



TABLE OF CONTENTS

About This Textbook	xvii	Available Short-Circuit Current	53
About the <i>National Electrical Code</i>	xxi	110.10 Circuit Impedance, Short-Circuit Current Rating, and Other Characteristics	53
About the Author	xxv	110.11 Deteriorating Agents	54
About the Illustrator	xxvi	110.12 Mechanical Execution of Work	54
About the Team	xxvii	110.13 Mounting and Cooling of Equipment	56
Article 90—Introduction to the <i>National Electrical Code</i>	1	110.14 Conductor Termination and Splicing	56
90.1 Purpose of the <i>NEC</i>	1	110.15 High-Leg Conductor Identification	62
90.2 Scope of the <i>NEC</i>	3	110.16 Arc-Flash Hazard Warning	63
90.3 Code Arrangement	5	110.21 Markings	63
90.4 Enforcement	6	110.22 Identification of Disconnecting Means	64
90.5 Mandatory Requirements and Explanatory Material	8	110.24 Available Fault Current	64
90.6 Formal Interpretations	8	110.25 Lockable Disconnecting Means	65
90.7 Examination of Equipment for Product Safety	8	Part II. 600V, Nominal, or Less	65
90.9 Units of Measurement	9	110.26 Spaces About Electrical Equipment	65
Article 90 Practice Questions	10	110.27 Guarding	72
CHAPTER 1—GENERAL	13	110.28 Enclosure Types	72
Article 100—Definitions	15	Chapter 1 Practice Questions	73
Article 110—Requirements for Electrical Installations	49	CHAPTER 2—WIRING AND PROTECTION	79
Part I. General Requirements	49	Article 200—Use and Identification of Grounded [Neutral] Conductors	81
110.1 Scope	49	Part I. General	82
110.2 Approval of Conductors and Equipment	49	200.1 Scope	82
110.3 Examination, Identification, Installation, and Use of Equipment	50	200.2 General	82
110.4 Voltages	51	200.4 Neutral Conductors	82
110.5 Copper Conductors	51	200.6 Neutral Conductor Identification	83
110.6 Conductor Sizes	51	200.7 Use of White or Gray Color	84
110.7 Wiring Integrity	51	200.9 Terminal Identification	86
110.8 Suitable Wiring Methods	51	200.10 Identification of Terminals	86
110.9 Interrupting Protection Rating	52	200.11 Polarity	86
		Article 210—Branch Circuits	87
		Part I. General Provisions	88
		210.1 Scope	88
		210.2 Other Articles	88

210.3	Branch-Circuit Rating.....	88	Part II. Branch-Circuit Load Calculations.....	135	
210.4	Multiwire Branch Circuits.....	89	220.12	General Lighting.....	135
210.5	Identification for Branch Circuits.....	92	220.14	Other Loads—All Occupancies.....	136
210.6	Branch-Circuit Voltage Limitations.....	94	220.18	Maximum Load on a Branch Circuit.....	140
210.7	Multiple Branch Circuits.....	94	Part III. Feeder and Service Calculations.....	141	
210.8	GFCI Protection.....	95	220.40	General.....	141
210.11	Branch Circuits Required.....	101	220.42	General Lighting Demand Factors.....	142
210.12	Arc-Fault Circuit-Interrupter Protection.....	104	220.43	Commercial—Show Window and Track Lighting Load....	142
210.17	Electric Vehicle Branch Circuit.....	106	220.44	Other than Dwelling Unit—Receptacle Load.....	143
210.18	Guest Rooms and Guest Suites.....	106	220.50	Motor Load.....	144
Part II. Branch-Circuit Ratings.....		106	220.51	Fixed Electric Space-Heating Load.....	144
210.19	Conductor Sizing.....	106	220.52	Dwelling Unit— Small-Appliance and Laundry Load.....	144
210.20	Overcurrent Protection.....	109	220.53	Dwelling Unit—Appliance Load.....	145
210.21	Outlet Device Rating.....	109	220.54	Dwelling Unit—Electric Clothes Dryer Load.....	145
210.22	Permissible Loads, Individual Branch Circuits.....	110	220.55	Electric Ranges and Cooking Appliances in Dwelling Units and Household Cooking Appliances Used in Instructional Programs.....	146
210.23	Permissible Loads, Multiple-Outlet Branch Circuits.....	110	220.56	Commercial—Kitchen Equipment Load.....	149
210.25	Branch Circuits in Buildings with Multiple Occupancies....	112	220.60	Noncoincident Loads.....	149
Part III. Required Outlets.....		112	220.61	Feeder/Service Neutral Unbalanced Load.....	150
210.50	General.....	112	Part IV. Optional Calculations for Computing Feeder and Service Loads.....	152	
210.52	Dwelling Unit Receptacle Outlet Requirements.....	112	220.82	Dwelling Unit—Optional Load Calculation.....	152
210.60	Receptacles in Guest Rooms, Guest Suites, Dormitories, and Similar Occupancies.....	121	220.83	Existing Dwelling Unit Calculations.....	153
210.62	Show Windows.....	122	220.84	Multifamily—Optional Load Calculation.....	154
210.63	Heating, Air-Conditioning, and Refrigeration (HACR) Equipment.....	122	220.85	Optional Calculation—Two Dwelling Units.....	155
210.64	Electrical Service Areas.....	123	220.87	Determining Existing Loads.....	156
210.70	Lighting Outlet Requirements.....	123	Article 225—Outside Branch Circuits and Feeders.....	157	
Article 215—Feeders.....		127	Part I. General.....	157	
215.1	Scope.....	127	225.1	Scope.....	157
215.2	Minimum Rating.....	128	225.2	Other Articles.....	158
215.3	Overcurrent Protection Sizing.....	130	225.6	Minimum Size of Conductors.....	158
215.4	Feeders with Common Neutral Conductor.....	130	225.7	Luminaires Installed Outdoors.....	159
215.6	Equipment Grounding Conductor.....	130	225.15	Supports Over Buildings.....	159
215.10	Ground-Fault Protection of Equipment.....	130	225.16	Attachment.....	159
215.12	Conductor Identification.....	131	225.17	Masts as Supports.....	160
Article 220—Branch-Circuit, Feeder, and Service Calculations.....		133	225.18	Clearance for Overhead Conductors.....	160
Part I. General.....		133	225.19	Clearances from Buildings.....	161
220.1	Scope.....	133	225.22	Raceways on Exterior Surfaces of Buildings or Other Structures.....	162
220.3	Application of Other Articles.....	133	225.26	Trees for Conductor Support.....	162
220.5	Calculations.....	134	225.27	Raceway Seals.....	163

Part II. Buildings or Other Structures Supplied by a Feeder(s) or Branch Circuit(s)	163	Part VI. Service Equipment—Disconnecting Means	180
225.30 Number of Supplies	163	230.70 Disconnect Requirements	180
225.31 Disconnecting Means.....	164	230.71 Number of Disconnects.....	182
225.32 Disconnect Location.....	164	230.72 Grouping of Disconnects	183
225.33 Maximum Number of Disconnects	165	230.76 Manual or Power Operated	183
225.34 Grouping of Disconnects	165	230.77 Indicating.....	183
225.35 Access to Occupants.....	165	230.79 Rating of Disconnect.....	183
225.36 Type.....	166	230.81 Connection to Terminals.....	184
225.37 Identification of Multiple Feeders	166	230.82 Connected on Supply Side of the Service Disconnect....	184
225.38 Disconnect Construction	166	Part VII. Service Equipment Overcurrent Protection	185
225.39 Rating of Disconnecting Means.....	166	230.90 Overload Protection Required.....	185
Article 230—Services	167	Article 240—Overcurrent Protection	187
Part I. General	168	Part I. General	188
230.1 Scope	168	240.1 Scope	188
230.2 Number of Services	168	240.2 Definitions.....	188
230.3 Not to Pass Through a Building	169	240.3 Protection of Equipment.....	189
230.6 Conductors Considered Outside a Building.....	169	240.4 Protection of Conductors.....	190
230.7 Service Conductors Separate from Other Conductors....	170	240.5 Protection of Flexible Cords and Fixture Wires.....	193
230.8 Raceway Seals.....	171	240.6 Standard Ampere Ratings	193
230.9 Clearance from Building Openings	171	240.10 Supplementary Overcurrent Protection.....	194
230.10 Vegetation as Support.....	172	240.13 Ground-Fault Protection of Equipment.....	194
Part II. Overhead Service Conductors	172	240.15 Ungrounded Conductors	195
230.23 Overhead Service Conductor Size and Rating.....	172	Part II. Location	196
230.24 Vertical Clearance for Overhead Service Conductors.....	173	240.21 Overcurrent Protection Location in Circuit.....	196
230.26 Point of Attachment.....	174	240.24 Location of Overcurrent Devices	201
230.27 Means of Attachment.....	174	Part III. Enclosures	203
230.28 Service Masts Used as Supports.....	174	240.32 Damp or Wet Locations	203
Part III. Underground Service Conductors	175	240.33 Vertical Position	203
230.31 Underground Service Conductor Size and Rating	175	Part V. Plug Fuses, Fuseholders, and Adapters	203
230.32 Protection Against Damage	176	240.50 General	203
Part IV. Service-Entrance Conductors	176	240.51 Edison-Base Fuses	204
230.40 Number of Service-Entrance Conductor Sets	176	240.52 Edison-Base Fuseholders.....	204
230.42 Size and Rating.....	176	240.53 Type S Fuses	204
230.43 Wiring Methods.....	177	240.54 Type S Fuses, Adapters, and Fuseholders.....	204
230.46 Spliced Conductors	178	Part VI. Cartridge Fuses and Fuseholders	204
230.50 Protection Against Physical Damage	178	240.60 General	204
230.51 Cable Supports	179	240.61 Classification	205
230.54 Overhead Service Locations.....	179	Part VII. Circuit Breakers	205
230.56 High-Leg Identification.....	179	240.80 Method of Operation	205
Part V. Service Equipment—General	180	240.81 Indicating.....	205
230.66 Listed as Suitable for Service Equipment	180	240.82 Nontamperable	206
		240.83 Markings.....	206
		240.85 Applications	207

Article 250—Grounding and Bonding	209	250.94	Intersystem Bonding Termination	260
Part I. General	209	250.96	Bonding Other Enclosures	262
250.1 Scope	209	250.97	Bonding Metal Parts Containing 277V and 480V Circuits	262
250.2 Definition	209	250.98	Bonding Loosely Jointed Metal Raceways.....	262
250.4 General Requirements for Grounding and Bonding.....	209	250.100	Bonding in Hazardous (Classified) Locations	263
Earth Shells	214	250.102	Bonding Conductors and Jumpers	263
250.6 Objectionable Current	216	250.104	Bonding of Piping Systems and Exposed Structural Metal	265
Objectionable Current.....	217	250.106	Lightning Protection System	269
Dangers of Objectionable Current.....	219			
250.8 Termination of Grounding and Bonding Conductors.....	220	Part VI. Equipment Grounding and Equipment Grounding Conductors		269
250.10 Protection of Fittings	221	250.110	Fixed Equipment Connected by Permanent Wiring Methods—General	269
250.12 Clean Surfaces.....	221	250.112	Specific Equipment Fastened in Place or Connected by Permanent Wiring Methods.....	270
Part II. System Grounding and Bonding	221	250.114	Cord-and-Plug-Connected Equipment.....	270
250.20 Systems Required to be Grounded	221	250.118	Types of Equipment Grounding Conductors.....	271
250.21 Ungrounded Systems.....	222	250.119	Identification of Equipment Grounding Conductors.....	274
250.24 Service Equipment—Grounding and Bonding	222	250.120	Equipment Grounding Conductor Installation.....	276
250.28 Main Bonding Jumper and System Bonding Jumper.....	228	250.121	Use of Equipment Grounding Conductors	276
250.30 Separately Derived Systems—Grounding and Bonding....	229	250.122	Sizing Equipment Grounding Conductor	277
250.32 Buildings Supplied by a Feeder	235	Part VII. Methods of Equipment Grounding		279
250.34 Generators—Portable and Vehicle-Mounted	237	250.130	Equipment Grounding Conductor Connections	279
250.35 Permanently Installed Generators.....	238	250.134	Equipment Connected by Permanent Wiring Methods	280
250.36 High-Impedance Grounded Systems	238	250.136	Equipment Considered Grounded.....	280
Part III. Grounding Electrode System and Grounding Electrode Conductor	239	250.138	Cord-and-Plug-Connected Equipment.....	281
250.50 Grounding Electrode System	239	250.140	Ranges, Ovens, and Clothes Dryers.....	281
250.52 Grounding Electrode Types.....	240	250.142	Use of Neutral Conductor for Equipment Grounding	281
250.53 Grounding Electrode Installation Requirements	243	250.146	Connecting Receptacle Grounding Terminal to Metal Enclosure.....	282
Measuring the Ground Resistance	246	250.148	Continuity and Attachment of Equipment Grounding Conductors in Metal Boxes.....	284
Soil Resistivity	248	Part VIII. Direct-Current Systems		286
250.54 Auxiliary Grounding Electrodes.....	248	250.166	Sizing Grounding Electrode Conductor	286
250.60 Lightning Protection Electrode	249			
250.62 Grounding Electrode Conductor.....	249	Article 285—Surge Protective Devices (SPDs)		287
250.64 Grounding Electrode Conductor Installation.....	250	Part I. General		288
250.66 Sizing Grounding Electrode Conductor	253	285.1	Scope	288
250.68 Termination to the Grounding Electrode	254	285.3	Uses Not Permitted	288
250.70 Grounding Electrode Conductor Termination Fittings	256	285.4	Number Required.....	288
Part IV. Grounding Enclosure, Raceway, and Service Cable Connections	256	285.5	Listing.....	288
250.80 Service Raceways and Enclosures	256	285.6	Short-Circuit Current Rating.....	289
250.86 Other Enclosures.....	256			
Part V. Bonding	257			
250.90 General	257			
250.92 Bonding Equipment for Services	257			

Part II. Installation	289
285.11 Location.....	289
285.12 Routing of Conductors.....	289
285.13 Type 4 and Other Component Type SPDs	289
Part III. Connecting Surge protective Devices	289
285.23 Type 1 SPD—Line Side of Service Equipment.....	289
285.24 Type 2 SPD—Feeder Circuits.....	290
285.25 Type 3 SPDs—Branch Circuits.....	291
Chapter 2 Practice Questions	292

CHAPTER 3—WIRING METHODS AND MATERIALS

Article 300—General Requirements for Wiring Methods and Materials

Part I. General	301
300.1 Scope	301
300.3 Conductors	302
300.4 Protection Against Physical Damage	305
300.5 Underground Installations	308
300.6 Protection Against Corrosion and Deterioration	313
300.7 Raceways Exposed to Different Temperatures.....	314
300.8 Not Permitted in Raceways	315
300.9 Raceways in Wet Locations Above Grade	316
300.10 Electrical Continuity	316
300.11 Securing and Supporting.....	316
300.12 Mechanical Continuity.....	318
300.13 Splices and Pigtails.....	319
300.14 Length of Free Conductors.....	321
300.15 Boxes or Conduit Bodies	322
300.16 Raceway or Cable to Open or Concealed Wiring.....	324
300.17 Raceway Sizing.....	324
300.18 Inserting Conductors in Raceways	326
300.19 Supporting Conductors in Vertical Raceways.....	326
300.20 Induced Currents in Ferrous Metal Enclosures and Raceways	327
300.21 Spread of Fire or Products of Combustion	328
300.22 Wiring in Ducts and Plenums Spaces.....	329
300.23 Panels Designed to Allow Access	333

Article 310—Conductors for General Wiring

Part I. General	336
310.1 Scope	336

Part II. Installation	336
310.10 Uses Permitted.....	336
310.15 Conductor Ampacity	339
Part III. Construction Specification	349
310.104 Conductor Construction and Application.....	349
310.106 Conductors	350
310.110 Conductor Identification	351

Article 312—Cabinet and Cutout Boxes.....

Part I. Scope and Installation	353
312.1 Scope	353
312.2 Damp or Wet Locations	354
312.3 Installed in Walls	354
312.4 Repairing Gaps	354
312.5 Enclosures	354
312.6 Deflection of Conductors.....	355
312.8 Cabinets and Cutout Boxes Containing Splices, Taps, and Feed-Through Conductors.....	356

Article 314—Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; and Handhole Enclosures.....

Part I. Scope and General	357
314.1 Scope	357
314.3 Nonmetallic Boxes	357
314.4 Metal Boxes.....	358
Part II. Installation	358
314.15 Damp or Wet Locations	358
314.16 Number of 6 AWG and Smaller Conductors in Boxes and Conduit Bodies	359
314.17 Conductors That Enter Boxes or Conduit Bodies.....	363
314.20 Boxes Recessed in Walls or Ceilings	364
314.21 Repairing Noncombustible Surfaces.....	365
314.22 Surface Extensions	365
314.23 Support of Boxes and Conduit Bodies	365
314.25 Covers and Canopies	368
314.27 Outlet Box	369
314.28 Boxes and Conduit Bodies for Conductors 4 AWG and Larger	371
314.29 Wiring to be Accessible	374
314.30 Handhole Enclosures.....	374

Article 320—Armored Cable (Type AC)	377	334.15	Exposed	391
Part I. General	377	334.17	Through or Parallel to Framing Members	392
320.1 Scope	377	334.23	Attics and Roof Spaces	392
320.2 Definition	377	334.24	Bends	393
Part II. Installation	377	334.30	Securing and Supporting	393
320.10 Uses Permitted.....	377	334.40	Boxes and Fittings.....	394
320.12 Uses Not Permitted	378	334.80	Conductor Ampacity.....	395
320.15 Exposed Work	378	Part III. Construction Specifications		396
320.17 Through or Parallel to Framing Members	378	334.100 Construction		396
320.23 In Accessible Attics or Roof Spaces	378	334.104 Conductors		396
320.24 Bends	379	334.108 Equipment Grounding Conductor.....		396
320.30 Securing and Supporting.....	379	334.112 Insulation		396
320.40 Boxes and Fittings.....	380	Article 338—Service-Entrance Cable		
320.80 Conductor Ampacity	380	(Types SE and USE)		397
Part III. Construction Specifications	381	Part I. General		397
320.100 Construction	381	338.1 Scope		397
320.108 Equipment Grounding Conductor.....	381	338.2 Definitions.....		397
Article 330—Metal-Clad Cable (Type MC)	383	Part II. Installation		398
Part I. General	383	338.10 Uses Permitted.....		398
330.1 Scope	383	338.12 Uses Not Permitted		398
330.2 Definition	383	338.24 Bends		399
Part II. Installation	384	Article 340—Underground Feeder and		
330.10 Uses Permitted.....	384	Branch-Circuit Cable (Type UF)		401
330.12 Uses Not Permitted	384	Part I. General		401
330.17 Through or Parallel to Framing Members	385	340.1 Scope		401
330.23 In Accessible Attics or Roof Spaces	385	340.2 Definition		401
330.24 Bends	385	340.6 Listing Requirements		401
330.30 Securing and Supporting.....	385	Part II. Installation		401
330.40 Fittings.....	386	340.10 Uses Permitted.....		401
330.80 Conductor Ampacities	387	340.12 Uses Not Permitted		402
Part III. Construction Specifications	387	340.24 Bends		402
330.108 Equipment Grounding Conductor.....	387	340.80 Ampacity.....		402
Article 334—Nonmetallic-Sheathed Cable		340.112 Insulation		402
(Types NM and NMC)	389	Article 342—Intermediate Metal Conduit		
Part I. General	389	(Type IMC)		403
334.1 Scope	389	Part I. General		403
334.2 Definition	389	342.1 Scope		403
334.6 Listed.....	389	342.2 Definition		403
Part II. Installation	390	342.6 Listing Requirements		403
334.10 Uses Permitted.....	390			
334.12 Uses Not Permitted	391			

Article 356—Liquidtight Flexible Nonmetallic Conduit (Type LFNC)..... 429

Part I. General 429

356.1 Scope 429

356.2 Definition 429

356.6 Listing Requirement..... 429

Part II. Installation 430

356.10 Uses Permitted..... 430

356.12 Uses Not Permitted 430

356.20 Trade Size 430

356.22 Number of Conductors 430

356.24 Bends 431

356.26 Number of Bends (360°) 431

356.30 Securing and Supporting..... 431

356.42 Fittings..... 431

356.60 Equipment Grounding Conductor..... 432

Article 358—Electrical Metallic Tubing (Type EMT)..... 433

Part I. General 433

358.1 Scope 433

358.2 Definition 433

358.6 Listing Requirement..... 433

Part II. Installation 433

358.10 Uses Permitted..... 433

358.12 Uses Not Permitted 434

358.20 Trade Size 434

358.22 Number of Conductors 435

358.24 Bends 435

358.26 Number of Bends (360°) 435

358.28 Reaming and Threading 436

358.30 Securing and Supporting..... 436

358.42 Couplings and Connectors 436

358.60 Grounding 437

Article 362—Electrical Nonmetallic Tubing (Type ENT)..... 439

Part I. General 439

362.1 Scope 439

362.2 Definition 439

Part II. Installation 439

362.10 Uses Permitted..... 439

362.12 Uses Not Permitted 441

362.20 Trade Sizes 442

362.22 Number of Conductors 442

362.24 Bends 442

362.26 Number of Bends (360°) 442

362.28 Trimming 443

362.30 Securing and Supporting..... 443

362.46 Bushings..... 443

362.48 Joints..... 443

362.60 Equipment Grounding Conductor..... 444

Article 376—Metal Wireways 445

Part I. General 445

376.1 Scope 445

376.2 Definition 445

Part II. Installation 445

376.10 Uses Permitted..... 445

376.12 Uses Not Permitted 446

376.21 Conductors—Maximum Size 446

376.22 Number of Conductors and Ampacity 446

376.23 Wireway Sizing 446

376.30 Supports 447

376.56 Splices, Taps, and Power Distribution Blocks..... 447

Article 380—Multioutlet Assemblies 449

Part I. General 449

380.1 Scope 449

Part II. Installation 449

380.10 Uses Permitted..... 449

380.12 Uses Not Permitted 449

380.76 Through Partitions..... 450

Article 386—Surface Metal Raceways..... 451

Part I. General 451

386.1 Scope 451

386.2 Definition 451

386.6 Listing Requirements 451

Part II. Installation 452

386.10 Uses Permitted..... 452

386.12 Uses Not Permitted 452

386.21 Size of Conductors 452

386.22 Number of Conductors 452

386.30 Securing and Supporting..... 453

386.56 Splices and Taps 453

386.60 Equipment Grounding Conductor..... 453

386.70 Separate Compartments 453

Article 392—Cable Trays	455	Article 404—Switches	479
Part I. General	455	404.1 Scope	479
392.1 Scope	455	404.2 Switch Connections	479
392.2 Definition	455	404.3 Switch Enclosures.....	481
Part II. Installation	456	404.4 Damp or Wet Locations	482
392.10 Uses Permitted.....	456	404.6 Position of Knife Switches.....	483
392.12 Uses Not Permitted	457	404.7 Indicating.....	483
392.18 Cable Tray Installations	457	404.8 Accessibility and Grouping	484
392.20 Cable and Conductor Installation.....	458	404.9 Switch Faceplates.....	485
392.22 Number of Conductors or Cables	458	404.10 Mounting Snap Switches	486
392.30 Securing and Supporting.....	458	404.11 Circuit Breakers Used as Switches.....	486
392.46 Bushed Raceway	459	404.12 Grounding of Enclosures	487
392.56 Cable Splices	459	404.14 Rating and Use of Snap Switches.....	487
392.60 Equipment Grounding Conductor.....	459	404.15 Switch Marking.....	488
392.80 Ampacity of Conductors.....	460	Article 406—Receptacles, Cord Connectors, and Attachment Plugs (Caps)	489
Article 393—Low Voltage Suspended Ceiling Power Distribution Systems	461	406.1 Scope	489
Chapter 3 Practice Questions	462	406.2 Definitions.....	489
CHAPTER 4—EQUIPMENT FOR GENERAL USE	467	406.3 Receptacle Rating and Type	489
Article 400—Flexible Cords and Flexible Cables	469	406.4 General Installation Requirements.....	490
400.1 Scope	469	406.5 Receptacle Mounting	493
400.3 Suitability.....	469	406.6 Receptacle Faceplates	495
400.4 Types of Flexible Cords and Flexible Cables	469	406.7 Attachment Plugs, Cord Connectors, and Flanged Surface Devices.....	496
400.5 Ampacity of Flexible Cords and Flexible Cables.....	470	406.9 Receptacles in Damp or Wet Locations	496
400.7 Uses Permitted.....	471	406.11 Connecting Receptacle Grounding Terminal to Equipment Grounding Conductor.....	498
400.8 Uses Not Permitted	471	406.12 Tamper-Resistant Receptacles.....	498
400.10 Pull at Joints and Terminals	472	406.15 Dimmer-Controlled Receptacles.....	499
400.14 Protection from Damage	473	Article 408—Switchboards, Switchgear, and Panelboards	501
400.23 Equipment Grounding Conductor Identification.....	473	Part I. General	501
Article 402—Fixture Wires	475	408.1 Scope	501
402.1 Scope	475	408.3 Arrangement of Busbars and Conductors.....	502
402.3 Types.....	475	408.4 Field Identification.....	503
402.5 Allowable Ampacity of Fixture Wires.....	475	408.5 Clearance for Conductors Entering Bus Enclosures	504
402.6 Minimum Size.....	475	408.7 Unused Openings.....	504
402.7 Raceway Size	475	Part III. Panelboards	504
402.8 Neutral Conductor.....	476	408.36 Overcurrent Protection of Panelboards	504
402.10 Uses Permitted.....	476	408.37 Panelboards in Damp or Wet Locations	505
402.11 Uses Not Permitted	476	408.40 Equipment Grounding Conductor.....	505
402.12 Overcurrent Protection	476	408.41 Neutral Conductor Terminations	506

Part IV. Construction Specifications 507
 408.54 Maximum Number of Overcurrent Devices..... 507

Article 410—Luminaires, Lampholders, and Lamps..... 509

Part I. General 509
 410.1 Scope 509
 410.2 Definitions..... 510
 410.6 Listing Required..... 510

Part II. Luminaire Locations..... 510
 410.10 Luminaires in Specific Locations..... 510
 410.11 Luminaires Near Combustible Material 512
 410.16 Luminaires in Clothes Closets 513
 410.18 Space for Cove Lighting 513

Part III. Luminaire Outlet Boxes and Covers 514
 410.22 Outlet Boxes to be Covered 514
 410.24 Connection of Electric-Discharge and LED Luminaires..... 514

Part IV. Luminaire Supports 515
 410.30 Supports 515
 410.36 Means of Support 516

Part V. Grounding (Bonding)..... 517
 410.44 Methods of Grounding..... 517

Part VI. Wiring of Luminaires 518
 410.50 Polarization of Luminaires..... 518
 410.62 Cord-Connected Luminaires..... 518
 410.64 Luminaires as Raceways 519
 410.68 Conductors and Ballasts 519

Part VIII. Installation of Lampholders..... 519
 410.90 Screw-Shell Lampholders..... 519
 410.96 Lampholders in Wet or Damp Locations 520
 410.97 Lampholders Near Combustible Material..... 520

Part X. Recessed Luminaires 520
 410.110 General 520
 410.115 Thermally Protected 520
 410.116 Recessed Luminaire Clearances 520
 410.117 Wiring 521

Part XII. Electric-Discharge Lighting 521
 410.130 General 521

Part XIV. Track Lighting 523
 410.151 Installation 523
 410.154 Fastening 523

Article 411—Lighting Systems Operating at 30V or Less and Lighting Equipment Connected to Class 2 Power Sources 525
 411.1 Scope 525
 411.3 Low-Voltage Lighting Systems 525
 411.4 Listing Required..... 526
 411.5 Specific Location Requirements 526
 411.6 Secondary Circuits..... 527
 411.7 Branch Circuit..... 527

Article 422—Appliances 529

Part I. General 529
 422.1 Scope 529
 422.2 Definition 529
 422.3 Other Articles 529
 422.5 Ground-Fault Circuit-Interrupter (GFCI) Protection 530

Part II. Branch-Circuit Requirements 530
 422.10 Branch-Circuit Rating..... 530
 422.11 Overcurrent Protection 531
 422.12 Central Heating Equipment (Furnaces) 532
 422.13 Storage Water Heaters 532
 422.15 Central Vacuums 532
 422.16 Flexible Cords 533
 422.18 Support of Ceiling Paddle Fans..... 534
 422.19 Space for Conductors..... 534
 422.20 Outlet Boxes to Be Covered..... 534
 422.21 Covering of Combustible Material at Outlet Boxes 534
 422.23 Tire Inflation and Automotive Vacuum Machines 534

Part III. Disconnect 535
 422.30 General 535
 422.31 Permanently Connected Appliance Disconnects 535
 422.33 Cord-and-Plug-Connected Appliance Disconnects 536
 422.34 Unit Switches as Disconnects 536
 422.51 Vending Machines..... 536
 422.52 Electric Drinking Fountains..... 537

Article 424—Fixed Electric Space-Heating Equipment 539

Part I. General 539
 424.1 Scope 539
 424.3 Branch Circuits 539
 424.9 Permanently Installed Electric Baseboard Heaters with Receptacles 540

Part III. Electric Space-Heating Equipment..... 540
 424.19 Disconnecting Means..... 540

Part V. Electric Space-Heating Cables..... 541
 424.36 Clearances of Wiring in Ceilings 541
 424.38 Area Restrictions..... 541
 424.39 Clearance from Other Objects and Openings..... 541
 424.44 Installation of Cables in Concrete or Poured Masonry
 Floors..... 541

Part VI. Duct Heaters 542
 424.65 Disconnect for Electric Duct Heater Controllers 542
 424.66 Installation 542

**Article 430—Motors, Motor Circuits, and
 Controllers**..... 543

Part I. General 543
 430.1 Scope 543
 430.2 Definitions..... 544
 430.6 Table FLC versus Motor Nameplate Current Rating 544
 430.8 Marking on Controllers..... 545
 430.9 Motor Controller Terminal Requirements 545
 430.14 Location of Motors 546
 430.17 The Highest Rated Motor 546

Part II. Conductor Size..... 546
 430.22 Single Motor Conductor Size 546
 430.24 Several Motors—Conductor Size 547
 430.28 Motor Feeder Taps 547

Part III. Overload Protection..... 548
 430.31 Overload 548
 430.32 Overload Sizing for Continuous-Duty Motors 549
 430.36 Use of Fuses for Overload Protection..... 550
 430.37 Number of Overload Devices..... 550

**Part IV. Branch-Circuit Short-Circuit and Ground-Fault
 Protection** 550
 430.51 General 550
 430.52 Branch-Circuit Short-Circuit and Ground-Fault
 Protection 551
 430.55 Single Overcurrent Device..... 553

Part V. Feeder Short-Circuit and Ground-Fault Protection 554
 430.62 Feeder Protection..... 554

Part VI. Motor Control Circuits..... 554
 430.72 Overcurrent Protection for Control Circuits 554
 430.73 Protection of Conductors from Physical Damage..... 555
 430.75 Disconnect for Control Circuits..... 555

Part VII. Motor Controllers..... 556
 430.83 Controller Rating 556
 430.84 Need Not Open All Conductors of the Circuit 556
 430.87 Controller for Each Motor 556

Part IX. Disconnecting Means..... 556
 430.102 Disconnect Requirement..... 556
 430.103 Operation of Disconnect..... 557
 430.104 Marking and Mounting 558
 430.107 Readily Accessible 558
 430.109 Disconnecting Means Rating..... 558
 430.111 Combination Controller and Disconnect 558

Part XIV. Tables 559
 Table 430.248 Full-Load Current, Single-Phase Motors 559
 Table 430.250 Full-Load Current, Three-Phase Motors 559
 Table 430.251 Locked-Rotor Currents 560

**Article 440—Air-Conditioning and Refrigeration
 Equipment**..... 561

Part I. General 561
 440.1 Scope 561
 440.2 Definitions..... 561
 440.3 Other Articles 561
 440.4 Marking on Hermetic Refrigerant Motor-Compressors
 and Equipment..... 562
 440.6 Ampacity and Rating..... 562

Part II. Disconnecting Means 562
 440.12 Rating and Interrupting Capacity 562
 440.13 Cord-Connected Equipment 562
 440.14 Location..... 562

Part III. Overcurrent Protection 563
 440.21 General 563
 440.22 Short-Circuit and Ground-Fault Overcurrent
 Device Size 563

Part IV. Conductor Sizing..... 564
 440.32 Conductor Size for Single Motor-Compressors 564

Part VII. Room Air Conditioners 565
 440.62 Branch-Circuit Requirements 565
 440.63 Disconnecting Means..... 565
 440.64 Supply Cords 565
 440.65 Leakage Current Detector-Interrupter and Arc-Fault
 Circuit Interrupter..... 566

Article 445—Generators	567	Article 480—Storage Batteries	575
445.1 Scope	567	480.1 Scope	575
445.11 Marking	567	480.2 Definitions.....	576
445.12 Overcurrent Protection	568	480.3 Battery and Cell Terminations	576
445.13 Ampacity of Conductors	568	480.4 Wiring and Equipment Supplied from Batteries	576
445.18 Disconnecting Means.....	569	480.8 Racks and Trays.....	576
445.20 Ground-Fault Circuit Interrupter Protection for Receptacles on 15 kW or Smaller Portable Generators.....	569	480.9 Battery Locations.....	577
Article 450—Transformers	571	Chapter 4 Practice Questions	579
Part I. General	571	INDEX	585
450.1 Scope	571		
450.3 Overcurrent Protection	571		
450.9 Ventilation	572		
450.10 Grounding and Bonding.....	573		
450.11 Marking	573		
450.13 Transformer Accessibility	573		
450.14 Disconnecting Means.....	574		