**ELEN 4210: Design and Analysis of Electric Motor-Drive Systems**

**Class Schedule:** 3 Credit course, meeting the equivalent of 2 -75 minute class periods per week

**Course Coordinator**: Nabeel A. O. Demerdash

**Course Materials:**

**Required:** Class Notes, by Course Instructor, Dr. N.A.O Demerdash

**Prerequisites:**  ELEN 2020, ELEN 3110 and ELEN 3210

**Selected Elective** in Power and Energy Systems area.

**Course Description:**

Principles of design of ac and dc electric machines, in particular design of electric motors in power electronically controlled adjustable speed drives, torque and power to volume analysis under constant volts per hertz torque-speed control. Covers design of ac induction, synchronous, universal and dc conventional as well as brushless dc motors, and low horsepower motors in adjustable speed drives. Covers effects of space and time harmonics on motor design and performance including harmonic abatement for control of torque pulsation. Use of modern modeling techniques throughout.

**Contribution to Professional Component:** Engineering Science 30%

Engineering Design 70%

**Course Goals:**

* Understanding the basic principles of power electronic processing of ac and dc power, rectification, chopping, inversion, pulse width modulation.
* Understanding the topologies of single phase, two phase and three phase ac rectification and inversion circuits.
* Understanding the basics of harmonic analysis of nonsinusoidal ac voltage and current signals, nonsteady dc voltage and current signals, and all associated power calculations.
* Understanding the impact of harmonic rich dc signals on the performance and design calculations of conventional brush-commutator type dc motors in dc adjustable speed drives.
* Understanding the principles of operation and methods of performance computation of brushless dc/electronically commutated motors and their design techniques in dc adjustable speed drives.
* Understanding the principles of operation and methods of performance computation of poly-phase induction motors in constant volts per hertz ac adjustable speed drives, and impact of the drives on motor design techniques.
* Understanding issues of harmonic effects (space and time harmonics) on motor output torque profiles (quality) in ac and dc adjustable speed drives.
* Understanding the principles of operation and methods of performance computation of fractional horse-power and small integral horse-power motors in adjustable speed drives, and understanding some special design considerations for these types of motors.
* Understanding the principles of operation and methods of performance computation of poly-phase synchronous and reluctance motors in constant volts per hertz ac adjustable speed drives, and impact of the drives on motor design techniques, including some torque profile (quality) issues.
* Understanding of the existence of advanced design and simulation modeling techniques for dealing with complex issues such as ac and dc power quality effects on motor losses and overall motor-drive efficiencies, and related topics.

**Course Objectives:**

*By the end of this course, the student should be able to....*

1. Explain dc and ac power conditioning/processing circuits and compute input/output power with complex profiles of ac and dc currents and voltages.
2. Compute performance and design dc adjustable speed drives containing conventional and modern brushless dc motors.
3. Compute performance and design ac adjustable speed drives containing polyphase induction, synchronous, reluctance ac motors.
4. Compute performance and design fractional and small horse-power single phase ac induction and ac commutator type universal motors in adjustable speed drives.
5. Comprehend and analyze practical systems involving losses and efficiency questions in motor-adjustable speed drives.
6. Extrapolate this knowledge and skills into new and unusual performance analysis and computation issues, with the use of complex simulations for motor-adjustable speed drive systems.

**Contribution to Program Objectives:**

Partial fulfillment of Criterion 3 objectives A, B, C, E, G, I, K

**Course Topics:**

1. Basic Concepts of Electromechanical Energy Conversion and Electric Machinery - the Qualitative and the Quantitative Points of View

2. Basic Concepts in Power Electronic Conditioning/Processing

3. Conventional Brush-Type and Brushless-Type DC Motors in Adjustable Speed Drives - Design and Performance Aspects

4. Three-Phase Induction Motors in Adjustable Speed Drives - Design and Performance Aspects

5. Three-Phase Induction Motors in Adjustable Speed Drives - Design and Performance Aspects

6. Three-Phase Synchronous Motors in Adjustable Speed Drives - Design and Performance Aspects

7. Fractional Horse-Power Motors, Single Phase Motors and Special Machines in Adjustable Speed Drives - Design and Performance Aspects

8. Advanced and General Practical Considerations in the Choice of Adjustable Speed Drives