

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 Delivery: Synchronous lectures will be delivered through Zoom at the scheduled time. Please use the link provided in Blackboard to attend the virtual meeting.

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 (PMA) 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 (Books 24x7):

- none

Course Policies:

1. **Lecture Delivery:** We will use synchronous delivery of course through WKU's Zoom Account. I will record the lecture and post them through the blackboard site.
2. **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.
3. **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.
4. Cell phones must be turned off at every class.
5. **Grading:**
 - a. Assignments:
 - i. Students taking the course for undergraduate credit

1. Homework Assignments (8-12)	-	30%
2. Exams (2)	-	50%
3. Final Exam	-	20%

- 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. $F < 60$

6. Tests:

- a. No makeup tests will be given.
- b. The use of headphones during any exam is not permitted.
- c. The final exam may or may not 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.

7. 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 UofL 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!
- f. **Upload a Single PDF in Blackboard for my grading.** Report style turns...

- 8. ***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 do not use the grade posting aspect of blackboard.

9. Title IX Misconduct/Assault Statement

Western Kentucky University (WKU) is committed to supporting faculty, staff and students by upholding WKU's Title IX Sexual Misconduct/Assault Policy (#0.2070) at <https://wku.edu/eoo/documents/titleix/wkutitleixpolicyandgrievanceprocedure.pdf> and

Discrimination and Harassment Policy (#0.2040) at https://wku.edu/policies/hr_policies/2040_discrimination_harassment_policy.pdf.

Under these policies, discrimination, harassment and/or sexual misconduct based on sex/gender are prohibited. If you experience an incident of sex/gender-based discrimination, harassment and/or sexual misconduct, you are encouraged to report it to the Title IX Coordinator, Andrea Anderson, 270-745-5398 or Title IX Investigators, Michael Crowe, 270-745-5429 or Joshua Hayes, 270-745-5121.

*Please note that while you may report an incident of sex/gender based discrimination, harassment and/or sexual misconduct to a faculty member, WKU faculty are "Responsible Employees" of the University and **MUST** report what you share to WKU's Title IX Coordinator or Title IX Investigator. If you would like to speak with someone who may be able to afford you confidentiality, you may contact WKU's Counseling and Testing Center at 270-745-3159.*

9. Ogden Student Course Attendance Statement

The faculty and staff of Ogden College of Science and Engineering are committed to providing you with learning experiences and opportunities. You must assume ownership of your education and be an active participant in the classroom and laboratory to take advantage of these opportunities. **Active participation requires you to attend.** Scientific studies have shown that attendance during scheduled classroom and laboratory meetings is directly correlated to your performance on assignments and exams and the potential to earn higher grades. Additionally, if you do not regularly attend class, you are missing important information about course topics, due dates, and assignment details that are crucial to your success in the course. Therefore, as a student enrolled in an Ogden course, you are expected to attend every class meeting and to inform your instructor regarding the reasons for any absences as soon as practical. **Your instructor may incorporate class attendance/participation as part of the grading criteria.**

10. ADA Accommodation Statement

In compliance with University policy, students with disabilities who require academic and/or auxiliary accommodations for this course must contact the Student Accessibility Resource Center located in Downing Student Union, 1074. SARC can be reached by phone number at 270-745-5004 [270-745-3030 TTY] or via email at sarc.connect@wku.edu. Please do not request accommodations directly from the professor or instructor without a faculty notification letter (FNL) from The Student Accessibility Resource Center.