ECE320: Energy Conversion and Power Electronics

Fall 2019

Instructor:	Bingsen Wang	Classroom:	EB 1234
Office:	ERC C133	Lecture hours:	M,W,F 8:00–8:50am
Tel:	517.355.0911	Office hours:	M, W 3-4:30pm
Email:	bingsen@egr.msu.edu	Course website:	d2L.msu.edu

Course Type:

Lecture

Recommended Textbook:

A. E. Fitzgerald, C. Kingsley and S. D. Umans, *Electric Machinery*, 6^{th} Ed., McGraw Hill, 2003.

Reference Books:

- N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics: Converters, Applications and Design*, 3^{rd} Ed., John Wiley & Sons, 2003.
- N. Mohan, *Electric Drives, an Integrative Approach*, MN-PERE, 2001.
- G. R. Slemon, *Electric Machines and Drives*, Addison Wesley, 1992.
- G. McPherson and R. Laramore, *Electric Machines and Transformers*, John Wiley, 1990.
- J. F. Lindsay and M. H. Rashid, *Electromechanics and Electrical Machinery*, Prentice Hall, 1986.
- K. Heumann, *Basic Principles of Power Electronics*, Springer Verlag, 1986.
- M. H. Rashid, *Power Electronics*, Prentice Hall, 1988.

Supplemental Materials:

Additional notes will be provided and posted on D2L.

Objectives:

Power has two distinct effects in our lives: on one hand we have to produce it, transmit it and receive it in a way that is affordable, reliable, and with minimal negative effect on the environment; on the other hand we have to control its use, so that we can make the best out of it, i.e. use it safely and efficiently, and harness it to achieve qualities like speed, accuracy and efficiency.

This course serves only as an introduction to both electrical machines and power electronics. It focuses on the most common devices and systems that an electrical engineer will encounter: AC machines, transformers, rectifiers and inverters, as well as electrical drives and uninterruptible power supplies. A lot is left out, e.g.:

- Commutation of DC machines,
- Dynamic models of Electrical Machines,
- Design of Electrical Machines,
- Detailed discussion of PWM inverters, matrix converters etc.,
- Control of Electrical Drives.

Some of this material will be covered in the lectures of ECE423, ECE425 and the laboratory of ECE420, and in graduate courses.

Learning Outcomes:

The course is directed to junior students and aims to introduce them to the theory of operation, analytical and circuit models and basic design concepts of Electric Power components and systems. At the end of this class students should have a working knowledge of: three-phase power and circuits, transformers, basic electric machines, induction machines, synchronous machines, AC/DC rectifiers, DC/AC inverters and DC/DC converters.

Attendance:

Attendance is mandatory, but there will be no attendance taken during lectures. Regardless of attendance, it is the students' responsibility to know exactly what is discussed in class and assigned, such as homework, notes, assignments, or changes in schedule. *Absence is not an excuse for anything.*

Attendance of the exams is, of course, mandatory and monitored. Absences due to serious reasons (health, family, religion, job interviews, even participation in sports) may be accepted, if a request and arrangements for a make-up test are made as soon as the student knows. In no case these reasons can become an excuse for lower expectations, nor can the same reason for makeup exams appear repetitively. The Ombudsman's site https://ombud.msu.edu/classroom-policies/index.html has a comprehensive discussion of this.

Quality of Work:

Tests and Homework should be clean, legible, self contained and self explanatory. All assumptions must be stated and thoughts outlined. sequence of equations and results is not adequate. There will be no partial credit given for problems not solved to the end.

Work that is not legible or not well explained will not be graded. A drawing goes a long way to help you solve the problem and show the grader that you understand.

Prerequisites:

Ability to use Kirchhoff's Laws, phasors, Faraday and Ampere Laws, average and RMS power, magnetic media, circuit analysis, and Matlab.

It is quite important that you are familiar with a calculator that can handle complex numbers, both in polar and in rectangular form. Although you may have used such functions in ECE201 and ECE202, you should sharpen these skills before the first exam, preferably before doing the first Homework. If you do not have such a calculator, a few are available at the bookstores around town for less than $20. Be sure that you can convert between rectangular and polar with one button, and that you can calculate series and parallel complex impedances quickly. Secondly, you are expected to be comfortable with Matlab calculations, plots etc. Since the graph function of a calculator is unnecessary, the calculator with graph function will be discouraged in exams.

Homework and Testing:

There will be a homework set assigned almost every week. For the whole semester, twelve (12) sets of homework assignment have been planned. Solutions will be posted on D2L a week later or before the exam, which ever is sooner. Past experience makes it strongly recommended that students do the homework by themselves, or at least attempt it seriously, so that they can come up with questions and solution methods. It is not a good idea at all to study solved homework problems. Keep in mind that the University expects three hours of work at home for every lecture hour, and this expectation remains in this class.

There will be five midterm exams and no final exam. In each exam you may have one handwritten single-sided 8.5 x 11-in sheet of notes, with your name and the date on the top. No photocopies will be allowed. It is a good idea to prepare these sheets well ahead of time, when solving homework problems.

The first exam will cover also the following prerequisites: phasors and complex numbers, circuit equations, and Norton and Thevenin equivalents. Other tests will use knowledge required in previous tests.

Cheating will not be tolerated at any level. Besides the obvious legal and ethical aspects, cheating lowers the quality of the University degree, angers fellow students, and diminishes the enjoyment of teaching for the instructor. Any instance, even the most minute, will have the heaviest possible repercussions.

Students with Disabilities will have all the accommodations determined by the Resource Center for Persons with Disabilities. The instructor should be notified during the first week of classes of such requirements.

The exam dates are below:

Exam 1 (Sep. 23, Monday)	Electrical circuits, 3-ph systems	100 pts
Exam 2 (Oct. 14, Monday)	Magnetic circuit and transformer	100 pts
Exam 3 (Nov. 4, Monday)	Asynchronous machines	100 pts
Exam 4 (Nov. 18, Monday)	Synchronous machines	100 pts
Exam 5 (Dec. 6, Friday)	Power electronics	100 pts
Homework		120 pts
	Total	620 pts

Late Homework Policy:

For homework that is turned in late, each extra day will cost an additional 10% discount of the originally graded score. For example, if you turn in your homework two days after the due date and the original score is graded homework is 90 out of 100, then your final score for that home work will be 72, which is 80% of the original 90.

Exception: No late turn-in is accepted if the assignment is due right before the exam.

Grading:

A numerical grade will be given based on the total combined score that is normalized to 100 points.

4.0: ≥ 90	3.5: ≥ 85, <90	3.0: ≥ 80, <85
2.5: ≥ 75, <80	2.0: ≥ 70, <75	1.5: ≥ 65, <70
1.0: ≥ 60, <65	0.0: <60	

In the past, those who got 3.5 or 4.0 mastered the material, concepts and applications and demonstrated consistently the capability of solving complex problems. If you come to class, work on the homework yourselves, and show understanding of the concepts in the exams, you should expect to pass this class.