Index

A

A, B test, 207, 228
Accessory conditions, 48, 60, 70, 187
Acetylene, 196
Action potential, 134, 158, 159
Active transport, 85
Additive constant, transform of, 71
Algebraic equations, 41, 71
ALGOL, 112
Analytic form, 112
Antiderivatives, 61
Antidifferentiation, 61
Aortic valve, 194
APL, 112
Arbitrary constants, 26, 44, 47, 48, 187
Area under a curve, 61
Artery, 204

B

BASIC, 112
Binomial theorem, 240
Biosynthesis, 155
Blood flow, 51, 194
  impulse injection method for, 196
Blood pressure, 139
Blood sugar, 60
Boundary conditions, 169, 170, 190
Boundary value problem, 170

C

Capillaries, 185, 194
Carbon monoxide, 196
Cardiac output measurement, 207
Cardiogreen, 196
Carotid sinus, 139
Cell membrane, 158
Chain rule, 12, 19
Chemical diffusion, 172
Chemical reaction, 85,86
Circadian rhythms, 160
Circular reaction, 37, 117
Circular reaction with changing rate constant, 117
Compartments, 84
  dilution
    in one compartment, 23, 27, 51
      mixed loss, 85
      nonzero initial concentration, 71
      time-dependent input, 110
    in two compartments, 32, 105
      model of, 32
      numerical solutions, 113
    in three compartments, 39
  diffusion between, 98
  flow in parallel, 202
  metabolic turnover, 28
Competitor, 157
Complex variables, 76
Concentration, 24, 56, 179

Concentration-dependent loss, 84, 88, 99, 175
Concentration-independent loss, 84, 88, 175, 178
Concentration–time curve, shape of, 202
Constant injection, 30
  measurement of blood flow, 196
Continuous functions, 5, 165
Contour integration, 76
Control systems, 132
Controlled variable, 133
Conversion of dimensions, 2, 20
Convolution, 78, 80, 99, 103, 104
Convolution integral, 79
Cosine, 127, 162, 248
Cylindrical diffusion, 185
Cylindrical shells, 186

D

Decay constant, 20
Decaying exponentials, 27, 204
Definite integral, 61, 80
Degrees, 127
Dependent variable, 3, 46
Derivative, 6, 8, 10, 21, 43, 128, 239, 248
  of sine and cosine, 128, 248
Differential, 15
  in more than one variable, 215
Differential calculus, 1
Differential equations, 16, 22, 23, 27, 39, 44, 71, 135, 167
  numerical methods for, 107, 112, 122
  order of, 47, 59
  table, 44
  transforming, 69
Differentiation, 61, 239
  rules for, 10, 239
Diffusion, 39, 52, 73, 88, 122, 158, 161, 169
  between compartments, 52, 73
  equation, 169
Digital computers, 112, 206
Dilution, 51
Dimensional balance, 1
Dimensional equation, 1, 20, 25, 28, 31, 86
Dimensionless plot, 36
Dimensionless quantity, 2
Dimensionless variables, 33
Dimensions, 1
  conversion of, 2
  of derivatives, 8
  of integrals, 65
  of Laplace transforms, 71
Diodrast, 196
Discontinuous function, 5, 165
Doubling range, 18
Dyes, 23, 196

E

e^{ax}, 13–15, 7
e^{x}, 12, 16, 161, 240
Effluent, 33
Enzyme, 155
Enzyme-limited, 157
Equilibrium, 53
Euler's method, 113
  modified, 117
Evans blue, 196
Experimental errors, 109
Exponential decay, 27, 205, 223
  multicomponent, 224
Exponential fitting, 223
Exponential functions, 42
Exponential solutions, 59
Exponentials, 47
Exponents, dimensions of, 2

F

Feedback "loop," 144
Fick method, 207
Finite section, 177, 181
First derivative, 70
First-order differential equation, 98
Float, 138
Flow, 194
Flow concentration integral, 196
FORTRAN, 112
Fourier coefficients, 163
Fourier series, 162, 192
Function that is its own derivative, 12
Functional relationship, 3, 33

G

Gauss reduction, 67, 82, 222
Gaussian distribution, 223
Gradient, 168

H

Half range, 18
Heat capacity, 169

Heat flow, 171
Higher order equations, numerical solutions, 122
Homogeneous and inhomogeneous equations, 30, 46, 48, 59
Hypertension, 139

I

^{131}I, 60
Impulse input, 85, 86, 97, 99, 100, 106, 196, 199
Indefinite integral, 61
Independent variable, 3, 8, 70
Indicator, 22
  dilution of, 196
Inertial effects, 143
Infinite series, 13, 161, 243
Inhomogeneous equation, *see* Homogeneous and inhomogeneous equations
Initial condition, 26, 169, 190
Input rate error response, 133
Input reconstruction technique, 109
Insulin, 134
Integral(s), 61, 66
  with infinite upper limit, 66
  of sine and cosine, 162
Integration, 61
Intensity, 29
Internal generation, 180
Inverted exponential, 31, 229
Iodine, 60, 196
Isotope, 29

K

Kidneys, 139
Kinetic laws, 155
Kinetic reactions, 56, 117, 155, 173
Kinetic theory, 173
Krogh equation, 185, 187

L

L, 173
Labeled metabolite, 28
Laplace transform, 61, 70, 76, 77, 87, 90, 98, 130, 146, 176, 246
  definition, 76
  of derivatives, 70
  dimensions of, 71
  inverse, 76, 78
  table, 246
  three special cases, 77
Least squares, method of, 218
Limit, 8, 10, 19, 52, 64, 89
Linear, 59
Linear differential equations, 44, 55, 62, 71, 100
Linear and nonlinear equations, 44
Linear inhomogeneous, 71
Linear process, 60
Linear superposition, 99, 101
Logarithm, 245
  derivative of, 295
Logarithmic plots, 16, 17, 27, 31, 200, 205
Logistic equation, 125

M

Maximization, 212
Memory, 159
Metabolic, 37
Metabolic loop, 117
Metabolic pooling, 143
Metabolite, 28, 37, 117, 143
Michaelis–Menten equation, 156
Minimization, 212
Mixed loss, 176
Mother–daughter radioactive decay, 37
Motor, 138
Muscle, 158

N

Negative concentration, 175
Nerve, 158
Neuron, 134, 141
Nitrous oxide, 196
Nonlinear equations, 216
Nonlinear fit, 223
Nonlinear least-squares fitting, 231
Nonsteady state, 188
Normal equations, 222, 232, 235
Numerical solutions, verifying result, 114

O

Oscillation, 127, 142, 147, 154, 158
Output rate error response, 133, 137
Overflow regulation, 134
Oxygen, 84, 173, 185, 196
Overshoot, 120, 141, 148, 149, 151, 160

P

Pacemaker, 159
Parallel compartments, flow in, 202
Parametric integrals, 80
Partial fraction expansion, 67, 78
Partial derivatives, 211, 213, 220
Partial pressure, 84, 187, 211, 213, 220
Passive diffusion, 172
Peel back, 205, 210
Picard's method, 117
Poisson distribution, 224
Pool, 28
Pooling delay, 143
Position feedback, 151
Potassium, 158
Pressure measurements, 109
Problem reconstruction, 116
Product inhibition, 157
Prony method, 210, 224, 227, 229
  flaw in, 226
  modified, 227
Proportional control, 134
Pump, 39, 109
Pumping, 172

Q

Quadratic equations, 41, 77, 225

R

Radians, 127
Radioactive decay, 29, 37, 39
Radioactive elements, 23, 29, 196
Radioactive gases, 196
Radioactive krypton, 196
Radioactively labeled metabolite, 28
Rate of change, 6, 9
  relative, 6
Rate of reaction, 56, 155
Recirculation, 199
Rectangular coordinates, 40
Regulation, 127
Relaxation oscillators, 158
Residual, 219, 223
Restricted value problems, 120
Reverse computation test, 114
Reversible reactions, 173
Rheostat, 138
Runge–Kutta method, 117

S

Second derivatives, 43, 70, 170
Second-order differential equation, 45, 47, 74, 98, 131
Semiinfinite section, 176, 180
Semilogarithmic, 16, 27, 31, 40, 200, 205 223
Sequential approximation, 124
Series, 221
Set point, 133, 136, 139, 145
Simultaneous equations
  differential, 39, 83, 95, 98, 144, 151
  linear, 67, 221
Sine, 127, 162, 248
Sodium, 158, 196
Solutions
  forms of, 47
  guessing, 54
  to selected problems, 249
  to simple differential equations, table, 45,
Specific heat, 169
Spherical diffusion, 182, 192
Spherical shell, 183
Spider web, 22
Split integral theorem, 65
Stationary systems, 194, 197
Steady state, 38, 86, 89, 135
Steady-state diffusion equation, 175
Steady-state solution, 89
Step input, 85, 105, 113
Stop–flow experiments, 110
Strip chart recording, 195
Substrate limited, 157
Sugar, 60

T

τ, 80
Temperature, 167
Thermal conductivity, 167
Thermal diffusion, 167
Thin bar, 167
Three-compartment dilution, 39
Three-compartment problems, 39, 95, 151
Threshold-dependent loss, 178
Time averages, 194
Time constant, 91
Time delay, 140, 143
Time-dependent diffusion, 89, 175, 188, 189
Time-dependent functions, 70

Time-dependent solutions, 89
Tracer, 22, 23, 26, 51, 84
Transformed variables, elimination of, 75
Transforms, new, finding, 75
Transit times, 201
Trial solution, 51, 54, 57
Trigonometry, 127
Two-compartment series dilution, 32, 34, 49, 72, 105

U

Unit impulse response, 87–99, 103–105, 107, 108, 110, 133, 136, 138, 146
  disturbance response, 133
  working backwards, 108
Units of integral, 65
Unstable systems, 154

V

V_{ZF}, 154
Van der Pole equation, 126
Vascular volume, 200
Veins, 194
Velocity feedback, 151
Volume, 135

W

Washout curves, 204
Waterfall, 140
Weighting, 222, 231

X

X-ray absorption, 29
Xenon, 196