ESE 352: Electromechanical Energy Converters

Fall 2020

Course Description:

An introduction to the conversion of mechanical power to electric power (generators) and the conversion of electric power to mechanical power (motors). Analysis of the interaction of magnetic fields with electric current and moving conductors to produce electromagnetic force and induced voltage. Energy converters studied include three phase AC synchronous generators and motors, AC induction motors, DC linear and rotating machines, and single phase AC motors.

Course Designation: Elective

Text Book: Electric Machinery Fundamentals (5^{th} ed. McGraw Hill) Chapman (ISBN 978-07-352954-0)

Prerequisites: ESE 372

Instructor: Timothy J. Driscoll (timothy.driscoll@stonybrook.edu)

Class/laboratory Schedule: 3 lecture hours per week

Goals:

Teach analysis and design techniques associated with the conversion of mechanical energy to electrical energy (generators) and the conversion of electrical energy to mechanical energy (motors).

Course Learning Outcomes:

Upon completion of this course, students will demonstrate an understanding of:

1. The interaction of magnetic fields with electric current and moving conductors in the production of electromagnetic induced force and voltage.
2. The design and application of three phase AC synchronous generators, induction machines and synchronous motors.
3. The design and application of DC generators and motors.
4. The design and application of single-phase AC machines.

Topics Covered:

Week 1.	Overview of electromechanical energy converter fundamentals: rotational motion, power, magnetic fields, core losses, induced force, induced voltage, linear DC machine.
Week 2.	Rotating loop in magnetic field, induced voltage in AC machines, induced torque, machine power flow, losses.

Week 3.	Real, Reactive, and Apparent Power flow in AC circuits. Faraday's Law
Week 4.	Synchronous generators including the following: construction, relationship between rotor mechanical speed and electrical frequency, internal generator voltage, equivalent circuit, phasor diagram representation, power and torque, operation, and ratings.
Week 5.	Synchronous motors including: rotating magnetic field, equivalent circuit, steady-state operation, starting issues, phasor diagrams, ratings.
Week 6.	Review sessions 1 through 5.
Week 7.	First exam.
Week 8.	Review First Exam. Induction machines including: construction, slip and frequency, equivalent circuit, torque, torque-speed characteristics, induction motor design, starting challenges, speed control, induction generators, and induction machine ratings.
Week 9.	DC machinery fundamentals including: rotating coil between magnetic poles, commutation, induced voltage and torque, machine construction, power flow, losses.
Week 10.	DC motors and generators including: equivalent circuits for separately excited, shunt, permanent magnet, series and compound machines; starting circuits, and machine efficiency.
Week 10.	Single phase motors including: universal motor, single phase induction motor, starting challenges, equivalent circuits.
Week 12.	Special-purpose motors including: split phase, capacitor start, capacitor start/capacitor run, shaded pole, and stepper motors. Discuss Presentation for Electromechanical Energy Converter Applications.
Week 13.	Presentations for Electromechanical Energy Converter Applications
Week 14.	Review for final exam.
Week 15	Final Exam

Notes:

- Homework assignments are due at next session.
- The weekly quiz will cover material discussed during the previous session.
- Final grade will be determined as follows:

Homework, Weekly Quiz, Participation	34%
First Exam	33%
Second Exam	33%
	100

	Student Outcomes	% contribution
1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	70
2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	10
3	an ability to communicate effectively with a range of audiences.	
4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in a global, economic, environmental, and societal contexts.	10
5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	10
6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.	
7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	