

# Contents

<b>Preface</b>	<b>ix</b>
<b>Electricity—An Overview .....</b>	<b>1</b>
<b>1 Direct Current Calculations .....</b>	<b>5</b>
1-1 Ohm's Law .....	5
1-2 Series Circuits .....	8
1-3 Parallel Circuits .....	11
1-4 Combination Circuits .....	15
Chapter 1 Test .....	22
<b>2 Alternating Current Calculations .....</b>	<b>25</b>
2-1 Single Phase .....	25
2-2 Three-Phase Power .....	29
2-3 Power Factor .....	32
2-4 Voltage Drop .....	39
2-5 Combining Loads, Single Phase and Three Phase .....	42
Chapter 2 Test .....	42
<b>3 Transformers .....</b>	<b>45</b>
3-1 Transformer Basics .....	45
3-2 Delta and Wye Characteristics .....	48
3-3 Delta Connection .....	49
3-4 Wye Connection .....	49
3-5 Grounded Delta .....	51
3-6 Open Delta .....	53
3-7 Motor Control Transformer .....	53
3-8 Series and Parallel Windings .....	55
3-9 Transformer Polarity .....	56
3-10 Buck and Boost Transformers .....	57
Chapter 3 Test .....	58
<b>4 Miscellaneous Calculations .....</b>	<b>61</b>
4-1 Conduit Size—Two or More Conductors of the Same Size .....	61
4-2 Different-Size Conductors .....	62
4-3 Sizing Junction Boxes for #6 and Smaller Conductors .....	64
4-4 Junction Boxes for #4 and Larger Conductors ..	66

4-5	Over 600 Volts .....	67
4-6	Shielded Cable .....	67
4-7	Grounding Electrode Conductor .....	70
4-8	Equipment Grounding Conductor .....	71
4-9	Sizing Neutral Conductors .....	72
	Open Neutral .....	75
4-10	Oversize Protection .....	76
	Air Conditioning and Refrigeration	
	Equipment .....	77
	Welders .....	77
	Transformers .....	79
4-11	Phase Identification .....	81
	Tape Measure Method .....	82
	Chapter 4 Test .....	83
<b>5</b>	<b>Motors .....</b>	<b>87</b>
5-1	Introduction .....	87
5-2	Branch Circuit Conductors .....	88
5-3	Running Overload Protection .....	89
5-4	Branch Circuit Short Circuit and Ground-Fault Protection .....	91
5-5	Control Circuits .....	92
5-6	Controllers .....	95
5-7	Disconnecting Means .....	95
5-8	Fire Pumps, Controllers, and Motors .....	97
5-9	Common Motor Connections .....	98
	Three-Lead Three-Phase Motors .....	98
	Six-Lead and 12-Lead Motors .....	98
	Nine-Lead Motors .....	99
	Two-Speed Motors .....	99
5-10	Load Classification .....	100
	Chapter 5 Test .....	100
<b>6</b>	<b>Single-Dwelling Load Calculations .....</b>	<b>103</b>
6-1	General Lighting and Receptacles .....	103
6-2	Ovens and Cooktops .....	104
6-3	Heating and Air Conditioning .....	105
6-4	Electric Clothes Dryer .....	106
6-5	Fixed Appliances .....	106
6-6	Load Calculation for a Single-Family Dwelling .....	106
6-7	Addition to Existing Dwelling .....	108
6-8	Optional Calculation for Single-Family Dwelling .....	110
6-9	Optional Calculation for a Two-Dwelling Unit .....	114
	Chapter 6 Test .....	116

<b>7</b>	<b>Multifamily Load Calculations .....</b>	<b>119</b>
7-1	Standard Calculations .....	119
7-2	Ovens of Unequal Rating .....	122
7-3	House Loads for Multifamily Dwellings .....	123
7-4	Optional Calculation for Multifamily Dwelling .....	125
7-5	Laundry in Each Unit .....	130
7-6	Optional Calculation without Electric Cooking Equipment .....	133
	Chapter 7 Test .....	135
<b>8</b>	<b>Commercial Calculations .....</b>	<b>137</b>
8-1	General .....	137
8-2	Single-Phase Small Commercial Calculation .....	139
8-3	Three-Phase Small Commercial Calculation .....	140
8-4	Three-Phase, Medium-Size Commercial Building .....	142
8-5	Convenience Store .....	144
8-6	Adding to Existing Service .....	148
8-7	Restaurant Calculations Standard .....	149
8-8	Restaurant Calculations, Optional .....	150
	Chapter 8 Test .....	152
<b>9</b>	<b>Miscellaneous Service Entrance Calculations .....</b>	<b>155</b>
9-1	School Calculation .....	155
9-2	Computing Farm Loads .....	157
9-3	Computing Mobile Homes and Mobile Home Parks .....	158
9-4	Recreational Vehicles and Parks .....	160
9-5	High-Rise Hotel .....	162
9-6	Machine Shop .....	165
	Chapter 9 Test .....	167
<b>10</b>	<b>Conduit Bending .....</b>	<b>169</b>
10-1	Offsets .....	169
	Method 1 .....	169
	Method 2 .....	170
	Method 3 .....	171
10-2	Multiple Offsets .....	174
10-3	Kicks .....	175
10-4	Three-Point Saddle .....	176
10-5	Four-Point Saddles .....	177
10-6	Ninety Degree Bends .....	179
	Back-to-Back 90 Degree Bends .....	179

**viii    Contents**

10-7 Segment Bending .....	182
10-8 Circular Bends on Large Vessels .....	190
10-9 Concentric 90 Degree Bends, Fast and Easy .....	191
Chapter 10 Test .....	192
<b>11 Math Review .....</b>	<b>195</b>
11-1 Fractions .....	195
11-2 Percentage .....	199
11-3 Decimals .....	201
11-4 Basic Algebra .....	203
11-5 Angles .....	209
11-6 Square Roots .....	214
11-7 Metric Measurements .....	217
Temperature Conversions .....	217
Linear Measurement .....	217
Weight Measurements .....	218
Liquid Measurement .....	219
Chapter 11 Test .....	220
<b>Final Test .....</b>	<b>223</b>
<b>Answers to End-of-Chapter Tests and Final Test .....</b>	<b>229</b>
<b>Index .....</b>	<b>255</b>