

# Index

- $H(\cdot)$ , 169
- $W(y_1, y_2)$ , 46
- $\mathcal{L}(\cdot)$ , 155
- $\delta(t)$ , 177
- $\det(\cdot)$ , 90
- $\forall$ , 45, 89
- $\mathbf{I}$ , 90
- $\nabla^2$ , 227
- $\text{Im}(\cdot)$ , 49
- $\text{Re}(\cdot)$ , 49
- $g$ , 23, 66, 75
- $i$ , 49
  
- Abel's formula, 46
- acceleration, 2, 22, 43, 83, 190
- advection equation, 189
- Airy's equation, 168
- amplitude, 67
- Archimedes' principle, 30, 77
- associated homogeneous equation
  - first-order equation, 17
  - matrix equation, 18
  - second-order equation, 44, 54, 59
- asymptotically stable, 35
  - linear system, 113
  - nonlinear system, 126, 127
- autonomous equation, 35, 120
  
- balance law, 190
- bang-bang wave, 172
- baseball, 31
- beam equation, 6
- Bernoulli equation, 19
- Bessel equation, 66
- Beverton-Holt model, 32
- boundary conditions, 191
  - diffusion equation, 195
  - periodic, 195, 232
  - wave equation, 214
- boundary value problem, 190
- Brownian motion, 190
- buoyant force, 30
- BVP, 190, 215
  
- catenary, 13
- center, 114
- central force field, 149
- characteristic equation, 47, 51, 190
  - eigenvalues, 90
- compatibility conditions
  - wave equation, 221
- complex conjugates, 94
- complex number, 49
  - imaginary part, 49
  - real part, 49
- convolution theorem, 162
- cosine series, 208
  - convergence theorem, 208
- differentiability, 211
- critical point, 39
  
- damped
  - critically damped, 78
  - over-damped, 78
- damped wave equation, 219
- damping
  - critically damped, 70
  - over-damped, 70
  - under-damped, 71
  - weakly damped, 72, 74
- damping constant, 70
- Dead Sea scrolls, 29
- defective matrix, 97
- delta function, 177
- determinant, 46, 90, 136
- differential equation
  - dependent variable, 2
  - first-order linear, 14
  - first-order system, 83
  - homogeneous, 3
  - independent variable, 3
  - linear, 3
  - order, 3
  - second-order linear, 43
- diffusion equation, 189
  - inhomogeneous, 222
  - inhomogeneous boundary conditions, 219
  - separation of variables, 195
  - steady state, 219
- discontinuous forcing
  - function, 175
- distribution, 180
- drag force, 23
  - on sphere, 31
- driving frequency, 73
- Dulong-Petit law of cooling, 27
  
- eigenvalue, 89
- eigenvalue problem, 90
  - BVP, 192
- eigenvector, 89
  - independent, 92
- electrostatic force, 149
- epidemic equilibrium, 134
- epidemics, 84
- equilibrium point, 39
- Euler equation, 79
- Euler's formula, 48
- existence and uniqueness theorem, 44
- exponential order, 174
  
- Fejér summation, 208
- floor function, 172
- flutter, 74
- forcing

- periodic, 78
- forcing amplitude, 73
- forcing function, 43
  - oscillator, 72
- Fourier sine series, 198, 202
- Galerkin method, 225
- general solution
  - diffusion equation, 198
  - first-order equation, 16
  - linear system, 88, 95
  - second-order equation, 44, 59
  - wave equation, 215, 229
- Gibbs phenomenon, 208
- gravitational acceleration
  - constant, 23, 66, 119
- gravitational force, 23, 66, 149
- half-life, 28
- half-plane of convergence, 173
- Hamiltonian, 140, 146, 148
- Hamiltonian system, 148
- Heaviside step function, 169
  - derivative, 180
- Hilbert space, 212
- homicide victim, 33
- homogeneous, 3
- Hooke's law, 66
- identity matrix, 90
- impulse, 178
- impulse forcing, 177
- indeterminate steady state, 130
- inhomogeneous, 3
- inhomogeneous boundary
  - conditions, 219
- initial condition, 2
  - diffusion equation, 195
  - separation of variables, 198
- initial conditions
  - second-order equation, 44
  - wave equation, 214
- initial value problem, 2
  - second-order equation, 44
- integral curves, 103
- integrating factor, 15, 224
- isolated steady states, 123
- IVP, 2
- Jacobian matrix, 128, 129
- joke model, 137
- jump discontinuity, 169, 173, 203
- Kelvin-Voigt material, 117
- Kermack-McKendrick
  - model, 84
- Laplace transform, 155
  - convergence theorem, 174
  - convolution, 162
  - impulse forcing, 177
  - inverse, 157
  - of derivative, 161
  - periodic function, 171
  - solving differential equations, 163
  - table, 158
- Laplace's equation, 227
  - periodic boundary conditions, 232
- libration, 143
- linear approximation, 128
- linear operator, 156
- linear system
  - first-order, 84
  - general solution, 88
  - homogeneous, 86, 183
  - inhomogeneous, 183
  - second-order, 118
- linearized stability theorem, 129
- linearly independent
  - equating coefficients, 58
  - functions, 45
  - vector functions, 89
  - vectors, 92
  - Wronskian, 46
- logistic equation, 25
- mass-spring-dashpot, 6, 66
- matrix
  - defective, 94
  - identity, 90
  - non-invertible, 90
  - singular, 90
- Maxwell material, 117
- Maxwell viscoelastic
  - material, 19
- measles, 120, 135
- method of undetermined
  - coefficients, 55
  - first-order equation, 18, 61
- Michaelis-Menten equations, 6, 124
- mixing problems, 20
- natural frequency, 67, 218
- natural mode, 218
- neutrally stable, 36, 113, 127
- Newton's law of cooling, 26
- Newton's second law, 2, 23, 43, 66, 67, 83, 138, 140, 149, 190
- ODE, 3
- one-sided stability, 42
- oscillator
  - Duffing, 124, 147
  - Morse, 147
  - simple harmonic, 67, 138
  - Toda, 124
  - Van der Pol, 124
- partial differentiation
  - notation, 189
- partial fractions, 165
- particular solution, 17
  - non-uniqueness, 55
  - second-order equation, 54
- PDE, 3
- pendulum, 6, 119, 142
  - period, 146
- periodic forcing, 78
- periodic orbit, 151
- periodic solution, 67, 138, 146
- phase, 67
- phase plane, 103
- phase portrait, 104, 129, 130
  - table, 105
- Picard-Lindelöf theorem, 12
- piecewise continuous, 173, 202
- predator-prey equations, 124
- principle of superposition, 5
  - linear system, 87
  - PDEs, 198
- radioactive decay, 1, 6, 28
- Rayleigh quotient, 194, 195
- reduction of order, 47, 80
- resonance, 73
- saddle, 114, 130
- saddle point, 131, 133
- sawtooth wave, 172
- Schrödinger's equation, 6
- separable equation, 7
- separation of variables
  - for ODE, 8

- 
- for PDEs, 196, 214, 228, 232
  - non-uniqueness, 11
  - separation constant, 196
  - separatrix, 143
  - simple harmonic motion, 67
  - sine series, 198
    - convergence theorem, 204
  - sink, 114, 130, 133
  - SIR model, 84, 120
  - Somigliana equation, 23, 75
  - source, 114, 130
  - spiral sink, 114, 130, 131
  - spiral source, 114, 130
  - spring constant, 66
  - square wave, 171
  - stability theorem
    - linear system, 114
    - nonlinear system, 129
    - single equation, 35
  - standing wave, 218
  - steady state, 35
    - linear system, 113
    - nonlinear system, 122
    - PDE, 219
  - Temple Scroll, 29
  - term-by-term differentiation, 211
  - terminal velocity, 24, 31
  - trace, 116, 136
  - transfer function, 165
    - systems, 186
  - triangle wave, 172
  - turkey, 32, 182
  - unstable, 35
    - linear system, 113
    - nonlinear system, 128
  - variation of parameters, 19, 62
  - velocity, 2, 22, 83
    - angular, 119
  - wave equation, 189
    - compatible boundary conditions, 221
    - damped, 219
  - weight, 23, 75, 77
  - Wronskian, 63, 89