Chemistry 728 **Electronics for Chemical Instrumentation** 3 credits
Spring 2024

Course URL: CANVAS

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Pre-requisites: graduate standing

Course Description: Learn and apply the principles of analog and digital electronics and computer interfaces for controlling and monitoring components of importance to chemical instrumentation.

Course Credits: This is a laboratory-based course. Students will meet the 3 credits of the course by spending at least 135 hours (45 hours per credit) on learning. This includes 2 three hour scheduled laboratory periods per week and additional time outside the laboratory.

Course Outline: The goal of this course is to provide you with a practical introduction to electronics as it applies to chemical research and/or chemical instrumentation. After taking this course you will be able to identify the working principles of the electronics behind modern chemical instrumentation, to interconnect and modify commercial instrumental modules for use in new applications, and to build new instrumental modules based on operational amplifiers, microcontrollers, and/or other integrated circuits.

To help you meet these goals and evaluate your performance, you will be required to: 1) Use supporting materials to learn fundamental background information related to electronics. The supporting materials may include texts, data sheets, videos, web sites, and research papers. 2) Complete the regular laboratory exercises and their corresponding report sheets. 3) Complete periodic problem sets covering electronics fundamentals. 3) Complete the extended laboratory exercises which includes a short lab practical 4) Complete a laboratory project.

Course Grading: Your course grade will be based on: Regular Labs 50%, Problem Sets 10%, Extended Lab and Practical 10%, and Project 30%. All written course assignments will be submitted on the course CANVAS page.

Course Topics: We will cover the following electronics topics:

Direct Current Circuits- Ohms Law, voltage dividers, Kirchhoff's laws, Thevenin's theorem, Norton's theorem, and DC power supplies.

Alternating Current Circuits- complex transfer functions and impedance analysis of R,C,and L circuits

Diodes and Transistors- semiconductor physics and applications

Microcontroller Programming- digital input-output, A to D conversion, Pulse width modulation, serial communication

Operational Amplifiers- basic concepts, applications, frequency response, feedback theory, and noise

Mixed Digital/Analog Circuits- basic digital terminology, relays, A to D and D to A conversion, comparators, timers, oscillators, flip-flops, registers, and multivibrators

Supporting Materials: There is an almost infinite amount of supporting materials to aid in your understanding of these topics. Here are some of the supporting materials that we find useful.

Practical Electronics for Inventors, 2nd. Ed. Paul Scherz

Introductory Electronics for Scientists and Engineers, **2nd Ed**. Robert E. Simpson

The Art of Electronics, 2nd Ed. Paul Horowitz and Winfield Hill

All About Circuits: www.allaboutcircuits.com

Electronics Tutorials: https://www.electronics-tutorials.ws/

All about Electronics You Tube Channel:
https://www.youtube.com/channel/UCBkOVp1Cqz4MR0LYR8vKpZg

EEVBlog: https://www.eevblog.com/

w2aew: https://www.youtube.com/user/w2aew

greatscott: https://www.youtube.com/user/greatscottlab/

We will also post lecture videos and notes, book chapters, web pages, application notes, research papers, and other supporting items that support the course topics, on the course CANVAS site.

Supporting Software (All open source):

TINA Circuit Modelling Software http://www.ti.com/tool/TINA-TI
Arduino microcontroller programming platform https://www.arduino.cc/
KiCAD circuit layout Software https://www.kicad.org/

Course Sections: Instructional laboratory located in 7455/7449 Chemistry
Project work will take place in S307 Chemistry

Sec 001 M-W 2:25 PM – 5:25 PM
Sec 003 T-Th 11:00 AM – 2:00 PM
Sec 004 T-Th 2:25 PM – 5:25 PM

Course Schedule: Learning electronics requires doing electronics and the laboratory will provide you with the opportunity to do electronics. We will follow the accompanying schedule to cover the course topics.

	Dates	Lab Work	Lab Mini lecture topic
Week 1	1/24 – 1/25	Unit 1 Measuring and Filtering	Course intro and voltage divider
Week 2	1/29 – 2/1	Unit 1 Measuring and Filtering Unit 1 Measuring and Filtering	RC circuits and TINA I/O impedance
Week 3	2/5 – 2/8	Unit 2 Discrete SS Components Unit 2 Discrete SS Components	Diodes and transistors TRIACs
Week 4	2/12 – 2/15	Unit 3 Microcontrollers Unit 3 Microcontrollers	Digital I/O DAC,ADC,PWM
Week 5	2/19 – 2/22	Unit 4 Operational Amplifiers Unit 4 Operational Amplifiers	Op amp basics Op amp examples
Week 6	2/26– 2/29	Unit 4 Operational Amplifiers Unit 5 Oscillators and Timing	Op amp feedback Relaxation oscillator
Week 7	3/4 – 3/7	Unit 5 Oscillators and Timing Unit 5 Oscillators and Timing	Multvibrators VCO
Week 8	3/11 – 3/14	Project work	TBA
Week 9	3/18 – 3/21	Project work	TBA
	3/25 – 3/28	Spring Break	
Week 10	4/1 – 4/4	Project work -Extended Lab Unit	TBA
Week 11	4/8 – 4/11	Project work- Extended Lab Unit	TBA
Week 12	4/15 – 4/18	Project work- Extended Lab Unit	TBA
Week 13	4/22 – 4/25	Project work- Extended Lab Unit	Project Sharing
Week 14	4/29 – 5/2	Project work	
Finals	5/6-5/9	Project Due Friday May 10	

RULES, RIGHTS & RESPONSIBILITIES

- See: https://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext

ACADEMIC CALENDAR & RELIGIOUS OBSERVANCES

- See: https://secfac.wisc.edu/academic-calendar/#religious-observances

ACADEMIC INTEGRITY

Recommended syllabus statement: By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion. https://conduct.students.wisc.edu/syllabus-statement/

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

McBurney Disability Resource Center recommended syllabus statement: The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. https://mcburney.wisc.edu/instructor/

DIVERSITY & INCLUSION

Institutional statement on diversity: Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world. https://diversity.wisc.edu/