Division of Engineering and Mathematics
School of Science, Technology, Engineering, and Mathematics
University of Washington Bothell

B ME 410 A Electric Power and Machinery (5 cr)

Autumn 2020

TTh 8:45 AM - 10:45 AM (Remote)

Instructor: Steven W. Collins, Ph.D., P.E.
Email: swcollin@uw.edu
Website: https://sites.uw.edu/swcollin/

Office Hours (Zoom): MW 10:00 - 10:30 AM, TTh 3:00 - 3:30 pm and by appointment

Canvas Homepage: https://canvas.uw.edu/courses/1407754

Catalog Description: Fundamentals of electrical circuits and components, and their application in motors, generators, and other machinery used in industrial applications. Includes laboratory. Prerequisite: Minimum grade of 1.7 in both STMATH 126 and B PHYS 122.

Course Description: This course introduces the theory and application of electric power in the industrial environment and grid-scale electric power system . Emphasis is on electrical machinery and systems that generate electrical energy from mechanical or other energy source, transmit electrical energy across a power grid, and convert electrical energy to mechanical energy at the point of use.

Learning Outcomes

At the end of this course, students will be able to:
1. Perform basic DC and AC circuit analysis.
2. Demonstrate an understanding of three-phase power.
3. Perform basic three-phase circuit analysis.
4. Explain how DC and AC machines work, and calculate their electrical and mechanical properties.
5. Identify the components of a power grid, and explain how the grid works.
6. Explain how renewable power systems work and evaluate their integration into the electrical grid.

ABET Learning Outcomes

The learning outcomes for this course support ABET Outcomes (1), (2), (6) and (7):

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare as well as global, cultural, social, environmental, and economic factors.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Required Materials

Textbook: Mohamed A. El-Sharkawi, *Electric Energy: An Introduction,* Third Edition, CRC Press, 2013. This book may be purchased or rented online at the UW Bookstore.
https://www.ubookstore.com/Electric-Energy-3e-12

Circuit Simulator Subscription: We will be using an online simulator called CircuitLab for some labs and homework:
https://www.circuitlab.com/
Purchase the "CircuitLab Micro" annual membership, which costs $24:
https://www.circuitlab.com/accounts/upgrade/academic/

Access to a computer form Zoom meetings: We'll be meeting in Zoom at the following link:
https://washington.zoom.us/j/96396707936
You will need to authenticate with you UWNetID to enter the meeting.

Assignments and Grading Criteria

Homework (15 %): Homework problems will be posted in Canvas approximately one week before their due dates.

- Solutions may be typed on a computer or tablet (using engineering paper as a template), or written out by hand on engineering paper. Follow the standard ME homework guidelines. Begin each problem on a new page and box the answer. Be neat and precise: use a straight edge for graphs and circuit diagrams.
- Students may help each other on homework problems. However, the work you submit should be your own. If you receive help, be sure you understand how to do the problem on your own.
- Scan your work, assemble it into a single pdf document, and upload your file into Canvas no later than the start of class (8:45 am) on the due date. Late homework will not be graded.
- Each homework set may be graded in full or in part; if the latter, a subset of the problems will be selected to assess.
- The lowest grade will be dropped.

Classwork (10%): We will do practice questions and problems in most classes; some of these will be graded. Graded classwork will be posted as "Classwork Quizzes" in Canvas. These quizzes will open at the appointed time during class. You will have time work the problems, after which we will discuss the results together. After going over them, you will have the chance to go back and correct any missed problems before the end of class.
The lowest grade will be dropped.

Four one-hour exams, lowest grade dropped (50%, equally weighted): Open book and notes, given during class time in Canvas.

- All questions are multiple choice or short-answer, and include a mix of concept questions and problems. Concept questions will be similar to those in the Reading Quizzes. Problems will be similar to those in the Homework.
- Problems that include the statement "SHOW WORK" require that you write out the solution on engineering paper, following the homework format, and upload your work as a single pdf file after finishing the exam. A special "Exam Docs" assignment will be created for this purpose.
- After time is called, you will have 15 minutes to upload your work into Canvas (as a single pdf file). A special "Exam Docs" assignment will be created for this purpose. If you need more time to get to your printer/scanner, you may take photos of each page and upload them separately. After class, take time to scan or convert photos to pdf, assemble the pages into a single file, and upload it as a single pdf document.
- Partial credit may be given for the show-work problems for the portion of work that is correct, even if the answer is wrong. Little or no credit is given to correct guesses with missing or incorrect supporting calculations.
- For some problems involving calculations, you may be required to explain in words how you arrived at the answer instead of showing the calculation.
- The lowest exam grade will be dropped, and the three highest grades weighted equally.

Lab Reports (15%): Eight lab activities are planned. Instructions for the lab will be posted in Canvas no later than 24 hours before the exam is scheduled in the syllabus. The first three activities will be carried out virtually, either on your own time or in an online Zoom meeting with me during the lab section for which you are signed up. The remaining five labs make use of equipment that will be set up in DISC 362. Because this equipment is not on site as of the start of the quarter, we will not know until a few weeks into the quarter exactly when the equipment will be ready for use. If possible we will do these labs in person, with appropriate social distancing. In any event, you will be given instructions on how to carry out each lab. Lab activities done virtually may include building and evaluating a circuit in the circuit simulator and/or watching me build and test a circuit in Zoom. You will then type a short memo (1-2 pages, single-spaced, including graphs) describing what you/we did during the lab, measurements that were made, and analysis of results. Graphs should be rendered in Excel or similar software, with all axes and curves clearly labeled. Lab reports are to be submitted in Canvas by 11:59 pm on the third day after the lab session (11:59 pm Friday for labs on Tuesday, 11:59 pm Sunday for labs on Thursday). Please understand that lab activities may be changed or cancelled if circumstances make it impossible to carry them out safely and effectively.[1]

Project (10%): Find an electrical device that has a motor, transformer, generator (or combination) and reverse-engineer it. Take it apart (hopefully, without destroying it!), play with it, figure out how it works. Create a diagram with as much detail as you can include. (If you know how to draw a schematic, great—do it, but it's not required.) If you want to build something—using Arduino, for example, or other kit you might have lying around) that you can reverse-engineer, that's fine too.

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[1] Should it prove impossible to prepare the transformer, motor, and generator for in-person or virtual use in the lab, I will plan another activity that we can do virtually together or that you can do on your own.

Report your findings on a poster. Your poster may be created in powerpoint or other presentation software, or it may be laid out hard-copy on a science fair-type poster board (~36" x 48"). Include photos, sketches, specifications, description of the device and its parts, and explanation of what it does and how it works. Be creative!! Convert your poster file into a pdf (or, if on poster board, snap a high quality photo and convert it to pdf) and upload into Canvas by start of class (8:45 am) December 10 (last day of class). Be prepared to share your work in discussion!

Grading: Exams, homework, and project are graded on the 100-point scale. Classwork and reading quizzes are scored in Canvas based on the number of questions, with one point given for each correct answer. Grades are converted to the 4-point scale using the following linear conversion: ≥95=4.0, 94=3.9, 93=3.8, 92=3.7, 91=3.6, 90=3.5,…,85=3.0,…,80=2.5,…,65=1.0, 62=0.7 (lowest passing grade), ≤62=0.
Info on the UW grading system: http://www.washington.edu/students/gencat/front/Grading_Sys.html

Late assignments: Missed exams and classwork can generally not be made up. Quizzes and other assignments for which there is no submission will automatically receive a grade of zero in the Canvas Gradebook. Since the lowest grade is automatically dropped for each category of assignments, a zero on one assignment will not affect the final grade. If an emergency should arise in which you must miss an exam, let me know by email beforehand. If in my judgment the reason is valid (sudden illness, death in family, power outage, etc), we may be able to work out an accommodation.

Policies and Campus Resources

For questions related to Zoom, Canvas, and the online course experience for students, see https://www.uwb.edu/it/learning

Academic integrity: Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the University of Washington's Student Code of Conduct (https://www.washington.edu/cssc/for-students/student-code-of-conduct/). Acts of academic misconduct may include but are not limited to

- Cheating, which includes working collaboratively and sharing answers on exams and other assignments, unless explicitly authorized to do so.
- Plagiarism, defined as representing the work of others as your own and not giving appropriate attribution to the author(s) whose work you are using in your research.

I consider use of Chegg and other outside providers of solutions and answer keys on exams and other graded assignments to be a combination of cheating and plagiarism. Although a student may get away with it, he or she should realize that such behavior not only constitutes academic misconduct, it also shows serious lack of integrity. If I have reason to suspect misconduct, I will file a report with Student Affairs and follow the procedures set forth in the University policies. For details, see Chapter 209 in Student Governance and Policies:
http://www.washington.edu/admin/rules/policies/SGP/SPCH209.html

A complete list of policies and resources available to students can be found here:
http://www.uwb.edu/getattachment/stem/about/stem-policies/classroom-policies-stem-fc-1-12-17.pdf.

Date	Topic	Reading	Assignment	Lab
10/1	Introduction to Electric Power Systems			No lab
10/6	Direct Current (DC), Resistance, Capacitance, Inductance	Ch 1, DC1		No lab
10/8	DC Circuit Analysis	DC2	HW 1	No lab
10/13	DC Transient Circuits	DC3		Resistance
10/15	Electromagnetism, Intro to AC, Phasors, Complex Number Analysis	EM, Ch 7, (7.1 - 7.5)	HW 2	Resistance
10/20	**Exam 1 (Hr 1)** Complex Impedance (Hr 2)	Ch 7 (7.7)		RC circuits
10/22	Power and Power Factor in AC Systems	Ch 7 (7.8)	HW 3	RC circuits
10/27	Three-Phase Systems	Ch 8 (all)		Impedance
10/29	Transformers	Ch 11 (11.1 - 11.4)	HW 4	Impedance
11/3	**Exam 2 (Hr 1)** Rotating Magnetic Fields (Hr 2)	Ch 12 (12.1)		Transformer*
11/5	Induction Machines	Ch 12 (12.2 - 12.4)	HW 5	Transformer*
11/10	Synchronous Machines	Ch 12 (12.5 - 12.6)		Motor 1*
11/12	Single-Phase AC and DC Machines	Ch 12 (12.7 - 12.9)	HW 6	Motor 1*
11/17	**Exam 3 (Hr 1)** Electric Power Grid (Hr 2)	Ch 14		Motor 2*
11/19	Wind Power Generation	Ch 6 (6.2)	HW 7	Motor 2*
11/24	Solar Power Generation	Ch 6 (6.1)		
11/26	**Thanksgiving**			
12/1	Geothermal and Biomass Power Generation	Ch 6 (6.4 - 6.5)		Motor 3*
12/3	Batteries, Hydrogen/Fuel Cells	Ch 6 (6.6 - 6.8)	HW 8	Motor 3*
12/8	**Exam 4 (Hr 1),** Discussion & Lab Prep (Hr 2)			Hydro-Generator*
12/10	Energy Transition, Future Power Systems	Ch 15	Project	Hydro-Generator*

1. Readings indicated by "Ch" are chapters in the textbook *Electric Energy: An Introduction*. Other readings will be accessible as pdf files in Canvas.
2. Labs are contingent on the instructor's ability to prepare the equipment and protocols. In some cases, circuit simulators may be used in place of actual equipment.
3. Labs indicated by * are tentatively planned to be in-person. If possible, the lab operations and data will be recorded. All other labs will virtual.