

References

- Abraham, R., and J.E. Marsden, [1978], *Foundations of Mechanics*, The Benjamin/Cummings Publishing Company, Reading, Mass.
- Abraham, R., J.E. Marsden, and T. Ratiu, [1983], *Manifolds, Tensor Analysis and Applications*, Addison–Wesley, Reading, Mass.
- Agah–Tehrani, A., E.H. Lee, R.L. Mallet, and E.T. Oñate, [1986], “The Theory of Elastic-Plastic Deformation at Finite Strain with Induced Anisotropy Modeled as Combined Isotropic-Kinematic Hardening,” *Metal Forming Report*, Rensselaer Polytechnic Institute, Troy, N.Y., June 1986.
- Aravas, N., [1987], “On the Numerical Integration of a Class of Pressure-Dependent Plasticity Models,” *International Journal for Numerical Methods in Engineering*, **24**, 1395–1416.
- Argyris, J.H., [1965], “Elasto-Plastic Matrix Analysis of Three Dimensional Continua,” *Journal of the Royal Aeronautical Society* **69**, 633–635.
- Argyris, J.H., and J.St. Doltsinis, [1979], “On the Large Strain Inelastic Analysis in Natural Formulation. Part I: Quasi-Static Problems,” *Computer Methods in Applied Mechanics and Engineering* **20**, 213–251.
- Argyris, J.H., and J.St. Doltsinis, [1980], “On the Large Strain Inelastic Analysis in Natural Formulation. Part II: Dynamic Problems,” *Computer Methods in Applied Mechanics and Engineering* **21**, 213–251.
- Argyris J.H., J.St. Doltsinis, W.C. Knudson, L.E. Vaz, and K.S. Willam, [1979], “Numerical Solution of Transient Nonlinear Problems,” *Computer Methods in Applied Mechanics and Engineering* **17/18**, 341–409.
- Arnold, V.I., [1978], *Mathematical Methods of Classical Mechanics*, Springer, Berlin.
- Asaro, R.J., [1979], “Geometrical Effects in the Inhomogeneous Deformation of Ductile Single Crystals,” *Acta Metallurgica* **27**, 445–453.
- Asaro, R.J., [1983], *Micromechanics of Crystals and Polycrystals*, in *Advances in Applied Mechanics*, Volume **23**, Academic Press, New York.
- Asaro, R.J., and J.R. Rice, [1977], “Strain Localization in Ductile Single Crystals,” *Journal of Mechanics and Physics of Solids* **25**, 309–338.
- Atluri, S.N., and E. Reissner, [1988], “On the Formulation of Variational Theorems Involving Volume Constraints,” in “Computational Mechanics ’88,”

- Proceedings of the International Conference on Computational Engineering Science*, Springer-Verlag, Berlin.
- Ball, J.M., [1977], "Convexity Conditions and Existence Theorems in Nonlinear Elasticity," *Archive for Rational Mechanics and Analysis* **63**, 337–403.
- Bertsekas, D.P., [1982], *Constrained Optimization and Lagrange Multiplier Methods*, Academic Press, New York.
- Budiansky, B., N.J. Dow, R.W. Peters, and R.P. Sheperd, [1951], "Experimental Studies of Polyaxial Stress-Strain Laws of Plasticity," *Proceedings of the 1st U.S. National Congress on Applied Mechanics*, ASME, New York, 503–512.
- Burrage, K., and J.C. Butcher, [1979], "Stability Criteria for Implicit Runge-Kutta Methods," *SIAM Journal of Numerical Analysis* **16** (1), 46–57.
- Burrage, K., and J.C. Butcher, [1980], "Nonlinear Stability of a General Class of Differential Equation Methods," *BIT* **20**, 185–203.
- Butcher, J.C., [1975], "A Stability Property of Implicit Runge-Kutta Methods," *BIT* **15**, 358–361.
- Carey, G, and J.T. Oden, [1983], *Finite Elements. Volume II: A Second Course*, Prentice-Hall Inc., Englewood Cliffs, N.J.
- Casey, J., and P.M. Naghdi, [1981], "On the Characterization of Strain in Plasticity" *Journal of Applied Mechanics* **48**, 285–295.
- Casey, J., and P.M. Naghdi, [1983a], "On the Nonequivalence of the Stress Space and Strain Space Formulations of Plasticity Theory," *Journal of Applied Mechanics* **50**, 350–354.
- Casey, J., and P.M. Naghdi, [1983b], "On the Use of Invariance Requirements for Intermediate Configurations Associated with the Polar Decomposition of a Deformation Gradient," *Quarterly of Applied Mathematics*, 339–342.
- Chadwick, P., [1976], *Continuum Mechanics*, John Wiley and Sons, Inc., New York.
- Chen, W.F., [1984], *Plasticity in Reinforced Concrete*, McGraw-Hill, New York.
- Chorin, A., T.J.R. Hughes, M.F. McCracken, and J.E. Marsden, [1978], "Product Formulas and Numerical Algorithms," *Communications on Pure and Applied Mathematics* **31**, 205–256.
- Christoffersen, J., and J.W. Hutchinson, [1979], "A Class of Phenomenological Theories of Plasticity," *Journal of Mechanics and Physics of Solids* **27**, 465–487.
- Christensen, R.M., [1971], *Theory of Viscoelasticity: An Introduction*, Academic Press, New York.
- Ciarlet, P., [1978], *The Finite Element Method for Elliptic Problems*, North-Holland Publishing Company, Amsterdam.
- Ciarlet, P., [1988], *Mathematical Elasticity. Volume I: Three-dimensional Elasticity*, North-Holland Publishing Company, Amsterdam.
- Coleman, B.D., and W. Noll, [1963], "The Thermodynamics of Elastic Materials with Heat Conduction and Viscosity," *Archive for Rational Mechanics and Analysis* **13**, 167–178.
- Coleman, B.D., and M. Gurtin, [1967], "Thermodynamics with Internal Variables," *Journal of Chemistry and Physics* **47**, 597–613.

- Cormeau, I.C., [1975], "Numerical Stability in Quasi-Static Elasto/Visco-plasticity," *International Journal for Numerical Methods in Engineering* **9**, 109–127.
- Dafalias, Y.F., [1984], "A Missing Link in the Formulation and Numerical Implementation of Finite Transformation Elastoplasticity," in *Constitutive Equations: Macro and Computational Aspects*, ed., K.J. Willam, ASME, New York.
- Dahlquist, G., [1963], "A Special Stability Problem for Linear Multistep Methods," *BIT* **3**, 27–43.
- Dahlquist, G., [1975], "Error Analysis of a Class of Methods of Stiff Non-linear Initial Value Problems," *Numerical Analysis, Dundee 1975*, Springer Lecture Notes in Mathematics, No. 506, 60–74.
- Dahlquist, G., [1978], "G-Stability is Equivalent to A-Stability," *BIT* **18**, 384–401.
- Dahlquist, G., and R. Jeltsch, [1979], "Generalized Disks of Contractivity and Implicit Runge–Kutta Methods," *Inst. for Numerisk Analys*, Report No. TRITA–NA–7906, Stockholm.
- Demengel, F., [1989], "Compactness Theorems for Spaces of Functions with Bounded Derivatives and Applications to Limit Analysis Problems in Plasticity," *Archive for Rational Mechanics and Analysis* **105**, No.2, pp.123–161.
- Dennis, J.E., and R.B. Schnabel, [1983], *Numerical Methods for Unconstrained Optimization*, Prentice–Hall, Inc., Englewood Cliffs, N.J.
- Desai, C.S., and H.J. Siriwardane, [1984], *Constitutive Laws for Engineering Materials, with emphasis on geologic materials*, Prentice–Hall, Englewood Cliffs, N.J.
- Dienes, J.K., [1979], "On the Analysis of Rotation and Stress Rate in Deforming Bodies," *Acta Mechanica* **32**, 217–232.
- DiMaggio, F.L., and I.S. Sandler, [1971], "Material Models for Granular Soils," *Journal of Engineering Mechanics* **97**, 935–950.
- Doherty, W.P., E.L. Wilson, and R.L. Taylor, [1969], "Stress Analysis of Axisymmetric Solids Utilizing Higher Order Quadrilateral Finite Elements," SESM Report No. 69-3, Department of Civil Engineering, University of California, Berkeley.
- Duvaut, G., and J.L. Lions, [1972], *Les Inequations en Mecanique et en Physique*, Dunod, Paris.
- Flory, R.J., [1961], "Thermodynamic Relations for Highly Elastic Materials," *Transactions of the Faraday Society*, **57**, 829–838.
- Fortin, M., and R. Glowinski, [1983], *Augmented Lagrangian Methods: Applications to the Numerical Solution of Boundary-Value Problems*, North-Holland Publishing Company, Amsterdam.
- Franca, L. P., [1989], "Algorithm to Compute the Square Root of a 3×3 Positive Definite Matrix", *Computers and Mathematics with Applications* **18**, 459–466.
- Fung, Y.C., [1965], *Foundations of Solid Mechanics*, Prentice–Hall International Series in Dynamics, Prentice–Hall, Englewood Cliffs, N.J.

- Gear, C.W., [1971], *Numerical Initial Value Problems in Ordinary Differential Equations*, Prentice–Hall, Englewood Cliffs, N.J.
- Gelfand, I.M., and S.V. Fomin, [1963], *Calculus of Variations*, Prentice–Hall, Englewood Cliffs, N.J.
- Girault, V., and P.A. Raviart, [1986], *Finite Element Methods for Navier-Stokes Equations. Theory and Algorithms*, Springer-Verlag, Berlin.
- Giroux, E.D., [1973], “HEMP User’s Manual,” Report UCRL-51079, Lawrence Livermore National Laboratory, Livermore, Calif.
- Glowinski, R., and P. Le Tallec, [1984], “Finite Element Analysis in Nonlinear Incompressible Elasticity,” in *Finite Elements, Vol V: Special Problems in Solid Mechanics*, eds., J.T. Oden and G.F. Carey, Prentice–Hall, Englewood Cliffs, N.J.
- Glowinski, R., and P. Le Tallec, [1989], *Augmented Lagrangian and Operator-splitting Methods in Nonlinear Mechanics*, Society for Industrial and Applied Mathematics, Philadelphia, Volume 9.
- Glowinski, R., [1984], *Numerical Methods for Nonlinear Variational Problems*, Springer-Verlag, New York.
- Goldstein, H., [1981], *Classical Mechanics*, 2nd ed., Addison–Wesley, Reading, Mass.
- Goudreau, G.L., and J.O. Hallquist, [1982], “Recent Developments in Large-Scale Finite Element Lagrangian Hydrocode Technology,” *Computer Methods in Applied Mechanics and Engineering* **33**, 725–757.
- Green, A.E., and P.M. Naghdi, [1965], “A General Theory of an Elastic-Plastic Continuum,” *Archive for Rational Mechanics and Analysis*, **18**, 251–281.
- Green, A.E., and P.M. Naghdi, [1966], “A Thermodynamic Development of Elastic-Plastic Continua,” *Proceedings of IUTAM Symposium*, Vienna, June 22–28, 1966.
- Green, A.E., and W. Zerna, [1960], *Theoretical Elasticity*, 2nd ed., Clarendon Press, Oxford.
- Gurtin, M.E., [1972], “The Linear Theory of Elasticity,” in *Handbuch der Physik*, Vol. VIa/2, Mechanics of Solids II, ed., C. Truesdell, Springer-Verlag, Berlin.
- Gurtin, M.E., [1981], *An Introduction to Continuum Mechanics*, Academic Press, Orlando, Fl.
- Hairer, E., S.P. Norsett, and G. Wanner, [1987], *Solving Ordinary Differential Equations I, Nonstiff Problems*, Springer-Verlag, Berlin.
- Hallquist, J.O., [1979], “NIKE 2D: An Implicit, Finite Deformation, Finite Element Code for Analyzing the Static and Dynamic Response of Two-Dimensional Solids,” Lawrence Livermore National Laboratory, Report UCRL-52678, University of California, Livermore.
- Hallquist, J.O., [1988], “DYNA 3D: An Explicit, Finite Element Code for Dynamic Analysis in Three Dimensions,” Lawrence Livermore National Laboratory, University of California, Livermore.
- Halphen, B. and Q.S. Nguyen, [1975], “Sur les Matériaux Standards Généralisés,” *Journal de Mécanique*, **14**, 39–63.

- Harrier, E., and G. Wanner, [1991], *Solving Ordinary Differential Equations II, Stiff and Differential-Algebraic Problems*, Springer-Verlag, Berlin.
- Herrmann, L.R., [1965], "Elasticity Equations for Incompressible and Nearly Incompressible Materials by a Variational Theorem," *AIAA Journal* **3** 1896-1900.
- Herrmann, L.R., and F.E. Peterson, [1968], "A Numerical Procedure for Viscoelastic Stress Analysis," in Proceedings 7th Meeting of ICRPG Mechanical Behavior Working Group, Orlando, Fl.
- Herstein, J.N., [1964], *Topics in Algebra*, Ginn and Company, Waltham, Mass.
- Hestenes, M., [1969], "Multiplier and Gradient Methods," *Journal of Optimization Theory and Applications* **4**, 303-320.
- Hill, R., [1950], *The Mathematical Theory of Plasticity*, Oxford University Press, Oxford, U.K.
- Hill, R., [1958], "A General Theory of Uniqueness and Stability in Elasto-Plastic Solids," *Journal of Mechanics and Physics of Solids* **6**, 236-249.
- Hill, R., [1966], "Generalized Constitutive Relations for Incremental Deformation of Metal Crystals by Multislip," *Journal of Mechanics and Physics of Solids* **14**, 95-102.
- Hill, R., [1978], "Aspects of Invariance in Solid Mechanics," *Advances in Applied Mechanics* **18**, 1-75.
- Hill, R., and J.R. Rice, [1972], "Constitutive Analysis of Elastic-Plastic Crystals at Arbitrary Strain," *Journal of Mechanics and Physics of Solids* **20**, 401-413.
- Hinton, E., and D.R.J. Owen, [1980], *Finite Elements in Plasticity: Theory and Practice*, Pineridge Press, Swansea, Wales.
- Hoger, A., and D.E. Carlson, [1984a], "Determination of the Stretch and Rotation in the Polar Decomposition of the Deformation Gradient," *Quarterly of Applied Mathematics* **42**, 113-117.
- Hoger, A., and D.E. Carlson, [1984b], "On the Derivative of the Square Root of a Tensor and Guo's Rate Theorems," *Journal of Elasticity* **14**, 329-336.
- Hughes, T.J.R., [1980], "Generalization of Selective Integration Procedures to Anisotropic and Nonlinear Media," *International Journal for Numerical Methods in Engineering* **15**, 1413-1418.
- Hughes, T.J.R., [1983], "Analysis of Transient Algorithms with Particular Emphasis on Stability Behavior," in *Computational Methods for Transient Analysis*, eds., T. Belytschko and T.J.R. Hughes, North-Holland Publishing Company, Amsterdam 67-155.
- Hughes, T.J.R., [1984], "Numerical Implementation of Constitutive Models: Rate-Independent Deviatoric Plasticity," in *Theoretical Foundations for Large Scale Computations of Nonlinear Material Behavior*, eds., S. Nemat-Nasser, R. Asaro, and G. Hegemier, Martinus Nijhoff Publishers, Dordrecht, The Netherlands 29-57.
- Hughes, T.J.R., [1987], *The Finite Element Method*, Prentice-Hall, Englewood Cliffs, N.J.
- Hughes, T.J.R., and K.S. Pister, [1978], "Consistent Linearization in Mechanics of Solids and Structures," *Computers and Structures* **9**, 391-397.

- Hughes, T.J.R., and F. Shakib, [1986], "Pseudo-Corner Theory: A Simple Enhancement of J_2 -Flow Theory for Applications Involving Non-Proportional Loading," *Engineering Computations* **3** (2), 116–120.
- Hughes, T.J.R., and R.L. Taylor, [1978], "Unconditionally Stable Algorithms for Quasi-Static Elasto/Viscoplastic Finite Element Analysis," *Computers and Structures* **8**, 169–173.
- Hughes, T.J.R., R.L. Taylor, and J.L. Sackman [1975], "Finite Element Formulation and Solution of Contact-Impact Problems in Continuum Mechanics—III," SESM Report No. 75-3, Department of Civil Engineering, University of California, Berkeley.
- Hughes, T.J.R., and J. Winget, [1980], "Finite Rotation Effects in Numerical Integration of Rate Constitutive Equations Arising in Large-Deformation Analysis," *International Journal for Numerical Methods in Engineering* **15**, 1862–1867.
- Hundsdorfer, W.H., [1985], *The Numerical Solution of Nonlinear Stiff Initial Value Problems: An Analysis of One Step Methods*, CWI Tract, Center for Mathematics and Computer Science, Amsterdam, The Netherlands.
- Hungerford, T.W., [1974], *Algebra*, Springer Verlag, New York.
- Iwan, D.W., and P.J. Yoder, [1983], "Computational Aspects of Strain-Space Plasticity," *Journal of Engineering Mechanics*, **109**, 231–243.
- Johnson, C., [1976a], "Existency Theorems for Plasticity Problems," *Journal de Mathematiques Pures et Appliques* **55**, 431–444.
- Johnson, C., [1976b], "On Finite Element Methods for Plasticity Problems," *Numerische Mathematik* **26**, 79–84.
- Johnson, C., [1977], "A Mixed Finite Element for Plasticity," *SIAM Journal of Numerical Analysis* **14**, 575–583.
- Johnson, C., [1978], "On Plasticity with Hardening," *Journal of Applied Mathematical Analysis* **62**, 325–336.
- Johnson, C., [1987], *Numerical Solution of Partial Differential Equations by the Finite Element Method*, Cambridge University Press, Cambridge, U.K.
- Johnson, G., and D.J. Bammann, [1984], "A Discussion of Stress Rates in Finite Deformation Problems," *International Journal of Solids and Structures* **20**, 725–737.
- Kachanov, L.M., [1974], *Fundamentals of the Theory of Plasticity*, MIR Publishers, Moscow.
- Karmanov, V., [1977], *Programmation Mathematique*, MIR Publishers, Moscow.
- Key, S.W., [1969], "A Variational Principle for Incompressible and Nearly Incompressible Anisotropic Elasticity," *International Journal of Solids Structures* **5**, 951–964.
- Key, S.W., [1974], "HONDO - A Finite Element Computer Program for the Large Deformation Response of Axisymmetric Solids," Report 74-0039, Sandia National Laboratories, Albuquerque, N.M.
- Key, S.W., C.M. Stone, and R.D. Krieg, [1981], "Dynamic Relaxation Applied to the Quasi-Static, Large Deformation, Inelastic Response of Axisymmetric

- Solids,” in *Nonlinear Finite Element Analysis in Structural Mechanics*, eds., W. Wunderlich et al., Springer, Berlin.
- Key, S.W., and R.D. Krieg, [1982], “On the Numerical Implementation of Inelastic Time Dependent and Time Independent, Finite Strain Constitutive Equations in Structural Mechanics,” *Computer Methods in Applied Mechanics and Engineering* **33**, 439–452.
- Koiter, W.T., [1953], “Stress-Strain Relations, Uniqueness and Variational Theorems for Elastic-Plastic Materials with a Singular Yield Surface,” *Quarterly of Applied Mathematics* **11**, 350–354.
- Koiter, W.T., [1960], “General Theorems for Elastic-plastic Solids,” in *Progress in Solid Mechanics* **6**, eds. I.N. Sneddon and R. Hill, North-Holland Publishing Company, Amsterdam, 167–221.
- Kratochvil, J., [1973], “On a Finite Strain Theory of Elastic-Inelastic Materials,” *Acta Mechanica* **16**, 127–142.
- Krieg, R.D., and S.W. Key, [1976], “Implementation of a Time Dependent Plasticity Theory into Structural Computer Programs,” *Constitutive Equations in Viscoplasticity: Computational and Engineering Aspects*, eds., J.A. Stricklin and K.J. Saczalski, AMD-20, ASME, New York.
- Krieg, R.D. and D.B. Krieg, [1977], “Accuracies of Numerical Solution Methods for the Elastic-Perfectly Plastic Model,” *Journal of Pressure Vessel Technology* **99**, 510–515.
- Kroner, E. and C. Teodosiu, [1972], “Lattice Defect Approach to Plasticity and Viscoplasticity,” in *Problems of Plasticity*, ed., A. Sawczuk, Noordhoff.
- Lang, S., [1983], *Real Analysis*, 2nd ed., Addison–Wesley Publishing Company, Inc., Reading, Mass.
- Lee, E.H., [1969], “Elastic-Plastic Deformations at Finite Strains,” *Journal of Applied Mechanics* **36**, 1–6.
- Lee, E.H., and D.T. Liu, [1967], “Finite Strain Elastic-Plastic Theory Particularly for Plane Wave Analysis,” *Journal of Applied Physics*, **38**, 19–27.
- Lee, R.L., P.M. Gresho, and R.L. Sani, [1979], “Smoothing Techniques for Certain Primitive Variable Solutions of the Navier-Stokes Equations,” *International Journal for Numerical Methods in Engineering* **14**, (12), 1785–1804.
- Lemaitre, J., and J.-L. Chaboche, [1990], *Mechanics of Solid Materials*, Cambridge University Press, Cambridge, U.K.
- Loret, B., and J.H. Prevost, [1986], “Accurate Numerical Solutions for Drucker-Prager Elastic-Plastic Models,” *Computer Methods in Applied Mechanics and Engineering* **54**, 259–277.
- Lubliner, J., [1972], “On the Thermodynamic Foundations of Non-Linear Solid Mechanics,” *International Journal of Non-Linear Mechanics* **7**, 237–254.
- Lubliner, J., [1973], “On the Structure of the Rate Equations of Materials with Internal Variables,” *Acta Mechanica* **17**, 109–119.
- Lubliner, J., [1984], “A Maximum-Dissipation Principle in Generalized Plasticity,” *Acta Mechanica* **52**, 225–237.
- Lubliner, J., [1986], “Normality Rules in Large-Deformation Plasticity,” *Mechanics of Materials* **5**, 29–34.

- Luenberger, D.G., [1972], *Optimization by Vector Space Methods*, John Wiley & Sons Inc., New York.
- Luenberger, D.G., [1984], *Linear and Nonlinear Programming*, Addison–Wesley Publishing Company, Reading, Mass.
- Maier, G., [1970], “A Matrix Structural Theory of Piecewise Linear Elastoplasticity with Interacting Yield Planes,” *Meccanica* **5**, 54–66.
- Maier, G., and D. Grierson, [1979], *Engineering Plasticity by Mathematical Programming*, Pergamon Press, New York.
- Malkus, D.S. and T.J.R. Hughes, [1978], “Mixed Finite Element Methods — Reduced and Selective Integration Techniques: A Unification of Concepts,” *Computer Methods in Applied Mechanics and Engineering* **15** (1), 68–81.
- Malvern, L., [1969], *An Introduction to the Mechanics of a Continuous Medium*, Prentice–Hall, Englewood Cliffs, N.J.
- Mandel, J., [1964], “Contribution Theorique a l’Etude de l’Ecoulement et des Lois de l’Ecoulement Plastique,” *Proceedings of the 11th International Congress on Applied Mechanics*, 502–509.
- Mandel, J., [1965], “Generalisation de la Theorie de la Plasticite de W.T. Koiter,” *International Journal of Solids and Structures* **1**, 273–295.
- Mandel, J., [1974], “Thermodynamics and Plasticity,” in *Foundations of Continuum Thermodynamics*, eds., J.J. Delgado et al., Macmillan, New York.
- Marcal, P.V., and I.P. King, [1967], “Elastoplastic Analysis of Two-Dimensional Stress Systems by the Finite Element Method,” *International Journal of Mechanical Science* **9**, 143–155.
- Marsden J.E. and T.J.R Hughes, [1994], *Mathematical Foundations of Elasticity*, Dover, New York.
- Matthies, H., [1978], “Problems in Plasticity and their Finite Element Approximation”, Ph.D. Thesis, Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Mass.
- Matthies, H. [1979], “Existence theorems in thermo–plasticity,” *Journal de Mecanique* **18** (4), 695–711.
- Matthies, H., and G. Strang, [1979], “The Solution of Nonlinear Finite Element Equations,” *International Journal for Numerical Methods in Engineering* **14** (11), 1613–1626.
- Matthies, H., G. Strang, and E. Christiansen, [1979], “The saddle point of a differential,” in *Energy Methods in Finite Element Analysis*, R. Glowinski, E.Y. Rodin, and O.C. Zienkiewicz, eds., John Wiley & Sons, New York.
- McMeeking, R.M., and J.R. Rice, [1975], “Finite-Element Formulations for Problems of Large Elastoplastic Deformations,” *International Journal of Solids and Structures* **11**, 601–616.
- Mehrabadi, M.M., and S. Nemat–Nasser, [1987], “Some Basic Kinematical Relations for Finite Deformations of Continua,” *Mechanics of Materials* **6**, 127–138.
- Mikhlin, S.G., [1970], *An Advanced Course of Mathematical Physics*, American Elsevier, New York.

- Moreau, J.J., [1976], "Application of Convex Analysis to the Treatment of Elastoplastic Systems," in *Applications of Methods of Functional Analysis to Problems in Mechanics*, eds., P. Germain and B. Nayroles, Springer-Verlag, Berlin.
- Moreau, J.J., [1977], "Evolution Problem Associated with a Moving Convex Set in a Hilbert Space," *Journal of Differential Equations* **26**, 347.
- Morman, K.N., [1987], "The Generalized Strain Measure with Application to Non-Homogeneous Deformations in Rubber-Like Solids," *Journal of Applied Mechanics* **53**, 726–728.
- Naghdi, P.M., [1960], "Stress-Strain Relations in Plasticity and Thermoplasticity," in Proceedings of the 2nd Symposium on Naval Structural Mechanics, Pergamon Press, London.
- Naghdi, P.M., and J.A. Trapp, [1975], "The Significance of Formulating Plasticity Theory with Reference to Loading Surfaces in Strain Space," *International Journal of Engineering Science*, **13**, 785–797.
- Nagtegaal, J.C., [1982], "On the Implementation of Inelastic Constitutive Equations with Special Reference to Large Deformation Problems," *Computer Methods in Applied Mechanics and Engineering* **33**, 469–484.
- Nagtegaal, J.C., and J.E. De Jong, [1981], "Some Computational Aspects of Elastic-Plastic Large Strain Analysis," *International Journal for Numerical Methods in Engineering*, **17**, 15–41.
- Nagtegaal, J.C., D.M. Parks, and J.R. Rice, [1974], "On Numerically Accurate Finite Element Solutions in the Fully Plastic Range," *Computer Methods in Applied Mechanics and Engineering*, **4**, 153–177.
- Nagtegaal, J.C., and F.E. Veldpaus, [1984], "On the Implementation of Finite Strain Plasticity Equations in a Numerical Model," in *Numerical Analysis of Forming Processes*, eds., J.F.T. Pittman, O.C. Zienkiewicz, R.D. Wood, and J.M. Alexander, John Wiley & Sons Ltd., Chichester, U.K.
- Nayak, G.C., and O.C. Zienkiewicz, [1972], "Elastoplastic Stress Analysis. Generalization of Various Constitutive Equations Including Stress Softening," *International Journal for Numerical Methods in Engineering* **5**, 113–135.
- Neal, B.G., [1961], "The Effect of Shear and Normal Forces on the Fully Plastic Moment of a Beam of Rectangular Cross Section," *Journal of Applied Mechanics* **28**, 269–274.
- Needleman, A., [1982], "Finite Elements for Finite Strain Plasticity Problems," *Plasticity of Metals at Finite Strains: Theory, Computation, and Experiment*, eds., E.H. Lee and R.L. Mallet, Division of Applied Mechanics, Stanford University, Stanford, California, 387–436.
- Needleman, A., and V. Tvergaard, [1984], "Finite Element Analysis of Localization Plasticity," in *Finite elements, Vol V: Special Problems in Solid Mechanics*, eds., J.T. Oden and G.F. Carey, Prentice-Hall, Englewood Cliffs, N.J.
- Nemat-Nasser, S., [1982], "On Finite Deformation Elasto-Plasticity," *International Journal of Solids Structures* **18**, 857–872.
- Nemat-Nasser, S., [1983], "On Finite Plastic Flow of Crystalline Solids and Geomaterials" *Journal of Applied Mechanics*, **50**, 1114–1126.

- Nguyen, Q.S., [1977], "On the elastic-plastic initial boundary value problem and its numerical integration," *International Journal for Numerical Methods in Engineering* **11**, 817–832.
- Oden, J.T., and G. Carey, [1983], *Finite Elements. Volume IV. Mathematical aspects*, Prentice–Hall, Englewood Cliffs, N.J.
- Oden, J.T., and J.N. Reddy, [1976], *Variational Methods for Theoretical Mechanics*, Springer-Verlag, Berlin.
- Ogden, R.W., [1982], "Elastic Deformations in Rubberlike Solids," in *Mechanics of Solids, the Rodney Hill 60th Anniversary Volume*, (eds., H.G. Hopkins and M.J. Sewell), Pergamon Press, Oxford, 499–537.
- Ogden, R.W., [1984], *Non-Linear Elastic Deformations*, Ellis Horwood Ltd., West Sussex, England.
- Ortiz, M., and J.C. Simo, [1986], "Analysis of a New Class of Integration Algorithms for Elastoplastic Constitutive Relations," *International Journal for Numerical Methods in Engineering* **23**, 353–366.
- Ortiz, M., and E.P. Popov, [1985], "Accuracy and Stability of Integration Algorithms for Elastoplastic Constitutive Equations," *International Journal for Numerical Methods in Engineering* **21**, 1561–1576.
- Ortiz, M., and J.E. Martin, [1989], "Symmetry-Preserving Return Mapping Algorithms and Incrementally Extremal Paths: A Unification of Concepts," *International Journal for Numerical Methods in Engineering* **28**, 1839–1853.
- Pazy, A., [1983], *Semigroups of Linear Operators and Applications to Partial Differential Equations*, Springer-Verlag, New York.
- Perzyna, P., [1971], "Thermodynamic Theory of Viscoplasticity," in *Advances in Applied Mechanics*, (ed., Chia-Shun Yih), Academic Press, New York, **11**, 313–354.
- Pinsky, P., M. Ortiz, and K.S. Pister, [1983], "Numerical Integration of Rate Constitutive Equations in Finite Deformation Analysis," *Computer Methods in Applied Mechanics and Engineering* **40**, 137–158.
- Pitkaranta, J., and R. Sternberg, [1984], "Error Bounds for the Approximation of the Stokes Problem Using Bilinear/Constant Elements on Irregular Quadrilateral Meshes," Report MAT-A222, Helsinki University of Technology, Institute of Mathematics, Helsinki.
- Powell, M.J.D., [1969], "A Method for Nonlinear Constraints in Minimization Problems," in *Optimization*, ed., R. Fletcher, Academic Press, London.
- Prager, W., [1956], "A New Method of Analyzing Stress and Strains in Work-Hardening Plastic Solids," *Journal of Applied Mechanics* **23**, 493–496.
- Pschenichny, B.N., and Y.M. Danilin, [1978], *Numerical Methods in Extremal Problems*, MIR Publishers, Moscow.
- Resende, L., and J.B. Martin, [1986], "Formulation of Drucker-Prager Cap Model," *Journal of Engineering Mechanics* **111**(7), 855–865.
- Rice J.R. and D.M. Tracey, [1973], "Computational Fracture Mechanics," in *Proceedings of the Symposium on Numerical Methods in Structural Mechanics*, ed., S.J. Fenves, Urbana, Illinois, Academic Press.

- Richtmyer, R.D., and K.W. Morton [1967], *Difference Methods for Initial Value Problems*, 2nd ed., Interscience, New York.
- Rolph, W.D., and K.J. Bathe, [1984], "On a Large Strain Finite-Element Formulation for Elasto-Plastic Analysis," in *Constitutive Equations, Macro and Computational Aspects*, ed., K.J. Willam, Winter Annual Meeting, 1984, ASME, New York.
- Rubinstein R., and S.N. Atluri, [1983], "Objectivity of Incremental Constitutive Relations over Finite Time Steps in Computational Finite Deformation Analyses," *Computer Methods in Applied Mechanics and Engineering* **36**, 277–290.
- Sandler, I.S., DiMaggio, F.L., and Baladi, G. Y., [1976], "Generalized CAP Model for Geological Materials," *Journal of the Geotechnical Engineering Division*, **102** (GT7), July, 683–699.
- Sandler, I.S., and D. Rubin, [1979], "An Algorithm and a Modular Subroutine for the Cap Model," *International Journal for Numerical and Analytical Methods in Geomechanics* **3**, 173–186.
- Schreyer, H.L., R.L. Kulak, and J.M. Kramer, [1979], "Accurate Numerical Solutions for Elastic-Plastic Models," *Journal of Pressure Vessel Technology*, **101**, 226–334.
- Sidoroff, F., [1974], "Un Modele Viscoelastique Non Lineaire Avec Configuration Intermediaire," *Journal de Mecanique* **13**, 679–713.
- Simo, J.C., [1986], "On the Computational Significance of the Intermediate Configuration and Hyperelastic Relations in Finite Deformation Elastoplasticity," *Mechanics of Materials* **4**, 439–451.
- Simo, J.C., [1987a], "On a Fully Three-Dimensional Finite-Strain Viscoelastic Damage Model: Formulation and Computational Aspects," *Computer Methods in Applied Mechanics and Engineering* **60**, 153–173.
- Simo, J.C., [1987b], "A J_2 -Flow Theory Exhibiting a Corner-Like Effect and Suitable for Large-Scale Computation," *Computer Methods in Applied Mechanics and Engineering* **62**, 169–194.
- Simo, J.C., [1988a], "A Framework for Finite Strain Elastoplasticity Based on Maximum Plastic Dissipation and the Multiplicative Decomposition: Part I. Continuum Formulation," *Computer Methods in Applied Mechanics and Engineering* **66**, 199–219.
- Simo, J.C., [1988b], "A Framework for Finite Strain Elastoplasticity Based on Maximum Plastic Dissipation and the Multiplicative Decomposition: Part II. Computational Aspects," *Computer Methods in Applied Mechanics and Engineering* **68**, 1–31.
- Simo, J.C., [1991], "Nonlinear Stability of the Time-Discrete Variational Problem of Evolution in Nonlinear Heat Conduction and Elastoplasticity," *Computer Methods in Applied Mechanics and Engineering* **88**, 111–131.
- Simo, J.C., and S. Govindjee, [1988], "Exact Closed-Form Solution of the Return Mapping Algorithm for Plane Stress Elasto-Viscoplasticity," *Engineering Computations* **3**, 254–258.

- Simo, J.C., and S. Govindjee, [1991], "Nonlinear B-Stability and Symmetry Preserving Return Mapping Algorithms for Plasticity and Viscoplasticity" *International Journal for Numerical Methods in Engineering* **31**, 151–176.
- Simo, J. C., K. D. Hjelmstad, and R. L. Taylor, [1984], "Numerical Formulations for Finite Deformation Problems of Beams Accounting for the Effect of Transverse Shear," *Computer Methods in Applied Mechanics and Engineering* **42**, 301–330.
- Simo, J.C., and T.J.R. Hughes, [1986], "On the Variational Foundations of Assumed Strain Methods," *Journal of Applied Mechanics* **53**, 51–54.
- Simo, J.C., and T.J.R. Hughes, [1987], "General Return Mapping Algorithms for Rate Independent Plasticity," in *Constitutive Laws for Engineering Materials*, (ed., C.S. Desai), Elsevier, N.Y.
- Simo, J.C., and J.W. Ju, [1989], "Finite Deformation Damage-Elastoplasticity: A Non-Conventional Framework," *International Journal of Computational Mechanics* **5**, 375–400.
- Simo, J.C., Ju, J. W., Pister, K. S., and Taylor, R. L., [1988], "An Assessment of the Cap Model: Consistent Return Algorithms and Rate-Dependent Extension," *Journal of Engineering Mechanics* **114**, 191–218.
- Simo, J.C., J.G. Kennedy, and S. Govindjee, [1988], "Non-Smooth Multisurface Plasticity and Viscoplasticity. Loading/Unloading Conditions and Numerical Algorithms," *International Journal for Numerical Methods in Engineering* **26**, 2161–2185.
- Simo, J.C., J.G. Kennedy, and R.L. Taylor, [1988], "Complementary Mixed Finite Element Formulations of Elastoplasticity," *Computer Methods in Applied Mechanics and Engineering* **74**, 177–206.
- Simo J.C., and J.E. Marsden, [1984], "On the Rotated Stress Tensor and the Material Version of the Doyle-Ericksen Formula," *Archive for Rational Mechanics and Analysis* **86**, 213–231.
- Simo, J.C., J.E. Marsden, and P.S. Krishnaprasad, [1988], "The Hamiltonian Structure of Elasticity. The Convective Representation of Solids, Rods and Plates," *Archive for Rational Mechanics and Analysis* **104**, 125–183.
- Simo J.C., and M. Ortiz, [1985], "A Unified Approach to Finite Deformation Elastoplasticity Based on the use of Hyperelastic Constitutive Equations," *Computer Methods in Applied Mechanics and Engineering* **49**, 221–245.
- Simo J.C., and K.S. Pister, [1984], "Remarks on Rate Constitutive Equations for Finite Deformation Problems: Computational Implications," *Computer Methods in Applied Mechanics and Engineering* **46**, 201–215.
- Simo, J.C., and L.V. Quoc, [1986], "A 3-Dimensional Finite Strain Rod Model. Part II: Geometric and Computational Aspects," *Computer Methods in Applied Mechanics and Engineering* **58**, 79–116.
- Simo J.C., and R.L. Taylor, [1985], "Consistent Tangent Operators for Rate Independent Elasto-Plasticity," *Computer Methods in Applied Mechanics and Engineering* **48**, 101–118.
- Simo, J.C. and R.L. Taylor, [1986], "Return Mapping Algorithm for Plane Stress Elastoplasticity," *International Journal for Numerical Methods in Engineering* **22**, 649–670.

- Simo, J.C., R.L. Taylor, and K.S. Pister, [1985], "Variational and Projection Methods for the Volume Constraint in Finite Deformation Elastoplasticity," *Computer Methods in Applied Mechanics and Engineering* **51**, 177–208.
- Simo, J.C., and R.L. Taylor, [1991], "Quasi-Incompressible Finite Elasticity in Principal Stretches. Continuum Basis and Numerical Algorithms," *Computer Methods in Applied Mechanics and Engineering* **85**, 273–310.
- Simo, J.C., and K. Wong, [1991], "Unconditionally Stable Algorithms for the Orthogonal Group That Exactly Preserve Energy and Momentum," *International Journal for Numerical Methods in Engineering* **31**, 19–52
- Sokolnikoff, I.S., [1956], *Mathematical Theory of Elasticity*, 2nd ed., McGraw Hill, New York.
- Stakgold, [1979], *Green's Functions and Boundary Value Problems*, John Wiley & Sons, New York.
- Strang, G., [1986], *Introduction to Applied Mathematics*, Wellesley-Cambridge Press, Wellesley, Mass.
- Strang, G., H. Matthies, and R. Temam, [1980], "Mathematical and Computational Methods in Plasticity," in *Variational Methods in the Mechanics of Solids*, ed., S. Nemat-Nasser, Pergamon Press, Oxford.
- Suquet, P., [1979], "Sur les Équations de la Plasticite," *Ann. Fac. Sciences Toulouse* **1**, 77–87.
- Suquet, P.M., [1981], "Sur les Equations de la Plasticite: Existence et Regularite des Solutions," *Journal de Mecanique* **20**, 3–39.
- Taylor, G.I., [1938], "Analysis of Plastic Strain in a Cubic Crystal," in *Stephen Timoshenko 60th Anniversary Volume*, ed., J.M. Lessels, Macmillan, New York.
- Taylor, G.I., and C.F. Elam, [1923], "Bakerian Lecture: The Distortion of an Aluminum Crystal During a Tensile Test," *Proceedings of the Royal Society of London* **A102**, 643–667.
- Taylor, G.I., and C.F. Elam, [1925], "The Plastic Extension and Fracture of Aluminum Crystals," *Proceedings of the Royal Society of London* **A108**, 28–51.
- Taylor, L.M. and E.B. Becker, [1983], "Some Computational Aspects of Large Deformation, Rate-Dependent Plasticity Problems," *Computer Methods in Applied Mechanics and Engineering* **41**, No. 3, 251–278.
- Taylor, R.L., K.S. Pister, and G.L. Goudreau, [1970], "Thermomechanical Analysis of Viscoelastic Solids," *International Journal for Numerical Methods in Engineering* **2**, 45–79.
- Taylor, R.L., K.S. Pister, and L.R. Herrmann, [1968], "On a Variational Theorem for Incompressible and Nearly-Incompressible Elasticity," *International Journal of Solids and Structures* **4**, 875–883.
- Taylor, R. L., J.C. Simo, O. C. Zienkiewicz, and A.C. Chan, [1986], "The Patch Test: A Condition for Assessing Finite Element Convergence," *International Journal for Numerical Methods in Engineering* **22**, 39–62.
- Temam, R., and G. Strang, [1980], "Functions of Bounded Deformation," *Archive for Rational Mechanics and Analysis* **75**, 7–21.

- Temam, R., [1985], *Mathematical Problems in Plasticity*, Gauthier-Villars, Paris (Translation of original 1983 French edition).
- Ting, T.T., [1985], "Determination of $C^{1/2}$, $C^{-1/2}$ and More General Isotropic Tensor Functions of C ," *Journal of Elasticity* **15**, 319–323.
- Triantafyllidis, N., A. Needleman, and V. Tvergaard, [1982], "On the Development of Shear Bands in Pure Bending," *International Journal of Solids and Structures* **18**, 121–138.
- Troutman, J.L., [1983], *Variational Calculus with Elementary Convexity*, Springer-Verlag, New York.
- Truesdell C., and W. Noll, [1965], "The Nonlinear Field Theories," *Handbuch der Physik*, Band III/3, Springer-Verlag, Berlin.
- Truesdell C., and R.A. Toupin, [1960], "The Classical Field Theories," in *Handbook der Physik*, III/1, Springer-Verlag, Berlin.
- Tsai, S.W. and E.M. Wu [1971], "A General Theory of Strength for Anisotropic Materials," *Journal of Composite Materials* **5**, 58.
- Tvergaard, V., A. Needleman, and K.K. Lo, [1981], "Flow Localization in the Plane Strain Tensile Test," *Journal of Mechanics and Physics of Solids* **29**, 115–142.
- Vainberg, M.M., [1964], *Variational Methods for the Study of Nonlinear Operators*, Holden-Day, Inc., San Francisco.
- Voce, E., [1955], "A Practical Strain Hardening Function," *Metallurgica* **51**, 219–226.
- Wanner, G., [1976], "A Short Proof of Nonlinear A-Stability," *BIT* **16**, 226–227.
- Whittaker, E.T., [1944], *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies*, Dover, New York.
- Wilkins, M.L., [1964], "Calculation of Elastic-Plastic Flow," in *Methods of Computational Physics 3*, eds., B. Alder et. al., Academic Press, New York.
- Yoder, P.J., and R.L. Whirley, [1984], "On the Numerical Implementation of Elastoplastic Models," *Journal of Applied Mechanics* **51**, (2), 283–287.
- Zaremba, S., [1903], "Sur une Forme Perfectionnée de la Théorie de la Relaxation," *Bul. Int. Acad. Sci. Cracovie* **8**, 594–616.
- Zeidler, E. [1985], *Nonlinear Functional Analysis and its Applications III: Variational Methods and Optimization*, Springer-Verlag, Berlin.
- Ziegler, H., [1959], "A Modification of Prager's Hardening Rule," *Quarterly of Applied Mathematics* **17**, 55–65.
- Zienkiewicz, O.C., and I.C. Corneau, [1974], "Viscoplasticity – Plasticity and Creep in Elastic Solids – a Unified Numerical Solution Approach," *International Journal for Numerical Methods in Engineering* **8**, 821–845.
- Zienkiewicz, O.C., [1977], *The Finite Element Method, 3rd ed.*, McGraw-Hill, London.
- Zienkiewicz, O.C., and R.L. Taylor [1989], *The Finite Element Method, 4th ed.*, McGraw-Hill, London, Vol. I.
- Zienkiewicz, O.C., R.L. Taylor, and J.M. Too, [1971], "Reduced Integration Technique in General Analysis of Plates and Shells," *International Journal for Numerical Methods in Engineering* **3**, 275–290.

Index

- A-contractive, 238, 239
- additive decomposition, 76, 269
- admissible variations, 262
- admissible velocity fields, 267
- algorithm for viscoplasticity, 66
- algorithmic tangent modulus, 52, 68, 212, 370, 371
- arc-length, 157
- associative flow rule, 8, 81, 87, 99, 309
- associative Levy-Saint Venant flow rule, 89
- associative plasticity, 115
- associativity of flow rule, 102
- assumed-strain method, 168, 176, 178
- axisymmetric billet, 324
- axisymmetric disk, 326

- B-bar method, 178, 181
- back stress, 17
- backward Euler, 33
- Biot stress, 251
- black-hole condition, 296
- boundary conditions, 22
- bulk modulus, 90, 110

- Cauchy stress tensor, 250
- Clausius–Duhem inequality, 350
- closest point projection, 41, 59, 118, 143, 151, 206
- combined isotropic/kinematic hardening, 43, 52, 90, 91
- complementary hardening potential, 103

- complementary Helmholtz free energy function, 229
- conditional stability, 53
- configuration space, 262
- consistency condition, 6, 77, 80, 204
- consistency parameters, 201
- consistent elastoplastic modulus, 145
- consistent tangent, 174
- consistent tangent modulus, 355
- constitutive equation, 73
- contractivity, 30, 64, 223, 233
- convective representation, 262, 276
- convex optimization, 39
- convex programming, 209
- convexity, 19, 20, 100, 102
- convolution, 339, 365
- Coulomb friction, 1
- creep function, 341
- current configuration, 241
- cutting plane algorithm, 148

- dead loading, 267
- deformation gradient, 241
- degree-one homogeneity, 21, 96
- deviatoric-volumetric multiplicative split, 305, 358
- Dirac delta function, 340
- discontinuous mean stress interpolation, 180
- discontinuous stress interpolation, 170
- discontinuous volume interpolation, 180
- discrete gradient operator, 171
- discrete Lagrangian, 164

- discrete plastic dissipation function, 163
- displacement field, 22, 72
- dissipation, 26, 64, 229, 349
 - function, 343
- Duvaut-Lions, 68, 110, 217

- elastic domain, 76, 200, 229, 270
- elastic predictor, 140
- elastic unloading, 78, 84
- elastic-plastic operator split, 140
- elasticity, 73
- elasticity tensor, 74
- elastoplastic tangent modulus, 12, 13, 18, 80, 96, 127, 204
- energy decay, 28
- energy estimate, 28
- energy method, 53
- energy norm, 184
- equations of motion, 251
- equilibrium response, 345
- equivalent plastic power, 12
- equivalent plastic strain, 11, 91
- equivalent plastic work, 91
- essential boundary condition, 25
- Euler parameters, 296
- Euler–Lagrange equations, 159
- Eulerian description, 246
- Eulerian strain tensor, 284, 303, 304
- evolution equation, 348, 365
- exponential map, 295
- external power, 26

- finite element solution of the IBVP, 46
- first Piola–Kirchhoff stress tensor, 250
- flow rule, 5, 59, 77, 270
- fluidity, 105
- forward Euler, 33
- frame indifference, 255
- frame invariance, 255
- free energy, 162, 343, 350
- Fréchet derivative, 156
- functional derivative, 158

- Gateaux variation, 156
- generalized displacement model, 171
- generalized hardening modulus, 229
- generalized midpoint rule, 33, 225
- generalized midpoint rule in $SO(3)$, 296
- generalized relaxation models, 343
- Green-McInnis-Naghdi stress rate, 255

- Hadamard condition, 74
- hardening law, 77, 270
- Heaviside function, 60
- Helmholtz free energy, 162, 343, 350
- Hessian, 210
- Hu–Washizu functional, 162
- Huber-von Mises yield condition, 89, 309
- Hughes-Winget algorithm, 298
- hyperelastic rate constitutive equations, 256
- hyperelasticity, 307
- hypoelasticity, 269

- incremental displacement gradient, 280
- incremental elastoplastic initial value problem, 34
- incremental loading, 49
- incremental solution procedure, 49
- incrementally objective algorithms, 276
- initial boundary value problem, 21, 23
- initial conditions, 23
- integration algorithms, 116, 351
- intermediate local configuration, 300
- internal energy, 26
- internal hardening variable, 9
- internal variables, 87, 337, 348, 365
- irreversible process, 75
- isoerror maps, 131
- isometry, 252
- isotropic function, 243, 270
- isotropic group, 259
- isotropic hardening, 9, 34, 35, 55, 62, 90, 135, 310
- isotropy, 259
- iterative solution procedure, 50

- Jaumann-Zaremba stress rate, 255
- J_2 flow theory, 89, 90, 110, 288
 - plane stress, 91

- Kelvin solid, 341
- kinematic hardening, 17, 68, 134, 310
- kinetic energy, 26
- Kirchhoff stress tensor, 250
- Kronecker delta, 347
- Kuhn–Tucker conditions, 6, 77, 99, 115, 116, 201, 207
 - discrete, 116, 208
- Kuhn-Tucker form, 271

- Lagrange multipliers, 99, 163
- Lagrangian, 99, 211
- Lagrangian description, 245
- Lagrangian strain tensor, 303
- Lamé constants, 74
- left Cauchy–Green tensor, 241
- left stretch tensor, 241
- Legendre transformation, 162
- Levy-Saint Venant flow rule, 89
- Lie algebra, 295
- Lie derivative, 254
- Lie’s formula, 139
- linearization, 122, 151, 174, 212, 355
 - consistent, 175
- loading/unloading conditions, 5, 13, 77, 102, 201, 271, 310
 - alternative form, 84

- material acceleration, 245
- material description of the motion, 245
- material points, 245
- material rate of deformation tensor, 249
- material time derivative, 247
- material velocity, 245
- material velocity gradient, 248
- Maxwell fluid, 341
- mechanical work, 26
- midpoint rule, 33
- mixed method, 182
- momentum balance, 262, 266
- multiplicative decomposition, 302
- multisurface plasticity, 199

- natural relaxation time, 62
- necking of a circular bar, 326
- neutral loading, 16, 78, 84
- nonlinear heat conduction, 220
- nonlinear stability, 226, 237
- nonlinear viscoelastic constitutive model, 364
- nonsymmetric nominal stress tensor, 250
- normality, 99
- normalized relaxation function, 349
- numerical solution of the IBVP, 31

- objective algorithm, 276, 290
- objective stress rates, 253
- objective time-stepping algorithms, 278
- objectivity, 252, 255
- operator splits, 139
- optimality conditions, 41
- orthogonal group, 295
- orthogonal projections, 179

- penalty formulation, 106
- perfect plasticity, 7, 80, 89, 98, 145
- perfect viscoplasticity, 111
- perforated strip, 185
- persistency (or consistency) condition, 6
- Perzyna, 59, 69, 216
- plane strain, 89
- plane stress, 91
- plastic corrector, 140, 141
- plastic dissipation functional, 163
- plastic loading, 78, 84, 116
- plastic strain, 75
- polar decomposition, 242
- Prandl-Reuss equations, 89
- pressure, 178
- principal directions, 242
- principal invariants, 241
- principal stretches, 242
- principle of maximum plastic dissipation, 98
- product formula, 139
- projection, 110
- projection operators, 178
- projection theorem, 111

- radial return algorithm, 317
- rate equilibrium equations, 267
- rate form, 23
- rate-independent plasticity, 75, 206

- rates, 15
- reference configuration, 241
- relative Eulerian strain tensor, 284
- relative Lagrangian strain tensor, 281
- relative left Cauchy–Green tensor, 285
- relative stress, 43
- relative time, 61
- relaxation function, 340
- relaxation test, 60, 340
- relaxation time, 150, 339
- representation theorem for isotropic functions, 261
- return mapping, 141
- return mapping algorithm, 35, 36, 44, 126, 143, 314
- rheological model, 58
- Riemannian metrics, 142
- right Cauchy–Green tensor, 241
- right stretch tensor, 241
- rotated description, 271
- rotated rate of deformation tensor, 249
- rotated representation, 277
- rotated stress tensor, 250
- rotation tensor, 241

- second law, 350
- second Piola–Kirchhoff stress tensor, 250
- semigroup property, 353
- shear modulus, 110
- single-crystal plasticity, 301
- softening, 69, 88
- space of bounded deformations, 233
- spatial acceleration, 246
- spatial description of motion, 246
- spatial discretization, 31
- spatial rate of deformation tensor, 248
- spatial velocity, 246
- spatial velocity gradient, 247, 248
- spectral decomposition, 241
- spin tensor, 248
- stability, 26
- stability analysis of the algorithmic IBVP, 53
- stability estimate, 64
- standard solid, 340
- stiffness ratio, 340
- stored energy, 73
- stored energy function, 359
- strain driven, 13, 32
- strain field, 22
- strain hardening, 9
- strain space, 8, 75, 82, 84
- strain tensor, 72, 114
- stress power, 26
- stress space, 75, 76
- stress tensor, 72, 114
- strip with a circular hole, 189
- strip with a circular notch, 190
- strong ellipticity, 74
- superposed rigid body motions, 252
- symmetric Piola–Kirchhoff stress tensor, 250

- tangent compliance, 103
- thermodynamics, 349
- thermodynamic equilibrium, 350
- thermodynamics of viscoelasticity, 349
- thick-walled cylinder, 184, 322
- time discretization, 31
- trial elastic state, 35, 43, 116, 140, 315
- trial state, 15, 16
- trial state (rates), 84
- Truesdell stress rate, 254

- unconditional stability, 53
- uniqueness, 29, 64, 88

- variational consistency, 176
- variational formulation, 262
- variational inequality, 103, 104
- velocity field, 22
- viscoelasticity, 336
- viscoplastic regularization, 62, 105, 231
- viscous stress, 338
- von Mises yield condition, 89, 309

- weak formulation, 24, 179, 232, 262, 266

- yield condition, 3, 76, 270, 309
- yield criterion, 96
- yield surface, 5, 77

- Ziegler rule, 17, 91