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# Fundamentals of Electric Drives (Electrical Engineering)

*By Mohamed El-Sharkawi*



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This text fills a need for a textbook that presents the basic topics and fundamental concepts underlying electric machines, power electronics, and electric drives for electrical engineering students at the undergraduate level. Most existing books on electric drives concentrate either on converters and waveform analysis (ignoring mechanical load dynamics), or on motor characteristics (giving short shrift to analysis of converters and controllers). This book provides a complete overview of the subject, at the right level for EE students. The book takes readers through the analysis and design of a complete electric drives system, including coverage of mechanical loads, motors, converters, sensing, and controllers. In addition to serving as a text, this book serves as a useful and practical reference for professional electric drives engineers.



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## **Editorial Review**

### **Review**

1. ELEMENTS OF ELECTRIC DRIVE SYSTEMS Historical Background / Basic Components of an Electric Drive System 2. INTRODUCTION TO SOLID STATE DEVICES Transistors / Thyristors / Other Power Devices / Ratings of Power Electronic Devices /  $di/dt$  and  $dv/dt$  Protection 3. INTRODUCTION TO SOLID STATE SWITCHING CIRCUITS Single-Phase, Half-Wave, ac-to-dc Conversion for Resistive Loads / Single-Phase, Full-Wave, ac-to-dc Conversion for Resistive Loads / Single-Phase, Half-Wave, ac-to-dc Conversion for Inductive Loads without Freewheeling Diode / Single-phase, Half-Wave, ac-to-dc Conversion for Inductive Loads with Freewheeling Diode / Three-Phase, Half-Wave ac-to-dc Conversion for Resistive Loads / Three-Phase, Half-Wave, ac-to-dc Conversion for Inductive Loads / Three-Phase, Full-Wave, ac-to-dc Conversion / dc-to-dc Conversion / dc-to-ac Conversion / Energy Recovery Systems / Three-Phase Energy Recovery System / Current Source Inverter 4. JOINT SPEED-TORQUE CHARACTERISTICS OF ELECTRIC MOTORS AND MECHANICAL LOADS Bi-Directional Electric Drives System / Four-Quadrant Electric Drives 5. SPEED-TORQUE CHARACTERISTICS OF ELECTRIC MOTORS dc Motors / Induction Motors / Synchronous Motors / Damages to Electric Machines 6. SPEED CONTROL OF DIRECT CURRENT MOTORS Speed Control of Shunt or Separately Excited Motors / Speed Control of Series Motor 7. SPEED CONTROL OF INDUCTION MOTORS Basic Principles of Speed Control / Speed Control Using Rotor Resistance / Rotor Voltage Injection / Slip Energy Recovery / Speed Control Using Inductance / Speed Control by Adjusting the Stator Voltage / Speed Control by Adjusting the Supply Frequency / Voltage/Frequency Control / Current Source Speed Control 8. BRAKING OF ELECTRIC MOTORS Regenerative Braking / Dynamic Braking / Counter-Current Braking 9. BRAKING OF DC MOTORS Regenerative Braking of dc Shunt Motors / Regenerative Braking of dc Series Motors / Dynamic Braking of dc Shunt Motors / Dynamic Braking of dc Series Motors / Counter-Current Braking of dc Shunt Motors / Counter-Current Braking of dc Series Motors 10. BRAKING OF INDUCTION MOTORS Regenerative Braking / Dynamic Braking / Counter-Current Braking 11. TRANSIENT TIME OF ELECTRIC DRIVES SYSTEM Moment of Inertia / Basic Concept of Traveling Time / Gears and Belts / Traveling Time of dc Motors / Traveling Time of Induction Motors / Traveling Time of Synchronous Motors / INDEX

### **About the Author**

Mohamed A. El-Sharkawi is a Fellow of IEEE and is a Professor of Electrical Engineering and the Associate Chair at the University of Washington. He received his Ph.D. in Electrical Engineering from the University of British Columbia in 1980. He is the founder of the international conference on the Application of Neural Networks to Power Systems (ANNPS) and Co-founder of the international conference on Intelligent Systems Applications to Power (ISAP). He is a member of the administrative committee of the IEEE Neural Networks Council representing the Power Engineering Society, Video Tutorial Chair of the IEEE Continuing Education Committee and founding Chairman of several IEEE task forces and working groups and subcommittees.

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