AUB/FEA/ECE

ELECTRIC MACHINES AND POWER FUNDAMENTALS

EECE 370 - 3 Credits

COURSE DESCRIPTION

Three-phase circuits and power calculation, magnetic circuits, transformers: single-phase ideal and real transformers, construction, operation, autotransformers, 3-pbase transformers. Fundamentals of AC and DC machines: Construction and basic concepts, DC machine: types, characteristics, and performance of series motor. Synchronous generators: construction, equivalent circuits, testing and performance characteristics. Induction motors construction, principle of operations, tests, power efficiency and torque. Prerequisite: EECE 210.

COURSE OBJECTIVES

- The proposed course provides fundamental theory related to 3-pbase circuits, electric machines, and power systems fundamentals. It covers basic concepts of electromagnetism and electromechanical energy conversion devices such as transformers, motors, and generators.

- The proposed course will be a pre-requisite to a series of machines, power, control, and drives-related courses and laboratories.

- The proposed course also provides essential support to a wide scope of topics and courses in the ECE program such as power electronics, control, instrumentation, power systems protection and planning, and industrial electrification.

COURSE OUTTLINE

Introduction

I. Magnetic Systems (5 lectures)
Review of magnetic fields and circuits: Faraday's and Ampere's laws, fundamental aspects, material saturation. Magnetic material: ferromagnetism, Hysteresis loop and iron losses. Induced voltage and force on a conductor.

II. Three-Phase Circuits (5 lectures)
Generation of 3-phase voltages and currents, Delta and Wye connections, power relationships in 3-phase circuits, power triangle, balanced 3-phase systems, and power factor correction.

III. Transformers (9 lectures)
Principle of operation, construction, types, ideal transformers, real transformers, equivalent circuits and phasor diagrams, open-circuit and short-circuit testing, per unit system, voltage regulation, efficiency, maximum-efficiency concept, autotransformers, three-phase transformers: analysis and application.

IV. Fundamentals of AC Machines (4 lectures)
Basic components, rotating magnetic field of poly-phase windings, stator and rotor MMF and flux distribution, induced voltage and torque, power flow and losses.

V. Synchronous Generators (6 lectures)
Mechanical construction, methods of excitation, equivalent circuits and phasor diagram, power and torque expressions, open and short-circuit testing, effect of load variations, synchronization.

VI. Induction Motors (7 lectures)
Construction, principle of operation, rotor slip, equivalent circuits, torque-speed characteristics, motor tests, power, losses, and efficiency.

VII. Fundamentals of DC Machines (5 lectures)
Stator and rotor winding, induced voltage and torque in a rotating loop, commutation and associated problems. Armature windings connections: lap and wave windings. Voltage and torque expressions in real dc machines, power flow diagram and losses. Types of DC machines; shunt and series motor characteristics

COURSE INSTRUCTORS
Prof. Hazem Chahine, Mr. Ghassan Dib, Mr. Khaled Joujou, Prof. Sami Karaki (coordinator)

COURSE PRE-REQUISITES: EECE210 Electric Circuits and Electronics

STUDENT ASSESSMENT
Attendance (5%), Drop Quizzes (5%), Homework (5%), Quiz 1 (Oct. 30, 2008) and Quiz2 (Dec. 4, 2008) (20% lowest – 30% highest), Final Exam (35%)

TEXTBOOK: Electric Machinery Fundamentals, S. Chapman, 4th Ed. McGraw-Hill, 2005

OTHER REFERENCES
Electric Machinery, Fitzgerald et al, McGraw-Hill, 2003
Electric Machinery and Transformers, B. Guru, 3rd Edition, 2001

LEARNING OUTCOMES
By the end of the course, students should be able to

- Acquire basic knowledge of three phase circuits.
- Understand the basics of electromagnetic systems.
- Understand the mechanical construction of electric machines.
- Describe different stages of electromechanical energy conversion.
- Simplify the complex machine operations by means of equivalent circuits.
- Acquire basic knowledge of poly-phase systems.
- Understand the operation of AC&DC series motors and ac power generators.
- Acquire basic knowledge for more advanced courses.
- Relate the theory to real life cases.

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