



## A

absolute zero, 72-73  
ac circuits  
  angular velocity, 548-59  
  applications, 575-77  
  average value, 559-66  
  capacitance, 591-94  
  complex numbers, 608-23  
  computer analysis, 577-81, 628-32  
  definitions, 541-43, 546  
  effective value, 566-70  
  frequency, 542, 545-46  
  frequency response, 597-602  
  frequency spectrum, 543-46  
  generation, 540-41  
  generator, 540  
  inductance, 590-91  
  instrumentation, 571-75  
  introduction, 131, 539-81  
  lagging, 555  
  leading, 555  
  oscilloscope, 558-59  
  parallel, 663-701  
  period, 542  
  phase relations, 554-59  
  phasors, 623-28  
  power, 567, 603-7, 835-64  
  power factor, 607-8  
  radians, 546-48  
  reactance, 591  
  resistance, 589  
  rms value, 570  
  series, 637-63  
  series-parallel, 713-37  
  sinusoidal ac voltage, 540-43, 546-59  
ac generator, 540  
accuracy, 11, 23  
active filter, 927  
admittance, 663-65  
admittance diagram, 665  
Ah rating, 48-51  
air gap, 525-27  
air trimmer capacitor, 411-12  
air-core transformer, 1009-12  
alkaline battery, 42-43  
alternating current, 539  
alternator 224-25, 540  
aluminum, 67  
ammeter, 53-54, 200-201, 247-48, 258, 360-63  
  design 266-67  
  loading effect, 161-62  
  series dc circuit, 139-40

ampere, 3  
  defined, 39-41  
Ampère, André-Marie, 3-5, 40, 461  
Ampère's circuital law, 461, 520-21  
ampere-hour rating, 48-51  
ampere-turns, 464  
amplitude  
  pulse waveform, 1068  
  sinusoidal waveform, 541  
analogies  
  parallel elements, 194  
  series elements, 134, 138  
angular velocity, 548-49  
anode, 47  
apparent power, 838-40, 1043, 1045-46  
appendices  
  conversion factors, 1120-22  
  determinants, 1128-35  
  Greek alphabet, 1136  
  magnetic parameter conversions, 1137  
  maximum power transfer conditions, 1138-39  
  PSpice, Multisim, and Mathcad, 1126-27  
  solutions to selected odd-numbered exercises, 1140-47  
  TI-86 calculator, 1123-25  
applications  
  12 V car battery charger, 56-58  
  (120 V at 60 Hz) versus (220 V at 50 Hz), 575-76  
  attenuators, 973-75  
  ballast transformer, 1019-21  
  boosting a car battery, 269-72  
  camera flash lamp, 493  
  car system, 224-26  
  constant current alarm system, 327-29  
  crossover networks, 972-73  
  dimmer control in an automobile, 93-94  
  electric baseboard heating element, 90-93  
  electronic systems, 272-73, 816-20  
  flash lamp, 443-46  
  flashlight, 54-56  
  GFCI, 728-30  
  graphic and parametric equalizers, 902-5  
  Hall effect sensor, 532-33  
  holiday lights, 165-67  
  household dimmer switch, 494-96  
  household wiring, 118-20, 226-28, 691-92

applications (*continued*)  
  low-voltage compensation, 1018-19  
  magnetic reed switch, 533-34  
  magnetic resonance imaging, 534  
  microwave oven, 116-18, 167-68  
  noise filters, 975-78  
  parallel computer bus connections, 228  
  parallel configurations, 223-28  
  phase-shift power control, 695-97  
  portable power generator, 859-61  
  safety concerns (high voltage and dc versus ac), 576-77  
  schematic with nodal voltages, 330-32  
  series alarm circuit, 167-68  
  series control, 164-65  
  speakers and microphones, 531-32, 692-95  
  strain gauges, 94-95  
  stray resonance, 902  
  surge protector (line conditioner), 446-49  
  TV or PC monitor yolk, 496-99  
  TV remote, 1085-88  
  Wheatstone bridge smoke detector, 329-30  
Armstrong, Edwin, 6  
atomic structure, 33-35, 64  
attenuators, 973-75  
auditory response, 924-25  
autotransformer, 1014  
average induced voltage, 487-89  
average power, 603-7, 837, 1043-45  
average value  
  fundamentals, 559-66  
  nonsinusoidal waveforms, 1096-97  
  pulse waveforms, 1074-75  
AWG, 67-69

## B

Babbage, Charles, 6  
Baird, John, 6  
balance conditions  
  ac networks, 765-69  
  dc networks, 321  
ballast transformer, 1019-21  
band frequencies  
  parallel resonance, 889-90  
  series resonance, 878-80  
bandwidth  
  parallel resonance, 889-91, 894  
  series resonance, 878-80  
Bardeen, John, 6  
base-line voltage, 1069

- battery, 38-39, 41-45, 55, 131-32, 142-43, 214-15, 224-26
- Bednorz, George, 76
- bel, 921-22
- block diagram approach  
ac, 713-25  
dc, 248-51
- Bode, Hendrick Wade, 944
- Bode plots, 943-72
- branch current analysis, 289-94
- Brattain, Walter H., 6
- breadboard, 162-64, 222-23
- breakdown strength, 52
- breakdown voltage, 403
- bridge networks  
ac, 764-69  
dc, 318-21
- bubbles, 520
- C**
- C++, 27
- Calculator *See* TI-86 or TI-89
- calculus, 567-68
- calibration factor, 571
- capacitance, 399-403
- capacitance comparison bridge, 769
- capacitors, 5, 59, 397-453, 493, 495, 591-97, 695-96  
ac response, 591-94, 640-42  
applications, 443-49  
breakdown voltage, 403  
capacitance, 399-403  
charging, 415-22  
construction, 403-15  
current  $i_C$ , 436-38  
dielectric, 401-3, 408  
discharging, 422-28  
electric field, 397-99, 401-2  
energy, 442  
farad, 400  
initial conditions, 429-31  
instantaneous values, 431-32  
labeling, 413-14  
leakage current, 412-13  
measurements, 414-15  
parallel, 438-39  
relative permittivity, 402-7  
series, 438-39  
standard values, 415  
temperature effects, 413  
Thévenin equivalent, 433-36  
time constant, 416-420, 424-25  
transients, 415-36  
types, 407-12
- camera flash lamp, 493
- car system, 224-26
- carbon composition resistor, 78
- CAT scan, 534
- cell, 4, 42
- ceramic capacitors, 410, 413
- ceramic trimmer capacitor, 412
- CGS system, 8-11
- charger, 56-58
- chassis ground, 725
- chip resistors, 79-80
- chokes, 473
- chopper network, 445
- Chu, Paul, 76
- circuit breakers, 115, 119-20
- circular mils, 64-66
- clamp meter, 573
- closed loop, 144
- coefficient of coupling, 990-92
- coercive force, 517
- coil *See* inductor
- color coding, 82-85
- common logarithm, 918-20
- compensated attenuator probe, 1085
- complex configurations, 243
- complex conjugate, 612
- complex numbers, 608-23  
addition, 613  
calculator, 618-20  
conversions between forms, 610-12  
division, 616-18  
imaginary axis, 608-9  
Mathcad, 620-23  
multiplication, 615-16  
phasors, 623-28  
polar form, 609-10  
real axis, 608-9  
rectangular form, 609  
subtraction, 613-14
- computer analysis  
introduction, 26-28  
Mathcad *See* Mathcad  
Multisim *See* Multisim  
PSpice *See* PSpice  
software packages, 27-28
- computer bus connections, 228
- computers, 6
- conductance, 86-87, 186-88, 220-21
- conductor, 38, 51, 63-64, 71-72
- constant current alarm system, 327-29
- contributors  
Bode, Hendrick Wade, 944  
Coulomb, Charles Augustin, 35  
Faraday, Michael, 400  
Fourier, Baron Jean, 1096  
Henry, Joseph, 466  
Hertz, Heinrich Rudolph, 542  
Joule, James Prescott, 109  
Kirchhoff, Gustav Robert, 143  
Norton, Edward L., 363  
Ohm, George Simon, 102  
Siemens, Werner von, 86  
Steinmetz, Charles Proteus, 625-26  
Tesla, Nikola, 464  
Thévenin, Leon-Charles, 353  
Volta, Count Alessandro, 37
- contributors (*continued*)  
Watt, James, 106  
Weber, Wilhelm Eduard, 463
- controlled sources, 743-44
- conventional flow, 41, 131-32
- conversion factors, Appendix A
- conversions  
dc sources, 285-87  
dependent and independent sources, 744-47
- Cooper effect, 76
- copper, 34-35, 51, 67
- core-type transformer, 1013-14
- corner frequency, 878-80
- coulomb, 36-38, 397-98, 400-401, 439
- Coulomb, Charles Augustin, 4, 35
- Coulomb's law, 35, 398
- coupled coils, 1006-9
- critical temperature, 77
- crossover networks, 972-73
- current, 33, 38-41
- current divider rule  
ac, 675  
dc, 208-12
- current sensitivity, 266-69
- current sources  
dependent, 749-50  
independent, 283-89, 743-44  
series connection, 289
- cutoff frequencies  
parallel resonance, 889-91  
series resonance, 878-80
- cycle, 542
- D**
- $\Delta$ -connected generator, 1039-40
- $\Delta$ - $\Delta$  system, 1040-41
- $\Delta$ -Y system, 1040-42
- $\Delta$ -Y, Y- $\Delta$  conversion  
ac circuits, 769-74
- d'Arsonval movement, 266-69, 571
- dB, 921-26
- dB measurements, 925-26
- dc circuits  
analogies, 194  
complex, 243  
introduction, 131-32  
instrumentation, 194-95  
methods of analysis, 283-334  
parallel, 185-231  
series, 131-71  
series-parallel, 243-74  
theorems, 345-88
- dc current (defined), 41
- dc-dc converter, 445
- decibels, 921-26
- DeForest, Lee, 6
- dependent sources  
conversion, 744-46  
introduced, 743-44

- dependent sources (*continued*)  
 mesh analysis, 749-50  
 nodal analysis, 757, 758-59  
 Norton's theorem, 810-12  
 superposition, 792-94  
 Thévenin's theorem, 799-806
- derivative  
 capacitor, 436, 592  
 inductor, 487, 590  
 sinusoidal function, 587-89
- determinants, 290, 292, Appendix D
- DIAC, 695-96
- diamagnetic, 464
- dielectric, 5, 401-3, 408
- dielectric constant, 402-7
- dielectric strength, 403
- difference engine, 6
- differential transformer, 1002
- differentiation, 590-93
- digital meter, 54, 218-20
- dimmer, 494-96
- dimmer control, 93-94
- diode, 56-59, 105-6
- dipole, 401
- dipped capacitors, 411
- direct current, 41, 131
- disc capacitors, 410-11
- DMM, 54, 88, 564, 573, 1107-8
- domain theory, 518, 520
- dot convention, 1008-9
- double subscript notation, 152-56
- double-tuned filter, 942-43
- duality, 220-21, 513
- ductility, 67
- duty cycle, 1071-72, 1074-75
- E**
- earth ground, 725-26
- eddy currents, 857
- Edison effect, 5
- Edison, Thomas, 5
- effective resistance, 856-59
- effective value, 566-70
- efficiency, 112-14, 117, 370-71
- Einstein's theory of relativity, 75
- electric baseboard heating element, 90-93
- electric field, 397-99
- electric field strength, 398, 401-2
- electric flux lines, 397-99
- electrodynamometer movement, 572
- electrolysis, 47-48
- electrolyte, 42, 47-48
- electrolytic capacitor, 407-10, 412
- electromagnet, 463, 513-14, 523-24
- electromagnetic induction, 5
- electromagnetic interference, 446-48
- electromagnetic theory, 5
- electromagnetism, 4, 462-63
- electromotive force, 41
- electron, 33-41
- electron flow, 41, 131-32
- electronic systems, 816-20
- emf, 41
- EMI, 446-48
- energy, 106, 108-14, 116-18, 442, 449, 492-93, 837, 842, 845
- engineering notation, 16-17, 23
- ENIAC, 6
- equivalent circuit, 682-84, 1002-5
- even function, 1097-98
- exponential function, 415-16
- F**
- fall time, 1069-70
- farad, 400
- Faraday, Michael, 5, 400, 461
- Faraday's law, 472-74, 540, 857, 989-92
- ferrite inductor, 469
- ferromagnetic materials, 465, 467, 514
- filament, 165-66, 214-15
- film resistors, 78-80
- filtering, 46
- filters, 59, 926-43  
 active, 927  
 applications, 973-78  
 Bode plots, 943-72  
 computer analysis, 979-81  
 double-tuned, 942-43  
 high-pass, 927-28, 932-36, 944-49  
 low-pass, 927-32, 949-51  
 pass-band, 927-28, 936-40  
 passive, 926  
 stop-band, 927-28, 940-42
- fixed capacitors, 407-11
- fixed inductors, 468-69
- fixed resistors, 78-80
- fixed-point notation, 16-17
- flash lamp, 443-46
- Fleming, John Ambrose, 5-6
- Fleming's valve, 5-6
- floating-point notation, 16-17
- fluorescent light, 1019-21
- flux density, 464, 513-14
- flyback, 446, 493
- FORTTRAN, 27
- Fourier analyzer, 1100
- Fourier series, 1096-1105
- Fourier, Baron Jean, 1096
- Franklin, Benjamin, 4
- free electron, 64
- frequency counter, 573
- frequency, 542, 545-46
- frequency response  
 capacitors, 598-99, 601-2  
 inductors, 598, 600-601  
 parallel ac circuits, 675-82  
 resistors, 597-600  
 series ac circuits, 653-63
- frequency spectrum, 543-46
- fringing, 401, 525
- fuel cell, 47-48
- full-wave rectified waveform, 571, 1095
- function generator, 540-41
- fundamental component, 1096
- fuse, 115, 214-15, 224-26
- G**
- gage, 67-69
- gallium arsenide, 52
- gauss, 465
- Gauss, Karl Friedrich, 461-62
- generators, 46
- germanium, 52
- GFCI breaker, 41, 115, 728-30
- gilbert, 464
- Gilbert, William, 3
- gold, 67
- graphic and parametric equalizers, 902-5
- Gray, Stephen, 4
- Greek alphabet, Appendix E
- ground fault circuit interrupter, 41, 115, 728-30
- grounding, 120, 227-28, 574, 725-28
- Grove, Sir William, 47
- Guericke, Otto von, 3-4
- H**
- half-power frequencies  
 parallel resonance, 889-90  
 series resonance, 878-80
- half-wave rectification, 1095-96, 1104-5, 1109-11
- half-wave symmetry, 1098-99
- Hall effect sensor, 532-33
- harmonic terms, 1096
- Hay bridge, 765-67
- heat sink, 58
- helium, 34
- henry, 466-68
- Henry, Joseph, 466
- hertz, 542
- Hertz, Heinrich Rudolph, 5, 542
- high-pass filter, 927-28, 932-36, 944-49
- history, 1-7
- horsepower, 106
- house wiring, 118-20, 226-28, 691-92
- household dimmer switch, 494-96
- hydrogen, 33, 47-48
- hysteresis, 516-20, 857-58
- I**
- ICs, 1-2, 6-7, 59, 207
- ideal pulse, 1067-68
- imaginary axis, 608-10
- impedance  
 capacitors, 640-42  
 inductors, 639-40  
 resistors, 640-42
- impedance diagram, 642-43
- impedance matching, 998-1001
- incandescent lamp, 575

- independent sources, 743-44
    - conversions, 744-46
  - induced voltage, 472-74, 487-89
  - inductance, 466-68, 989-92
  - inductors
    - ac response, 590-91, 639-40
    - applications, 493-99
    - average induced voltage, 487-89
    - computer analysis, 499-504
    - construction, 466-68
    - energy, 492-93
    - henry, 466-68
    - induced voltage, 472-74
    - inductance, 466-68
    - initial conditions, 477-79
    - instantaneous value, 487
    - labeling, 471-72
    - Lenz's law, 473
    - magnetic effects, 461-65
    - measurement, 472
    - parallel, 489-90
    - practical equivalent, 470-71
    - series, 489-90
    - steady-state conditions, 490-92
    - Thévenin equivalent, 484-86
    - time constant, 476
    - transients, 474-84
    - types, 468-70
  - inferred absolute temperature, 72-74
  - initial conditions
    - capacitive networks, 429-31
    - inductive networks, 477-79
  - instantaneous values, 431-32, 487, 541
  - instrumentation
    - ac measurements, 571-75
    - ammeter, 200-201
    - capacitors, 414-15
    - dB, 925-26
    - digital, 218-20
    - DMM, 219, 564-66, 1107-8
    - LCR meter, 472
    - loading effects, 161-62
    - nonsinusoidal circuits, 1100
    - Norton's theorem, 366
    - ohmmeters, 81, 87-88, 134, 194-95, 414-15, 472
    - oscilloscopes, 558-59, 564-66, 687-90, 1084-85
    - parallel circuits, 194-95, 200-201
    - power, 855-56
    - pulse waveforms, 1075
    - series circuits, 138-40
    - series supplies, 142-43
    - series-parallel circuits, 247-48, 258
    - Thévenin's theorem, 360-63
    - voltmeters, 200-201, 218-20
    - VOM, 219-20
  - insulator, 51-52, 63, 71-72
  - integrated circuit, 1-2, 6-7, 207
  - integration, 563, 567-68, 593, 1099-1100
  - internal resistance, 156-60, 286
  - inverter, 541
  - ion, 36, 48
  - iron-core transformer, 992-1006
  - isolation, 1001-2
- J**
- joule, 36-37, 106-9, 492-93
  - Joule, James Prescott, 109
- K**
- kilowatthour, 109-12
  - kilowatthour meter, 109
  - Kirchhoff, Gustav Robert, 5, 143
  - Kirchhoff's current law
    - ac circuits, 669-75
    - dc circuits, 203-8
  - Kirchhoff's voltage law
    - ac circuits, 644
    - dc circuits, 143-47
- L**
- labeling
    - capacitors, 413-14
    - inductors, 471-72
    - resistors, 82-86
  - ladder networks
    - ac, 724-25
    - dc, 258-61
  - lagging, 555
  - languages, 27
  - lead-acid secondary cell, 43-44
  - leading, 555
  - leakage current, 412-13
  - leakage flux, 1003
  - LED, 446-47
  - Leibniz wheel, 6
  - Leibniz, Gottfried Wilhelm von, 6
  - Lenz's law, 473
  - Leyden jar, 4
  - lithium battery, 43
  - logarithms, 917-26
    - common, 918
    - decibels, 921-26
    - log-log plot, 918-20
    - natural, 918
    - properties, 920-21
    - scale, 88-89
    - semilog paper, 918-20
  - log scale, 88-89
  - logic probe, 331-32
  - log-log plots, 918-20
  - Lorentz, Hendrick, 532
  - low-pass filter, 927-32, 949-51
  - low-voltage compensation, 1018-19
- M**
- magnet, 461-63
  - magnetic circuits, 513-34
    - air gap, 525-27
  - magnetic circuits (*continued*)
    - Ampere's circuital law, 520-21
    - applications, 531-34
    - domain theory, 518, 520
    - electromagnet, 513-14, 523-24
    - ferromagnetic materials, 514
    - flux density, 513-14
    - flux paths, 521
    - fringing, 525
    - hysteresis, 516-20
    - magnetic field, 513-14
    - magnetic flux lines, 513-15
    - magnetizing force, 515-20
    - magnetomotive force, 513-15, 520-21
    - normal magnetization curve, 518-20
    - Ohm's law, 514-15
    - permeability, 514
    - relative permeability, 514
    - reluctance, 514
    - residual flux density, 517
    - saturation, 520
    - series configurations, 521-27
    - series-parallel configurations, 527-29
    - table approach, 522-25
    - transformer, 524-25
  - magnetic field, 461-65, 513-14
  - magnetic flux density, 464-65, 513-14
  - magnetic flux lines, 462-65, 472-73, 515, 992-94
  - magnetic parameter conversions, Appendix F
  - magnetic reed switch, 533-34
  - magnetic resonance imaging, 534
  - magnetism, 461-65
  - magnetizing force, 515-20
  - magnetomotive force, 464, 513-15, 520-21
  - magnetron, 117
  - malleability, 67
  - Marconi, Guglielmo, 5
  - Mathcad
    - branch-current analysis, 292-93
    - complex numbers, 620-23
    - exponential function, 432-33
    - introduction, 28, 95-97
    - ladder network, 260-61
    - mesh analysis, 305, 752
    - nodal analysis, 317, 756-57
    - parallel resistors, 199-200
    - system requirements, Appendix C
    - total impedance, 722-23
  - maximum power transfer theorem
    - ac circuits, 812-16
    - dc circuits, 367-76
    - derivation (ac networks), Appendix G
  - Maxwell, James Clerk, 5, 462
  - Maxwell bridge, 768
  - Maxwell's equations, 5
  - megohmmeter, 269
  - menu, 27

- mesh analysis, 295-306, 747-54
    - ac circuits
      - format approach, 750-54
      - general approach, 747-50
    - dc circuits
      - format approach, 301-6
      - general approach, 295-301
      - supermesh, 299-301
  - metal-oxide varistor, 448-49
  - meters
    - kilowatt-hour meter, 109
  - methods of analysis
    - ac circuits, 743-77
      - bridge networks, 764-69
      - mesh analysis, 747-54
      - nodal analysis, 754-64
    - dc circuits, 283-334
      - branch-current analysis, 289-94
      - mesh analysis, 295-306
      - nodal analysis, 306-18
  - mica capacitor, 411, 413
  - microbar, 924-25
  - microwave oven, 116-18, 167
  - mil, 64
  - milliohmmeter, 269
  - Millman's theorem, 376-79
  - mirror symmetry, 1098-99
  - MKS system, 8-11
  - molded carbon composition
    - potentiometer, 81
  - MOV, 448-49
  - MRI, 534
  - Muller, Alex, 76
  - multiple-load transformer, 1015-16
  - Multisim
    - ac sources, 578-81
    - high-pass filter, 981
    - introduction, 28
    - ladder network, 735-37
    - mesh analysis, 333-34
    - Ohm's law, 124-27
    - parallel dc circuits, 230-31
    - parallel resonance, 909-11
    - parallel R-L network, 700-701
    - series dc circuits, 170-71
    - series R-L response, 630-32
    - superposition, 387-88, 824-25
    - system requirements, Appendix C
    - transformer, 1024-25
    - transient R-L response, 503-4
  - Musschenbroek, Pieter van, 4
  - mutual inductance, 989-92, 1006-9
- N**
- nameplate data, 1012-13
  - nanotechnology, 1-2
  - National Electric Code, 120
  - natural frequency, 872
  - natural logarithm, 918, 920
  - negative temperature coefficient, 53, 72, 88-89
  - negative-going pulse, 1069
  - neutral, 119
  - neutrons, 34
  - newtons, 35
  - NiCAD battery, 45
  - nickel hydrogen battery, 45
  - nickel-cadmium battery, 45
  - nickel-metal hydride secondary cell, 44-45
  - Ni-H battery, 45
  - NiMH battery, 44-45
  - Nipkow, Paul, 6
  - nodal analysis
    - ac circuits
      - format approach, 759-64
      - general approach, 754-59
    - dc circuits
      - format approach, 313-18
      - general approach, 306-11
      - supernode, 311-13
  - node, 290
  - noise filters, 975-78
  - non sinusoidal circuits, 1095-1114
    - addition and subtraction, 1111-12
    - average value, 1096-97
    - circuit response, 1105-11
    - computer analysis, 1112-14
    - even function, 1097-98
    - Fourier series, 1096-1100
    - half-wave symmetry, 1098-99
    - instrumentation, 1100, 1107-8
    - mirror symmetry, 1098-99
    - odd function, 1097
    - square wave, 1102-4
  - normal magnetization curve, 518-20
  - normalization, 929
  - Norton, Edward L., 363
  - Norton's theorem
    - ac circuits, 806-12
    - dc circuits, 363-66
  - notation, 151-56
    - double-subscript, 152-56
    - single-subscript, 153-56
  - nucleus, 33-34
- O**
- odd function, 1097
  - Oerstad, Hans Christian, 4, 461
  - ohm, 3, 63
  - Ohm, Georg Simon, 3, 102
  - ohmmeter, 81, 87-88, 194-95, 268-69, 360-62, 414-15, 472, 575, 687
  - ohm/volt rating, 219-20
  - Ohm's law, 2, 5, 101-7, 120-27, 135-38, 195, 514-15, 589-90, 644
  - oil capacitor, 411
  - open circuits, 214-15, 217-18, 419
  - oscilloscope, 558-59, 564-66, 573-74, 687-90, 1001-2, 1084-85
  - overshoot, 1070
  - oxygen, 47-48
- P**
- parallel circuits
    - ac, 663-701
      - admittance diagram, 665
      - applications, 691-97
      - computer analysis, 697-701
      - current divider rule, 675
      - frequency response, 675-82
      - Ohm's law, 668
      - phase measurements, 687-90
      - power, 669
      - R-C network, 671-73
      - R-L network, 669-71
      - R-L-C network, 673-75
      - source current, 668
      - summary table, 682
      - susceptance, 665
      - total impedance, 664
    - dc, 185-232
      - analogies, 194
      - applications, 223-28
      - capacitors, 438-39
      - computer analysis, 228-31
      - current divider rule, 208-12
      - current sources, 287-89
      - inductors, 489-90
      - instrumentation, 194-95, 200-201
      - Kirchhoff's current law, 203-8
      - Ohm's law, 195
      - power distribution, 201-3
      - protoboard, 222-23
      - summary table, 220-21
      - voltage sources, 213-14
  - parallel resonance, 885-902
    - bandwidth, 889-91, 894
    - cutoff frequencies, 889-91
    - examples, 896-902
    - maximum impedance, 887-88, 892-95
    - quality factor, 888-89, 891-95
    - selectivity, 888-91
    - summary table, 895-96
    - unity power factor, 886-87, 891-92
  - paramagnetic, 464
  - Pascal, 27
  - Pascal, Blaise, 6
  - pass-band, 927-28, 936-40
  - passive filter, 926-27
  - PC monitor, 496-99
  - peak amplitude, 541
  - peak value, 541
  - peak-to-peak value, 541
  - period, 542
  - periodic pulse train, 1071
  - periodic waveform, 542
  - permanent magnet, 461-63, 520
  - permeability, 464-65, 514
  - phase measurements, 687-90
  - phase relationship, 554-59
  - phase sequence, 1033-34, 1040



- phase sequence indicator, 1055  
 phase-shift power control, 695-97  
 phasor diagram, 624, 639-40, 642  
 phasors, 623-28, 638  
 phenolic inductor, 469  
 phosphorescent coating, 497-99  
 photoconductive cell, 89  
 photons, 540-41  
 pixel, 498-99  
 point symmetry, 518  
 polar form, 609-12  
 polarized, 401-2  
 polyester film capacitor, 407-10  
 polyphase systems, 1029-56  
    $\Delta$ -connected generator, 1039-40  
    $\Delta$ - $\Delta$  system, 1040-41  
   phase sequence, 1033-34, 1040  
   phase sequence indicator, 1055  
   power, 1042-48  
   single-phase, 1029  
   three-phase, 1030-42  
   three-wattmeter method, 1048-49  
   two-wattmeter method, 1049-52  
   unbalanced systems, 1052-56  
   Y-connected generator, 1031-39  
   Y- $\Delta$  system, 1037-39  
   Y-Y system, 1035-37  
 Popov, Aleksandr, 5  
 positive temperature coefficient, 72  
 positive-going pulse, 1069  
 potential difference, 38, 101  
 potential energy, 38  
 potentiometer, 80-81, 695-96  
 potentiometer loading, 264-66  
 power, 567  
   ac, 118-20, 603-7, 644, 835-64  
   dc, 106-8, 140-41, 201-3  
   efficiency, 112-14  
   nonsinusoidal functions, 1107  
   three-phase systems, 1042-48  
   transformer, 997-98  
 power factor, 607-8, 646, 648, 650, 670,  
   672, 674, 839, 841, 845, 874,  
   1044, 1046  
 power factor correction, 851-55  
 power generator, 859-60  
 power meters, 855-56  
 power supplies, 46-47, 142-43, 156-60  
 power triangle, 845-47  
 powers of ten, 12-16, 18-19, 25-26  
 ppm/ $^{\circ}$ C, 75, 413  
 prefixes, 17-18  
 preshoot, 1070  
 primary cell, 42-43  
 primary winding, 989-92  
 programs, 27  
 protoboards, 162-64, 222-23  
 proton, 33-35  
 PSpice  
   ac bridge network, 730-35  
   reciprocal, 612-13  
   reciprocity theorem, 381-82  
   rectangular form, 609-12  
   rectification, 46  
   rectified ac waveform, 1095-96  
   reed switch, 533-34  
   reflected impedance, 996-98  
   regulator, 56-57  
   relative permeability, 465, 514  
   relative permittivity, 402-7  
   release phase, 479-84  
   rels, 514  
   reluctance, 514, 992  
   residual flux density, 517  
   resistance, 63-97, 104-6, 589, 637-39,  
     856-59  
     applications, 90-95  
     circular mils, 64-66  
     circular wires, 64-71  
     coefficient of resistance, 74  
     color coding, 82-85  
     conductance, 86-87  
     inferred absolute temperature, 72-74  
     Mathcad, 95-97  
     metric units, 69-71  
     photoconductive cell, 89  
     ppm/ $^{\circ}$ C, 75  
     resistivity, 64, 66, 70-71  
     superconductors, 75-77  
     symbol, 63  
     temperature effects, 71-75  
     thermistor, 88-89  
     types, 78-82  
     varistors, 89-90  
   resistivity, 64, 66, 70-71  
   resistors  
     parallel, 185-95  
     series, 132-34  
   resonance, 871-911  
     parallel, 885-902  
     series, 872-84  
     stray, 902  
   RFI, 446-48, 494  
   rheostat, 80  
   right-hand rule, 462-63  
   rise time, 1069-70  
   rms value, 566-70, 1106  
   Röntgen, Wilhelm, 5  
   rotor, 224, 540, 1029  
  
**S**  
 safety concerns, 576-77  
 saturation, 520  
 sawtooth waveform, 1095  
 schematic with nodal voltages,  
   330-32  
 scientific notation, 16-17  
 SCR, 445-46, 493-96  
 secondary cell, 42-45  
 secondary winding, 989-92

- PSpice (*continued*)  
   ac sources, 577-78  
   average capacitive current, 451-53  
   capacitors and the ac response, 628-30  
   current-controlled current source, 775-77  
   dc bridge network, 332-33  
   double-tuned filter, 979-81  
   Fourier series, 1112-14  
   introduced, 28  
   maximum power transfer, 383-87  
   nodal analysis, 774-75  
   Ohm's law, 120-24  
   parallel dc networks, 228-30  
   parallel resonance, 907-9  
   power curves, 861-64  
   R-C response, 1088-90  
   series ac circuit, 697-700  
   series circuits, 168-70  
   series resonance, 905-7  
   system requirements *See* Appendix C  
   Thévenin's theorem, 382-83, 820-24  
   transformer, 1021-24  
   transient R-C response, 449-51  
   transient response with initial  
     conditions, 501-2  
   transient R-L response, 499-501  
   voltage divider supply, 273-74  
   voltage-controlled voltage source,  
     822-24  
 pulse repetition rate, 1071-72  
 pulse train, 1071  
 pulse transformer, 1014  
 pulse waveforms, 1067-90  
   average value, 1074-75  
   computer analysis, 1088-90  
   definitions, 1068-70  
   duty cycle, 1071-72, 1074-75  
   ideal, 1067-68  
   instrumentation, 1075, 1084-85  
   pulse repetition rate, 1071-72  
   pulse width, 1068

- Q**  
 quality factor  
   parallel resonance, 891-95  
   series resonance, 874-76  
 QBASIC, 27

- R**  
 radian, 546-48  
 radiation losses, 856  
 radio, 5-6  
 radio frequency interference, 447-48  
 R-C response, 1074-84  
 reactance  
   capacitors, 593, 640  
   inductors, 591, 639  
 reactive power, 840-41, 844, 1043-45  
 real axis, 608-10  
 real power, 603-7, 837

- selectivity
    - parallel resonance, 888-91
    - series resonance, 878-80
  - semiconductors, 52-53, 71-72
  - semilog paper, 918-20
  - series capacitors, 438-39
  - series circuits
    - ac, 637-63
      - computer analysis, 697-700
      - frequency response, 653-63
      - impedance diagram, 642-44
      - Ohm's law, 644
      - power, 644
      - R-C circuit, 646-48
      - R-L circuit, 645-46
      - R-L-C circuit, 648-50
      - source current, 644
      - summary table, 663
      - voltage divider rule, 650-51
    - dc, 131-71
      - ammeter, 139-40
      - current, 135
      - Kirchhoff's voltage law, 143-47
      - notation, 151-56
      - Ohm's law, 135-38
      - power, 140-41
      - resistors, 132-34
      - supplies, 141-43
      - voltage, 136-37
      - voltage divider rule, 148-51
      - voltmeter, 139
    - magnetic, 521-27
  - series inductors, 489-90
  - series-parallel networks
    - ac, 713-37
      - applications, 728-30
      - block impedances, 713-25
      - computer analysis, 730-37
      - examples, 713-24
    - dc, 243-74
      - block diagram approach, 248-51
      - examples, 251-58
      - ladder networks, 258-61
      - Mathcad, 260-61
      - reduce and return approach, 244-51
    - magnetic, 527-29
  - series resistors, 132-34
  - series resonance, 872-84
    - bandwidth, 878-80
    - cutoff frequencies, 878-80
    - examples, 882-84
    - quality factor, 874-76
    - selectivity, 878-80
    - total impedance, 876-78
  - sheet resistance, 70
  - shells, 34-35
  - shell-type transformer, 1013
  - Shockley, William, 6
  - short circuits, 214-18, 419
  - SI system, 9-11, 463-65, 513
  - siemen, 86-87
  - Siemens, Werner von, 86
  - significant figures, 11-12
  - silicon, 52
  - silicon-controlled rectifier *See* SCR
  - silver, 67
  - single subscript notation, 153-56
  - single-phase generator, 1029
  - single-phase, 859, 1029-30
  - single-pole, double-throw relay, 329-30
  - sinusoidal ac voltage, 540-43, 546-59
  - sinusoidal alternating current, 131
  - sinusoidal waveforms, 546-559
  - skin effect, 856-57
  - smart remote, 1087
  - software packages, 27-28
  - solar cell, 42, 45-46, 540-41
  - source conversions
    - ac
      - dependent, 746-47
      - independent, 744-46
    - dc, 285-89
  - speaker system, 531-32, 692-95, 1000-1001
  - specific gravity, 44
  - spectrum analyzer, 1100
  - speed of light, 75
  - square wave, 539, 1077-83, 1095, 1102-4
  - static electricity, 3
  - stator, 540
  - steady-state solution, 429, 490-92
  - Steinmetz, Charles Proteus, 625-26
  - step-down transformer, 994-95
  - step-up transformer, 994
  - stop band, 927-28, 940-42
  - strain gauges, 94-95
  - stray capacitance, 442-43
  - stray resonance, 902
  - substitution theorem, 379-81
  - summary tables
    - Bode plots, 970-72
    - parallel ac circuits, 682
    - parallel dc circuits, 220-21
    - parallel resonance, 895-96
    - series ac circuits, 663
    - series dc circuits, 220-21
  - superconductors, 75-77
  - supermesh current, 299-301
  - supernode, 311-13
  - superposition theorem
    - ac circuits, 787-94
    - dc circuits, 345-52
  - surface mount resistors, 85-86
  - surge protector (line conditioner), 446-49
  - susceptance, 665
  - swinging choke, 1020
  - symbols, 22
  - symmetrical lattice, 318-19
  - systems of units, 8-11, 19-22
    - CGS, 8-11
    - English, 8-11
  - systems of units (*continued*)
    - MKS, 8-11
    - SI, 9-11
- T**
- tantalum capacitor, 407-8, 413
  - tapped transformer, 1015-16
  - television, 6
  - temperature coefficient of resistance, 74
  - temperature effects
    - capacitors, 413
    - resistance, 71-75
  - tesla, 464
  - Tesla, Nikola, 464
  - theorems
    - ac networks, 787-825
      - maximum power transfer theorem, 812-16
      - Norton's theorem, 806-12
      - superposition, 787-94
      - Thévenin's theorem, 794-806
    - dc networks, 345-88
      - maximum power transfer theorem, 367-76
      - Millman's theorem, 376-79
      - Norton's theorem, 363-66
      - reciprocity theorem, 381-82
      - substitution theorem, 379-81
      - superposition, 345-52
      - Thévenin's theorem, 353-63
  - thermistor, 88-89
  - Thévenin, Leon-Charles, 353
  - Thévenin's theorem
    - ac circuits, 794-806
    - attenuator probe, 1084
    - capacitive networks, 433-36
    - dc circuits, 353-63
    - inductive networks, 484-86
  - three-phase generator, 1030-42
  - three-phase systems *See* polyphase systems
  - three-wattmeter method, 1048-49
  - TI-86 calculator, Appendix B
  - TI-89 calculator
    - basic operations, 23-26
    - complex numbers, 618-20, 752
    - determinants, 293, 305-6, 319-20
    - exponential function, 420-21, 432
    - logarithms, 921
    - nodal analysis (ac), 761
    - Norton's theorem (ac), 809
    - sinusoidal functions, 552-53
    - superposition (ac), 792
    - total admittance, 720-21
    - total impedance, 723
    - voltage divider rule (ac), 650-53
  - tilt, 1070
  - time constant
    - capacitive networks, 416-20, 424-36
    - inductive networks, 476
  - transformation ratio, 994-1000

- transformers, 56-59, 216, 524-25, 575, 989-1025  
 air-core, 1009-12  
 applications, 1017-21  
 coefficient of coupling, 990-92  
 computer analysis, 1021-25  
 differential, 1002  
 dot convention, 1008-9  
 equivalent circuit, 1002-5  
 frequency considerations, 1005-6  
 impedance matching, 998-1001  
 iron-core, 992-1006  
 isolation, 1001-2  
 mutual inductance, 989-92  
 mutually coupled, 1006-9  
 nameplate data, 1012-13  
 power, 996-98  
 primary winding, 989-1006  
 reflected impedance, 996-98  
 secondary winding, 989-1006  
 step-down, 994-95  
 step-up, 994  
 transformation ratio, 994-1000  
 types, 1013-17
- transients  
 capacitive networks, 415-36  
 inductive networks, 474-79
- transistor, 6, 717-18, 763-64, 798-99, 803-6, 816-20
- TRIAC, 494-96, 695-96
- triangular wave, 539, 1095
- trigger network, 445
- trimmer, 81-82
- troubleshooting, 221-22
- true rms meter, 571, 1107-8
- tube, 5-6
- tuned networks, 871-72
- turns ratio, 57
- TV monitor, 496-99
- TV remote, 1085-88
- tweeter, 692-95
- two-wattmeter method, 1049-52
- U**  
 unbalanced three-phase system, 1052-56  
 units of measurement, 7-11
- V**  
 VA, 838-39, 844  
 vacuum tube, 6  
 VAR, 841, 844  
 variable capacitors, 411-12  
 variable inductors, 469-70  
 variable resistors, 80-82  
 varistors, 89-90, 448-49  
 volt, 3, 36-37  
 Volta, Count Alessandro, 3-4, 37  
 voltage, 33, 35-38  
 volt-ampere, 838-39  
 volt-ampere-reactive, 841, 844  
 voltage divider rule  
   ac circuits, 650-51  
   dc circuits, 148-51  
 voltage divider supply, 261-64  
 voltage regulation, 156-60  
 voltage sensitivity, 267-68  
 voltage sources, 141-43, 213-14, 743-44, 749
- voltaic cell, 4
- voltmeter, 53-54, 139, 161-62, 200-201, 218-20, 247-48, 258, 267-68, 360-63
- VOM, 54, 88, 219-20, 571
- W**  
 watt, 106-8  
 Watt, James, 106  
 wattsecond, 109  
 wave analyzer, 1100  
 waveforms, 541  
 weber, 463-64  
 Weber, Wilhelm Eduard, 463  
 Wheatstone bridge smoke detector, 329-30  
 wire tables, 67-69  
 wire-wound resistors, 78-79  
 woofer, 692-95  
 Wu, Man Kven, 76
- X**  
 x-rays, 5, 498
- Y**  
 Y- $\Delta$  system, 1037-39  
 Y- $\Delta$  and  $\Delta$ -Y conversions  
   ac circuits, 769-74  
   dc circuits, 321-27  
 Y-connected generator, 1031-39  
 yolk, 496-99  
 Y-Y system, 1035-37









