Index

Absolute temperature, 210, 243, 362
Acceleration, 6, 152, 267, 361
  gravitational, 371
  vector, 182
Adiabatic, 210
Adjoint, 38
Adjunct, 38
Airy stress function, 301–309
Algebraic
  equations, 328
  multiplicity, 70
Almansi–Hamel strain tensor, 104
Alternating symbol, 25
Ampere's law, 254
Analytical solution, 272, 369, 379
Angle of twist, 308
Angular
  momentum, 4, 169, 193–206
  velocity, 14
Anisotropic, 222, 238, 258
Antisymmetric tensor, see skew symmetric
Applied mechanics, 255
Approximate solution, 272
Approximation functions, 328
Area change, 97
Associative, 35
Asymmetry, 292
Axial vector, 119
Axisymmetric
  body, 148
  boundary condition, 292
  flow, 364
  geometry, 296
  heat conduction, 376
  problem, 61

Balance of
  angular momentum, 203, 212
  energy, 207, 212
  linear momentum, 193, 212, 216
Barotropic constitutive model, 243
Basis, 19
  contravariant, 43
  covariant, 43
  orthonormal, 21–23, 26, 74, 78, 82, 158,
  reciprocal, 19, 20, 43
  unitary, 21, 42, 43
Beam, 2, 7, 278–284, 303–306
  bending, 278
  theory, 124, 278, 280, 305, 328, 351
Beltrami–Michell equations, 270, 271, 352
Beltrami's equations, 271
Bending moment, 217, 280, 288, 305, 321–325, 346
Bernoulli's equations, 385
Betti's reciprocity theorem, 288
Bianchi formulas, 147
Biaxial state of strain, 146
Biharmonic
  equation, 301
  operator, 301
Bilinear form, 326
Bingham model, 247
Body couple, 5, 169, 173, 205
Body force, 152, 197
Boundary
  conditions, 364
  curve, 18
  value problem, 265
Bulk viscosity, 244

Cable supported beam, 282
Caloric equation of state, 357
Cantilever beam, 123, 217, 287, 290, 303, 344
Carreau model, 247
Cartesian, 21, 29, 46–48, 50, 57–59, 184, 266, 358
Castigliano's theorem I, 322, 342
Cauchy
  strain tensor, 103
  stress tensor, 138, 154, 224, 226, 265
Cauchy–elastic material, 226
Cauchy–Green deformation tensor,
  Left , 99, 224
  right, 99, 224
Cauchy–Green tensor, 98, 137, 251

Cauchy's
equation of motion, 199
formula, 151, 204, 286
Causality, 223
Chain, 195
Chain rule of differentiation, 183
Characteristic
equation, 62–71
value, 62
vector, 62, 64
Chrisotoffel symbol, 59
Circular
cylinder, 376
hole, 306
pipe, 364
Clapeyron's theorem, 285–287, 344
Clausius–Duhem inequality (also see Entropy inequality) , 5, 210
Co-deformational, 248
Coefficients
hygroscopic expansion, 257
thermal expansion, 257
Cofactor, 38
Cogredient components, 21
Collinear, 12
Commutative, 35
Compatibility
conditions, 120, 125, 147, 269
equations, 120–123,309
Complementary error function, 384
Complex mixtures, 245
Compliance coefficients, 230
Composite, 157, 221
Component of acceleration, 361
Compressible fluid, 243
Computational framework, 248
Concentrated load, 280
Conduction, 251
heat, 3, 208, 225
electrical, 377
Conductive material, 254
Configuration of body, 82, 265
Conservation of mass, 182, 212
Conservative forces, 335
Consistency, 222, 246
Constitutive equation, 221, 268, 356
Constitutive theory, 222
Continuity equation, 185, 187, 356
Continuous medium, 82, 339,
Continuous systems, 334
Continuum, 1, 81, 82, 89, 181, 339
Contragredient components, 21
Contravariant, 21, 43, 59
Control surface, 186, 187, 194, 203–206
Control volume, 186, 190, 193–198, 203, 206, 370
Convection, 251
heat transfer coefficient, 252
Cooling fin, 374
Coordinate curve, 42
Coordinate transformations, 9, 56, 58, 75, 157
Coordinates
Cartesian (see also Cartesian), 21, 29, 34, 42, 51
curvilinear, 41–44, 51, 189, 212, 357
cylindrical, 51, 52, 60, 79, 116–118, 189, 201, 202, 215, 262, 266–268, 301, 373, 384
polar, 298, 337
spherical, 51, 52, 60, 79, 116–118, 189, 201, 266–268, 374
Coplanar, 12
Correspondence principle, 412
Cosserat's equation, 206
Couette flow, 363
Couple stress tensor, 205
Coupled
fluid flow, 381
partial differential equation, 293
Contravariant, 21, 43, 59
derivative, 248
Covariant, 21, 43, 45, 59
Creep
compliance, 396, 398, 400, 401, 403, 406–408, 410, 413, 415, 420–422
response, 391, 396–401, 404, 406, 407
test, 390,
Creeping flows, 367
Cross product, 14, 19, 25, 27, 37, 47, 54, 59
Curl of vector, 47, 50–53, 60, 119, 125
Curl theorem, 52
Curvilinear coordinate, 41, 266, 358
Cylindrical coordinate, 51, 201, 266

Dashpot constant, 390
Deformable body, 89
Deformation, 82, 89
gradient, 89, 91, 224
mapping, 83
tensor, 244, 355

Deformed
area, 154
configuration, 82–85, 96–100
Del operator, 45–52, 60, 184
Density, 1, 81, 152, 186, 191, 201
Determinant, 36
Determinism, 223
Deviatoric, 342
components, 410
stress tensor, 160
tensor, 67
Diagonal elements, 31
Diagonal matrix, 31, 64
Dielectric material, 254
Differential
models, 248
operator, 46
Dilatant, 246
Dimensionality, 223
Dirac delta function, 391
Direction cosines, 30, 295
Directional derivative, 45
Dirichlet boundary condition, 318
Discrete systems, 334
Displacement, 285
boundary value problem, 271
field, 88
function, 252
Divergence
of vector, 47
theorem, 52, 286
Dot product, 12
Double-dot product, 12, 47, 54, 72, 208
Dual basis, 20
Dual principles, 316
Dummy index, 24
Dyadic, 53
Dyads, 53
Dynamic response, 390

Eigenvalues, 62–71, 100
Eigenvectors, 62–71, 109, 134
Elastic
bar, 287
beam, 413
compliance, 240, 256
material, 226
solid, 224, 228, 245, 285
spring, 286
strain energy, 207
viscoelastic analogies, 415
Elasticity, 181
Electric
current density, 377
displacement, 258
field intensity, 253
flux, 253
Electrical conductivity, 377
Electroelasticity, 257
Electromagnetics, 253
End spring, 327
Energetically conjugate, 219
Energy equation, 5, 207–210, 224, 255, 356, 370, 373
Energy transport, 252
Engineering constants, 234
Engineering notation, 230
Engineering shear strains, 112
Engineering solution, 303
Enthalpy function, 258
Entropy
density, 256
flux, 211
inequality, 210–212, 224
principle, 213
supply, 211
Equation of state, 355
Equations of motion, 197, 201, 267, 356
Equilibrium equations, 151, 169, 173, 179, 267, 270, 300
Equipresence, 222
Essential boundary condition, 318
Euclidean, 44
Euler equations, 328, 352, 370
Euler strain tensor, 103, 104, 139
Euler–Bernoulli beam theory, 124, 279–283, 316, 328, 340
Euler–Bernoulli hypothesis, 279
Eulerian description, 83, 88, 243
Eulerian strain tensor, 134
Euler–Lagrange equations, 316, 336, 339
Exact solution, 274, 311, 322, 337, 340, 346, 347, 349, 369
Extra-stress tensor, 245, 248
Extremum, 335

Fading memory, 223
Faraday's law, 254
Ferromagnetic, 255
Fiber-reinforced layer, 158
Fick's law, 256
Filament-wound, 239
Film conductance, 252, 375

Finger tensor, 99, 251
Finite strains, 125
First law of thermodynamics, 5, 206
First Piola–Kirchhoff stress tensor, 164
First variation, 315
First-order tensor, 56
Fixed material volume, 84
Fixed time, 334
Flexural rigidity, 287
Fluid mechanics, 221, 355
Four-element solid, 404
Fourier's (heat conduction) law, 225, 228, 251, 252, 256, 259
Fourth-order
  elasticity tensor, 319
  tensor, 229
Frame indifference, 130, 139, 222–224, 243
Frame of reference, 131, 139, 222, 224
  nonrotating, 83, 131
  rotating, 131,
Free index, 24
Functional, 314, 326, 336
  constitutive, 223, 224, 243, 247, 254
  minimum of a, 315
  potential energy, 316, 317, 319, 320, 327, 328, 351, 352
  quadratic, 327, 329, 351
  strain energy, 207, 219, 238, 241, 257, 261, 286

Gauss' law, 254
Gâuteax derivative, 315
Generalized
  Hooke's Law, 228, 316, 319
  displacement, 322
  Kelvin–Voigt model, 401
  Maxwell model, 399
  Newtonian fluids, 245
Geometric multiplicity, 70
Gibb's free-energy potential, 258
Global form, 191
Gradient, 45, 52, 152
  theorem, 53
  vector, 53,59
Gram–Schmidt orthonormalization, 22, 74
Gravitational
  acceleration, 371
  force, 338, 361
Green strain tensor, 100, 107–109, 112, 115, 116, 119, 125, 128, 129, 131, 136, 138, 142–146, 219, 224, 242, 261, 343
Green-elastic material, 226
Green–Lagrange strain tensor, see Green strain tensor
Green–St. Venant strain tensor, 100

Hamilton's principle, 314, 334, 335, 338
Heat
  conduction, 6, 208, 251, 356, 374
  convection, 6, 251, 252, 374, 375, 382, 387
  radiation, 208, 251–253
  transfer, see Heat Transfer
Heat supply, 210
Heat transfer, 3, 6, 251–258, 333, 355–366, 371, 373–381, 386
  coupled with fluid flow, 381
Helmholtz free energy, 211, 224, 226, 256
Hereditary integrals, 407–413
Hermite cubic polynomial, 324
Herschel–Buckley, 247
Heterogeneous, 222
Homogeneous
  deformation, 93, 135, 139
  form, 284, 319, 328–330, 404
  , material, 222, 224, 281, 346
  motion, 93
  processes, 210
  stretch, 141
Hookean solids, 228–239
  neo–, 241
Hooke's law, 5, 228, 241, 265, 290, 316, 319, 389
Hydrostatic
  pressure, 227, 355, 360
  stress tensor, 160, 177, 261
Hygrothermal, 256
Hyperelastic material, 226, 227, 241
Hysteretic, 255

Ideal cross-linked polymer, 403
Ideal fluid, 243
Identity matrix, 31
Impact response, 405
Incompressible, 244
  elastic, 227
  fluids, 357, 367, 373
  material, 241
Indeterminate beam, 283

Inelastic, 245
Inextensibility, 279
Infinitesimal
rotation tensor, 111
rotation vector, 114
strain tensor, 111, 116
Initial values, 391
Inner product, 12
In-plane distortion, 308
Integral
identities, 185
model, 250
transform methods, 273
Integration-by-parts, 318
Internal combustion engine, 381
Internal
dissipation, 210
energy, 207, 211, 223, 371, 373
entropy production, 210
heat generation, 375
Interpolation functions, 322
Invariant form, 53, 130
Invariants, 56, 157
of strain, 109
Inverse of matrix, 36
Inverse method, 272
Inviscid fluid, 360
Irreversible
heat energy, 211
process, 207, 210
Irrotational motion, 263
Isentropic, 210
Isochoric, 189
Isochoric deformation, 93
Isothermal conditions, 243
Isotropic, 222, 237, 268, 293
Isotropic tensor, 59

Jacobian, 42, 93, 128, 165
Jacobian of motion, 90
Jaumann derivative, 249
Jet of air, 216
Jet of fluid, 194
Johnson–Segalman model, 249
Joule heating, 255

Kaye–BKZ fluid, 251
Kelvin–Voigt model, 390, 400
Kenel of the transformation, 392
Kinematic linearization, 234
Kinematics, 82
Kinetic, 4
energy, 207, 273, 334–338
energy coefficient, 371
equation of state, 356
variables, 221
Kronecker delta, 25, 73

Lagrange
equation of motion, 336
multiplier, 227
Lagrangian
function, 335
description, 83, 88, 228, 265
strain tensor, 134
stress tensor, 164
Lamé constants, 237, 268
Lamé–Navier equations, 270
Laplace equation, 379
Laplace transform, 392–398, 403–405, 415
Left Cauchy stretch tensor, 132
Leibnitz rule, 185
Level surface, 46
Linear, 268
differential equation, 392
form, 326
momentum, 169, 193, 198, 205
Linearized elasticity, 228, 265, 269
Linearly dependent, 11, 37, 62
Linearly independent, 12, 20, 22, 63, 70, 225, 328
Local
action, 223
form, 191
rate of change, 182
Lodge rubber-like, 251
Lorentz force, 255
Lower-convected, 248
Lubricant, 368

Magnetic field intensity, 253, 255
Magnetic flux, 255
Magnetic materials, 255
Mapping, 83, 88, 93
Mass diffusivity, 256
Mass flow, 189
Material
coordinate, 82, 86, 90, 112, 182, 209, 228
derivative, 86,183,193
description, 83,199, 209, 213
frame indifference, 130, 222, 223

linearization, 234
objectivity, 125, 129, 130
plane of symmetry, 231
symmetry, 222
time derivative, 182, 188, 357
Matrix, 31
addition, 32
adjoint, 38
inverse, 36, 38, 80, 92, 105
minor, 38
multiplication, 32
orthogonal, 39, 40, 58, 75, 129, 134
singular, 38
transpose, 33, 35, 58
Maximum shear stress, 162
Maxwell, 248
element, 397
fluids, 249
model, 390
Maxwell's
equations, 253
reciprocity relation, 236
reciprocity theorem, 291
Mean molecular mass, 243
Mechanical pressure, 243
Mechanics of
fluids, 221
particles, 207
solids, 123
Memory, 389
Memory effects, 245
Method of potentials, 273
Metric tensor, 43
Michell's equations, 271
Minimum
shear stress, 163
total potential energy, 316
Mixed
boundary value problems, 272
components, 59
principles, 316
Moisture-induced strain, 257
Moment, 13, 203, 206
Momentum transport, 252
Monoclinic material, 232, 238
Monopolar continuum mechanics, 203
Mooney–Rivlin, 241
Multiplication of vector by scalar, 11
Multipolar continuum mechanics, 205

Nanson formula, 142
Natural boundary conditions, 316, 318
Navier equations, 262, 269, 319, 341
Navier–Stokes equations, 263, 357, 362
Necessary condition, 315
Neo–Hookean, 241
Neumann boundary condition, 318
Newtonian
fluid, 228, 242, 356
constitutive equation, 244
Newton's
law of cooling, 252
law of viscosity, 242
second law, 193
second law of moments, 169
Nominal stress tensor, 164
Noncircular, 308
Nonconservative, 337
Nondissipative, 389
Non-Euclidean, 44
Nonhomogeneous
deformation, 95, 96, 136, 139
process, 210
Nonion, 54
Nonisothermal, 246
Nonlinear
deformation tensor, 250
elastic, 241
Non-Newtonian viscosities, 246
Normal derivative, 48
Normal stress, 155, 160, 228, 233
Normed vector space, 10
Null vector, 10
Nozzle, 194
Numerical solutions, 272

Objectivity, 130, 225
of Cauchy stress tensor, 171
of Deformation gradient tensor, 130, 138
of Green strain tensor, 131
of Piola–Kirchhoff stress tensors, 172
of stretch tensors, 138
Observer transformations, 129
Oldroyd fluid, 248
One-dimensional, 278, 370
Orthogonal, 13, 39, 64, 90
coordinate system, 30, 51
matrix, 3, 129
projection, 13
tensor, 57, 127, 132
Orthogonal rotation matrix, 226
Orthogonality condition, 366
Orthonormal, 21

basis, 21–23, 26, 30, 64, 73, 74, 82, 158
coordinates, 26–29, 73
system, 21, 29
Orthotropic, 233
Outer product, 14
Outflow, 186
Out-of-plane distortion, 308

Parallel flow, 362
Parallelepiped, 16
Parallelogram law of addition, 15
Pendulum, 336
Perfect gas, 243, 362
Perimeter, 375
Permittivity, 254
Permutation symbol, 25
Perturbation methods, 273
Phan Thien–Tanner model, 249
Phenomenological approach, 389
Physical admissibility, 222
Physical components, 21
Piezoelectric
effect, 257
moduli, 257, 258
Piola–Kirchhoff stress tensor, 164–168, 172, 199, 224
Plane strain, 293
Plane stress, 293, 297
Plane elasticity, 293
Planes of material symmetry, 229
Poiseuille flow, 363
Poisson equation, 332, 379
Poisson's ratio, 234, 268
Polar decomposition, 132, 226
Polarization, 254, 257
Polymers, 245
Positive-definite, 39, 64, 238, 284, 320
Postfactor, 54
Potential energy functional, 207, 316–322, 334, 351, 352, 371
due to external loads, 339
Power-law
index, 246
model, 246
Prandtl stress function, 309, 311, 332, 333, 351, 352
Prefactor, 54
Pressure
hydrostatic, 227, 241, 245
thermodynamic,
Primal principles, 316
Primary variable, 221, 318
Principal
directions, 170
directions of strain, 109, 134
invariants, 246
planes, 160
stresses, 157, 160
stretches, 134
value, 62, 109, 170
Principle of
equipresence, 224
minimum total potential energy, 314, 316–322, 334, 351
superposition, 234, 283, 291
Principles of mechanics, 181
Prismatic bar, 276
Problem coordinates, 228
Product, 33
Projection, 12
Propellers, 371
Proper orthogonal, 39, 90, 127, 130–133, 138, 148, 173, 223, 226
Pseudo stress vector, 165
Pseudoplastic, 246
Pure dilatation, 93
Pyroelectric effect, 257

Quadratic functional, 327, 329, 351

Radiant energy, 252
Radiation, 208, 251, 252
Rate of
change, 45
deformation, 118, 122, 139, 142, 208, 224, 241, 244–246, 249
deformation gradient, 219
strain tensor, 118
Reciprocal basis, 19, 20
Rectangular
cartesian, 21
plate, 379
Reference
configuration, 265
frame, 82
Relaxation
kernel, 250
modulus, 396
response, 391
test, 390
Remnant polarization, 255
Response function, 224

Reversible, 207, 210
Reynold's tranport theorem, 186, 193
Riemannian, 44
Right Cauchy stretch tensor, 132
Right Cauchy–Green deformation tensor, 99, 224
Rigid body, 89, 114, 125, 226, 272
Ritz method, 326, 330
Rotary devices, 371
Rotation tensor, 132, 325

Saint–Venant's principle, 303
Scalar
  components, 19
  potential, 301
  product, 12
  triple product, 16
Second Piola–Kirchhoff stress tensor, 165, 209, 265
Secondary field variable, 221
Second-order tensor, 56
Semi-inverse method, 272, 309
Sense of travel, 18
Separation of variables, 366
Shear stress, 155, 235, 355
Shear thinning, 245, 246, 250
Shear viscosity, 244
Simple
  extension, 94
  fluids, 248
  shear, 94
Simply supported beam, 331, 414
Singular, 36, 38
Skew product, 14
Skew symmetric tensor, 56, 119, 211
Slider bearing, 369
Slurries, 245
Small deformations, 169
Solenoid, 114, 189
Solid circular disk, 298
Solid mechanics, 221, 272
Solution methods, 271
Spatial
  coordinates, 85
  description, 85, 197
  density, 244
Specific internal energy, 207
Specified geometric boundary condition, 329
Spectral theorem, 64
Sphere, 367
Spherical
  coordinates, 51, 184, 201, 267, 358
  pressure vessel, 273
  stress tensor, 160
Spin tensor, 118
Spring constant, 390
Sprinkler nozzle, 190
St. Venant's compatibility, 120
Saint-Venant's principle, 303–308
Standard linear solid, 404
Statically equivalent, 278, 304
Stefan–Boltzmann, 252
Stieljes integral, 409
Stiffness
  coefficients, 229
  matrix, 324
Stokes, 245, 367
Stokes's law, 337
Stokesian fluid, 263
Straight beam, 323
Strain
  Cauchy–Green, 98
  compatibility, 120
  deviatoric, 342, 410
  energy density, 227, 229, 238, 284
  Green–Lagrange, 100
  measure, 98, 140
  rate of, 118
  tensor, 90
Stream function, 359
Stress
  boundary value problems, 272
  Cauchy, 138, 151, 153, 154, 157, 164–168, 171–175, 180, 200, 212, 219, 224, 265
  deviatoric, 160, 177, 243, 248, 342, 360, 410
  dyadic, 153, 156, 161, 180
  extra, 245
  function, 125, 301, 311
  hydrostatic, 160, 177, 199, 261–263
  power, 209
  resultants, 280
  singularity, 303
  tensor, 5, 62, 151, 153, 154, 157, 164–168, 171–175, 180, 200, 212, 219, 224, 244, 257, 261, 266, 356
  trace of, 411
  vector, 4, 152
  viscous, 384
Stretch tensor, 132
Stretching of beams, 278

Subsidiary variable, 392
Sufficient condition, 315
Summation convention, 24
Superposed rigid-body motion, 125
Superposition principle, 283
Surface
  force, 197
  traction, 285
Susceptibility tensor, 255
Symmetric, 56, 211
  matrix, 33, 39
  second-order tensor, 8, 49, 59
Symmetry transformation, 232
Syringe, 190

Taylor's series, 228, 264
Temperature, 251, 355
Temperature gradient vector, 224, 225
Tensor calculus, 59
Tensor, 9, 53–61
  components, 59
  deviatoric, 67, 160, 177
  product, 53, 54
  rate of deformation, 244
  stress,
Tetrahedron, 152
Themodynamic form, 209
Thermal
  coefficients of expansion, 256
  conductivity, 251
  expansion, 228, 257
Thermodynamic
  form, 219
  pressure, 243, 355
  principles, 206
  state, 246
Thermoelastic, 224, 389
Thermoelasticity, 256
Thermoviscoelastic, 389
Thin plate, 298
Third-order tensor, 58, 257
Three-element model, 402
Timoshenko beam theory, 353
Torsion, 308–313, 350
Total potential energy, 314–316
Trace, 31, 237
  of matrix, 31
  of second-order tensor, 56
Traction vector, 155, 271
Transformation
  equations, 157
  law, 28
  matrix, 232
  of strain, 106
  of stress, 157
  of tensor, 57
  of vector, 31
Transformed current force, 166
Translation
  rigid-body, 93, 116, 123, 127, 130, 173, 223, 277, 325, 346
  vertical, 325
Transpose of
  forward gradient operator, 47
  dot product of tensors, 54
  dyad, 54
  dyadic, 53
  matrix, 33, 73
  tensor, 33, 61, 73
Transverse
  displacement, 279
  normal strain, 279
  shear strain, 279
Transversely isotropic, 261
Triadics, 58
Triclinic material, 230, 232
Triple products of vectors, 16, 37
Turbines, 371
Twist (angle of), 308, 313, 350, 437
Twist per length, 308
Two-point tensor, 90, 165

Uniform
  deformation, 91
  shear, 94
Uniformly distributed load, 290, 414
Uniqueness of solutions, 284
Unit
  impulse, 391
  normal vector, 18, 46, 48, 97, 151, 155
  step function, 391
  vector, 10, 14, 41, 46, 50
Unitary basis, 21, 42
Universal gas constant, 243, 362
Unsteady heat transfer, 378
Upper-convected, 248

Variational
  calculus, 315, 318, 321
  methods, 273, 351
  operator, 314-316, 321
  principle, 314, 316

problem, 326, 327, 342
Vector
acceleration, 182
body force, 169, 202, 263, 268, 303, 309, 384
components, 19, 31, 142, 160, 175
couple traction, 205
differential, 46
displacement, 12, 88, 91, 199, 301
electric displacement, 258
identities, 184
product, 13, 15
stress, 151–156, 164–180, 198, 204, 355
traction, 155, 173, 321
triple product, 16
velocity, 53, 87, 118, 182, 202, 354
Velocity
gradient, 118, 225, 243, 248
potential, 44, 263
Virtual
kinetic energy, 335
work, 338
Viscoelastic, 245, 247
solid, 389
stress, 250
Viscometric, 250
Viscosity, 242
Viscous
dissipation, 252
fluids, 243, 357
incompressible fluids, 244, 363
stress tensor, 245, 355
Voigt–Kelvin notation, 230
Volume change, 96, 128, 243
von Mises yield, 247
Vorticity, 359
tensor, 118–120, 146, 208, 243
vector, 119, 146, 359

Warping function, 309
Weissenberg effect, 245
White–Metzner model, 250

Yield point, 247
Young's modulus, 2, 234, 236, 411

Zero
matrix, 32
viscosity, 243
Zero-order Bessel functions, 366
Zeroth-order tensor, 56