

# Index

- $k$ -vector, 32
- Abelian group, 203
- Acceleration, 101, 103, 160, 182, 185, 363
  - angular
    - Coriolis, 124
    - inertial, 124
    - internal, 119, 124
  - apparent, 124, 182
    - internal, 124
  - centrifugal, 124
  - centripetal, 124
  - Coriolis, 124
  - Euler, 124
  - gradient, 387
    - tensor, 388
  - inertial, 124
  - true, 124
  - wave, 245
- Acceptable variability, 3, 5, 6, 168
- Adiabatic
  - boundary, 250, 271
  - compressibility, 222, 274
  - process, 233
- Affinities, 234
- Almansi–Hamel strain tensor, 96, 296
- Alternating
  - symbol, *see* Levi–Civita symbol
  - tensor, *see* Levi–Civita tensor
- Amount of shear, 94, 366
- Angle, 120
- Anisotropic
  - material, 208, 214, 296–305
  - solid, 289
- Apparent shear viscosity, 383
- Area stretch ratio, 81, 118
- Axes of stretching, 365, 366
- Axiom of continuity, 75
- Azimuthal shearing of annular wedge, 319, 335
- Balance
  - angular momentum, 154, 163, 167, 168, 183, 447
  - energy, 155, 175, 176, 179, 184, 239, 248, 447
  - entropy, 447
  - law, 149, 151, 165–167, 447, 454, 473, 474
  - linear momentum, 154, 162, 167, 447
  - mass, 153, 162, 361, 447
  - mechanical energy, 169, 174, 239, 378
- Barotropic
  - flow, 373
  - fluid, 188, 351, 379
- Barycentric velocity, 152
- Basic field, 192, 285, 342
- Basis, 14, 18, 25, 40, 59, 68, 186, 456, 461
  - Cartesian, 41, 42
  - function, 214, 252, 255
  - natural, 16, 17, 19, 20, 46, 455
    - reciprocal, 16, 19
  - new, 19, 20, 47, 458
    - reciprocal, 19
  - polynomial, 304, 330, 331
  - reciprocal, 456
- Bending
  - annular wedge, 318, 319
  - rectangular block, 317, 320
- Bernoulli’s equation, 379
- Bianchi’s identities, 54, 99
- Biaxial stress, 170
- Bivector, 39
- Body

- couple
    - apparent, 182
    - inertial, 182
  - force
    - apparent, 182
    - inertial, 182
  - load, 156
  - material, 73, 74, 103, 149, 151
- Boundary, 103
  - adiabatic, 250
  - condition, 216, 245, 250–251, 271
  - free, 250
  - ideal, 251
  - no-penetration, 103
  - no-slip, 103
  - stationary, 103
  - surface, 250
  - thermally isolated, 250
- Boundary layer
  - equations, 371
  - flow, 371
  - thermal, 371
- Bulk modulus
  - isentropic, 333
  - isothermal, 305, 332
- Bulk viscosity, 352, 357, 359, 372
- Caloric
  - compliance, 222, 259
  - stiffness, 222, 259
- Cartesian
  - coordinate system, 41–43, 45, 46, 59, 74, 122, 440, 474, 476, 478
  - decomposition, 91, 111, 116
- Cauchy’s
  - first law, 165, 167
  - lemma, 163
  - second law, 165, 168
  - stress
    - quadratic, 170
    - tensor, 169, 309, 448
  - theorem, 164
- Cauchy–Green
  - difference history tensor
    - right, 390
  - strain tensor
    - left, 92
    - relative, 110, 387
    - right, 77, 92
- Causality principle, 191–193
- Cayley–Hamilton theorem, 85–88, 140, 260, 308, 348, 485
  - generalized, 484
- Center of mass, 152
- Characteristic polynomial, 85, 86, 139, 170, 301, 360
- Chemical potential, 219, 246, 251
- Christoffel symbol, 462, 467
  - first kind, 51
  - second kind, 51, 69
- Circulation-preserving motion, 363, 369, 370
- Clausius–Clapeyron equation, 248
- Clausius–Duhem inequality, 235, 242, 271, 272, 275, 277, 284–289, 340
- Closed system, 216
- Coefficient
  - binomial, 387, 424
  - damping, 415
  - permeability, 262
  - pressure
    - isochoric, 220
  - response, 207
  - tension, 374
  - thermal expansion, 220, 222, 274, 374, 375
    - isentropic, 333
    - isothermal, 305
  - thermal stress, 305
  - thermal tension
    - isochoric, 220
    - isometric, 220
  - volume expansion, 220, 238
- Coldness function, 192, 243
- Coleman–Noll procedure, 242, 340–341
- Compression, 170, 312
- Configuration, 73
  - current, 79, 81, 82, 106, 108
  - deformed, 74, 94, 96, 201, 310
  - initial, 73, 108
  - reference, 73, 74, 79, 81, 82, 94, 96, 106, 108, 188, 192, 200–202, 204, 207, 310
    - local, 201
  - undeformed, 73

|                                               |                                                                                 |
|-----------------------------------------------|---------------------------------------------------------------------------------|
| undistorted, 208                              | Crystallographic group, 289                                                     |
| Conservation of mass, 153, 185                | Curie’s principle, 295                                                          |
| Constitutive                                  | Curl, 440                                                                       |
| equation, 192                                 | vector field, 56, 61                                                            |
| general, 195, 396                             | Current configuration, 79, 81, 82, 106, 108                                     |
| rate type, 417                                | Curvature, 451, 452                                                             |
| reduced, 208                                  | Gaussian, 464, 465                                                              |
| simple fluid, 212                             | mean, 481                                                                       |
| simple isotropic solid, 212                   | surface, 136, 150, 465, 468                                                     |
| thermodynamical, 218                          | normal, 451, 468                                                                |
| function, 194                                 | principal, 132, 468                                                             |
| simple material, 200                          | radius, 452                                                                     |
| principles, 191, 192                          | space, 42, 54                                                                   |
| quantity, 193                                 | tensor, 463                                                                     |
| relation, 8                                   | total, 464, 482                                                                 |
| theory, 8, 191, 251                           | Curvilinear coordinate system, 16, 19, 45                                       |
| Constitutively admissible process, 233        | Cylindrical polar coordinate, 46, 48, 59–62, 68, 70, 144, 317–319, 475, 477–479 |
| Contact                                       | D’Alembert motion, 363                                                          |
| couple, 156                                   | Darcy’s law, 262                                                                |
| discontinuity, 249                            | generalized, 262                                                                |
| entropy supply, 176                           | Deformation, 5, 74, 76                                                          |
| force, 156                                    | function, 74                                                                    |
| heat supply, 174                              | gradient tensor, 76, 82, 83                                                     |
| load, 156                                     | dilatational part, 82                                                           |
| Continuum, 3                                  | isochoric part, 82                                                              |
| mechanics, 2, 74                              | relative, 108                                                                   |
| Contravariant components, 18                  | homogeneous, 78, 310                                                            |
| Controllable solution, 207                    | line element, 77                                                                |
| Convected                                     | relative, 106                                                                   |
| entropy flux, 288                             | rigid, 140, 158                                                                 |
| heat flux, 288                                | surface element, 80                                                             |
| rate, 128                                     | volume element, 82                                                              |
| stress tensor, 288                            | Derivative, 42                                                                  |
| tensor, 142, 210                              | absolute, 449                                                                   |
| time derivative, 128                          | convected, 128                                                                  |
| Coordinates, 16                               | corotational, 128                                                               |
| anholonomic, 450                              | covariant, 52, 53                                                               |
| holonomic, 450                                | surface, 466                                                                    |
| Cotter–Rivlin tensor, 128, 130, 388, 418, 425 | Fréchet, 44, 407                                                                |
| Couette flow, 383, 429                        | Gateaux, 44                                                                     |
| Couple stress                                 | intrinsic, 449                                                                  |
| tensor, 158, 165, 180                         | Jaumann, 128, 160, 419, 425                                                     |
| vector, 157, 161                              | material, 102, 131, 134, 136                                                    |
| Covariant components, 18                      | Determinant, 14–16, 440                                                         |
| Creeping flow, 371                            |                                                                                 |
| Cross product, 16, 28, 31, 40, 41, 440        |                                                                                 |
| Crystal symmetry, 289, 295, 327–329           |                                                                                 |

- Deviatoric
  - component, 35, 67, 87, 120
  - stress, 172
- Die swell effect, 384
- Differential geometry, 449
- Dilatant fluid, 384
- Dilatation, 82, 312, 365
- Dilatational
  - motion, 365
  - viscosity, 276, 351
- Direction
  - cosine, 20, 41, 78, 171, 173, 301
  - principal, 90, 92, 169
  - vector, 57, 77
- Discontinuous
  - curve, 63
  - point, 63, 132
  - surface, 63, 150, 244, 473
- Dislocation, 98, 244
- Dispersion relation, 301, 302, 360
- Displacement
  - gradient tensor
    - material configuration, 97
    - spatial configuration, 97
  - vector, 96, 97, 100, 299, 300
- Dissipation, 234
- Dissipation inequality, *see* Clausius–Duhem inequality, Residual entropy inequality
- Dissipative
  - power
    - total, 240
  - stress, 341, 347, 398
- Distance, 120, 125, 158
- Divergence, 440
  - dyadic tensor, 62
  - surface, 465
  - theorem, 63
    - generalized, 64, 150
    - surface, 471
  - vector field, 55, 60
- Double vector, 76, 126
- Doubly superposed viscometric flow, 393
- Dual
  - multivector, 41
  - tensor, 37
- Dummy index, 18
- Dyadic product, *see* Tensor product
- Dynamic nonequilibrium chemical potential, 246
- Dynamical system, 116
- Dynamics, 4
- Ehrenfest classification, 247, 259
- Eigenvalue, 85, 86
  - problem, 85, 86, 170
- Eigenvector, 86
- Einstein convention, 18
- Elastic
  - compliance tensor
    - isentropic, 219, 225, 259
    - isothermal, 220, 225, 259
  - hydrostatic pressure, 241
  - potential function, 240
  - properties, 331
  - stiffness tensor, 298, 330, 331
    - isentropic, 218, 259
    - isothermal, 220, 259
- Elasticity, 8
  - linear, 8
  - nonlinear, 8
  - tensor, 299
- Electrical work, 2
- Elongational flow, 385, 393, 416
- Empirical
  - inequality, 316
  - temperature, 192, 243
- Enstrophy, 115
- Enthalpy, 247
  - minimum principle, 238
  - potential, 227, 229, 259
- Entropy, 155, 259
  - flux, 178
    - hypothesis, 176
  - inequality, 156, 178, 180, 194
  - maximum principle, 236
  - production, 156, 176, 181, 236, 242, 246, 247, 249, 250
- Equation of state, 219, 380
  - caloric, 220, 357
  - thermal, 220, 357, 373, 374
- Equilibrium
  - chemical potential, 251
  - Gibbs free energy, 251
  - jump conditions, 251
  - process, 239

|                                          |                                       |
|------------------------------------------|---------------------------------------|
| state, 217, 235, 288                     | law of heat conduction, 349           |
| thermodynamics, 7, 235                   | Fourier–Stokes heat flux theorem, 176 |
| Eshelby energy-momentum tensor, 246      | Frame                                 |
| Euclidean                                | angular velocity, 123, 182            |
| frame, 181, 183                          | indifference, 120, 125                |
| space, 16, 41, 54, 99                    | principle, 191                        |
| transformation, 121, 127, 183, 194       | inertial, 125, 182                    |
| Euler’s                                  | invariance, 20                        |
| equation, 221                            | scalar, 20                            |
| equation of motion, 154, 158, 351,       | tensor, 22, 120                       |
| 352, 372                                 | vector, 20, 21                        |
| theorem, 221                             | reference, 120                        |
| Euler–Fourier equations, 349             | spin rate, 182                        |
| Euler–Piola–Jacobi identities, 84        | Free                                  |
| Eulerian description, 101                | body, 156                             |
| Event, 120                               | boundary, 250                         |
| Eversion of sector of spherical shell,   | energy, 227                           |
| 319                                      | index, 19                             |
| Extension of annular wedge, 318, 319     | Free-slip, 249                        |
| Extensional flow, 393                    | Frenet–Serret formulas, 453           |
| Extensive property, 216                  | Friction, 246                         |
| Exterior product, 39                     | Fumi method of direct inspection, 291 |
| External load, 156                       | Fundamental form of surface           |
| Extra stress, 316, 398                   | first, 457                            |
| Field tensor, 41, 199                    | second, 463, 467                      |
| Finite linear viscoelastic material, 411 | third, 463                            |
| Finite strain tensor                     | Fundamental relation, 217, 221, 226,  |
| current configuration, 96, 97            | 227, 234, 235, 263, 276, 278,         |
| material configuration, 96, 97           | 280, 357, 487, 488                    |
| First fundamental tensor of surface,     | Galilean transformation, 125, 127     |
| 457                                      | Gauss equation, 464                   |
| Flat space, 54                           | Gauss–Green theorem, 62, 471          |
| Flow                                     | Gaussian curvature, 464, 465          |
| barotropic, 373                          | General relativity, 13, 125, 449      |
| boundary layer, 371                      | Generalized                           |
| creeping, 371                            | Cayley–Hamilton theorem, 484          |
| perturbed, 371                           | convection vector, 368                |
| Fluid, 9, 208, 339                       | Darcy’s law, 262                      |
| crystal, 208                             | divergence theorem, 64, 150           |
| ideal, 9, 187, 188, 360, 372, 377        | Gauss–Green theorem, 62               |
| incompressible, 373                      | Kronecker delta symbol, 33, 439       |
| Newtonian, 10, 352, 372                  | Leibniz rule, 133                     |
| piezotropic, 373                         | Reynolds transport theorem, 138,      |
| rate type, 418                           | 150                                   |
| Stokesian, 372                           | shear modulus, 313                    |
| Force, 156                               | Stokes theorem, 65, 135               |
| Fourier’s                                | surface                               |
| inequality, 288                          | divergence theorem, 150, 471          |

- transport theorem, 150
- Generating transformation, 290
- Genuine scalar, 57
- Gibbs
  - equation, 219, 288
  - free energy minimum principle, 238
  - potential, 227, 259
- Gibbs–Duhem equation, 221, 226
- Grüneisen
  - parameter, 306
  - tensor, 229, 259
- Gradient, 440
  - operator, 45
  - scalar field, 49, 60
  - surface, 458, 465
  - vector field, 50, 51, 60
- Green–St. Venant strain tensor, 96
- Heat, 2
  - conduction, 289
  - inequality, 340
  - energy, 155
  - flux, 176
    - hypothesis, 175
    - theorem, 176
  - increment, 222
- Helmholtz
  - free energy, 235
  - minimum principle, 238
  - potential, 227, 259
- Helmholtz–Zorawski criterion, 363, 370
- Hemitropic
  - function, 214
  - material, 208
- History tensor, 390
- Hodge dual, 37
- Homochoric motion, 154
- Homogeneous
  - deformation, 78, 310
  - function, 221
  - material, 197, 202, 284
  - motion, 102, 360
  - simple material, 198
  - strain, 315
- Hooke’s law, 8
- Hydrostatic stress, 165, 241, 314, 352
- Hydrostatics, 362
- Hygrosteric materials, 418
- Hyperelastic material, 261, 289
- Hypo-elastic material, 289, 406, 419
- Ideal
  - boundary, 243, 247, 251
  - fluid, 9, 187, 188, 360, 372, 377
  - gas, 280, 347, 372, 379, 380
- Improper
  - orthogonal
    - matrix, 15, 88
    - transformation, 88
- Incompressible
  - deformation, 313, 314, 316, 355
  - fluid, 9, 262, 352, 357, 373–375, 383, 384, 398, 399, 411, 413
  - material, 261, 316, 317
  - motion, 137, 355
- Inertial frame, 125, 182
- Infinitesimal
  - right stretch tensor, 98
  - rotation tensor, 98
  - strain tensor
    - material configuration, 97
    - spatial configuration, 97
- Inflation
  - annular wedge, 318, 319
  - sector of spherical shell, 319
- Initial configuration, 73
- Inner product, *see* Scalar product
- Intensive property, 216
- Internal
  - angular acceleration, 119
    - apparent, 124
    - inertial, 124
  - angular velocity, 119, 152
    - apparent, 123
    - gradient, 119
  - energy, 2, 154, 259
    - balance, 179
    - minimum principle, 236
  - inertia tensor, 152, 180
  - load, 156
  - spin, 152
    - apparent rate, 181, 182
    - inertial, 181
    - production, 169
    - tensor, 153
- Invariant, *see* Scalar invariant, Principal invariant
- Inviscid fluid, 351

- contact surface, 249
- Irreducible invariant subspace, 36
- Irrotational motion, 115, 145, 366
- Isentropic path, 232
- Isochoric
  - deformation, 75
  - irrotational motion, 367
  - motion, 104, 114, 137, 154, 365
  - pressure coefficient, 374
  - thermal tension, 259
- Isolated system, 216
- Isometric thermal tension coefficient, 220
- Isopiestic thermal expansion tensor, 219
- Isothermal
  - compressibility, 220, 274, 374
  - path, 232
- Isotropic
  - function, 214
  - invariant, 214
  - material, 208
  - solid, 212
  - tensor, 26, 442, 446
- Jump, 133, 138
  - condition, 151, 244
    - angular momentum, 168
    - characterization, 245
    - energy, 179, 180
    - entropy, 181
    - equilibrium, 251
    - linear momentum, 167
    - mass, 166
  - operator, 64
- Kelvin effect, 314
- Kelvin–Voigt model, 9
- Kinematic vorticity number, 145, 363
- Kinematics, 4, 73
- Kinetic energy, 153
  - internal rotational, 153
  - translational, 153
- Kronecker delta symbol, 15, 16, 26, 439
  - generalized, 33, 439
- Lagrange multiplier, 242
- Lagrange’s equation, 368
- Lagrangian
  - coordinate, 74
  - description, 101
- Lamé’s
  - constants
    - isothermal, 305
    - stress ellipsoid, 172
- Lamb
  - surfaces, 369
  - vector, 368
- Lamellar
  - acceleration, 371
  - field, 366
- Laplacian
  - gradient field, 56
  - scalar field, 61
- Latent heat, 248
- Lattice
  - angle, 289
  - base-centered, 289
  - body-centered, 289
  - Bravais, 289
  - face-centered, 289
  - parameter, 289
  - primitive, 289
  - variation, 289
- Legendre transformation, 226, 487
- Leibniz rule, 132
  - generalized, 133
- Length stretch ratio, 78, 118
- Levi–Civita
  - symbol, 16, 439
    - generalized, 32, 439
    - two-dimensional, 456
  - tensor, 26, 57
    - absolute, 28
    - generalized, 32
    - surface, 457
- Lie time derivative, 130
- Lineal motion, 361
- Linear
  - deformation, 296, 305
  - momentum, 152
- Linear liquid, 375
- Local
  - reference configuration, 201
  - relative stretch rate
    - area, 118
    - tangent, 117

- volume, 118
- Müller–Liu procedure, 242, 342–347
- Mainardi–Codazzi equation, 464, 482
- Mass, 3, 151
  - conservation equation, 165
  - density, 3, 151
  - total, 152
- Material
  - anisotropy, 197
  - class, 206
  - coordinate, 73
  - deformation gradient, 76
  - derivative
    - line integral, 131
    - surface integral, 134
    - volume integral, 136
  - description, 101
  - descriptor, 197
  - displacement gradient, 97
  - frame indifference, 194
  - inhomogeneity, 197
  - micromorphic, 169
  - micropolar, 169
  - microstretch, 169
  - particle, 73
  - point, 73, 74
  - singular surface, 248
  - smoothness principle, 191
  - stress power, 448
  - surface, 103
  - symmetry, 199
    - group, 204
    - principle, 192
    - transformation, 202
  - tube, 371
- Matrix, 14
  - column, 15
  - determinant, 15, 19
  - groups, 204
  - identity, 15
  - improper orthogonal, 15
  - inverse, 15
  - proper orthogonal, 15
  - row, 15
  - skew-symmetric, 15
  - symmetric, 15
  - transpose, 14
- Maximum shear stress, 172
- Maxwell
  - model, 9
  - relation, 225, 228, 230, 231
- Mean
  - shear stress, 246
  - stress, 172
  - surface curvature, 465, 468
  - value theorem, 161, 175, 177
- Mechanical
  - dissipation inequality, 341
  - energy, 169
  - pressure, 180, 350
  - strain tensor, 297
  - work, 2
- Mechanically admissible process, 233
- Mechanics, 4
  - Newtonian, 4
  - quantum, 4
  - relativistic, 4
    - quantum, 4
- Memory
  - influence function, 406
  - principle, 191
- Method of direct inspection, 291, 332
- Metric tensor, 22, 47, 48
- Mohr’s circles, 173
- Mole number density, 217
- Moment, 156
  - center, 153
  - momentum, 153
- Mooney–Rivlin, 334
  - material, 316, 334
- Motion, 100
  - circulation-preserving, 370
  - complex-lamellar, 367, 369
  - complex-screw, 368
  - constant stretch history, 390, 399
  - D’Alembert, 363
  - dilatational, 365
  - homogeneous, 360
  - irrotational, 366
  - isochoric, 365
  - lineal, 361
  - plane, 361
  - pseudo-lineal
    - first kind, 361
    - second kind, 361
  - pseudo-plane

- first kind, 362
  - second kind, 362
- rigid, 365
- rotationally symmetric, 362
- screw, 368
- shearing, 366
- steady, 362
  - with steady density, 362
  - with steady stream lines, 363
  - with steady vorticity, 370
  - without acceleration, 363
- Motzkin sum numbers, 443
- Mutual load, 156
- Natural
  - base vector, 46
  - state, 284
- Navier equations, 372
- Navier–Stokes equations, 352, 372, 375
- Negative
  - definite matrix, 89
  - semi-definite matrix, 89
- Neo-Hookean material, 316, 334
- Neumann’s principle, 289, 293
- Newton’s law of motion
  - second, 154
  - third, 154, 156
- Newton–Fourier equations, 352
- Newtonian fluid, 352, 372
- No-penetration condition, 250
- No-slip condition, 250
- Noll’s rule, 204
- Non-inertial frame, 182
- Non-isotropic function, 213
- Non-Newtonian fluid, 384
- Non-simple material, 198
- Nonequilibrium
  - state, 235
  - thermodynamics, 7
- Nonhomogeneous strain, 316
- Nonlinear deformation, 304, 306
- Nonpolar material, 168, 184
- Normal
  - curvature, 468
  - plane, 453
  - stress, 164
- Object of anholonomity, 450
- Objectivity, 125
- Observer, 120
- Oldroyd tensor, 128, 141
- Onsager’s principle, 235
- Open system, 216
- Orr–Sommerfeld equations, 371
- Orthogonal
  - coordinates, 16
  - curvilinear coordinate system, 58
  - matrix, 88, 90
  - transformation, 88
- Osculating plane, 453
- Particle, 74
- Path, 100
  - line, 104
- Perfect fluid, 349
- Permutation
  - symbol, *see* Levi–Civita symbol
  - tensor, *see* Levi–Civita tensor
- Perturbation theory, 371
- Perturbed flow, 371
- Phase
  - change surface, 247
  - transition, 259
- Physical component, 60
- Piezocaloric tensor, 220
- Piezotropic fluid, 373
- Piola–Kirchhoff
  - entropy flux, 448
  - heat flux, 448
  - stress tensor, 309, 448
- Plane
  - motion, 142, 361
  - strain, 142
- Plasticity, 8
- Poiseuille flow, 427, 430
- Poisson ratio
  - isentropic, 333
  - isothermal, 305
- Polar
  - decomposition theorem, 91, 93
  - material, 119, 152, 168, 184
  - scalar, 57
  - vector, 57
- Positive
  - definite matrix, 89
  - semi-definite matrix, 89
- Potential
  - energy, 239

theory, 367  
Poynting effect, 314, 322  
Prandtl, L., 371  
Preferred state, 284  
Pressure coefficient, 220  
Principal  
  axes of stress, 170  
  direction, 90  
  invariant, 85, 90  
  scalar, 87  
  stress, 170  
  stretch, 92, 365  
    direction, 92  
  value, 90  
Principle of objectivity, 121  
Process, 155  
Projector, 67  
Propagation of sound, 357  
Proper  
  orthogonal  
    matrix, 15, 88  
    transformation, 88  
  subgroup, 203  
Property tensor, 199, 259  
Pseudo-  
  lineal motion  
    first kind, 361, 366  
    second kind, 361  
  plane motion  
    first kind, 362  
    second kind, 362  
  scalar, 57  
  tensor, 26  
  vector, 57  
Pseudoplastic fluid, 384  
Pull-back operation, 129  
Push-forward operation, 129  
  
Quadric surface, 29, 35, 170, 171  
Quasi-equilibrium process, 239  
Quasi-static process, 239  
  
Radón–Nikodym theorem, 150  
Radius  
  curvature, 452  
  torsion, 453  
Rate  
  material type, 196, 418  
  rotation tensor, 111

strain tensor, 111  
Ratio of specific heats, 224, 259  
Real symmetric matrix, 88  
Reciprocal base vector, 46  
Rectifying plane, 453  
Rectilinear shearing, 366  
Reduced  
  entropy inequality, 306, 344, 346,  
    348–350  
  form, 210  
Reference  
  configuration, 73  
  coordinate, 73  
Reiner–Rivlin fluid, 350, 384  
Relative  
  angular velocity, 119  
  Cauchy–Green strain tensor  
    left, 110  
    right, 110  
  deformation, 106  
  gradient, 108  
  frame  
    rotation tensor, 123  
    spin tensor, 123  
  motion, 108, 386  
Residual  
  entropy inequality, 242, 244, 340,  
    341, 347  
  stress, 334  
Response  
  coefficient, 207  
  functional, 193  
Retarded motion, 409  
Reversible process, 233  
Reynolds transport theorem, 137, 239  
  generalized, 138, 150  
Ricci’s theorem, 56, 462, 463, 480, 481  
Riemann–Christoffel tensor, 54, 99, 449,  
  464, 482  
Riemannian space, 54  
Riesz representation theorem, 410  
Rigid  
  deformation, 140  
  motion, 114, 365  
  transformation, 121  
Rigid body  
  angular velocity, 115  
  dynamics, 38, 119, 158–161

|                                                |                                          |
|------------------------------------------------|------------------------------------------|
| Rivlin–Ericksen tensor, 387, 388               | tension, 170                             |
| Rotation tensor, 91                            | thermomechanical process, 233            |
| Rotationally symmetric motion, 362             | Skew-symmetric tensor, 30                |
| Rubber, 8                                      | Slip, 166                                |
| Rubber-like material, 316                      | condition, 250                           |
| Scalar                                         | Solid, 8, 207                            |
| axial, 57                                      | Sound speed, 360                         |
| field, 49, 70                                  | Space, 3                                 |
| function, 14, 483                              | Spatial                                  |
| invariant, 85                                  | description, 101                         |
| product, 440                                   | displacement gradient, 97                |
| tensor, 30                                     | material smoothness, 196, 198            |
| triple, 16, 17, 65                             | natural basis, 455                       |
| vector, 16, 27                                 | velocity gradient, 103, 110              |
| Screw motion, 368                              | Specific                                 |
| Second fundamental tensor of surface, 463, 467 | energy release rate, 246                 |
| Shear                                          | heat, 222                                |
| layer, 371                                     | constant pressure, 274, 374              |
| thickening fluid, 383                          | constant strain, 298                     |
| thinning fluid, 383                            | constant stress, 298                     |
| viscosity, 10, 351                             | constant thermostatic tension, 223, 259  |
| Shear modulus                                  | constant thermostatic volume, 223, 259   |
| generalized, 313                               | constant volume, 274, 374                |
| isothermal, 305                                | volume, 151, 166, 216–218, 220, 271, 341 |
| ordinary, 313                                  | Spherical                                |
| Shear-rate function, 402, 427–429              | component, 87                            |
| Shearing                                       | coordinate system, 476                   |
| annular wedge, 318                             | coordinates, 48, 59                      |
| motion, 366                                    | stress, 172                              |
| rectangular block, 317                         | stretching tensor, 145                   |
| sector of hollow circular cylinder, 318        | tensor, 87                               |
| stress, 164                                    | Spin tensor, 111, 388                    |
| Shock, 371                                     | Square root of matrix, 93                |
| surface, 245                                   | Stagnation                               |
| elastic medium, 246                            | flow, 385                                |
| inviscid fluid, 246                            | point, 104, 367, 368                     |
| wave, 245                                      | State function, 155                      |
| SI units, 225                                  | Statics, 4                               |
| Simple                                         | Stationary surface, 249                  |
| compression, 170, 312                          | Steady                                   |
| dilatation, 312                                | motion, 104, 362                         |
| extension, 311, 312                            | with steady density, 362                 |
| material, 198                                  | vorticity, 370                           |
| shear, 94, 313                                 | Stiffness tensor, 299                    |
| shear flow, 383                                | Stokes                                   |
| shearing, 145, 366                             |                                          |

|                                         |                                    |
|-----------------------------------------|------------------------------------|
| flow, 371                               | normal, 455                        |
| hypothesis, 352, 372                    | physical basis, 458, 459           |
| theorem, 63, 135, 472                   | projection tensor, 461, 465        |
| generalized, 65, 135                    | reciprocal basis, 456              |
| Stokesian fluid, 372                    | tangential Levi–Civita tensor, 457 |
| Stored energy function, 261             | tensor, 458                        |
| Straightening sector of hollow circular | traction, 156                      |
| cylinder, 318                           | transport theorem, 150             |
| Strain, 5                               | unit normal vector, 461            |
| energy, 239                             | Symmetry                           |
| function, 240, 261                      | group, 202, 214                    |
| total, 240                              | finite, 203                        |
| kinematics, 95                          | infinite, 203                      |
| tensor, 96                              | transformation, 213                |
| Streak line, 105                        | Syzygies, 443                      |
| Stream line, 104                        |                                    |
| Stress, 6                               | Tangent bundle, 116                |
| extra, 316, 398                         | Tangential tensor, 459             |
| invariant, 170                          | Temperature, 233, 234              |
| power, 169                              | absolute, 192, 241                 |
| quadric of Cauchy, 170                  | Temporal material smoothness, 196, |
| tensor, 6, 164                          | 198                                |
| vector, 6, 161                          | Tension, 170                       |
| Stretch                                 | Tensor                             |
| rectangular block, 317, 320             | absolute, 26                       |
| sector of hollow circular cylinder,     | analysis, 13                       |
| 318                                     | anti-symmetric, 32                 |
| tensor, 111, 388                        | axial, 26                          |
| left, 91                                | Cartesian, 13, 439                 |
| right, 91                               | contraction, 29                    |
| Subgroup, 203                           | contravariant components, 19, 20,  |
| Summation convention, 18                | 25                                 |
| Surface, 455                            | convected, 142, 210                |
| Christoffel symbol of second kind,      | covariant components, 19, 21, 25   |
| 467                                     | deviatoric, 35, 67                 |
| coordinate system, 455                  | dual, 37                           |
| couple, 156                             | dyadic, 19                         |
| covariant derivative, 466, 468          | field, 41, 199                     |
| divergence, 465, 468, 469               | function, 484                      |
| theorem, 150, 471                       | generator, 214                     |
| dual basis, 456                         | identity, 26                       |
| embedded in space, 45                   | isotropic, 35, 67, 483             |
| force, 156                              | material description, 75           |
| gradient, 468                           | objective, 120                     |
| integral, 81                            | order, 19                          |
| load, 156                               | orthogonal, 31                     |
| metric tensor, 456                      | polyadic, 24                       |
| natural basis, 455                      | product, 21, 29                    |
|                                         | rank, 19                           |

- relative, 26
- scalar, 19
- skew-symmetric, 32
  - completely, 32
- spatial description, 75
- spherical, 35
- symmetric, 30, 32
  - completely, 32, 67
- trace, 30
- transpose, 31
- two-point, 76, 126
- unit, 26, 67
- vector, 19
  - weighted, 26
- Tetrahedron, 161
- Thermal
  - conductivity, 351
    - tensor, 298
  - energy, 240
  - expansion
    - coefficient, 274
    - isopiestic tensor, 219, 259
    - tensor, 298
  - stiffness tensor
    - isentropic, 218, 259
  - strain tensor, 220, 259, 297
  - stress
    - coefficient, 305
    - tensor, 298
  - tension
    - isochoric, 259
- Thermally isolated boundary, 250
- Thermodynamic
  - constitutive equation, 218
  - equilibrium, 235
    - stability, 235
    - state, 288, 341, 346
  - flux, 234
  - force, 234
  - path, 232
  - potential, 217, 226
  - pressure, 218, 350
  - principle, 192
  - process, 218, 232
    - admissible, 233
    - homogeneous, 218
  - property, 259
  - state, 216, 219
- Thermodynamics, 6, 154, 216
  - first law, 174, 179
  - second law, 156, 181, 192
  - zeroth law, 192
- Thermoelastic potential, 288, 296, 297, 304, 306, 307
- Thermostatic
  - process, 239
  - temperature, 218, 259
  - tension, 218, 259
  - volume, 217, 259
- Thermostatistics, 7, 155, 174
  - first law, 241
- Third fundamental tensor of surface, 463
- Time, 3
  - lapse, 120
- Time-independent rigid transformation, 123
- Torsion, 453
  - annular wedge, 318
- Traction, 6
- Trajectory, 100
- Transport theorem, 131
- Transverse isotropy, 289, 294
- Triaxial stress, 170
- Triclinic crystal, 301
- Triply superposed viscometric flow, 393
- Trivector, 40
- True
  - acceleration, 124
  - internal
    - angular acceleration, 124
    - angular velocity, 123
    - spin rate, 181
    - velocity, 123
- Truesdell tensor, 128
- Uniaxial stretch, 310
- Unimodular
  - group, 202
  - transformation, 202
- Universal
  - relation, 207, 308, 314
  - solution, 207
- Vector, 14, 39, 440
  - axial, 41, 57, 115
  - field, 131, 134, 135, 215

- function, 42, 63, 483
  - generator, 214
  - position, 153
  - product, 16, 28
  - space, 14
- Velocity, 101
  - angular, 58, 115
  - internal, 119
  - apparent, 123
  - gradient tensor, 103, 110, 116, 391–393
  - inertial, 123
  - potential, 366
- Virtual displacement, 236
- Viscoelasticity, 9, 383
- Viscometric flow, 384, 393
- Voigt matrix, 293, 299, 305, 332
- Volume, 3
  - integral, 82
  - stretch ratio, 82, 118
- Vortex
  - sheet, 245
  - tube, 371
- Vorticity vector, 58, 115, 119, 185, 187, 188, 361, 368, 370, 380
- Wedge product, 39
- Weingarten formula, 463, 464
- Weissenberg effect, 384
- Weyl’s theory of invariant polynomials, 443
- Work, 155
  - increment, 222
- Young modulus
  - isentropic, 333
  - isothermal, 305
- Zorawski criterion, 135, 363