ECE 330
Power Circuits and Electromechanics

Course Goals

This is one of the technical electives (3 out of 5) in the EE curriculum. The goals are to impart basics of three phase power circuits, transformers and electromechanical systems with an emphasis on rotating machines. This addresses the ECE department Program Educational Objectives to provide depth, breadth, and learning environment.

Instructional Objectives

The letters (1)-(8) refer to ABET Objectives as follows:

(1) Principles: An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.

(2) Design: 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) Experimentation: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

(4) Communication: An ability to communicate effectively with a range of audiences.

(5) Responsibility: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

(6) Learning: An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.

(7) Teamwork: An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

(8) Foundations: Knowledge of the foundations of engineering, science, and mathematics and their applications in electrical and computer engineering.

A. At the end of three weeks of classes the students should be able to analyze single and three phase sinusoidal balanced circuits (1, 6). This includes being knowledgeable in the following topics:

- Phasors; r.m.s. values; peak values; phase angle
- power factor (leading (capacitive) or lagging (inductive))
- complex power; real and reactive power; lagging and leading power factor
- apparent power (volt amps); rated VA; rated volts; rated amps
- use of phasors to calculate all complex power variables

- conservation of complex power
- Y and Delta connections; line and phase voltages and currents for Y and Delta connections
- Y-Delta transformation (balanced only); power in 3-phase circuit, per phase calculations
- Improvement of power factor

B. At the end of six weeks of classes, the students should be able to analyze magnetic circuits (1, 2, 6, 8). This includes being knowledgeable in the following topics:

- flux, magneto-motive force (MMF) (Ni); reluctance
- calculation of fluxes; flux linkages and inductances (self and mutual)
- coefficient of coupling for coupled coils; polarity dot marking; coupled coil equations
- ideal transformers; transformer equivalent circuits
- current, voltage and impedance relations for transformers
- losses in transformers; efficiency,
- approximate transformer equivalent circuits; voltage regulation
- open and short circuit tests to determine transformer parameters

C. At the end of nine weeks of classes, the students should understand basic principles of electromechanical energy conversion, compute forces and torques of electric origin in magnetic devices such as relays, transducers etc. (1, 3, 6, 8). This includes being knowledgeable in the following topics:

- flux linkage (self and mutual); use of magnetic circuits to calculate flux linkages
- calculation of energy W_m (path of integration); use of energy to calculate f^e
- use of energy to calculate T^e; calculation of co-energy
- calculation of co-energy (paths and integration)
- f^e and T^e using co-energy (single and multiple terminal pair systems)
- dynamics of lumped mechanical systems

D. At the end of twelve weeks of classes, the students should be able to simulate numerically simple electromechanical systems and find the stability of the equilibria. (1, 6, 8). This includes being knowledgeable in the following topics:

- nonlinear dynamic model; static equilibrium points
- dynamic equations of motion; graphical method of computing equilibrium points
- state space formulation
- Euler’s method to integrate non-linear differential equations (numerical)
- linearization of dynamic equations and stability of static equilibrium points

E. By the end of the semester the student should be able to analyze the basic steady-state operation of synchronous machines, induction machines and DC machines (1, 2, 6). This includes being knowledgeable in the following topics:

- form of flux linkages; calculation of torque,
- per-phase equivalent circuit; power relations; motor and generator operation
- multiple pole machines-speed of operation
- power and efficiency calculations; torque-speed curves

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