ECE 3600

Introduction to AC Power Engineering
Spring 2024 Class Syllabus

Instructor: Arn Stolp
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Cell: (801) 783-6589 **<u>Always</u> TEXT FIRST & start text with "ECE 3600"**. This is the best way to contact me.
E-mail: arnstolp@ece.utah.edu I rarely check my e-mail, so text me if you send me email that I need to read. Subject should start with "ECE 3600". DO NOT use other email addresses or Canvas messaging.
Office hours: My "office hours" are the problem sessions at the end of class. Otherwise it's catch me if you can. To increase your chances, talk to me after class. I'm usually around between 12:20 a.m. & 3 p.m. M,W & F. If I'm not in my office, check the lab.
DO NOT send messages via Canvas. I don't have the time to monitor them.

Web Site: http://www.ece.utah.edu/~ece3600/

Required and Recommended books and lab supplies:
Textbook: *Electrical Machinery and Power System Fundamentals*, by Stephen J. Chapman. International edition is cheaper and fine for this class.
Calculator that easily handles complex-number arithmetic.
Ring binder for additional materials to be handed out in class.
Lab notebook (bound or spiral) and standard ECE lab supplies

Prerequisites: ECE 2210 or ECE 2240

Introduction:

Why do people care about electricity? Basically for two reasons-- information and energy. Computers, TVs, phones and control systems all process, present, store and use information in the form of electrical signals. The circuits and theories behind these occupy the majority of your studies in Electrical Engineering. These circuits also require some energy to function (power supplies) and often need to control some energy to produce outputs (power amplifiers), both subjects for a power electronics class, not this class. Here we cover electrical energy in a more primal form– the energy that lights your house, washes your clothes and moves you up the ski lift, all of which is done with AC power.

This class will introduce you to AC power use and generation, AC and DC machines, and AC power systems. We will study single-phase and 3-phase power, power factors and corrections, transformers, synchronous and induction machines, DC motors, power transmission lines, and introduce the concepts used to analyze power flow and faults.

I teach will concepts and the use of those concepts to solve problems, not formulas and memorization. The hands-down easiest way get a good grade in this class is to learn the concepts.

This class consists of:

Lectures: M, W & F 3:00 - ~4:10 pm in WEB L114

Lectures set the direction and tone of the class and cover more than the written material. You will be held accountable for everything discussed in the lectures, so your attendance is important.

Problem Sessions: M, W & F ~4:10 - 4:20 pm in WEB L114

I will use this time to work examples and to answer your questions in detail. I will rarely cover new material in the problem session times, although I will sometimes be flexible about the boundary between class and problem session.

Textbook:

Electrical Machinery and Power System Fundamentals, by Stephen J. Chapman.

Handouts:

There will be a number of handouts for, homework, labs, notes, etc.. I will hand these out before class or you may download them from canvas or the class web site; http://www.ece.utah.edu/~ece3600/.

Homework, homework, and more homework: 15%

I will assign a lot of homework, it will be your main study tool. As such, I'll give you all the numeric answers so that you can check your work immediately. In fact, you'll have to self-correct your homework. If you can't get the answer, check the web site for corrections, study some more, come to the problem session, ask for help, or see the posted solutions (outside my office). Sometimes I even post solutions before the homework is due. So, you might ask, "Why is it handed in and 'graded'?". Well, to answer a question with a question, "Would you even do it otherwise?"

Your homework should be neat and clear and show all your work. For most problems the grader will simply check to see that you've done it and that your paper shows the necessary work to get the answer. Only a few problems will be checked in greater detail. You may collaborate with others to learn how to do the homework, but will need to hand in your own work. Copying or allowing another student to copy your work is considered cheating.

You will probably learn more from doing the homework than any other part of this class. If you thoroughly understand the homework, you will know what the class is about, and the exams should give you no trouble.

You will need to scan your homework, create a .pdf file, and turn that in on canvas by 11:59 pm of the due date. Solutions will be posted in my office window. Most graded material will be returned on Canvas.

Midterms: (300 exam pts) 43.75%

You will take three 50-minute midterms throughout the semester. They will cover material up to the time of the test. All exams are closed book, closed notes, no phones, tablets or computers allowed. These exams will usually be in two parts, a no calculator, no reference material part where I ask for items that you should have committed to memory, and a part with *some* reference material where I will ask you to solve problems that may

require your calculator. The second section will be designed to see if you learned concepts and problem solving strategies and whether you can work with them, sometimes in new and different ways. Don't try to memorize formulas or specific problems. Exams also cover what you learn in the labs and field trips. Exams will be returned in class. If you miss class, come to my office.

Final: Thursday, 4/25/24, 3:30 - 5:30+ pm (180 exam pts) 26.25%

The final will be comprehensive with greater emphasis on the most recent material. It will also be in two parts. There will be a zoom review session. Listen for details in class.

Labs: MEB 2365 15%

Lab will be held every other week. Many of the subjects covered in lab aren't covered anywhere else in class, so make sure you pay attention and read the lab instructions. You will have to keep a laboratory notebook as a requirement of the lab. Your lab TA will either collect and grade these notebooks or ask you to scan them and submit on canvas.

Labs are **not optional.** For each lab that you miss or fail (< 60% score), your final grade will suffer a **half letter drop** (5% of possible points). Be sure to make-up any labs you miss or fail.

Field Trips: scored as labs

I'm planning three field trips which will take place during lab and class time (approximately); Gadsby power plant, Rocky Mountain Power dispatch, and Terminal Substation. You will be responsible for your own transportation. If you cannot make a field trip you will have to make it up with some personal field investigation. Field trip reports will be graded with your labs. A missed field trip can also result in a 5% grade drop.

Grades:

Homework:	15%
Labs:	15%
Exams:	70%
Total:	100%
Failed lab:	-5%
Cheating:	-100%

% of total	Grade
> 93	A
90-93	A-
87-90	B+
83-87	B
80-83	B-
77-80	C+
73-77	C
70-73	C-
67-70	D+
63-67	D
60-63	D-
< 60	

If you want any deviations from the normal requirements (say credit for labs, you've done before) you will need to see me before the work would normally be due and get an agreement *in writing*. You'll need to turn in your copy of the agreement with your final, so I'll remember to grade you properly.

Disclaimer:

All information provided here is subject to change due to external factors or unintended typos or errors.

ECE 3600

A. Stolp

Tentative

01/07/24

Spring 2024 COURSE SCHEDULE

Week		Date	lect	Topics	Textbook
1	M	01/08	1	Introduction, Energy sources, generation, & environment	1.1
	W	01/10	2	Hw1, Review of steady-state AC and phasors	notes, 1.2
	F	01/12	3	Review of steady-state AC and phasors	notes
2	M	01/15		Martin Luther King Day	
	W	01/17	4	RMS, Single-phase AC power	notes, 1.8
	F	01/19	5	Single-phase AC power, P, Q, S, |S|, pf, pf correction	notes, 1.8
3	M	01/22	6	Single-phase AC power, 3-phase power	2.1 - 2
	W	01/24	7	3-phase power, Y- and delta-connections	2.3 - 6
	F	01/26	8	3-phase power, balanced systems, efficiency, One-line diagrams	2.4 - 6
4	M	01/29		Field Trip	
	W	01/31	9	Electromagnetics, Ideal transformers, Ratings	1.4, Ch 3
	F	02/02	10	Transformation of impedance, Model of the non-ideal transformer	3.4 - 5
5	M	02/05	11	Non-ideal transformer, tests	3.7 - 8
	W	02/07	12	Transformer voltage reg., Autotransformers, 3-phase, etc.	3.9 - 10
	F	02/09	13	Power system diagrams Per-unit system	3.6, 10.1
6	M	02/12		Exam 1	
	W	02/14	14	Per-unit system	3.6, 10.2
	F	02/16	15	Rotational Motion, AC Machinery Fundamentals	1.3, Ch 4
7	M	02/19		Presidents Day	
	W	02/21	16	Synchronous machines	5.1 - 6
	F	02/23	17	Synchronous machines as generators, examples	5.8, Ch 6
8	M	02/26	18	Placing generator on line, Synchronous machines as motors	Ch 6, 5.9
	W	02/28	19	Synchronous motors, pf correction	5.10 - 13
	F	03/01	20	3-phase Induction motors,	7.1 - 5
	S	03/02		Spring Break	
	Su	03/10			

ECE 3600 Spring 2024 Course Schedule p2

Week		Date	lect	Topics	Textbook
9	M	03/11	21	3-phase Induction motors, examples	7.6 - 8
	W	03/13	22	3-phase Induction motors, tests	7.9 - 10
	F	03/15	23	Single-phase Induction motors	notes
10	M	03/18		Exam 2	
	W	03/20	24	DC motors	notes, 8.1-2
	F	03/22	25	DC motors	8.4 - 9
11	M	03/25		Field Trip	
	W	03/27	26	DC motors & loads	notes, 8.10
	F	03/29	27	Finish DC motors, Transmission lines	notes, 9.1-5
12	M	04/01	28	Transmission lines	notes, 9.6
	W	04/03	29	Transmission line models, calculations & examples	9.8 - 9
	F	04/05		Exam 3	
13	M	04/08		Field Trip	
	W	04/10	30	Power System & Power Flow Problem	9.6, 10.3
	Th	04/11			
	F	04/12	31	Power Flow Problem, Faults	Ch 12
14	M	04/15	32	Types of faults, The 3 "sequences"	Ch 13
	W	04/17	33	Faults, Sequence Impedances	notes
	Th	04/18		ME Design Day, Union Build.	
	F	04/19	34	Protection	notes
15	M	04/22	35	Protection	notes
	T	04/23		Last Day of Classes	
	W	04/24		Reading Day, ECE 3600 Review	
	Th	04/25		ECE3600 Final 3:30 pm	
	F	04/26			
16	M	04/29			
	T	04/30			
	W	05/01			

ECE 3600 Spring Semester

01/07/24

Week	Month	Mon	Tue	Wed	Thur	Fri
1	Jan	8 L1 Introduction, Energy sources, generation, & environment	9	10 L2 Hw1, Review of steady-state AC and phasors	11	12 L3 Review of steady-state AC and phasors
2		15 Martin Luther King Day	16	17 L4 RMS, Single-phase AC power	18	19 L5 Single-phase AC power, P, Q, S, |S|, pf, pf correction
3		22 L6 Single-phase AC power, 3-phase power	23	24 L7 3-phase power, Y- and delta-connections	25	26 L8 3-phase power, balanced systems, efficiency, One-line diagrams
4		29 Field Trip	30	31 L9 Electromagnetics, Ideal transformers, Ratings	1	2 L10 Transformation of impedance, Model of the non-ideal transformer
5	Feb	5 L11 Non-ideal transformer, tests	6	7 L12 Transformer voltage reg., Autotransformers, 3-phase, etc.	8	9 L13 Power system diagrams Per-unit system
6		12 Exam 1	13	14 L14 Per-unit system	15	16 L15 Rotational Motion, AC Machinery Fundamentals
7		19 Presidents Day	20	21 L16 Synchronous machines	22	23 L17 Synchronous machines as generators, examples
8		26 L18 Placing generator on line, Synchronous machines as motors	27	28 L19 Synchronous motors, pf correction	29	1 L20 3-phase Induction motors,
	Mar	4 Spring Break	5	6	7	8
9		11 L21 3-phase Induction motors, examples	12	13 L22 3-phase Induction motors, tests	14	15 L23 Single-phase Induction motors
10		18 Exam 2	19	20 L24 DC motors	21	22 L25 DC motors
11		25 Field Trip	26	27 L26 DC motors & loads	28	29 L27 Finish DC motors, Transmission lines
12	April	1 L28 Transmission lines	2	3 L29 Transmission line models, calculations & examples	4	5 Exam 3
13		8 Field Trip	9	10 L30 Power System & Power Flow Problem	11	12 L31 Power Flow Problem, Faults
14		15 L32 Types of faults, The 3 "sequences"	16	17 L33 Faults, Sequence Impedances	18 ME Design Day, Union Build.	19 L34 Protection
15		22 L35 Protection	23 Last Day of Classes	24 Reading Day, ECE 3600 Review	25 ECE3600 Final 3:30 pm	26
16	May	29	30	1	2 Freedom	3

ECE 3600 Spring Semester

ECE 3600 Spring Semester 2024 Likely HW Due-Dates (canvas date will overide)

01/07/24

Week	Month	Mon	Tue	Wed	Thur	Fri	Sat
1	Jan	8	9	10	11	12 Hw1 Energy sources, generation, & environment	13
2		15 Martin Luther King Day	16 Hw2A Review of steady-state AC and phasors	17	18	19	20 Hw2B AC Superposition, Thevenin
3		22 Hw3A RMS	23	24 Hw3B Single-phase AC power	25	26	27 Hw4 3-phase power
4		29 Field Trip	30	31 Hw5 3-phase power	1	2	3 Hw6 Electromagnetics
5	Feb	5 Hw7 Ideal transformers	6	7 Hw8A Non-ideal Transformers	8	9	10 Hw8B Non-ideal Transformers
6		12 Exam 1	13	14 Hw9 Autotransformers, 3-phase	15	16	17 Hw10 Per-unit system
7		19 Presidents Day	20 Hw11 Per-unit system	21	22	23 SG1 Synchronous machines	24
8		26	27 SG2 Synchronous generators	28	29	1 SG3 Synchronous motors	2
	Mar	4 Spring Break	5	6	7	8	9
9		11	12 Ind1 3-phase Induction motors	13	14	15 Ind2 3-phase Induction motors	16
10		18 Exam 2	19	20 Ind3 3-phase & single-phase Induction motors	21	22	23 DC1 DC motors
11		25 Field Trip	26	27 DC2 DC motors	28	29	30
12	April	1 DC3 DC motors & mechanical loads	2	3	4	5 Exam 3	6 TL1 Transmission lines
13		8 Field Trip	9	10 TL2 Transmission lines	11	12	13 PF1 Power Flow
14		15	16	17 LF1 Line Faults	18 ME Design Day, Union Build.	19 Go to ME Design day	20 DD Design day
15		22 LF2 Line Faults	23 Prot Protection	24 Reading Day, ECE 3600 Review	25 ECE3600 Final 3:30 pm	26	27
16	May	29	30	1	2 Freedom	3	4

ECE 3600 Spring Semester 2024 Likely HW Due-Dates (canvas date will overide)

ECE 3600 Spring Semester 2024 Labs 01/07/24

Week	Month	Mon	Tue	Wed	Thur	Fri
1	Jan	8	9	10	11	12
2		15 Martin Luther King Day	16	17	18	19
3		22	23	24	25	26
4		29 Field Trip	30	31	1	2
5	Feb	5 Lab 1: Electrical safety & Power factor correction	6	7	8	9
6		12 Exam 1	13	14	15	16
7		19 Presidents Day	20	21	22	23
8		26 Lab 2: Transformer model	27	28	29	1
	Mar	4 Spring Break	5	6	7	8
9		11 Lab 3: Synchronous machines, Connection to the	12	13	14	15
10		18 Exam 2 Lab 3: Synchronous machines, Connection to the	19	20	21	22
11		25 Field Trip	26	27	28	29
12	April	1 Lab 4: Induction motors	2	3	4	5 Exam 3
13		8 Field Trip	9	10	11	12
14		15 Lab 5: DC motors	16	17	18 ME Design Day, Union Build.	19
15		22 Makeup	23	24 Reading Day, ECE 3600 Review	25 ECE3600 Final 3:30 pm	26
16	May	29	30	1	2 Freedom	3

ECE 3600 Spring Semester 2024 Labs

MERRILL ENGINEERING BUILDING (BLDG. 064)

SECOND FLOOR PLAN