ESE 352: Electromechanical Energy Converters

Fall 2024

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. An introduction to inverter-based renewable energy generation in power systems.

Textbook: Electric Machinery Fundamentals (5th ed. McGraw Hill) Chapman (ISBN 978-07-352954-0)

Prerequisites: ESE 273

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Light Engineering 215

Office Hours: Wednesday 9:30 am-11:30 am, 12:30 pm-14:30 pm (in-person or online)

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.
5. Fundamental knowledge of power converters and the application of inverter-based resources (IBRs) in power systems

Grading:

- Final grade will be determined as follows:

Homework (9 assignments in total)	27%
Weekly quiz (8 quizzes in total)	8%
Mid-term exam	30%
Final exam	30%
Class participation	5%
	100%

- Homework assignments are posted every Wednesday and are typically due by midnight the following Wednesday.
- The weekly quiz will cover material discussed during the previous session.

Schedule of Lectures, Quiz, and Homework (HW)

Week	Topic	Quiz	HW
Week 1 (8/28)	Overview of electromechanical energy converter fundamentals: rotational motion, power, magnetic fields and circuits, induced force and voltage, linear DC machine, real, reactive, and apparent power flow in AC circuits, Faraday's Law.		HW1
Week 2 (9/4)	Transformers including: ideal transformers, equivalent circuit, efficiency, voltage regulation, three-phase transformers.	Q1	HW2
Week 3 (9/11)	Fundamentals of AC machines: rotating loop in magnetic field, induced voltage in AC machines, induced torque, machine power flow, losses.	Q2	HW3
Week 4 (9/18)	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.	Q3	HW4
Week 5 (9/25)	Synchronous motors including: rotating magnetic field, equivalent circuit, steady-state operation, starting issues, phasor diagrams, ratings.	Q4	HW5
Week 6 (10/2)	Review session for mid-term exam.		
Week 7 (10/9)	Mid-term exam covering lectures in weeks 1-6.		
Week 8 (10/16)	Induction machines including: construction, slip and frequency, equivalent circuit, torque, torque-speed characteristics, induction motor design, starting challenges,		HW6

	speed control, induction generators, and induction machine ratings.		
Week 9 (10/23)	DC machinery fundamentals including: rotating coil between magnetic poles, commutation, induced voltage and torque, machine construction, power flow, losses.	Q5	HW7
Week 10 (10/30)	DC motors and generators including: equivalent circuits for separately excited, shunt, permanent magnet, series and compound machines; starting circuits, and machine efficiency.		HW8
Week 11 (11/6)	Single phase motors including: universal motor, single phase induction motor, starting challenges, equivalent circuits.	Q6	HW9
Week 12 (11/13)	Fundamentals of power inverters. Inverter-based resources (IBRs) in Photovoltaics (PV) systems including: PV array modeling, maximum power point tracking (MPPT), grid-connected PV system. IBRs in wind generation systems including: fundamentals for wind turbine, wind generation systems, Type I-IV wind turbines.	Q7	
Week 13 (11/20)	Fundamentals of IBR control: grid connection of inverters, double-loop control of IBRs, primary control, secondary control, distributed control.	Q8	
Week 14 (11/27)	Thanksgiving Break (no classes in session)		
Week 15 (12/4)	Review session for final exam.		
TBD	Final exam covering lectures in weeks 8-15.		

Student Accessibility Support Center Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodation is necessary and appropriate. All information and documentation are confidential.

Academic Integrity Statement

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology and Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-

specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_ integrity/index.html.

Critical Incident Management

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.