Course name	GEOS 440: Environmental Sensing
Semester	Fall, 2019
Instructor	Dr. Shane D. Mayor
Meetings	Lectures: Mondays and Wednesdays from 11:00 to 11:50 AM in Holt 113. Lab: Fridays from 2:00 to 4:50 PM in PHSC 225.
Office hours	Tues. 2:00 - 2:50 PM & Thurs. 9:30 AM - 12:00 PM (Please e-mail me to let me know you are coming. If not in office, check PHSC 128 or PHSC 217.)
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Class webpage	http://physics.csuchico.edu/~sdmayor/teaching/GEOS440_F19/index.html
Prerequisites	PHYS 202B, PHYS 204B, or PHYS 204C (may be taken concurrently).
Required Book	Harrison, R. G., *Meteorological Measurements and Instrumentation*, ©2015, Wiley Blackwell, 257 pages. (Available on-line as free e-book through University Library.)
Required Hardware	Arduino data acquisition & thermistor kit. Available for purchase at the first lab. Access to a PC or a Mac with USB port and network connectivity is also required. Ideally, a modern laptop that you can bring to lab and use at home.
Recommended Books	Hughes, I. F. and T. P. A. Hase, ©2010: Measurements and their Uncertainties. Oxford University Press. [Expected to be on reserve at library soon.] Nicholas, J. V. and D. R. White, ©2001: Traceable Temperatures, 2nd Edition, John Wiley & Sons. (Available on-line as free e-book through University Library.) Banzi, M. and M. Shiloh, ©2015: Make: Getting Started With Arduino, 3rd Edition, 246 pages. Link Monk, S. ©2016: Programming Arduino: Getting Started with Sketches, 2nd Edition. 176 pages. Link Kinder, J. M. and P. Nelson, ©2018: A student's guide to Python for physical modeling: Updated Edition. On reserve at the library.
Related Books	Brock, F. V. and S. J. Richardson, ©2001: *Meteorological Measurement Systems*, Oxford University Press, 290 pages. DeFelice, T. P., ©1998: *An Introduction to Meteorological Instrumentation and Measurement*, Prentice Hall, 229 pages. Fritschen, L. J. and L. W. Gay, ©1979: *Environmental Instrumentation*, Springer-Verlag, 216 pages.

Course Overview — Instruments are critical to making *quantitative* observations, and observations are critical to the scientific method. The subject of environmental instrumentation is vast and constantly changing as new technologies emerge. In this course, through a combination of lectures and hands-on projects, you will (1) learn about the physical basis for various measurements and be introduced to (2) the process of assembling and characterizing electronic instrument systems, (2) collecting and analyzing data (especially time series data), and (3) writing reports and giving presentations on your results.

Attendance — Attendance is obligatory. A record of attendance will be made, and it will be a factor in the determination of course grades. Attendance in this course is more important than usual due to technical nature of the subject. Valid excuses for absence include illness, accident, or death in the family. Official documentation, such as a note from a physician, is required.

Course Grade — Course grades will *tentatively* be based upon attendance, performance on the projects described below, quizzes, and a final exam. Note: Attendance is likely to be a significant part of your grade (40 meetings x 2 points each = 80 points). Letter grades will be assigned based on the total of number of points accumulated. For example, $\geq$97% A+, 93% A, 90% A-, 87% B+, 83% B, 80% B-, 77% C+, 73% C, 70% C-, 67% D+, 63% D, <63% F. The instructor reserves the right to adjust the number of factors, the weighting, the total number of points, and the grade scale as he deems necessary.

Extra credit — **Opportunity #1:** Hand in a lab notebook at the end of the semester for *up to* 10% of the total number of points you earned in the course. Submitted notebooks will be evaluated for neatness, accuracy, thoroughness, etc. Show your notebook to me (and hand me an ink pen) during lab so that I may sign it for evidence that you are updating it weekly. (See *Lab notebooks* below for more.)

Opportunity #2: Use LaTeX to type any written report associated with the above projects and receive *up to* 10% of the points earned per report. To take advantage of this offer, you must "do it yourself" and bring it to my attention (e-mail me or write an obvious note in the beginning of the report that you used LaTeX).

PROJECTS — Two very important projects are required for completion of the course.

Project 1 — Assemble a data acquisition system and connect and characterize a thermistor for temperature measurement. This requires purchasing an Arduino data acquisition kit which will be made available at the first lab. The project will involve soldering components which you can do during lab time with university tools and uploading programs from a PC or Mac. You will connect the thermistor, collect some experimental temperature data, evaluate the system's accuracy, precision, response time, and write a lab report. Due date: **Friday, 4 October 2019 at 5 PM.**

Project 2 — Select a different sensor of interest (not the thermistor included with your kit), connect it to your Arduino data acquisition system, and program it to acquire data. Develop tests to characterize your chosen sensor's performance. You must obtain or write Arduino code to sample the signal from your sensor and write the data to the memory card of your data acquisition system. You must write a lab report and give a brief presentation on your instrument to the class near the end of the semester. Due date: **Friday, November 22, 2019 at 5 PM.**

Programming — This is not a computer programming course and your grade will not be based upon your ability to write computer programs from scratch or fluency with any particular programming language. However, you are expected to learn about the advantages of using computer programming languages, generic programming practices and program control structures, and use and modify publically-available computer programs to achieve course goals.

Lab notebooks	You are strongly urged to purchase and take notes every week in a lab notebook. These technical notes will help you throughout the semester. Hand the lab notebook in at the end of the semester for extra credit. You must keep notes in only one notebook. Spiral bound, graph-ruled, notebooks are available at the University Bookstore. Extra credit points will be based upon how neat, accurate, and thorough your notes are. (Lab notebooks written at the end of the semester will not be accepted.)
Time	In addition to the Friday afternoon labs, you are required to spend a substantial amount of time out of class working on your projects. This can be done at a time and location of your choosing. Consider: additional time will be required to learn about your sensors, experiment with them, troubleshoot problems, collect and analyze data, write reports, and prepare presentations.
Drop & Add	You may drop (or add) without obtaining permission until Friday, September 6. From September 7 to September 20, you must obtain permission from the instructor to drop. After Friday, September 20, you will need a serious and compelling reason to drop and your request must be approved by the Department Chair and the College Dean. Students adding after classes have started are responsible for obtaining a syllabus and lecture notes and making up any missed quizzes, assignments, and lab work.
Etiquette	**Please do not eat in lecture or lab.** The noises and smells may be a distraction for your peers. Plan your day so that you have adequate nourishment before class. Please silence mobile phones and put them away. Texting and surfing the web while in class is rude. Please do not hold conversations with neighbors during lecture. Also, please be mindful of the volume of your voices when in lab: voices carry and professionalism is important. **Please come to class or lab on time.** Walking in several minutes late is a distraction for everyone. We understand if it happens due to unforseen events or higher priority appointments, but chronic lateness projects a lack of maturity and respect, and it will be taken into account for your course grade.
Plagiarism	Plagiarism is a serious violation of academic integrity and when detected will result in a failing grade for the course and an incident report submitted to the Office of Student Judicial Affairs. For more information on plagiarism, please see the university's Academic Integrity webpage. If you still have a question about what plagiarism is and how to avoid it, please contact the instructor by e-mail or visit during office hours.
Disabilities	If you need course adaptations or accommodations because of a disability or chronic illness, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with the instructor as soon as possible, or see me during office hours. Please also contact the Accessibility Resource Center (ARC) as they are the designated department responsible for approving and coordinating reasonable accommodations and services for students with disabilities. ARC will help you understand your rights and responsibilities under the Americans with Disabilities Act and provide you further assistance with requesting and arranging accommodations.
Learning goals	1. Learn about how electronic measurements of the environment are made and characterized. 2. Gain experience with electronic sensing of the environment and recording digital data. This involves using a data acquisition system, connecting a sensor, characterizing the performance of the sensor and data acquisition system, and sampling the environment in an intelligent way. 3. Understand possible limitations and problems associated with electronic measurement systems. 4. Experience transferring electronic field data to a computer and using software other than Excel to read and display the data. Calculate statistical quantities required to characterize and analyze the data. Make professional quality plots of the data.

Fall 2019 GEOS 440 meeting dates, significant events, and *tentative* schedule.

1	Mon.	26	Aug.	Lecture: Review syllabus, discuss importance of measurements in science.
2	Weds.	28	Aug.	Lecture: Computer architecture, components, and Arduino Dues
	Fri.	30	Aug.	Lab 1: Purchase kits, practice soldering, begin soldering headers
	Mon.	2	Sept.	Labor Day. No class.
3	Weds.	4	Sept.	Lecture: temperature and liquid-in-glass thermometers
	Fri.	5	Sept.	Lab 2: Connect thermistor and load first Ardunio program.
				Also, last day to add or drop without permission from instructor.
4	Mon.	9	Sept.	Lecture: General concepts in measurement science
5	Weds.	11	Sept.	
	Fri.	13	Sept.	Lab 3: Setting real-time clock and writing data to the SD card.
6	Mon.	16	Sept.	Lecture: temperature and electronic temperature sensors
7	Weds.	18	Sept.	Lecture: programming concepts: data types and fundamental programming concepts
	Fri.	20	Sept.	Lab 4: Reading SD card and experiments to characterize performance of thermistors
				Also, last day to add or drop without a serious and compelling reason.
8	Mon.	23	Sept.	Lecture: basic statistical descriptions of data
9	Weds.	25	Sept.	Lecture: introduction to time-series analysis
	Fri.	27	Sept.	Lab 5: Continued characterization of thermistor performance
10	Mon.	30	Sept.	Lecture: exponential response time
11	Weds.	2	Oct.	Lecture: exponential response time
	Fri.	4	Oct.	Lab 6: Conclude lab report writing. **Report on Project #1 due at 5 PM.**
12	Mon.	7	Oct.	Lecture: Solar radiation and short-wave sensors
13	Weds.	9	Oct.	Lecture:
	Fri.	11	Oct.	Lab 7:
14	Mon.	14	Oct.	Lecture: IR radiation and IR sensors
15	Weds.	16	Oct.	Lecture:
	Fri.	18	Oct.	Lab 8:
16	Mon.	21	Oct.	Lecture: Humidity and water vapor measurements.
17	Weds.	23	Oct.	Lecture:
	Fri.	25	Oct.	Lab 9:
18	Mon.	28	Oct.	Lecture: Pressure and barometers
19	Weds.	30	Oct.	Lecture:
	Fri.	1	Nov.	Lab 10:
20	Mon.	4	Nov.	Lecture: Wind
21	Weds.	6	Nov.	Lecture:
	Fri.	8	Nov.	Lab 11:
	Mon.	11	Nov.	Veterans Day. Campus closed.
22	Weds.	13	Nov.	Lecture: Precipitation
	Fri.	15	Nov.	Lab 12:
23	Mon.	18	Nov.	Lecture: Remote sensing
24	Weds.	20	Nov.	Lecture:
	Fri.	22	Nov.	Lab 13: **Report on Project #2 due at 5 PM.**
	Mon.	25	Nov.	Thanksgiving break. Campus closed.
	Weds.	27	Nov.	Thanksgiving break. Campus closed.
	Fri.	29	Nov.	Thanksgiving break. Campus closed.
25	Mon.	2	Dec.	Lecture:
26	Weds.	4	Dec.	Lecture:
	Fri.	6	Dec.	Lab 14:
27	Mon.	9	Dec.	Review week. Instructor at AGU.
28	Weds.	11	Dec.	Review week. Instructor at AGU.
	Fri.	13	Dec.	Lab 15: Review week. Instructor at AGU.
	Mon.	16	Dec.	Final Exams Week

Note: This is a *tentative* schedule and the exact dates and agenda items are subject to change. Students are responsible for coming to class to learn about any changes in the schedule, course content, and grading policy. Instructor reserves the right to modify this syllabus at any time.