Faculty of Engineering and Applied Science

CHEE 270 – CHEMETRONICS

Course Syllabus – Fall 2021

This is your course syllabus. Please download the file and keep it for future reference.

TEACHING TEAM

<table>
<tr>
<td>

COURSE INSTRUCTOR

Paul Hungler, PhD, PEng
Department of Chemical Engineering
Queen's University
Dupuis Rm 313
613-533-6618
E-mail: paul.hungler@queensu.ca

</td>
<td>  </td>
</tr>
<tr>
<td>

TEACHING ASSISTANT

Josh Zacks
Department of Chemistry
Stamplecoskie Research Group
Chernoff Rm 435
E-mail: 16jmbz@queensu.ca

</td>
<td>  </td>
</tr>
</table>

COURSE TIMINGS

Lecture – Tuesday 9:30-10:30, Mac-Corry Rm D122
Active Learning Session – Thursday 2:30-5:30, BMH Rm 314

COURSE INFORMATION

COURSE DESCRIPTION

This course combines elements of chemical and electrical engineering to measure, calculate and control electrical signals. The course introduces basic electrical circuit analysis theory with an emphasis on concepts utilized in analytical chemistry instrumentation and energy conversion and storage. An introduction to signal analysis, data acquisition, sampling and quantization, as well as the fundamental statistical techniques necessary to process and analyze measured data with uncertainty is given. Course content is delivered via a blended offering with on-line instruction and active learning sessions. ((0/0/0/36/0))

Prerequisites: APSC 143 (Computer Programming for Engineers), APSC 112 (Physics II)

PRE-REQUISITE KNOWLEDGE

This course is designed for learners who need to acquire fundamental knowledge and understanding of energy storage and conversion and electrical signal analysis. The concepts are applied during active learning sessions which focus on their application in analytical chemistry instrumentation and other areas of engineering chemistry.

COURSE LEARNING OUTCOMES (CLO)

CLO	DESCRIPTION	INDICATORS
CLO 1	Analyze electrical circuits utilized in analytical chemistry instrumentation.	KB-ES-ApplChem (b)
CLO 2	Compare electrical power designs related to energy conversion and storage.	KB-ES-ApplChem (b)
CLO 3	Analyze analog and digital signals.	IN-Synthesis ET-Apply
CLO 4	Select transducers for temperature, light, pressure, flow and conductivity measurements.	ET-Apply
CLO 5	Calculate uncertainty from measured data sets.	IN-Analysis
CLO 6	Apply statistical methods to single and derived data sets.	IN-Analysis
CLO 7	Design an experimental procedure and analytical instrument to obtain data required to solve a given problem.	KB-ES-ApplChem (b) IN-Conduct ET-Create

This course develops the following attributes at the 2nd year level:

Knowledge base, Engineering Science (**KB-ES**): **ApplChem (b)** Applies knowledge of electrochemistry and electrochemical engineering to analyze and design electrochemical systems and processes.

Investigation (**IN**): **Conduct** Conduct investigations to test hypotheses related to complex problems. **Analysis** Analyze and interpret data using appropriate techniques and tools. **Synthesis** Synthesize information from investigations, considering sources of uncertainty and limitations to reach substantiated conclusions.

Engineering Tools (ET): **Create** Develop, adapt and/or extend appropriate software, equipment, models, and simulations for a range of engineering activities. **Apply** Apply and manage appropriate techniques, apparatus, databases, models, tools, and/or processes to accomplish a task.

COURSE EVALUATION

DESCRIPTION

Due to the COVID-19 pandemic, the course has been moved online to an asynchronous teaching environment to be completed within six weeks. To keep with asynchronous teaching, all weekly evaluations (Quizzes, ALS reports, etc.) are due by Sunday at 23:59 EST.

ASSESSMENT WEIGHTING

Assessment Tool	Due Date (before 23:59 EST)	Weight	Alignment with CLOs
Quizzes	**Weeks 1,2,3,4,5,6**	**20%**	**1, 2, 3, 4, 5, 6, 7**
Review Quiz	Sunday of Week 12	2%	1
Quiz 1	Sunday of Week 1	2%	1
Quiz 2	Sunday of Week 2	2%	1,2
Quiz 3	Sunday of Week 3	2%	1,2
Quiz 4	Sunday of Week 4	2%	1,2
Quiz 5	Sunday of Week 5	2%	1,3
Quiz 6	Sunday of Week 6	2%	3,4,5,6,7

Quiz 7	Sunday of Week 7	2%	3,4,6
Quiz 8	Sunday of Week 8	2%	3,4,6
Quiz 9	Sunday of Week 9	2%	7
Active Learning Session Reports (Individual)	**Weeks 1, 2, 3**	**20%**	**1, 2, 3, 4, 5, 6, 7**
ALS Report 1	Tuesday of Week 2	4%	1
ALS Report 3	Tuesday of Week 4	4%	1,2
ALS Report 5	Tuesday of Week 6	4%	1,3,5,6
ALS Report 6	Tuesday of Week 7	8%	3,4,5,6,7
Active Learning Session Reports (Team)	**Weeks 1, 3, 4**	**20%**	**1, 2, 3, 4, 5, 6**
ALS Report 2	Tuesday of Week 3	5%	1
ALS Report 4	Tuesday of Week 5	5%	1,2
ALS Report 7	Tuesday of Week 8	5%	3,4,6
ALS Report 8	Tuesday of Week 9	5%	2,3,4
Lab Design Project (Team)	ALS Session of Week 12	**37.5%**	7
Peer Review	Week 12	**2.5%**	**1,2,3,4,5,6**
		100%	

WEEKLY COURSE OUTCOMES

Week	Learning Outcomes
	Module 1 – Electrical Circuit Analysis and Power
1	**Introduction to Circuits** By the end of this week, learners will be able to: • Identify symbols and nomenclature used in electrical circuits. [CLO 1,2] • Compare basic elements of an electrical circuit. [CLO 1,2] • Implement basic voltage-divider and current-divider circuits. [CLO 1,2] • Conduct measurements with a multimeter. [CLO 1,3] • Analyze circuits using Ohm's Law, Kirchoff's Current Law (KLC), and Kirchoff's Voltage Law (KVL). [CLO 1,2]
2	**Circuit Analysis** By the end of this week, learners will be able to: • Investigate the circuit design of various metering devices. [CLO 1, 2] • Compare the operation of different types of operational amplifiers. [CLO 1,2] • Utilize node-voltage and mesh-current methods to solve circuits. [CLO 1,2,3] • Examine how different circuits are used in Analytical Chemistry equipment. [CLO 1,3]
3	**Capacitors & Inductors** By the end of this week, learners will be able to: • Investigate how a capacitor behaves and the requirement to have continuous voltage. [CLO 1,2] • Investigate how an inductor behaves and the requirement to have continuous current. [CLO 1,2] • Solve simple circuits containing capacitors and inductors to find voltage, current and power. [CLO 1,2,3]
4	**AC Three-Phase Power, Transformers & Microgrids** By the end of this week, learners will be able to: • Investigate the difference between AC and DC power. [CLO 2] • Analyze a balanced 3 phase circuit. [CLO 2,3] • Calculate average, reactive and complex power in three-phase circuits. [CLO 2,3] • Examine impedance and transmission lines. [CLO 2,3] • Examine mutual inductance transformers. [CLO 2,3]

Module 2 – Data Acquisition and Analysis (Arduino)	
5	**Introduction to Arduinos, Analog and Digital Signals** By the end of this week, learners will be able to: • Identify various transducers and their function. [CLO 4] • Construct basic circuits for simple transducers. [CLO 1,4] • Execute a simple program on your own Arduino, using IDE software on your computer. [CLO 3] • Collect data from digital sensors. [CLO 1,3,4] • Interpret the output from an analog sensor on your Arduino, convert the ADC value to a voltage. [CLO 1,3,4] • Calculate means and standard deviations for sets of data points. [CLO 5] • Make estimates of uncertainty and noise in our measurements and average or smooth that noise to improve the accuracy of our time series. [CLO 3,4,5,6]
6	**Colorimetry Design** By the end of this week, learners will be able to: • Design a colorimeter to take irradiance readings of a sample [CLO 7] • Record time series data from our transducers with a microcontroller. [CLO 3,4] • Calculate means and standard deviations for sets of data points. [CLO 5,6] • Create calibration curves for a series of solutions with varying concentrations [CLO 3,4,5,6]
7	**Introduction to MATLAB GUIs** By the end of this week, learners will be able to: • Develop MATLAB GUIs [CLO 7] • Collect data from analog sensors. [CLO 1,3,4] • Use time series data to determine sensor constants. [CLO 6]
8	**I^2C Sensors and MATLAB GUIs** By the end of this week, learners will be able to: • Read I2C devices using Arduino IDE and MATLAB GUIs [CLO 1,3,4] • Calibrate analog sensors in MATLAB [CLO 3] • Calculate density using temperature, pressure and humidity readings [CLO 3,6] • Design a MATLAB GUI [CLO 7]

Module 3 – Experimental Design Project	
9-12	**Experimental Design Project** By the end of this week, learners will be able to: • Develop an experimental procedure which will produce the required data to solve the problem provided. [CLO 7] • Utilize transducers, circuits and a microcontroller to develop an analytical instrument which can acquire the required measurements. [CLO 4] • Assess the accuracy of your designed experiment. [CLO 6]

COURSE MATERIALS

Required Textbook

- Kuphaldt, T. R. (2006). Lessons in electric circuits, volume I – DC. Retrieved from https://www.ibiblio.org/kuphaldt/electricCircuits/DC/DC.pdf (open source)

Required Calculator

- A Casio 991 is required. **ONLY** this type of non-programmable, non-communicating calculator will be allowed during tests and exams.

Other Material

The following references are recommended as supplementary sources:

- Harvey, D. (2016). Analytical Chemistry 2.0. Chemistry LibreTexts. Open Text book available through eCampus Ontario
- Johnson, D. (2014). Fundamentals of Electrical Engineering I. OpenStax-CNX. Open Text book available through eCampus Ontario

All other course material is accessible via OnQ.

SUGGESTED TIME COMMITMENT

This course represents a study period of one semester spanning 12 weeks. Each week will consist of 4 hours of class. Learners can expect to invest on average 1 hour per week online, 1 hour per week in lecture, 3 hours per week in Active Learning Sessions (ALS). Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course on time.

ASSESSMENT DESCRIPTIONS

Quizzes

There are ten quizzes in the course. The quizzes are comprised of multiple choice, calculations, and short answer questions that will help to identify gaps in conceptual understanding. These quizzes are taken on the course website. You must complete the quiz prior to attending the weekly Active Learning Session. Once initiated, you have 30 minutes and one attempt to complete a quiz.

Active Learning Session Reports (Individual)

There are four individual Active Learning Session Reports. These reports will provide you with the opportunity to demonstrate your knowledge and understanding of the concepts and processes conducted in the ALS.

Active Learning Session Reports (Team)

There are four team Active Learning Session Reports. These reports will provide you with the opportunity to demonstrate your knowledge and understanding of the concepts and processes conducted in the ALS.

Lab Design Project

This is an open-ended experimental design scenario which requires students to utilize knowledge and understanding of course content. They will work in groups to come up with a design, execute the design, and get results from the experiment. This will be summarized in a report.

Peer Review

There will be one peer review to provide feedback to your design project partner on how they performed and participated as a group member throughout the design project process. A peer review tool called GRASP will facilitate this process.

Late Policy

Any applicable late penalties are described in the details for each assessment. In the event of extenuating circumstances, you may request an extension to an assignment due date without penalty. Requests must be made to your instructor prior to the original due date of the assignment, and some substantiating documentation is often required. Note that unacceptable reasons include malfunctioning computer, travel plans to go home for holidays, generally behind on schoolwork, etc. In the absence of substantiating documentation, the normal late penalty will apply as described in the assignment or departmental policies.

Grading

All assessments in this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to the established Grade Point Index.

Feedback on Assessments

The teaching team will provide feedback on graded activities. You can expect feedback on your assessments within seven days of the due date.

Accessing Your Final Grade

Your final grades will show on SOLUS. Official transcripts showing final grades will be available on the Official Grade Release Date. Please note that in official transcripts, a mark of IN (incomplete) is considered a grade, and your transcript is released with this grade.

COURSE COMMUNICATION

QUESTIONS ABOUT COURSE MATERIAL

Questions or comments regarding the course material that can be of benefit to other students should be posted in the Q&A forum on the class website. The instructor, TAs, and students are encouraged to answer these questions directly in the discussion forum for the benefit of everyone in the course.

COURSE ANNOUNCEMENTS

The instructor will routinely post course news in the Announcements section on the main course homepage on OnQ. Please sign up to be automatically notified by email when the instructor posts new information in the Announcements section. Instructions on how to modify your notifications are found in the **Begin Here** section of the class website.

OFFICE HOURS

In addition to interaction in the Q&A discussion forums, you will have the opportunity to interact in a synchronous fashion with either a TA or the instructor through office hours. The instructor will provide a schedule of availability at the beginning of the term.

CONFIDENTIAL MATTERS

If you have a confidential matter you would like to discuss with your instructor, their contact details are on the first page of this document. Expect email replies within 48 hours and in some cases within 24 hours.

COURSE POLICIES

Please review the following policies concerning copyright, academic integrity, absences and academic accommodations:

COPYRIGHT

Unless otherwise stated, the material on the course website is copyrighted and is for the sole use of students registered in CHEE 270. The material on the website may be downloaded for a registered student's personal use but shall not be distributed or disseminated to anyone other than students registered in this course.

ACADEMIC INTEGRITY

Information on policies concerning academic integrity is available in the Queen's University Code of Conduct, in the Senate Academic Integrity Policy Statement, on the Faculty of Engineering and Applied Science website, and from your instructor.

ABSENCES (ACADEMIC CONSIDERATION) AND ACADEMIC ACCOMMODATIONS

For absences and academic accommodations please review the information on the FEAS website.

TECHNICAL SUPPORT

No specialized computer-related technical skills are required for this course. If you require technical assistance, please contact Technical Support.

PERSONAL SUPPORTIVE COUNSELLING

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the Faculty of Engineering and Applied Science.