

Mike Holt's Electrical Calculations Video Program

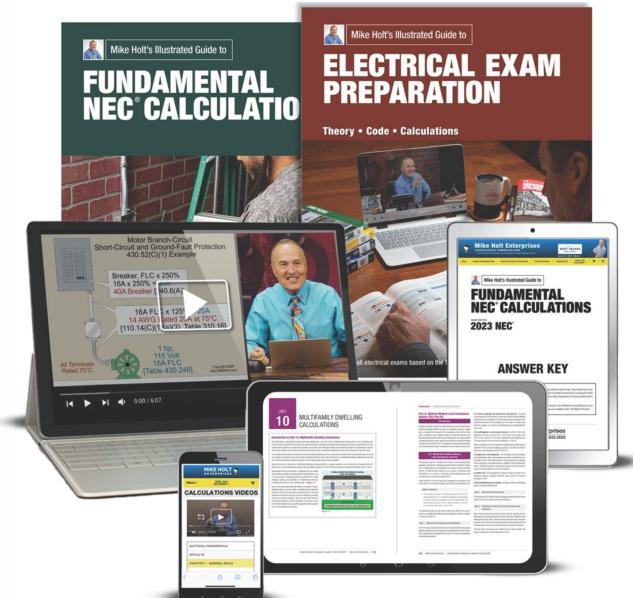


Table of Contents

This document includes the Table of Contents from each book that is included in your library. Click on the title to view details of the contents of that book.

Title	page #
Fundamental NEC Calculations.....	2
Electrical Exam Preparation	5

2023
NEC®



Mike Holt Enterprises | 888.632.2633 | MikeHolt.com

2023 FUNDAMENTAL NEC CALCULATIONS

About This Textbook	viii	Part II. Branch-Circuit Ratings	48
Additional Products to Help You Learn	xi	210.19 Conductor Sizing	48
How to Use the <i>National Electrical Code</i>	1	210.20 Overcurrent Protection	52
Article 90—Introduction to the <i>National Electrical Code</i>	7	Article 215—Feeders	53
90.1 Scope	7	215.1 Scope	53
90.2 Use and Application of the <i>NEC</i>	7	215.2 Conductor Sizing	54
90.3 <i>Code Arrangement</i>	11	215.3 Overcurrent Protection Sizing.....	58
90.4 <i>NEC Enforcement</i>	12	215.6 Feeder Equipment Grounding Conductor.....	59
90.5 Mandatory Requirements and Explanatory Material	13	Article 220—Branch-Circuit, Feeder, and Service Load Calculations	61
90.7 Examination of Equipment for Safety	14	Part I. General	61
Article 90—Review Questions	15	220.1 Scope	61
CHAPTER 1—GENERAL RULES	19	220.3 Application of Other Articles.....	62
Article 100—Definitions	21	220.5 Calculations	62
Article 110—General Requirements for Electrical Installations	31	Part II. Branch-Circuit Load Calculations	63
Part I. General Requirements	31	220.11 Maximum Load	63
110.1 Scope	31	220.14 Other Loads—Occupancies	63
110.2 Approval of Conductors and Equipment.....	32	Part III. Standard Method—Feeder/Service Load Calculations	66
110.3 Use of Equipment.....	32	220.60 Noncoincident Loads.....	66
110.5 Conductor Material	34	220.61 Neutral Calculated Load.....	66
110.6 Conductor Sizes	34	220.70 Energy Management Systems.....	68
110.7 Wiring Integrity	34	Article 230—Services	69
110.8 Suitable Wiring Methods	35	230.1 Scope	69
110.12 Mechanical Execution of Work	35	Part IV. Service-Entrance Conductors	69
110.14 Conductor Termination and Splicing.....	36	230.42 Conductor Sizing	70
Chapter 1—Review Questions	39	Part VII. Service Conductor Overcurrent Protection	72
CHAPTER 2—WIRING AND PROTECTION	45	230.90 Overload Protection—Where Required.....	72
Article 210—Branch Circuits	47	Article 240—Overcurrent Protection	75
Part I. General Provisions	47	Part I. General	76
210.1 Scope	47	240.1 Scope	76
		240.3 Other Articles (Overcurrent Protection of Equipment).....	77
		240.4 Overcurrent Protection of Conductors.....	77
		240.5 Overcurrent Protection of Flexible Cords, Flexible Cables, and Fixture Wires	82

240.6 Standard Ampere Ratings.....	82	Article 424—Fixed Electric Space-Heating Equipment	133
Part II. Location of Overcurrent Protective Device	83	Part I. General	133
240.21 Location of Overcurrent Protective Device in Circuit.....	83	424.1 Scope	133
Chapter 2—Review Questions	91	424.4 Branch Circuits	133
CHAPTER 3—WIRING METHODS AND MATERIALS			
Article 310—Conductors for General Wiring	99	Article 430—Motor Circuits, Controllers, and Adjustable-Speed Drives	135
Part I. General	99	Part I. General	135
310.1 Scope	99	430.1 Scope	135
310.3 Conductors, Minimum Size and Material.....	99	430.6 Motor Table FLC versus Motor Nameplate Current Rating....	136
Part II. Construction Specifications.	101	430.17 Highest Rated Motor.....	137
310.4 Conductor Construction and Application	101	Part II. Conductor Ampacity	138
Part III. Installation	103	430.22 Motor Conductor Ampacity.....	138
310.12 Dwelling Services and Feeders	103	Part IV. Branch-Circuit Short-Circuit and Ground-Fault Protection	139
310.14 Ampacities for Conductors Rated 0V to 2000V.....	106	430.51 General.....	139
310.15 Ampacity Tables.....	107	430.52 Branch-Circuit Short-Circuit and Ground-Fault Protection.....	140
310.16 Ampacities of Insulated Conductors.....	114	Part XIV. Tables	143
Article 334—Nonmetallic-Sheathed Cable (Type NM)			
Part I. General	117	Table 430.248 Full-Load Current, Single-Phase Motors.....	143
334.1 Scope	117	Table 430.250 Full-Load Current, Three-Phase Motors	143
Part II. Installation	118		
334.80 Conductor Ampacity.....	118	Article 440—Air-Conditioning Equipment	
Article 376—Metal Wireways			
Part I. General	121	Part I. General	145
376.1 Scope	121	440.1 Scope	145
Part II. Installation	122	440.4 Marking on Hermetic Motor-Compressors and Equipment....	146
376.22 Number of Conductors and Ampacity	122	Article 445—Generators	
376.23 Wireway Sizing	123	445.1 Scope	147
Chapter 3—Review Questions	125	445.13 Conductor Ampacity	147
CHAPTER 4—EQUIPMENT FOR GENERAL USE			
Article 422—Appliances			
Part I. General	131	Article 450—Transformers	
422.1 Scope	131	450.1 Scope	149
Part II. Branch-Circuit Requirements	131	450.3 Primary Overcurrent Protection.....	150
422.10 Branch Circuits.....	131	Chapter 4—Review Questions	152
422.11 Overcurrent Protection.....	132	CHAPTER 6—SPECIAL EQUIPMENT	
Article 625—Electric Vehicle Power Transfer System			
Part I. General	157		
625.1 Scope	157		
Part III. Installation	158		
625.40 Electric Vehicle Branch Circuit.....	158		
625.41 Overcurrent Protection	158		
625.42 Load.....	159		
Chapter 6—Review Questions	161		

FINAL EXAM 163

INDEX 173

About the Author 175

About the Illustrator 176

About the Mike Holt Team 177

2023 ELECTRICAL EXAM PREPARATION

About This Textbook	ix	Unit 13—Watt's Law	25
Passing Your Exam	xiii	13.1 Introduction	25
Additional Products to Help You Learn	xix	13.2 Watt's Law	25
How to Use the <i>National Electrical Code</i>	1	13.3 Power Formula Circle	26
		13.4 Power Changes with the Square of the Voltage	27
		Unit 13—Review Questions	28
		Unit 14—Series Circuits	31
		14.1 Introduction	31
		14.2 Series Circuits	31
		14.3 Understanding Series Circuits	31
		14.4 Series Circuit Summary	34
		14.5 Series-Connected Power Supplies	35
		14.6 Applications of Series Circuits	36
		Unit 14—Review Questions	37
		Unit 15—Parallel Circuits	39
		15.1 Introduction	39
		15.2 Understanding Parallel Circuits	39
		15.3 Parallel Circuit Resistance Calculations	41
		15.4 Parallel Circuit Summary	44
		15.5 Parallel-Connected Power Supplies	44
		15.6 Practical Uses of Parallel Circuits	45
		Unit 15—Review Questions	47
		Unit 16—Series-Parallel Circuits	51
		16.1 Introduction	51
		16.2 Understanding Series-Parallel Circuits	51
		16.3 Calculating Resistance in Series-Parallel Circuits	51
		Unit 16—Review Questions	53
		Unit 17—Alternating Current Fundamentals	55
		17.1 Introduction	55
		17.2 How Alternating Current is Produced	55
		17.3 Waveforms	56
		17.4 Frequency	58
		17.5 In-Phase Waveforms	59
		17.6 Out-of-Phase Waveforms	59
		17.7 Alternating-Current Waveform Values	59
		Unit 17—Review Questions	63

THEORY

MODULE I—ELECTRICAL FUNDAMENTALS	7
Unit 10—Basic Math	9
10.1 Introduction	9
10.2 Whole Numbers	9
10.3 Fractional Numbers	9
10.4 Decimal Numbers	9
10.5 Percentages	10
10.6 Parentheses	11
10.7 Squaring a Number	11
10.8 Square Root	11
10.9 Kilo	11
10.10 Rounding	12
10.11 Surface Area of a Rectangle or Square	12
10.12 Surface Area of a Circle	13
10.13 Volume	14
10.14 Reciprocal	15
10.15 Testing Your Answer	15
Unit 10—Review Questions	16
Unit 12—Ohm's Law	19
12.1 Introduction	19
12.2 The Electrical Circuit	19
12.3 Electromotive Force (Pressure)	19
12.4 Circuit Resistance	20
12.5 Circuit Intensity	21
12.6 Ohm's Law	21
Unit 12—Review Questions	23

Unit 20—True Power, Power Factor, and Apparent Power	67	Unit 29—The Formula Wheel	105
20.1 Introduction	67	29.1 Introduction	105
20.2 True Power	67	29.2 Formula Wheel Quadrants	105
20.3 Power Losses of Wires	67	29.3 Using the Formula Wheel	106
20.4 Power Losses at Terminals	68		
20.5 Equipment Efficiency	69	Unit 29—Review Questions	108
20.6 Cost of Power	69	Module I—Electrical Fundamentals—Practice Exam	111
20.7 Power Factor	70	Module I—Electrical Fundamentals Section Reference Index	117
20.8 Apparent Power	72		
20.9 Apparent Power versus True Power	73		
Unit 20—Review Questions	74		
Unit 21—Motors	77		
21.1 Introduction	77		
21.3 Motor Horsepower Rating	77		
21.5 Motor Nameplate Amperes	78		
21.7 Reversing the Rotation of Alternating-Current Motors	79		
21.8 Alternating-Current Motor Types	80		
Unit 21—Review Questions	81		
Unit 22—Generators	83		
22.1 Introduction	83		
22.4 Generator Output Current	83		
22.5 Single-Phase and Three-Phase Generator Voltages	84		
Unit 22—Review Questions	85		
Unit 23—Relays	87		
23.1 Introduction	87		
23.2 How Relays Operate	87		
23.3 Relay Contacts	88		
Unit 23—Review Questions	89		
Unit 24—Transformers	91		
24.1 Introduction	91		
24.6 Transformer Turns Ratios	91		
24.8 Autotransformers	93		
24.11 Transformer Current Rating	93		
Unit 24—Review Questions	97		
Unit 25—Overcurrent Protection	101		
25.1 Introduction	101		
25.6 Available Short-Circuit Current	101		
25.7 Overcurrent Protective Devices, Interrupting Rating	103		
Unit 25—Review Questions	104		
		CODE	
		MODULE II—NEC REVIEW QUESTIONS	119
		NEC Article 90—Introduction to the <i>National Electrical Code</i>	
		Review Questions	121
		NEC Chapter 1—General Rules Review Questions	123
		NEC Chapter 2—Wiring and Protection Review Questions	130
		NEC Chapter 3—Wiring Methods and Materials Review	
		Questions	155
		NEC Chapter 4—Equipment for General Use Review	
		Questions	172
		NEC Chapter 5—Special Occupancies Review Questions	185
		NEC Chapter 6—Special Equipment Review Questions	192
		NEC Chapter 7—Special Conditions Review Questions	199
		NEC Chapter 8—Communications Systems Review	
		Questions	219
		Module II—NEC Review Questions—Practice Exam	225
		Module II—NEC Review Questions <i>Code Rule Index</i>	235
		CALCULATIONS	
		MODULE III—NEC CALCULATIONS	239
		Unit 1—Raceway Calculations	241
		1.1 Conductor Cross-Sectional Area—Chapter 9, Tables 5 and 8	241
		1.2 Raceway Properties	245
		1.3 Sizing Raceways, Conductors all the Same Size—Annex C	247
		1.4 Raceways Sizing with Different Size Conductors	251
		1.5 Multiconductor and Optical Fiber Cables—Chapter 9, Note (5)	
		and Note (9)	253
		1.6 Wireways and Cable Tray Systems	254
		1.7 Tips for Raceway Calculations	258
		Unit 1—Review Questions	259

Unit 2—Box Calculations	265	4.2 Motor Full-Load Current and Motor Nameplate Current Rating [430.6(A)]	317
Part A—Outlet Box Sizing	265	4.3 Branch-Circuit Conductor Sizing Continuous Duty Application [430.22]	318
Introduction	265	4.4 Branch-Circuit Conductor Sizing for Duty-Cycle Application [430.22(E)]	321
2.1 Box Sizing—Conductors All the Same Size [Table 314.16(A)]	266	4.5 Overcurrent Protection	322
2.2 Outlet Box Fill Calculations [314.16(B)]	267	4.6 Motor Overload Protection	323
2.3 Outlet Box Sizing, Examples [314.16(B)]	271	4.7 Branch-Circuit Short-Circuit and Ground-Fault Protection [430.52(C)(1)]	327
2.4 Tips for Outlet Box Sizing	272	4.8 Branch-Circuit Summary	331
Part B—Pull and Junction Boxes	273	4.9 Motor Circuit Equipment Grounding Conductor Size [250.122(D(1))]	332
Introduction	273	4.10 Feeder Conductor Sizing [430.24]	332
2.5 Pull/Junction Box Sizing Requirements	273	4.11 Feeder Short-Circuit and Ground-Fault Protection [430.62(A)]	334
2.6 How to Size Pull/Junction Boxes	275	Part B—Air-Conditioning Calculations	336
2.7 Pull Box Sizing Examples	275	Introduction	336
2.8 Tips for Pull Box Sizing	277	4.12 Air-Conditioning Equipment Nameplate [440.4(B)]	336
Unit 2—Review Questions	279	4.13 Air-Conditioning Equipment, Short-Circuit and Ground-Fault Protection [440.22]	337
Unit 3—Conductor Sizing and Protection Calculations	283	4.14 Air-Conditioning Equipment, Conductor Ampacity [440.33]	339
Part A—Conductor Insulation, Terminals, and Overcurrent Protection	283	Part C—Transformers	340
Introduction	283	Introduction	340
3.1 Conductor Insulation [Table 310.4(1)]	283	4.15 Transformer Primary Only Overcurrent Protection [450.3(B)]	340
3.2 Conductor Sizes	284	4.16 Transformer Secondary Conductor Sizing [240.21(C)]	343
3.3 Conductor Size—Equipment Terminal Rating [110.14(C)]	285	Unit 4—Review Questions	345
3.4 Overcurrent Protection of Conductors [240.4]	288	Unit 5—Voltage-Drop Calculations	351
Part B—Conductor Ampacity and Protection	290	Part A—Conductor Resistance Calculations	351
Introduction	290	Introduction	351
3.5 Conductor Ampacity Table [310.15(A)]	290	5.1 Conductor Cross-Sectional Area in Circular Mills [Chapter 9, Table 8]	351
3.6 Conductor Ampacity Correction [310.15(B)(1)]	290	5.2 Conductor Resistance	353
3.7 Conductor Ampacity Adjustment [310.15(C)(1)]	292	5.3 Conductor Resistance [Chapter 9, Table 8]	354
3.8 Ampacity Correction and Adjustment [310.15]	294	Part B—Voltage-Drop Calculations	356
3.9 Neutral Current-Carrying Conductor [310.15(E)]	295	Introduction	356
3.10 Branch Circuit Conductor Sizing [210.19(A)(1)]	297	5.4 Conductors' Voltage Drop—Ohm's Law Method	356
3.11 Branch Circuit Conductor Sizing—Loads	298	5.5 Single-Phase Circuit Voltage Drop—Formula Method	357
3.12 Branch Circuit Overcurrent Protection Sizing [210.20(A)]	299	5.6 Three-Phase Circuit Voltage Drop—Formula Method	359
3.13 Feeder Conductor Sizing [215.2(A)(1)]	300	5.7 Sizing Conductor Single-Phase Circuit Voltage Drop—Formula Method	360
3.14 Feeder Neutral Conductor Size [215.2(A)(1) Ex 3]	301	5.8 Sizing Conductor Three-Phase Circuit Voltage Drop—Formula Method	362
3.15 Feeder Overcurrent Protection Sizing [215.3]	302	Unit 5—Review Questions	365
3.16 Feeder Tap Rules [240.21(B)]	302		
Unit 3—Review Questions	307		
Unit 4—Motor, Air-Conditioning, and Transformer Calculations	315		
Part A—Motor Calculations	315		
Introduction	315		
4.1 Motor Full-Load Current (FLC)	315		

Unit 6—Dwelling Unit Calculations	369
Part A—Optional Method Load Calculations [Article 220, Part IV]	369
Introduction	369
6.1 Dwelling Unit Optional Load Calculations [220.82]	369
6.2 Dwelling Unit Optional Load Calculation [220.82]	371
Part B—Standard Method Load Calculations [Article 220, Part III]	372
Introduction	372
6.3 Dwelling Unit Standard Load Calculation	372
6.4 General Lighting and General-Use Receptacle Demand Load [220.41 and Table 220.45]	372
6.5 Fixed Appliance Demand Load [220.53]	375
6.6 Dryer Demand Load [220.54]	376
6.8 Electric Cooking Equipment Demand Load [220.55]	376
6.10 Electric Vehicle [220.57]	378
6.11 Air-Conditioning Versus Heating [220.50, 220.51, and 220.60]	379
6.12 Service Conductor Size [Table 310.12(A)]	380
6.13 Standard Method Load Calculations [Article 220, Part III]	381
6.14 Number of General Lighting and General-Purpose Receptacle Circuits [210.11(A)]	382
Part C—Neutral Load Calculations	383
Introduction	383
6.15 Neutral Calculations—Dryers and Ranges [220.61]	383
6.16 Service Neutral Calculation [220.61]	384
Unit 6—Review Questions	387
Module III—NEC Calculations Practice Exam	393
MODULE IV—ADVANCED NEC CALCULATIONS	401
Unit 7—Multifamily Dwelling Calculations	403
Part A—Optional Method Load Calculations [Article 220, Part IV]	403
Introduction	403
7.1 Multifamily Dwelling Optional Load Calculations [220.84]	403
7.2 Multifamily Dwelling Optional Method, Example [220.84]	404
Part B—Standard Method Load Calculations [Article 220, Part III]	405
Introduction	405
7.3 General Lighting and General-Use Receptacle Demand Load [220.41 and 220.45]	406
7.4 Appliance Demand Load [220.53]	407
7.5 Dryer Demand Load [220.54]	408
7.6 Single-Phase Dryers on Three-Phase Service [220.54]	410
7.7 Single-Phase Ranges on Single-Phase Service [220.55]	412
7.8 Single-Phase Ranges on Three-Phase Service [220.55]	414
7.9 Air-Conditioning and Heating Demand Load	416
7.10 Service Conductor Sizing [Table 310.16]	417
7.11 Multifamily Dwelling Calculations—Standard Method, Examples	418
7.12 Two-Family (Duplex) Dwelling Units Load Calculations [220.85]	421
Part C—Neutral Load Calculations	423
Introduction	423
7.13 Neutral Demand Load—Dryers and Ranges [220.61]	423
7.14 Service Neutral Demand Load [220.61(B)]	424
Unit 7—Review Questions	427
Unit 8—Commercial Calculations	435
Part A—General Commercial Demand Loads	435
Introduction	435
8.1 General Lighting Load [Table 220.42(A)]	435
8.2 General Lighting Load, Examples [Table 220.42(A)]	436
8.3 General Lighting Load Demand Factors [Table 220.45]	437
8.4 Number of General Lighting Circuits	438
8.5 Sign Circuit [220.14(F)]	439
8.6 Multioutlet Assemblies [220.14(H)]	439
8.7 Receptacle Demand Load [220.14(I) and 220.47]	440
8.8 Air-Conditioning versus Heating Demand Load [220.60]	442
Part B—Office, Mobile Home, Kitchen, Restaurants, and School Examples	442
Introduction	442
8.9 Office Building, Example	443
8.10 Mobile Home Parks [550.31]	444
8.11 Kitchen Equipment and Restaurants	444
8.12 School Optional Method Load Calculations [220.86]	447
Part C—Welder Calculations	448
Introduction	448
8.13 Arc Welders	448
8.14 Resistance Welders	450
Part D—Light Industrial Calculations	452
Introduction	452
8.15 Light Industrial Calculations	452
Unit 8—Review Questions	455
Module IV—Advanced NEC Calculations—Practice Exam	461
Modules III and IV—NEC Calculations Questions Code Rule Index	465
About the Author	469
About the Illustrator	470
About the Mike Holt Team	471