

Electric Machines and Drives

EE 436

Instructor: Michael L. McIntyre, Ph.D., P.E.

Office: WS Speed Hall, Room 200A

Office Hours: To be announced or by appointment

Phone: (502) 852-7505

Prerequisites (by Topic):

1. **Introduction to analog electronics**
2. **Concepts of electromagnetics or similar training on magnetic concepts, specifically circuits and electro-mechanical energy conversion.**
3. **Familiarity with the following software programs: PSPICE(Orcad)/Multisim; Matlab; and Excel.**

Co-requisite: None

Credit: 3 credit hours

Course Description: AC/DC electric-machine drives for speed/position control. Integrated discussion of electric machines, power electronics, and control systems. Computer simulations. Applications in electric transportation, robotics, process control, and energy conservation.

Course Learning Objectives: This course provides the student with a solid background in the topic of electric machines and drives. Students will become knowledgeable about the various forms of the electric machines along with the electrical drives systems (circuits and controls) and its applications. Students will learn about various aspects of designing and analyzing these systems, including requirements from the mechanical systems, design considerations (electrical, magnetic, and control), and the use of modern simulation tools for design/analysis validation.

Course Learning Outcomes: *At the completion of this course, students will be able to:*

1. Describe the structure of electric drives systems and their role in various applications;
2. Analyze and design power electronic systems in drives using switch-mode converters and pulse width modulations to synthesize the voltages in dc and ac motor drives;
3. Describe the operation of dc motor drives to satisfy four-quadrant operation to meet mechanical load requirements;
4. Analyze torque, speed and position controllers of motor drives;
5. Describe systems containing induction machines in steady state; and
6. Analyze speed controllers for induction machines.

Course Outline:

- Introduction to Electric Drive Systems
- Understanding Mechanical System Requirement for Electrical Drives
- Review of Basic Electrical Circuits
- Basic Understanding of Switch-Mode Power Electronic Converters
- Review of Magnetic Circuits

- Basic Principles of Electromechanical Energy Conversion
- DC-Motor Drives and Electronically-Commutated Motor Drives
- Feedback Controllers for Motor Drives
- Introduction to AC Machines and Space Vectors
- Sinusoidal Permanent Magnet AC (PMAC) Drives, LCI-Synchronous Motor Drives, and Synchronous Generators
- Induction Motors: Balanced, Sinusoidal, Steady State Operations
- Induction Motor Drives: Speed Control
- Reluctance Drives: Stepper-Motors and Switched-Reluctance Drives
- Energy Efficiency of Electric Drives and Inverter-Motor Interactions

Required Text:

- N. Mohan, “Electric Machines and Drives, A First Course” John Wiley and Sons, 2012, ISBN: 978-1-118-07481-7

Reference Text:

- None.

Course Policies:

1. **Attendance:** Attendance is encouraged in this course. Attendance grades may be given several times during the semester in the form of quizzes and will be factored into the homework grade. Each student is responsible for anything that is discussed, stated or handed out in class.
2. **Integrity: Academic dishonesty will not be tolerated.** Students are encouraged to work in groups in discussion and problem solving. However, all homework and exam results are to reflect individual work. Dishonest work can result in a failing grade in the course, and possible further action deemed appropriate by the University. Students are expected to do their own work including computer assignments, homework, and exams. Copying is against the law and all parties involved in cheating are equally guilty.
3. Cell phones must be turned off at every class.
4. **Grading:**
 - a. Assignments:
 - i. Students taking the course for undergraduate credit

1. Homework Assignments (5-10)	-	20%
2. Exams (2)	-	60%
3. Final Exam	-	20%
 - ii. Students taking the course for graduate credit (*if applicable*)

1. Homework Assignments (5-10)	-	20%
2. Exams(2)	-	50%
3. Final Exam	-	20%
4. Research Paper/Presentation	-	10%

- b. The final course grade will be determined according to the following table:
 - i. $90 \leq A < 100$
 - ii. $80 \leq B < 90$
 - iii. $70 \leq C < 80$
 - iv. $60 \leq D < 70$
 - v. $F < 60$

5. Tests:

- a. No makeup tests will be given.
- b. The use of headphones during any exam is not permitted.
- c. The final exam will be comprehensive.
- d. The final exam will be administered according to the university final exam schedule.
- e. All in-class tests are closed book, closed notes, unless specified otherwise.

6. Homework:

- a. Graded problems must be submitted by the due date at the beginning of class.
- b. To be successful in this class, you are strongly encouraged to work all of the homework problems.
- c. Homework may be weighted (i.e. some assignments will count more than others). Details concerning weighting will be provided when the homework is assigned.
- d. Solutions will be made available through the WKU blackboard system.
- e. **Make sure your homework is neat, readable, no stamp-sized drawings, etc.) and proceeds logically to the solution** – if I can't read it or make sense of it, you will NOT get the points!

- 7. ***Blackboard and email:*** This course will have a Blackboard site and you will be expected to utilize the site to receive course information, including assignments. You should check this site daily throughout the semester. I will use both UofL and WKU sites along with the email address that are made present through these blackboard sites. No exceptions will be made. I do not use the gradebook aspect of blackboard.
- 8. The University of Louisville is committed to providing access to programs and services for qualified students with disabilities. If you are a student with a disability and require accommodation to participate and complete requirements for this class, notify me immediately and contact the **Disability Resource Center** (Robbins Hall, 852.6938) for verification of eligibility and determination of specific accommodations.
- 9. Federal law and university policy prohibit discrimination on the basis of religious belief. It is the policy of the University of Louisville to accommodate students, faculty, and staff who observe religious work-restricted holy days. Students: Students who observe work-restricted religious holy days must be allowed to do so without jeopardizing their

academic standing in any course. Faculty are obliged to accommodate students' request(s) for adjustments in course work on the grounds of religious observance, provided that the student(s) make such request(s) in writing during the first two (2) weeks of term.

10. The University of Louisville strives to foster and sustain an environment of inclusiveness that empowers us all to achieve our highest potential without fear of prejudice or bias.

We commit ourselves to building an exemplary educational community that offers a nurturing and challenging intellectual climate, a respect for the spectrum of human diversity, and a genuine understanding of the many differences-including race, ethnicity, gender, gender identity/expression, sexual orientation, age, socioeconomic status, disability, religion, national origin or military status-that enrich a vibrant metropolitan research university.

We expect every member of our academic family to embrace the underlying values of this vision and to demonstrate a strong commitment to attracting, retaining and supporting students, faculty and staff who reflect the diversity of our larger society.

11. Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other nonconsensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain **confidential** support from the PEACC Program (852-2663), Counseling Center (852-6585), and Campus Health Services (852-6479). To report sexual misconduct or sex discrimination, contact the Dean of Students (852-5787) or University of Louisville Police (852-6111).

Disclosure to University faculty or instructors of sexual misconduct, domestic violence, dating violence, or sex discrimination occurring on campus, in a University-sponsored program, or involving a campus visitor or University student or employee (whether current or former) is **not confidential** under Title IX. Faculty and instructors must forward such reports, including names and circumstances, to the University's Title IX officer.

For more information, see <http://louisville.edu/hr/employeerelations/sexual-misconduct-brochure>.