

Index

- ABC flow, 12, 369
Abel's theorem, 60, 147, 244, 321
action principle, 328
action-angle variables, 353
adjoint, 273
advection derivative, 19
affine, 28
algebra
 computer, 32, 375
 fundamental theorem, 29, 31
 linear, 47
algebraic multiplicity, 29, 46
Allee effect, 21
alpha limit set, 137
angular momentum, 23
antisymmetry, 326
area-preserving map, 360
asymptotic
 backward, 159
 expansion, 109
 forward, 159
 stability, 114
attracting, 114
 set, 142
attractor, 7, 142
 basin, 143
 measure, 144
 strange, 145, 249
 strange, nonchaotic, 252
autonomous, 3
Baker–Campbell–Hausdorff theorem, 41
ball, 70
Banach space, 75
basin of attraction, 143, 159
Beltrami property, 13
Bendixson's formula, 208
bifurcation, 12, 257
 Andronov–Hopf, 12, 285, 288
Bautin, 290
cusp, 292
diagram, 258, 377
fold-Hopf, 290
Gavrilov–Guckenheimer, 290
Hamiltonian–Hopf, 351
homoclinic, 298
Hopf, 285
pitchfork, 284
saddle-node, 268, 279
Shilnikov, 310
supercritical, 284
Takens–Bogdanov, 290, 295
transcritical, 284
big oh, 109
bijection, 103
bijective, 125
bilinear, 326
binomial theorem, 64
Birkhoff, 234, 359
blow-up, 221
Bolzano–Weierstrass theorem, 71, 118
boundary, 71
boundary value problem, 4
bounded, 71
Boussinesq equations, 19
calculus of variations, 329
canonical, 325, 370
Cantor set, 255, 355
Casimir invariant, 370
catalysis, 22
catastrophe, 291
Cauchy sequence, 74
Cayley–Hamilton theorem, 52, 64
center, 37, 110
 focus, 198
manifold, 190, 282
manifold theorem, 179
topological, 192, 197
chaos
 definition, 233, 236
 discovery, 20
 example, 13, 237, 359
 resonance overlap, 366
 two-dimensional, 210
characteristic
 exponent, 242
 polynomial, 28
chemical reaction, 22
closed set, 71
codimension, 270
cokernel, 273
collision singularity, 107
commutator, 40, 346
compact set, 71
competitive exclusion, 24
complete set, 30
computer algebra, 375
configuration, 323
conjugacy, 263
 diffeomorphic, 129
 equivalence, 126
 topological, 126
Conley, Charles, 144
connected, 139
conservative, 319, 325
contraction map, 76, 82, 169
 uniform, 172
convection, fluid, 186
convergence, uniform, 71
cyclic coordinate, 338
degenerate equilibrium, 37
degree, topological, 209
degree-of-freedom, 10, 324
depensation, 21
derivation, 326
determinant, 33
deterministic system, 102
diagonalizable, 32

- diffeomorphism, 126
 differentiable, 73
 differential equation, 1, 2
 partial, 181, 201
 differential form, 17
 differential inequality, 90
 dimension, 1, 2
 box, 250
 Hausdorff, 252
 Diophantine frequency, 355
 direction field, 210
 discriminant, 33
 dynamical system, 1, 101

 eigenspace
 generalized, 46
 eigenvector, 28
 deficiency of, 31
 generalized, 47
 embedding, 178
 energy, 323, 325
 equilibrium, 13, 102, 108
 nondegenerate, 262
 equivalent, 263
 equivariant, 339
 ergodic, 235, 356
 Euler
 characteristic, 210
 equations, 327
 Euler's formula, 36
 Euler–Lagrange equation, 334
 Eulerian
 dynamics, 12
 fluid, 321
 exact form, 17
 existence, 80, 105
 interval, 94
 nonautonomous, 88
 exponential, 39, 49

 Fermat's principle, 328
 Floquet
 exponent, 59
 multiplier, 59, 146
 theory, 58
 flow, 103
 complete, 104
 volume-preserving, 321
 fluxions, 2
 focus, 110
 center, 198
 stable, 36
 topological, 192, 197
 unstable, 34
 Fréchet derivative, 329

 fractal, 249
 Fredholm, 273
 function, 2
 fundamental matrix, 58

 Galerkin truncation, 19
 Gaussian elimination, 33
 general solution, 4
 generic system, 55
 geodesic, 328
 geometric multiplicity, 30
 Grönwall inequality, 90, 107,
 170
 gradient system, 108
 group, 103

 Hamilton's principle, 334
 Hamilton, William, 322
 Hamiltonian
 Floquet multipliers, 148
 formulation, 323
 Liénard, 215
 Lyapunov exponents, 244
 matrix, 345
 Melnikov function, 308
 perturbation, 301
 reversible, 203
 separatrix, 160, 162
 system, 10, 122, 140, 196
 harmonic, 23, 28
 Hartman–Grobman theorem,
 132, 182, 271
 Hausdorff, Felix, 251
 Hessian, 342, 345
 heteroclinic, 161
 homeomorphism, 125
 homoclinic, 161, 295
 homogeneous
 linear system, 30
 ODE (ordinary differential
 equation), 16
 polynomial, 191, 228, 271
 Hopf bifurcation, 285
 hyperbolic, 55, 109

 ignorable, 370
 immersion, 176
 implicit function theorem, 261
 incommensurate, 252, 254, 354
 index, 210
 induced, 263
 initial value problem, 4
 injective, 125
 integrable, 351
 integral, 319

 integrating factor, 66
 interior, 71
 invariant, 319
 integral, 332
 set, 14, 102, 142
 involution, 203, 352

 Jacobi identity, 326
 Jacobian, 73, 176, 329
 Jordan curve, 205, 211

 KAM theory, 355
 kernel, 30
 King Oscar's Prize, 161
 Kovalevskaya top, 353, 372
 Krein
 collision, 349
 quartet, 347
 signature, 349
 Kronecker Delta, 52

 Lagrangian, 86
 dynamics, 12
 fluid, 322
 LaSalle's invariance principle,
 121
 Legendre
 condition, 342
 transformation, 344
 Levi–Civita regularization, 107
 librating motion, 364
 Lie
 algebra, 345, 346
 bracket, 273, 346
 Liénard system, 215, 289
 liminf, 241
 limit cycle
 bifurcation, 287, 311, 312
 center-focus, 198
 definition, 12, 138
 existence, 213
 Hilbert's problem, 213
 Liénard system, 215
 Poincaré–Bendixson, 199
 limsup, 241
 linear, 27
 linear superposition, 27
 linearization, 109
 linearly independent, 30
 Liouville integrable, 352
 Liouville's theorem, 325
 Lipschitz, 78
 little oh, 109
 logistic equation, 5, 21, 112,
 122, 257

- Lorenz
 attractor, 145
 model, 18, 120, 144, 157
- Lotka–Volterra, 8, 14, 24, 319
- Lyapunov
 Aleksandr, 240, 346
 basis, 243
 equation, 155
 exponent, 13, 238, 241
 exponents, 376
 function, 118
 spectrum, 241
 stability, 326
- manifold, 2, 70
- map, 175, 209
 proper, 178
- Maple, 3, 375, 378
- Mathematica, 3, 375, 376
- MATLAB, 3, 375, 376
- matrix, 28
 commutator, 40
 eigenvalues, 28
 exponential, 40, 376
 fundamental, 44, 240
 hyperbolic, 54
 kernel, 30
 logarithm, 61
 monodromy, 59, 240
 nilpotent, 41
 orthogonal, 247
 QR factorization, 247
 range, 30
 semisimple, 32
 similar, 32, 64
- Melnikov
 function, 306
 integral, 301
 theorem, 307
 Viktor, 300
- metric, 73
- Michaelis–Menten mechanism, 22
- Milnor, John, 144
- minimal, 142
- module, 373
- momentum, 323
 canonical, 324
- monodromy, 59, 62, 146
- multiple eigenvalue, 29
- natural numbers, 70
- Navier–Stokes equations, 13, 24
- neighborhood, 70
- Neile’s parabola, 291
- Newton
 dynamics, 10, 86, 322
 gravity, 107
 Isaac, 2, 319
 mechanics, 335
 nilpotent, 41, 44, 48
 node
 improper, 50
 proper, 50
 stable, 34
 topological, 192
 unstable, 33
 nonautonomous, 4, 16, 88
 nondegeneracy, 268
 nonwandering, 141
 norm
 Euclidean, 70
 L_2 , 73
 operator, 38
 sup, 73
 normal form, 271
 normal matrix, 113
 null space, 30
 nullcline, 13
 nullity, 31
- ODEs (ordinary differential equations), 3
- omega-limit set, 137
- one form, 332
- open set, 70
- operator
 bounded, 38, 63
 linear, 38
- orbit, 102
- order, ODEs (ordinary differential equations), 2
- Oseledec’s theorem, 242
- passive
 scalar, 12
 tracer, 321
- pendulum, 323, 337, 363
- periodic orbit, 138
- Perron triangulation, 247
- phase space, 1
 extended, 324
- Picard iteration, 81
- Picard–Lindelöf theorem, 82
- pigeonhole principle, 236
- Poincaré
 Henri, 159, 161, 285, 300, 308, 346
 index, 205, 210
 invariant, 331
- map, 149, 295, 331, 379
 section, 149
 sphere, 221
 transformation, 220
- Poincaré–Bendixson theorem, 211, 233
- Poisson
 bracket, 326
 matrix, 325
 system, 326
- population dynamics, 8, 14, 21, 122, 229, 257, 316, 320
- predator–prey model, 8, 229, 320
- projection, 166
- quadratic system, 20, 21, 157, 187
- quadrature, 6
- quasiperiodic, 252
- Rössler system, 237
- range, 30
- rank, 30
- real line, 69
- regular point, 214
- regular value, 209
- regularization, 107
- resonance, 273, 364
 module, 373
- reversor, 203
- rigid body, 327, 370
- Routh–Hurwitz criterion, 64
- Runge–Kutta, 376
- saddle, 34, 109
 connection, 162
 node, 276
- section, 149
- self-similar, 249
- semidefinite, 39
- semisimple, 32, 48
- semistable, 112, 276
- sensitive dependence, 20, 234
- separable, 16
- separation of variables, 5
- separatrix, 160, 162, 214, 228, 364
- cycle, 162, 300
- set theory notations, 69
- set, invariant, 102
- Shimizu–Morioka model, 157
- similarity, 32, 48
- singular values, 39

- singularity, 268
sink, 109, 112
skew product, 149, 163
Smale, Stephen, 145
smooth, 73
source, 109, 112
span, 30
Sprott, Clint, 20
stability
 asymptotic, 56, 114
 linear, 56
 Lyapunov, 111
 periodic orbit, 146
 spectral, 53
 structural, 124, 260
stable
 equilibrium, 111
 set, 143, 159, 175
stable manifold
 global, 175
 local, 168
 theorem, 169
stochastic system, 102
stream function, 322
submanifold, 174
subspace
 center, 54
 invariant, 47
 stable, 54
 unstable, 54
supremum, 38
surjective, 125
symmetric orbit, 204
symmetry, 203, 339
symplectic, 331
 form, 325
 group, 345
 matrix, 345
tangent space, 239
time, 2
 reversal symmetry, 203
Tonelli's theorem, 342
topology, 69, 125, 211, 311, 358
trace, 33
trajectory, 102
transitive, 234
transversality, 268, 280
trapping region, 142
unfolding, 263
 miniversal, 264
 versal, 263
uniqueness, 85
unstable, 111
 set, 159
van der Pol oscillator, 11, 215, 289
vector
 field, 3, 28, 80, 104
 space, 73
volume-preserving, 321, 325
wave-wave interaction, 320, 369
Weierstrass
 function, 78
 M-test, 40, 84