success topics, including time management, note-taking strategies, financial literacy, stress management, and job interviews. (http://studentsuccess.csumb.edu/)
- **Disability accommodations.** If you are a student with a disability and you need accommodations, please make an appointment with me to discuss your needs during the first week of class or as soon as possible. Bring your forms from Student Disability Resources (SDR) located in the Health and Counseling Centers Building (#80). Web: http://sdr.csumb.edu. Phone: 831-582-3672, FAX/TTY: 831-582-4024, Email: student_disability_resources@csumb.edu,
- **Life out of control?** Sometimes life doesn't go exactly according to plan. I know that. If you are concerned that you may be falling behind due to family or personal issues, work schedules, health problems, or other situations that feel out of your control, please let me know, so I can help you figure out how to remain successful in the class.With issues or concerns that are beyond my training and experience, I can help connect you with professionals on campus who are eager and qualified to help you.

9. Tentative Calendar:

Because of the self-paced, project-based nature of this course, it is not feasible to provide a specific day-by-day calendar.