



ELE769

SPECIAL TOPICS IN ELECTRIC POWER SYSTEMS
Electrical Motor Drive Systems

Spring Semester 2003-2004

Content:

Basic operating characteristics and classification of electrical drives. Solid-state DC motor control. Solid-state AC motor control. Dynamic behaviour of electrical machines. Electrical braking. Starting of electrical machines. Intermittent loads. Drive applications. Modern methods of reactive power compensation. Electrical Energy Saving.

Prerequisites: ELE 454 and ELE 361
Strongly recommended: ELE 362

Goals:

This course is designed to equip seniors with knowledge about operation principles and design of modern, static AC and DC motor drives, and to give them an ability to choose such systems for various industrial applications.

Prerequisite by Topic:

- 1- Electromechanical energy conversion principles
- 2- Operating principles and steady-state performance characteristics of AC and DC motors
- 3- Terminal characteristics of power semiconductors
- 4- Operating characteristics of converters performing interconversion of electrical energy
- 5- Classical control techniques

Topics:

I- INTRODUCTION (6 class hours)
Basic definitions for static dc and ac drives, classifications, four-quadrant operation and operating characteristics. Load characteristics. Definition of the speed control problem.

- II. SOLID STATE DC MOTOR SPEED CONTROL (8 class hours)
- 2.1. Single-phase line-commutated drives
Half-wave, full-wave and Gaudet drive circuits
- 2.2. Three-phase line-commutated drives. Three-phase, incomplete bridge, complete bridge, effects of freewheeling diode on the performance
- 2.3. DC-DC drives
A dc motor supplied from a chopper, Basic Jones chopper circuit, motoring and regeneration.
- 2.4. Field winding supply methods
- 2.5. Speed control by field weakening
- III. SOLID STATE AC MOTOR SPEED CONTROL (9 class hours)
- 3.1. The static variable-frequency ac drives. Constant Volts/Hz operation, The dc link converter, frequency control, alternative methods of voltage control, control circuitry.
- 3.2. Induction motor speed control by the variation of stator voltage.
Basic circuits including back-to-back connected thyristors, phase-angle control and integral cycle control, control circuitry.
- 3.3. Wound rotor induction motor speed control by a static converter cascade
- 3.4. Static control of external rotor resistance for wound-rotor induction motor speed control.
- IV. PROTECTION (2 class hours)
- Protection against line voltage transients, overload, faults, such as transient voltage suppressors, snubbers, semiconductor fuses, chokes, capacitors. Safety margins in semiconductor device selection.
- V. PRACTICAL ASPECTS OF ELECTRIC MOTOR DRIVES (2 class hours)
- Speed sensing, current sensing, practical firing circuits. Basic control circuits.
- VI. DYNAMIC ANALYSIS OF ELECTRIC MOTORS (2 class hours)
- 6.1. Mathematical model of mechanical system
- 6.2. Mathematical model of the electric motor
- 6.3. Treatment of the problem and methods of solution
- VII. ELECTRIC BRAKING (4 class hours)
- Static braking methods for dc and induction motors, free deceleration, dynamic and regenerative braking techniques, plugging.
- VIII. ELECTRIC MOTOR STARTING (2 class hours)
- Static starting methods for dc and ac motors, practical circuits.
- IX. SELECTION OF DRIVES (3 class hours)
- The system decision tree, factors affecting the choice. Applications and candidate configurations for power range below 1000 kW, and above.
- X. INTERMITTENT LOADS (2 class hours)
- Definitions, determination of the hp rating of the motor for intermittent loads, rms power and rms torque criteria.

REFERENCES

1. Dewman S.B., Slemon G.R., and Straughen A., Power Semiconductor Drives, John Wiley and Sons, 1984.
2. Kusko, A., Solid State DC Motor Drives, The MIT Press, 1979.
3. Murphy J.M.D., Thyristor Control of AC Motors, Pergamon Press, 1975.
4. Krishnan, R. 'Electric Motor Drives: Modeling, Analysis, and Control', Prentice Hall, 2001.
5. Bose B., Power Electronics and AC Drives, Prentice Hall, 1986.
6. Subrahmanyam V., Thyristor Control of Electric Drives, Mc Graw-Hill, 1988.
7. Rashid M.H., Power Electronics: Circuits, Devices and Applications, Prentice Hall, 1988.
8. Mohan N., Undeland T.M. and Robbins, W.P., 'Power Electronics. Converters, Applications and Design, John Wiley and Sons, 2nd Ed., 1995.
9. Bose B., Power Electronics and Variable Frequency Drives, IEEE, 1996.
10. Lander, Cyril W., Power Electronics, Mc Graw Hill, 3rd. Ed.