

ELECTRICAL ENERGY UTILISATION

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Adam Marszalek Publishing House, Torun, 1998

This text evolved from notes used in teaching an undergraduate course *Energy Utilisation* at the University of Cape Town. As the curricula of electrical engineering programmes became more and more overcrowded, many electrical engineering departments decided to limit the number of compulsory courses in heavy current electrical engineering. As a result, the number of lectures in electrical machines and related subjects have been reduced. Under such circumstances students need a concise textbook which covers electrical motors with emphasis on their performance, selection and applications, characteristics of modern electrical drives including variable speed drives and the use of electrical energy in households.

This textbook deals with fundamentals of electrical motors, drives, electrical traction and domestic use of electrical energy. It is intended to serve second or third year students taking a one-semester course in energy utilisation or electric power engineering. Transformers and electromechanical generators have been omitted as transformation and generation of electric power is usually covered by a parallel course in power systems.

The textbook consists of seven chapters: 1. *Energy and drives*, 2. *D.c. motors*, 3. *Three-phase induction motors*, 4. *Synchronous motors*, 5. *Variable-speed drives*, 6. *Electrical traction* and 7. *Domestic use of electrical energy*. Chapter 7 also contains principles of *illumination*. For a one semester course and two lectures per week the authors recommend the first four chapters. For four lectures per week the authors recommend all seven chapters. Students using this textbook should have taken courses in circuit theory and electromagnetism as prerequisites.

Free solution manual is provided with minimum 10 copies ordered.

7 chapters, 4 Appendixes, 245 pages, 19 tables, 150 line drawings, 21 numerical problems with solutions, 52 numerical problems without solutions.

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Today in an industrialized country more than 65% of the generated electrical energy is consumed by electrical drives.

Other recent books written by Prof. J.F. Gieras:

Gieras J.F. **Linear induction drives**, Clarendon Press, Oxford, 1994, GBP 55.00

Gieras J.F. and Wing. M.: **Permanent magnet motors technology: design and applications**, 2nd edition, Marcel Dekker Inc., New York, 2002, US\$ 185.00

CONTENTS

1. ENERGY AND DRIVES. Electrical energy. Conservation of electrical energy. Classification of electric motors. Applications of electric motors drives. Trends in the electric motor and drives industry. How many motors are used in affluent homes ? Fundamentals of mechanics of machines. Torque equation. Mechanical characteristics of machines. Problems.
2. D.C. MOTORS. Construction. Fundamental equations. D.c. shunt motor. D.c. series motor. Compound-wound motor. Starting. Speed control of d.c. motors. Braking. Permanent magnet d.c. commutator motors. Disc motors. Problems.
3. THREE-PHASE INDUCTION MOTORS. Construction. Fundamental relationships. Equivalent circuit. No-load and blocked-rotor tests. Torque-speed characteristics. Starting. Induction motors that use skin effect in the rotor winding. Speed control. Braking. Connection of a three-phase motor to a single-phase power supply. Abnormal operating conditions. Problems.
4. SYNCHRONOUS MOTORS. Construction. Fundamental relationships. Phasor diagram. Characteristics. Starting. Comparison with induction motors. Permanent magnet synchronous motors. Synchronous reluctance motors. Hysteresis motors. Problems.
5. VARIABLE-SPEED DRIVES. Power semiconductor devices. D.c. motor drives (speed control, Ward-Leonard system, closed-loop control system, controlled rectifiers, choppers, switch-mode d.c.-d.c. converters). Induction motor drives (speed control, a.c. voltage regulators, a.c.-a.c. converters, cycloconverters, inverter-fed induction motor capabilities, vector control method, energy efficient motors). Synchronous motor drives. Electronically commutated motors (permanent magnet d.c. brushless motors, stepping motors, switched reluctance motors). Problems.
6. ELECTRICAL TRACTION. Characteristics of traction systems. Track geometry. Power supply systems for electric traction. Current collection systems. Electrolysis by currents through the earth. Train movement. Traction effort equation. Driving mechanisms. Energy consumption. Survey of modern high-speed trains (TGV, *Shinkansen*, ETR, IC Express, X2000, AVE, *Eurostar*). Linear induction motor driven trains. Problems.
7. DOMESTIC USE OF ELECTRICAL ENERGY. Electric water heating. Clothes washers. Clothes driers. Refrigeration. Air-conditioners. Cookers. Heaters. Lights. Fundamental quantities, units and laws in lighting technology. Safety. Problems.

APPENDIX A. Left-hand rule and right-hand rule.

APPENDIX B. Three-phase windings.

APPENDIX C. Rotating magnetic field.

APPENDIX D. Winding factor.

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<http://members.cox.net/jgieras>

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