ECE 5391/4391—Electric Machines and Drives, Fall 2019  
Room: ECE 122, Class Time: TT 12:30 – 01:50 p.m.

Catalog Data:  

Textbooks:  

Instructor:  
Dr. Michael Giesselmann, P.E. Professor & Chair, Room EE 224

Objectives:  
Upon completion of this course students should be able to analyze the dynamics and control of DC and 3-phase induction machines. In addition, students will be able to develop and validate models for machines and complete drive systems. Students will also gain insight into hardware and software aspects for drive design.

Prerequisites by topic:  
1. Electromagnetics  
2. Feedback control theory

Topics:  
1. Analysis of permanent magnet and shunt field DC machines  
2. Steady state and dynamic models of DC machines  
3. Principle material limitations of electric machines, Torque & Power Density  
4. Steady state models of AC induction machines  
5. Dynamic models of AC induction machines; model validation  
6. V/Hz control of induction machines  
7. Hardware & Software of V/Hz drives for AC induction machines  
8. Indirect field oriented (Vector) control of AC induction machines  
9. Speed sensor less field oriented (Vector) control of AC induction machines  
10. Tests and reviews

Software Usage:  
Extensive use of MathCAD and LTspice.  
Course materials will be available through ERaider login at: http://aln.coe.ttu.edu/ecw/

Class schedule:  
Offered annually as an elective.

Grading:  
Homework: 25%  
Tests (3): 45%  
Final Project: 30%.

Disability Policy:  
Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as possible to make necessary arrangements. Students must present appropriate verification from Student Disability Services during the instructor’s office hours. Please note that instructors are not allowed to provide classroom accommodation to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact Student Disability Services office in 335 West Hall or call 806-742-2405. Further details are provided by Texas Tech Operating Policy 10.08.

Religious Holidays:  
Any student absent for a religious holiday should make that intention known in writing to the instructor prior to the absence and will be permitted to make up missed exams in accordance with Texas Tech Operating Policy 34.19.

Graduate Credit:  
In accordance with University Operating Policy 34.11, assignments and tests for ECE 5391 will exceed the assignments for ECE 4391 quantitatively and qualitatively.

Academic integrity:  
It is the aim of the faculty Texas Tech to foster a spirit of complete honesty and a high standard of integrity. The attempt of students to present as their own any work that they have not honestly performed is regarded by the faculty and administration as a serious offense and renders the offenders liable to serious consequences, possibly suspension.
Relationship of course to Program learning Outcomes:

This course addresses new ABET Program Outcomes 1, 2 & 6. The Assessment is through quantitative evaluations of scores of Tests and the Final Project. The specific outcomes are:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.

Upon completion of this course, the students will be able to:

1. Analyze the steady state performance of DC & AC-Induction machines.
2. Analyze the dynamic behavior of DC & AC-Induction machines, including loads.
3. Analyze & Design variable speed drives for DC & AC-Induction machines.

Detailed Schedule: “Topics and/or dates may be changed during the semester at the instructor’s discretion because of scheduling issues, developments in the discipline, or other contingencies.”

Demo of Machines & Drives, Intro to DC-Machines, Motivation for studying DC Machines
Aug 29, 2019: DC Machine construction and basic behavior, Introduction to MathCAD
Sep 03, 2019: DC Machines, construction details, voltage & torque generation, k_e & k_i, moment of inertia, control
DC Machine quantitative example, PM & Wound Field examples
Sep 05, 2019: Introduction into machine dynamics, control of DC machines
Sep 10, 2019: Closed loop DC-Machine control, modeling and demonstration
Sep 12, 2019: Field trip to Brandon & Clark (tentative)
Sep 17, 2019: Magnetic Circuit basics, Ampere’s & Faraday’s laws, transformer theory
Construction basics of induction machine
Sep 19, 2019: System level review of machine basics, Torque & Power density
Sep 24, 2019: Review of AC power, transformers, derivation of steady state equivalent circuit of induction machine
Sep 26, 2019: Detailed Analysis of single phase equivalent circuit of Induction machine, deep rotor bars
Details for Induction machine construction, windings, Test 1 review
Oct 01, 2019: Test 1
Oct 03, 2019: Development of the dynamic models in various reference frames for AC induction machines (I)
Oct 08, 2019: Development of the dynamic models in various reference frames for AC induction machines (II)
Oct 10, 2019: Implementation of solutions for the dynamic model of the Induction machine, examples
Oct 15, 2019: Introduction to Control of Induction machines, derivation of V/Hz control theory
Oct 17, 2019: Discussion of Power Electronics for control of Induction machines
Oct 22, 2019: Power Semiconductors for Machine Control, Review of material for Test 2
Oct 24, 2019: Test 2
Oct 29, 2019: Digital software implementation of V/Hz control of Induction machines

Oct 31, 2019: Development of vector control theory for Induction machines (I)

Nov 05, 2019: Development of vector control theory for Induction machines (II)

Nov 07, 2019: Development of LT-Spice Simulation models for Vector Control of Induction machines

Nov 12, 2019: Simulation examples of Vector Control of Induction machines

Nov 14, 2019: Vector Control of Induction machines, Sensors and Implementation Issues

Nov 19, 2019: Review of material for Test 3, Assignment of Test 3 take-home exam on machine dynamics

Nov 21, 2019: Introduction to Speed-sensorless control of Induction machines

Nov 26, 2019: Derivation of Speed-sensorless control of Induction machines

Nov 28, 2019: Thanksgiving Holiday, no classes

Nov 26, 2019: Period of no examinations until Dec 05

Dec 03, 2019: Implementation of Speed-sensorless control of Induction machines

Dec 10, 2019: Final Papers (constituting the Final Exam) due at 5:00 p.m.

Dec 13, 2019: Graduate Commencement, 7:30 pm

Dec 14, 2019: Undergraduate Commencement, 9:00 am