

Contents

Preface xi

Chapter 1 Introduction to Electrical Engineering 1

- 1.1 Electrical Engineering 2
- 1.2 Electrical Engineering as a Foundation for the Design of Mechatronic Systems 4
- 1.3 Fundamentals OF Engineering Exam Review 15
- 1.4 Brief History of Electrical Engineering 16
- 1.5 System of Units 17
- 1.6 Special Features of this book 18

PART I CIRCUITS 22

Chapter 2 Fundamentals of Electric Circuits 23

- 2.1 Definitions 24
- 2.2 Charge, Current, AND Kirchhoff's Current Law 28
- 2.3 Voltage and Kirchhoff's Voltage Law 34
- 2.4 Electric Power and Sign Convention 38
- 2.5 Circuit Elements and Their i - v Characteristics 42
- 2.6 Resistance and Ohm's Law 43
- 2.7 Practical Voltage and Current Sources 61
- 2.8 Measuring Devices 62

Chapter 3 Resistive Network Analysis 81

- 3.1 Network Analysis 82
- 3.2 The Node Voltage Method 83
- 3.3 The Mesh Current Method 93
- 3.4 Node and Mesh Analysis with Controlled Sources 100
- 3.5 The Principle of Superposition 105
- 3.6 One-port Networks and Equivalent Circuits 108
- 3.7 Maximum Power Transfer 126
- 3.8 Nonlinear Circuit Elements 129

Chapter 4 AC Network Analysis 149

- 4.1 Energy Storage (Dynamic) Circuit Elements 150
- 4.2 Time-dependent Signal Sources 167

- 4.3 Solution of Circuits Containing Energy Storage Elements (Dynamic Circuits) 173
- 4.4 Phasor Solution of Circuits with Sinusoidal Excitation 175
- 4.5 AC Circuit Analysis Methods 191

Chapter 5 Transient Analysis 215

- 5.1 Transient Analysis 216
- 5.2 Writing Differential Equations for Circuits Containing Inductors and Capacitors 217
- 5.3 DC Steady-state Solution of Circuits Containing Inductors and Capacitors—Initial and Final Conditions 222
- 5.4 Transient Response of First-order Circuits 228
- 5.5 Transient Response of Second-order Circuits 249

Chapter 6 Frequency Response and System Concepts 283

- 6.1 Sinusoidal Frequency Response 284
- 6.2 Fourier Analysis 289
- 6.3 Filters 299
- 6.4 Bode Plots 322

Chapter 7 AC Power 343

- 7.1 Power in AC Circuits 344
- 7.2 Complex Power 351
- 7.3 Transformers 371
- 7.4 Three-phase Power 380
- 7.5 Residential Wiring; Grounding and Safety 388
- 7.6 Generation and Distribution of AC Power 392

PART II ELECTRONICS 408

Chapter 8 Electronic Instrumentation and Measurements 409

- 8.1 Measurement Systems and Transducers 410
- 8.2 Wiring, Grounding, and Noise 416
- 8.3 Signal Conditioning 420
- 8.4 Analog-to-digital and Digital-to-analog Conversion 434
- 8.5 Comparator and Timing Circuits 450

8.6 Other Instrumentation Integrated Circuits 461

PART III ELECTROMECHANICS 476

Chapter 9 Principles of Electromechanics 477

- 9.1 Electricity and Magnetism 478**
- 9.2 Magnetic Circuits 489**
- 9.3 Magnetic Materials and B - H Curves 504**
- 9.4 Transformers 506**
- 9.5 Electromechanical Energy Conversion 510**

Chapter 10 Introduction to Electric Machines 541

- 10.1 Rotating Electric Machines 542**
- 10.2 Direct-current Machines 554**
- 10.3 Direct-current Generators 560**
- 10.4 Direct-current Motors 564**
- 10.5 AC Machines 577**
- 10.6 The Alternator (Synchronous Generator) 579**
- 10.7 The Synchronous Motor 581**
- 10.8 The Induction Motor 586**

Chapter 11 Special-purpose Electric Machines 607

- 11.1 Brushless DC Motors 608**
- 11.2 Stepping Motors 615**
- 11.3 Switched Reluctance Motors 623**
- 11.4 Single-phase AC Motors 627**
- 11.5 Motor Selection and Application 641**

Appendix A Linear Algebra and Complex Numbers 653

Appendix B The Laplace Transform 661

Appendix C Fundamentals of Engineering (FE) Examination 671

Appendix D Answers to Problems 679

Index 687