

References

- [1] R. Albanese, G. Rubinacci: "Integral formulations for 3-D eddy-currents computation using edge-elements", *IEEE Proc., Part A*, 135, 7 (1988), pp. 457-62.
- [2] M.A. Armstrong: *Basic Topology*, McGraw-Hill (London), 1979.
- [3] D.N. Arnold, F. Brezzi: "Mixed and non-conforming finite element methods: Implementation, postprocessing and error estimates", *M²AN*, 19, 1 (1985), pp. 7-32.
- [4] I. Babuška, A.K. Aziz: "On the angle condition in the finite element method", *SIAM. J. Numer. Anal.*, 13, 2 (1976), pp. 214-26.
- [5] J. Baez, J.P. Muniain: *Gauge fields, knots and gravity*, World Scientific (Singapore), 1994.
- [6] D. Baldomir, P. Hammond: *Geometry of Electromagnetic Systems*, Oxford U.P. (Oxford), 1996.
- [7] R.E. Bank, D.J. Rose: "Some Error Estimates for the Box Method", *SIAM J. Numer. Anal.*, 24, 4 (1987), pp. 777-87.
- [8] E. Bänsch: "Local Mesh Refinement in 2 and 3 Dimensions", *Impact of Computing Sci. Engrg.*, 3 (1991), pp. 181-91.
- [9] J. Bey: "Tetrahedral Grid Refinement", *Computing*, 55, 4 (1995), pp. 355-78.
- [10] A. Bossavit: "Eddy-currents and forces in deformable conductors", in *Mechanical Modellings of New Electromagnetic Materials* (Proc. IUTAM Symp., Stockholm, April 1990, R.K.T. Hsieh, ed.), Elsevier (Amsterdam), 1990, pp. 235-42.
- [11] A. Bossavit: "Solving Maxwell's Equations in a Closed Cavity, and the Question of Spurious Modes", *IEEE Trans., MAG-26*, 2 (1990), pp. 702-5.
- [12] A. Bossavit: *Computational Electromagnetism*, Academic Press (Boston), 1998.
- [13] A. Bossavit: "Computational electromagnetism and geometry", *J. Japan Soc. Appl. Electromagn. & Mech.*, 6 (1998), pp. 17-28, 114-23, 233-40, 318-26; 7 (1999), pp. 150-9, 294-301, 401-8; 8 (2000), pp. 102-9, 203-9, 372-7.
- [14] A. Bossavit: "On axial and polar vectors", *ICS Newsletter*, 6, 3 (1999), pp. 12-14.
- [15] A. Bossavit: "Most general 'non-local' boundary conditions for the Maxwell equations in a bounded region", *COMPEL*, 19, 2 (2000), pp. 239-45.
- [16] A. Bossavit: "'Stiff' Problems in Eddy-Current Theory and the Regularization of Maxwell's Equations", *IEEE Trans., MAG-37*, 5 (2001), pp. 3542-5.
- [17] A. Bossavit: "On the notion of anisotropy of constitutive laws: Some implications of the 'Hodge implies metric' result", *COMPEL*, 20, 1 (2001), pp. 233-9.
- [18] A. Bossavit: "On the Representation of Differential Forms by Potentials in Dimension 3", in *Scientific Computing in Electrical Engineering* (U. van Rienen, M. Günther, D. Hecht, Eds), Springer-Verlag (Berlin), 2001, pp. 97-104.
- [19] A. Bossavit, L. Kettunen: "Yee-like schemes on a tetrahedral mesh, with diagonal lumping", *Int. J. Numer. Modelling*, 12 (1999), pp. 129-42.
- [20] F.H. Branin, Jr.: "An Abstract Mathematical Basis for Network Analogies and its Significance in Physics and Engineering", *Matrix and Tensor Quarterly*, 12, 2 (1961), pp. 31-49.
- [21] W.L. Burke: *Applied Differential Geometry*, Cambridge U.P. (Cambridge), 1985.
- [22] A. Di Carlo, A. Tiero: "The Geometry of Linear Heat Conduction", in *Trends in Applications of Mathematics to Mechanics* (W. Schneider, H. Troger, F. Ziegler, Eds), Longman (Harlow), 1991, pp. 281-7.
- [23] C.J. Carpenter: "Comparison of alternative formulations of 3-dimensional magnetic-field and eddy-current problems at power frequencies", *Proc. IEE*, 124, 11 (1977), pp. 1026-34.
- [24] G. Chavent, J.E. Roberts: "A unified presentation of mixed, mixed-hybrid finite elements and standard finite difference approximations for the determination of velocities in waterflow problems", *Adv. Water Resources*, 14, 6 (1991), pp. 329-48.
- [25] M. Clemens, T. Weiland: "Transient Eddy-Current Calculation with the FI-Method", *IEEE Trans., MAG-35*, 3 (1999), pp. 1163-6.
- [26] G. Cohen, P. Joly, N. Tordjman: "Construction and analysis of higher order elements with mass-lumping for the wave equation", in *Mathematical Aspects of Wave Propagation Phenomena*, SIAM (Philadelphia), 1993, pp. 152-60.
- [27] M. Costabel, M. Dauge: "Singularités des équations de Maxwell dans un polyèdre", *C.R. Acad. Sci. Paris*, 324, I, 9 (1997), pp. 1005-10.
- [28] H.L. de Cougny, M.S. Shephard: "Parallel refinement and coarsening of tetrahedral meshes", *Int. J. Numer. Meth. Engng.*, 46, 7 (1999), pp. 1101-25.
- [29] J.L. Coulomb, F.X. Zgainski, Y. Maréchal: "A Pyramidal Element to Link Hexahedral, Prismatic and Tetrahedral Edge Finite Elements", *IEEE Trans., MAG-33*, 2 (1997), pp. 1362-5.
- [30] B. Courbet, J.P. Croisille: "Finite volume box schemes on triangular meshes", *M²AN*, 32, 5 (1998), pp. 631-49.

- [31] D. Van Dantzig: "The fundamental equations of electromagnetism, independent of metrical geometry", *Proc. Cambridge Phil. Soc.*, 30 (1934), pp. 421-7.
- [32] D. Van Dantzig: "On the geometrical representation of elementary physical objects and the relations between geometry and physics", *Nieuw. Archief vor Wiskunde*, 3, 2 (1954), pp. 73-89.
- [33] G.L. Dirichlet: "Über die Reduktion der positiven quadratischen Formen mit drei unbestimmten ganzen Zahlen", *J. Reine Angew. Math.*, 40 (1850), p. 209.
- [34] J. Dodziuk: "Finite-difference approach to the Hodge theory of harmonic forms", *Amer. J. Math.*, 98, 1 (1976), pp. 79-104.
- [35] P. Dular, J.-Y. Hody, A. Nicolet, A. Genon, W. Legros: "Mixed Finite Elements Associated with a Collection of Tetrahedra, Hexahedra and Prisms", *IEEE Trans.*, MAG-30, 5 (1994), pp. 2980-3.
- [36] F. Ebeling, R. Klatt, F. Krawczyk, E. Lawinsky, T. Weiland, S.G. Wipf, B. Steffen, T. Barts, M.J. Browman, R.K. Cooper, H. Deaven, G. Rodenz: "The 3-D MAFIA group of electromagnetic codes", *IEEE Trans.*, MAG-25 (1989), pp. 2962-4.
- [37] B. Eckmann: "Topology, Algebra, Analysis—Relations and Missing Links", *Notices AMS*, 46, 5 (1999), pp. 520-7.
- [38] A. Elmkins, P. Joly: "Éléments finis d'arête et condensation de masse pour les équations de Maxwell: le cas de dimension 3", *CRAS*, 325, Série I (1997), pp. 1217-22.
- [39] J.G. Ergatoudis, B.M. Irons, O.C. Zienkiewicz: "Curved, isoparametric, 'quadrilateral' elements for finite element analysis", *Int. J. Solids Struct.*, 4 (1968), pp. 31-42.
- [40] F.A. Firestone: "A new analogy between mechanical and electrical systems", *J. Acoust. Soc. Am.*, 4 (1933), pp. 249-67.
- [41] Th. Frankel: *The Geometry of Physics, An Introduction*, Cambridge U.P. (Cambridge), 1997.
- [42] T. Gallouet, J.P. Vila: "Finite volume element scheme for conservation laws of mixed type", *SIAM J. Numer. Anal.*, 28, 6 (1991), pp. 1548-73.
- [43] B.R. Gelbaum, J.M.H. Olmsted: *Counterexamples in Analysis*, Holden-Day (San Francisco), 1964.
- [44] A.S. Goldhaber, W.P. Trower: "Resource Letter MM-1: Magnetic monopoles", *Am. J. Phys.*, 58, 5 (1990), pp. 429-39.
- [45] V. Gradinaru, R. Hiptmair: "Whitney elements on pyramids", *ETNA*, 8 (1999), pp. 154-68.
- [46] P.R. Halmos: *Measure theory*, Van Nostrand (Princeton), 1950.
- [47] L. Hamouda, B. Bandelier, F. Rioux-Damidaou: "Mixed Formulation for Magnetostatics", in *Compumag 2001* (paper PE4-11), to appear.
- [48] Y. Haugazeau, P. Lacoste: "Condensation de la matrice masse pour les éléments finis mixtes de $H(\text{rot})$ ", *C.R. Acad. Sci. Paris*, t. 316, Série I (1993), pp. 509-12.
- [49] B. Heinrich: *Finite Difference Methods on Irregular Networks*, Akademie-Verlag (Berlin), 1987.
- [50] A. Henle: *A Combinatorial Introduction to Topology*, Dover (New York), 1994.
- [51] P.J. Hilton, S. Wylie: *Homology Theory, An Introduction to Algebraic Topology*, Cambridge U.P. (Cambridge), 1965.
- [52] R. Hiptmair: "Discrete Hodge operators", *Progress in Electromagnetics Research, PIER* 32 (2001).
- [53] Huang Jianguo, Xi Shitong: "On the finite volume element method for general self-adjoint elliptic problems", *SIAM J. Numer. Anal.*, 35, 5 (1998), pp. 1762-74.
- [54] J. M. Hyman, M. Shashkov: "Natural Discretizations for the Divergence, Gradient, and Curl on Logically Rectangular Grids", *Computers Math. Applic.*, 33, 4 (1997), pp. 81-104.
- [55] K. Jänich: *Vector Analysis*, Springer (New York), 2001.
- [56] E.F. Kaasschieter, A.J.M. Huijben: "Mixed-Hybrid Finite Elements and Streamline Computation for the Potential Flow Problem", *Numer. Meth. for PDEs*, 8 (1992), pp. 221-66.
- [57] A. Kameari: "Symmetric Second Order Edge Elements for Triangles and Tetrahedra", *IEEE Trans.*, MAG-35, 3 (1999), pp. 1394-7.
- [58] A. Kheyfets, J.A. Wheeler: "Boundary of a Boundary and Geometric Structure of Field Theories", *Int. J. Theor. Phys.*, 25, 6 (1986), pp. 573-80.
- [59] H.E. Koenig, W.A. Blackwell: "Linear Graph Theory: A Fundamental Engineering Discipline", *IRE Trans. Edu.*, E-3 (1960), pp. 42-9.
- [60] P.R. Kotiuga: *Hodge Decompositions and Computational Electromagnetics (Thesis)*, Dpt. of Electrical Engng., McGill University (Montréal), 1984.
- [61] F. Kottler: "Maxwell'sche Gleichungen und Metrik", *Sitzungber. Akad. Wien IIa*, 131 (1922), pp. 119-46.
- [62] J.-F. Lee, Z. Sacks: "Whitney Elements Time Domain (WETD) Methods", *IEEE Trans.*, MAG-31, 3 (1995), pp. 1325-9.
- [63] R. Leis: "Zur Theorie elektromagnetischer Schwingungen in anisotropen inhomogenen Medien", *Math. Z.*, 106, (1968), pp. 213-24.
- [64] I. Madsen, J. Tornehave: *From Calculus to Cohomology*, Cambridge U.P. (Cambridge), 1997.

- [65] C. Mattiussi: "The Finite Volume, Finite Element, and Finite Difference Methods as Numerical Methods for Physical Field Problems", *Advances in Imaging and Electron Physics*, 113 (2000), pp. 1-146.
- [66] J.M. Maubach: "Local bisection refinement for N -simplicial grids generated by reflection", *SIAM J. Sci. Stat.* 16, 1 (1995), pp. 210-27.
- [67] J.C. Maxwell: "On reciprocal figures and diagrams of forces", *Phil. Mag., Series 4*, 27 (1864), pp. 250-61.
- [68] R. von Mises: "On Network Methods in Conformal Mapping and in Related Problems", *US Dpt of Commerce, NBS, Appl. Math. Series*, 18 (1952), pp. 1-6.
- [69] R. Mittra, O. Ramahi, A. Khebir, R. Gordon, A. Kouki: "A review of absorbing boundary conditions for two and three-dimensional electromagnetic scattering problems", *IEEE Trans., MAG-25*, 4 (1989), pp. 3034-8.
- [70] P. Monk, E. Süli: "A convergence analysis of Yee's scheme on nonuniform grids", *SIAM J. Numer. Anal.*, 31, 2 (1994), pp. 393-412.
- [71] R. Mosé, P. Siegel, P. Ackerer, G. Chavent: "Application of the mixed hybrid finite element approximation in a groundwater flow model: Luxury or necessity?", *Water Resources Research*, 30, 11 (1994), pp. 3001-12.
- [72] W. Müller: "Analytic torsion and R -torsion of Riemannian manifolds", *Advances in Mathematics*, 28 (1978), pp. 233-305.
- [73] I. Munteanu: "Tree-Cotree Condensation Properties", *ICS Newsletter*, 9, 1 (2002), pp. 10-4.
- [74] J.C. Nédélec: "Mixed finite elements in $\mathbb{R}^3$ ", *Numer. Math.*, 35 (1980), pp. 315-41.
- [75] R. Nicolaides, D.-Q. Wang: "Convergence analysis of a covolume scheme for Maxwell's equations in three dimensions", *Math. Comp.*, 67 (1998), pp. 947-63.
- [76] E.J. Post: "The constitutive map and some of its ramifications", *Annals of Physics*, 71 (1972), pp. 497-518.
- [77] E.J. Post: "Kottler-Cartan-van Dantzig (KCD) and Noninertial Systems", *Foundations of Physics*, 9, 7/8 (1979), pp. 619-40.
- [78] E.J. Post: "The metric dependence of four-dimensional formulations of electromagnetism", *J. Math. Phys.*, 25, 3 (1984), pp. 612-3.
- [79] F. Rapetti, F. Dubois, A. Bossavit: "Discrete vector potentials for non-simply connected three-dimensional domains", to appear.
- [80] Z. Ren: "Autogauging of vector potential by iterative solver—Numerical evidence", in *3d Int. Workshop on Electric and Magnetic Fields*, A.I.M. (31 Rue St-Gilles, Liège), 1996, pp. 119-24.
- [81] Z. Ren, N. Ida: "High-order elements of complete and incomplete bases in electromagnetic field computation", *IEEE Trans., MAG-3* (to appear), 2001.
- [82] G. de Rham: "Relations entre la topologie et la théorie des intégrales multiples", *L'Enseignement Mathématique*, 35 (1936), pp. 213-28.
- [83] G. de Rham: *Variétés différentiables*, Hermann (Paris), 1960.
- [84] J. Rosen: "Transformation Properties of Electromagnetic Quantities under Space Inversion, Time Reversal, and Charge Conjugation", *Am. J. Phys.*, 41, 4 (1973), pp. 586-8.
- [85] W. Rudin: *Functional Analysis*, McGraw-Hill (New York), 1973.
- [86] A.H. Schatz, I.H. Sloan, L.B. Wahlbin: "Superconvergence in finite element methods and meshes that are locally symmetric with respect to a point", *SIAM J. Numer. Anal.*, 33, 2 (1996), pp. 505-21.
- [87] J.A. Schouten: *Tensor analysis for physicists*, Dover (New York), 1989.
- [88] B. Schutz: *Geometrical methods of mathematical physics*, Cambridge U.P. (Cambridge), 1980.
- [89] H. Seifert, W. Threlfall: *A Textbook of Topology*, Academic Press (Orlando), 1980. (First German ed., 1934.)
- [90] R. Shaw, F.J. Yeadon: "On $(a \times b) \times c$ ", *Am. Math. Monthly*, 96, 7 (1989), pp. 623-9.
- [91] P. Silvester, M.V.K. Chari: "Finite Element Solution of Saturable Magnetic Field Problems", *IEEE Trans., PAS-89*, 7 (1970), pp. 1642-51.
- [92] J.B. Smyth, D.C. Smyth: "Critique of the paper 'The Electromagnetic Radiation from a Finite Antenna'", *Am. J. Phys.*, 45, 6 (1977), pp. 581-2.
- [93] R. Sorkin: "The electromagnetic field on a simplicial net", *J. Math. Phys.*, 16, 12 (1975), pp. 2432-40.
- [94] E. Süli: "Convergence of finite volume schemes for Poisson's equation on nonuniform meshes", *SIAM J. Numer. Anal.*, 28, 5 (1991), pp. 1419-30.
- [95] A. Taflov: *Computational Electromagnetics, The Finite Difference in Time Domain Method*, Artech House (Boston, London), 1995.
- [96] E.F. Taylor, J.A. Wheeler: *Spacetime physics*, Freeman (New York), 1992.
- [97] F.L. Teixeira, W.C. Chew: "Lattice electromagnetic theory from a topological viewpoint", *J. Math. Phys.*, 40, 1 (1999), pp. 169-87.
- [98] E. Tonti: "On the Geometrical Structure of Electromagnetism", in *Gravitation, Electromagnetism and Geometrical Structures* (G. Ferrarese (ed.), Pitagora (Bologna), 1996, pp. 281-308.
- [99] E. Tonti: "A Direct Formulation of Field Laws: The Cell Method", *CMES*, 2, 2 (2001), pp. 237-58.

- [100] B. Trapp, I. Munteanu, R. Schuhmann, T. Weiland, D. Ioan: "Eigenvalue computation by means of a tree-cotree filtering technique", (to appear in *IEEE Trans.*).
- [101] M.A. Uman: "Reply to Smyth and Smyth", *Am. J. Phys.*, 45, 6 (1977), p. 582.
- [102] O. Veblen, J.H.C. Whitehead: *The foundations of differential geometry*, Cambridge, 1932.
- [103] T. Weiland: "Maxwell's Grid Equations", in *Proc. URSI Int. Symp. Electromagnetic Theory* (Sydney, Australia), 1992, pp. 37-39.
- [104] T. Weiland: "Time domain electromagnetic field computation with finite difference methods", *Int. J. Numer. Modelling*, 9 (1996), pp. 295-319.
- [105] T. Weiland: "Three Dimensional Resonator Mode Computation by Finite Difference Methods", *IEEE Trans., MAG-21*, 6 (1985), pp. 2340-3.
- [106] A. Weiser, M.F. Wheeler: "On convergence of block-centered finite differences for elliptic problems", *SIAM J. Numer. Anal.*, 25, 2 (1988), pp. 351-375.
- [107] J.S. Van Welij: "Calculation of Eddy Currents in Terms of H on Hexahedra", *IEEE Trans., MAG-21*, 6 (1985), pp. 2239-41.
- [108] D.A. White, J.M. Koning: "A Novel Approach for Computing Solenoidal Eigenmodes of the Vector Helmholtz Equation", *CEFC'00* (p. 328 of the "digest of abstracts"), to appear.
- [109] H. Whitney: *Geometric Integration Theory*, Princeton U.P. (Princeton), 1957.
- [110] Xiang You-qing, Zhou Ke-ding, Li Lang-ru: "A new network-field model for numerical analysis of electromagnetic field", in *Electromagnetic Fields in Electrical Engineering* (Proc. BISEF'88, Oct. 19-21, Beijing, China, Ding Shunnian, ed.), Pergamon Press (Oxford), 1989, pp. 391-8.
- [111] K.S. Yee: "Numerical Solution of Initial Boundary Value Problems Involving Maxwell's Equations in Isotropic Media", *IEEE Trans., AP-14*, 3 (1966), pp. 302-7.
- [112] T.V. Yioultis, T.D. Tsiboukis: "Development and Implementation of Second and Third Order Vector Finite Elements", *IEEE Trans., MAG-33*, 2 (1997), pp. 1812-5.
- [113] K. Yosida: *Functional Analysis*, Springer-Verlag (Berlin), 1980. (First ed., 1965.)