

# ESE 352: Electromechanical Energy Converters

Fall 2022

## 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<sup>th</sup> ed. McGraw Hill) Chapman (ISBN 978-07-352954-0)

**Prerequisites:** ESE 372

**Instructor:** Timothy J. Driscoll ([timothy.driscoll@stonybrook.edu](mailto:timothy.driscoll@stonybrook.edu))

**Office Hours:** Zoom by appointment

**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 and circuits, core losses, induced force and voltage, linear DC machine, regenerative braking, |
| 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.<br>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: Wednesday October 6, 4:30 – 7:00 PM  |
| Week 8.  | Review First Exam.<br>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.<br>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 as specified in Blackboard.
- 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                          | <u>33%</u> |
|                                      | 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.  |                |

**University Policies:**

**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, 128 ECC Building, (631) 632-6748, or at [sasc@stonybrook.edu](mailto:sasc@stonybrook.edu). They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center. For procedures and information go to the following website: <https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-people-physical-disabilities> and search Fire Safety and Evacuation and Disabilities.

**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 & 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](http://www.stonybrook.edu/commcms/academic_integrity/index.html)

**Important Note:** Any form of academic dishonesty, including cheating and plagiarism, will be reported to the Academic Judiciary.

**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.