EPILOGUE:

Some "real-life" finite element model examples

GEOMETRY OF MIDDLE SURFACE

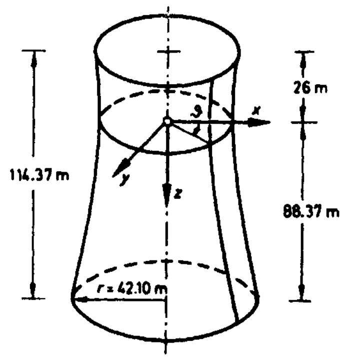
POSITION VECTOR

$$\mathbf{x} = \begin{bmatrix} r \cdot \cos \xi^1 \\ r \cdot \sin \xi^1 \\ \xi^2 \end{bmatrix}$$

WHERE

$$r = 24.85 \sqrt{1 + (\xi^2 / 64.62)^2}$$

PARAMETER DEFINITION $\xi^1 = \vartheta$, $\xi^2 = z$

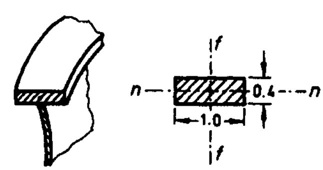


MATERIAL DATA

YOUNG'S MODULUS	$E = 3 \cdot 10^9$ kp/m^2	
POISSON'S RATIO	$\nu = 0.2$	
SPECIFIC GRAVITY	$\gamma = 1.0$ kp/m^3	(FOR BUCKLING ANALYSIS)
DENSITY	$\rho = 1.0$ kp s^2/m^4	(FOR VIBRATION ANALYSIS)

GEOMETRICAL DATA

SHELL THICKNESS	$t = 0.14$ m
STIFFENER AT THE TOP OF THE SHELL	$A = 0.4$ m^2
	$I_{ff} = 3.333 \cdot 10^{-2}$ m^4
	$I_{nn} = 5.333 \cdot 10^{-3}$ m^4
	$J = 1.597 \cdot 10^{-2}$ m^4

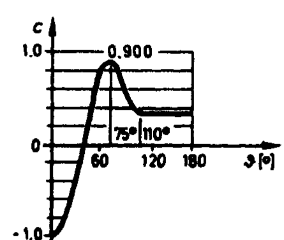


BOUNDARY CONDITIONS

$z = -26.0$ FREE EDGE

$z = 88.37$ BUILT-IN

WINDLOAD

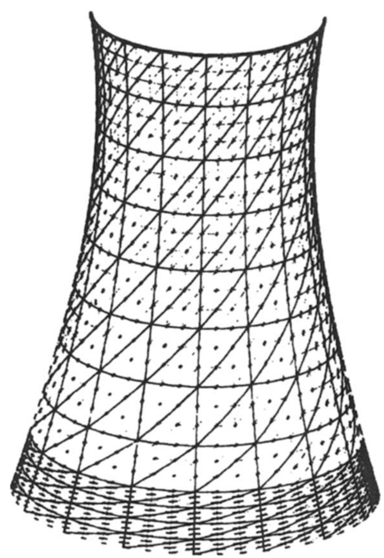


DISTRIBUTION OF WINDLOAD

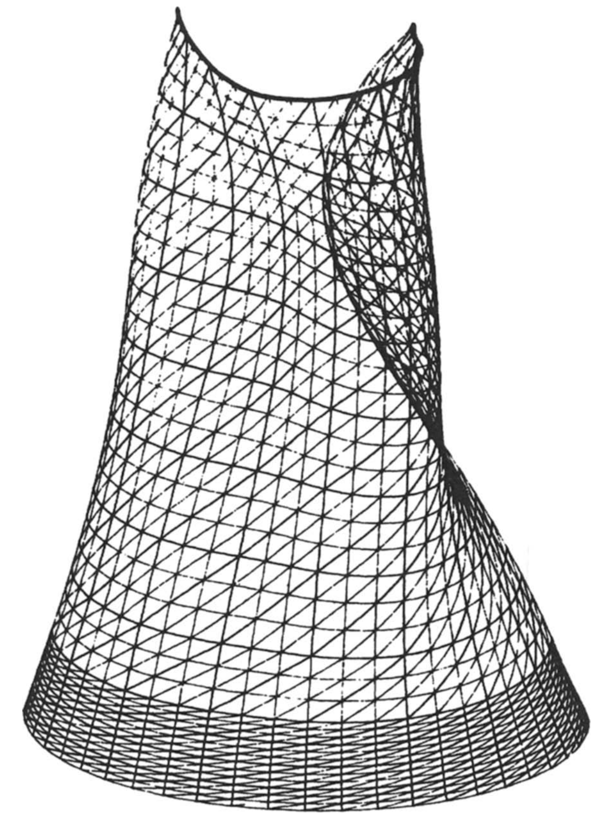
$P_w = c(\vartheta) \cdot q(z)$

$q(z) = -100$ kp/m^2 = constant

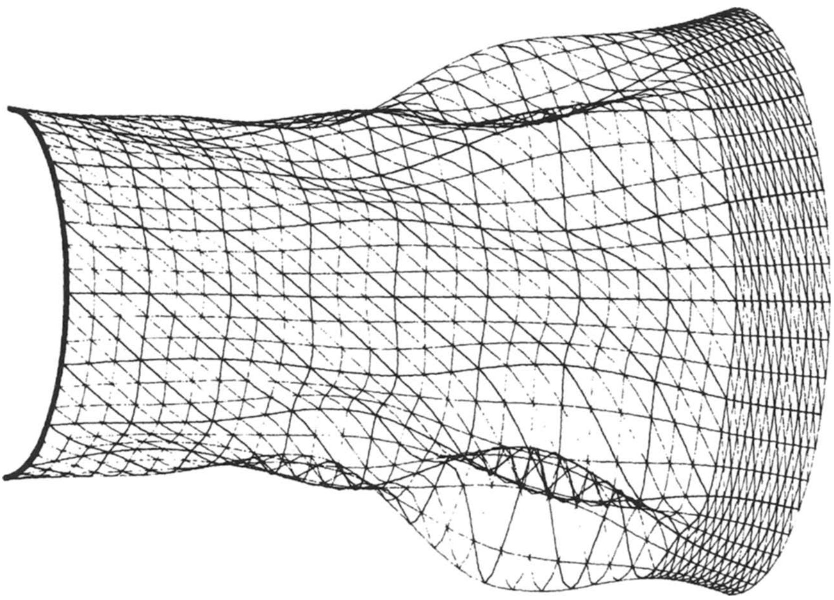
Cooling tower: Geometry, dimensions and input data.
Reproduced by courtesy of Professor J.H. Argyris.



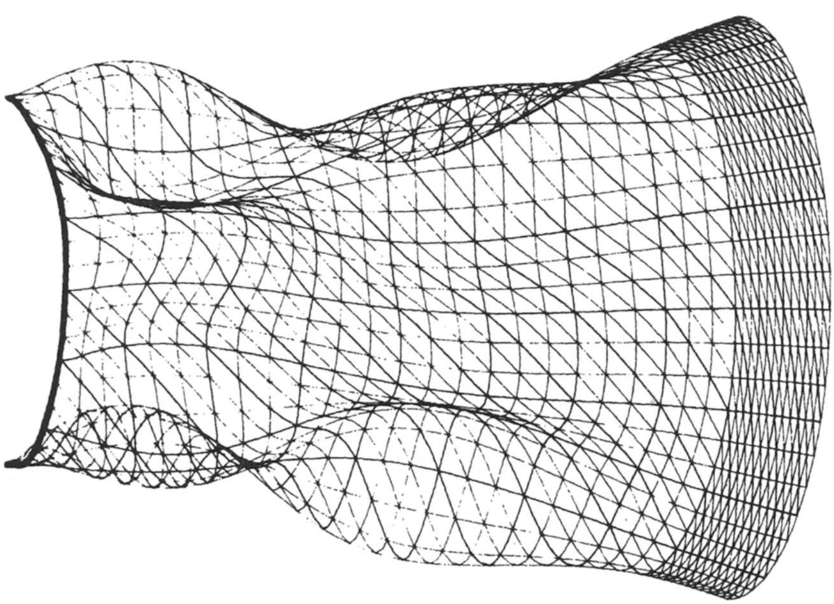
Cooling tower: Triangulation.
Reproduced by courtesy of Professor J.H. Argyris.



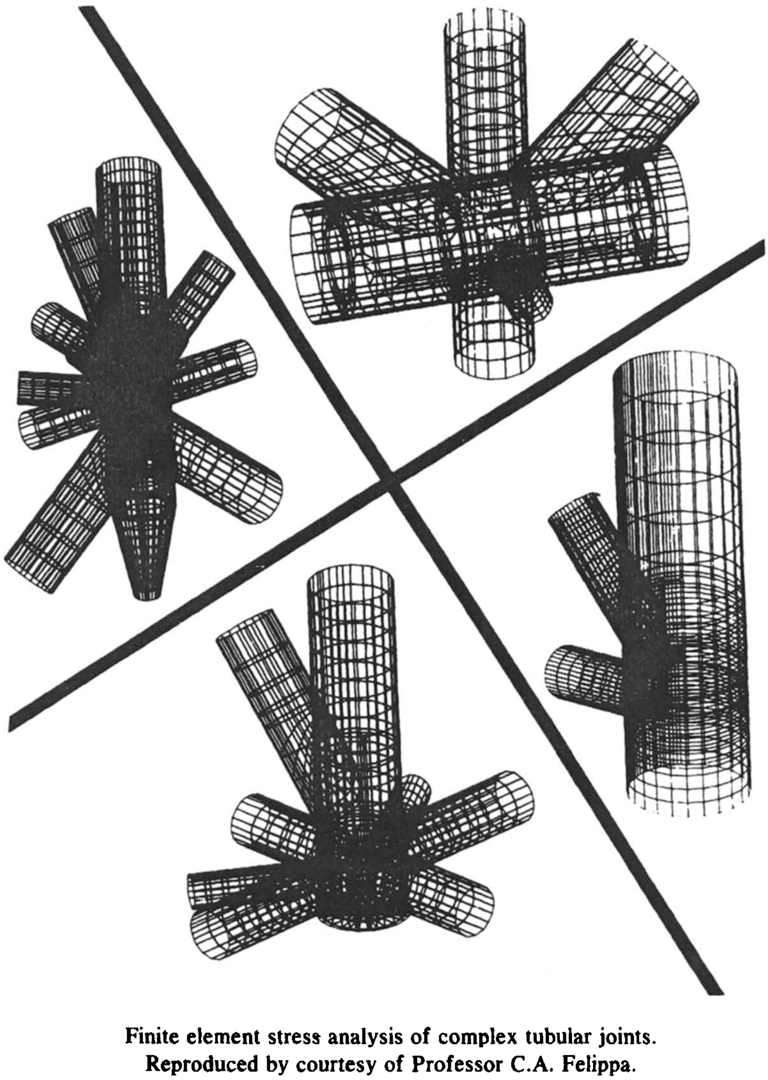
Cooling tower: Deformed structure under wind load.
Reproduced by courtesy of Professor J.H. Argyris.



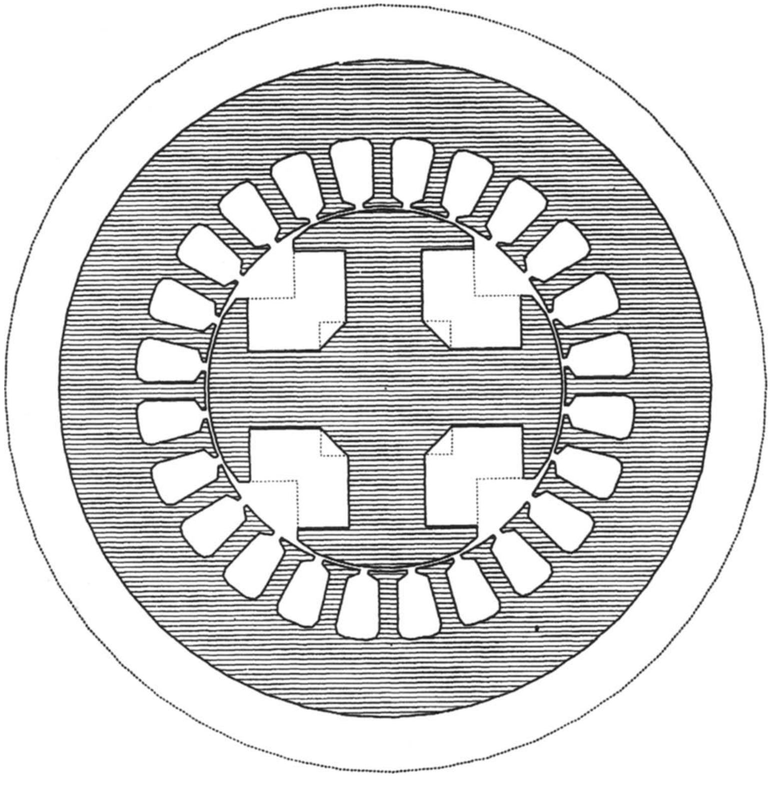
Cooling tower: First buckling mode under dead weight.
Reproduced by courtesy of Professor J.H. Argyris.



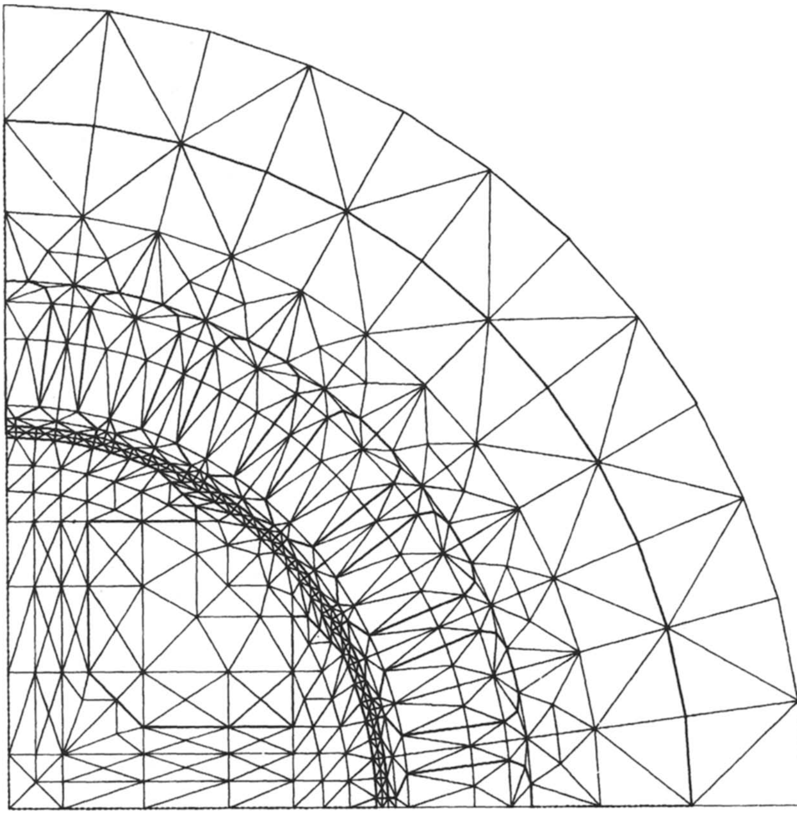
Cooling tower: First vibration mode.
Reproduced by courtesy of Professor J.H. Argyris.



Finite element stress analysis of complex tubular joints.
Reproduced by courtesy of Professor C.A. Felippa.



Tetrapolar alternator.
Reproduced by courtesy of Professor R. Glowinski and Mr. A. Marrocco.



Tetrapolar alternator: Example of a triangulation.
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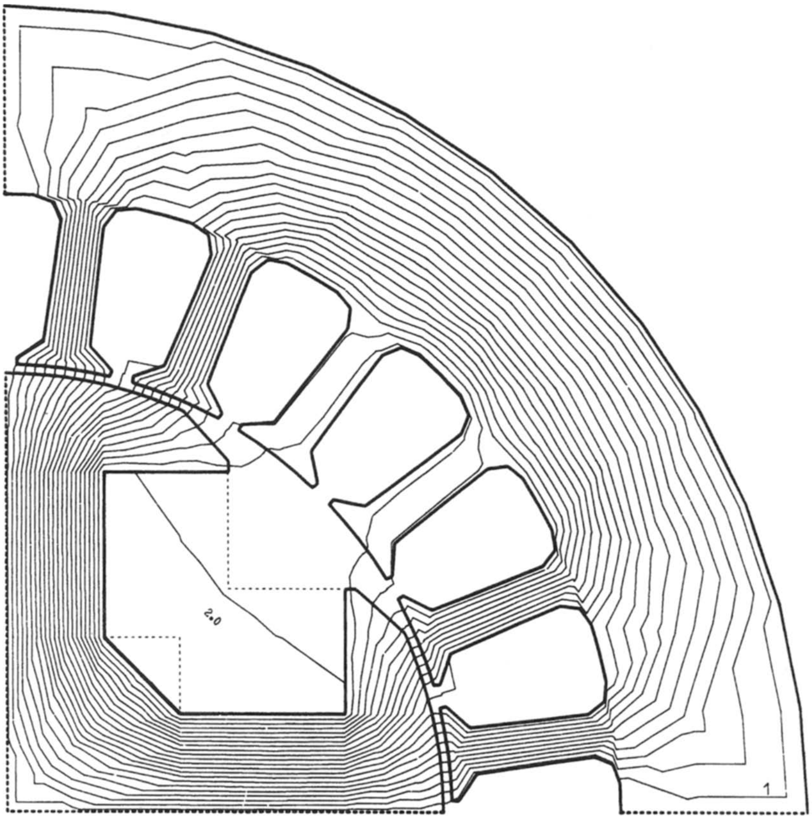
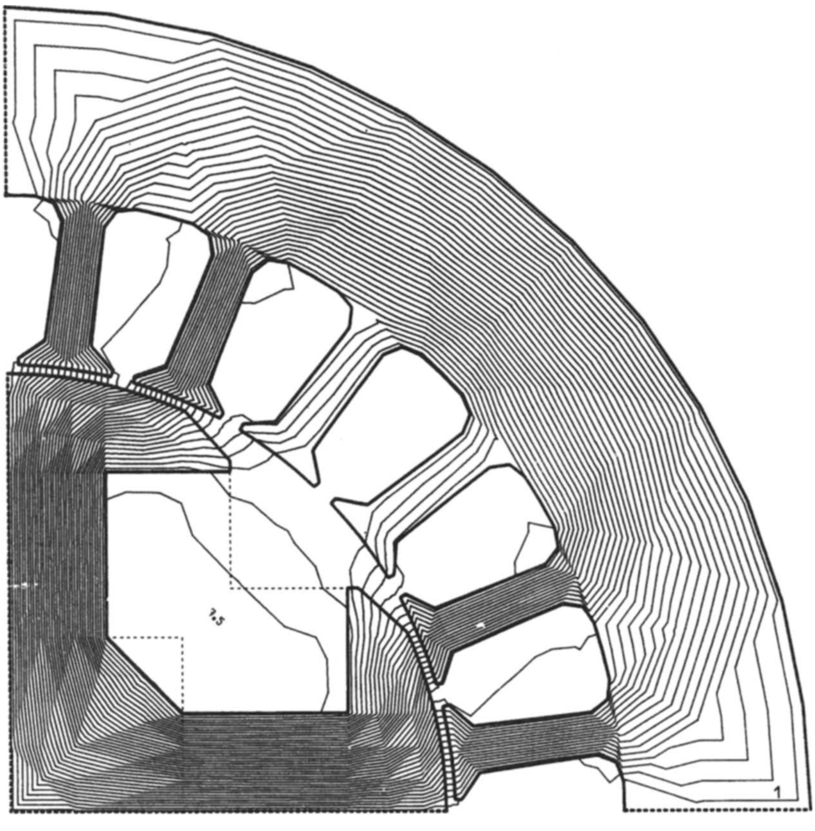
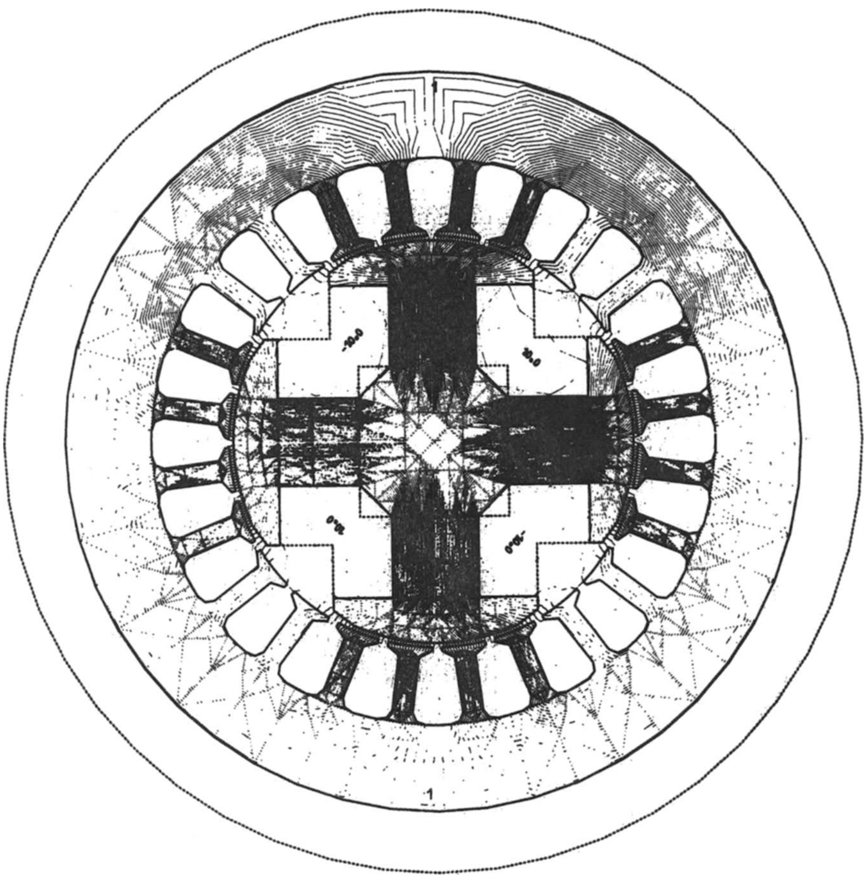


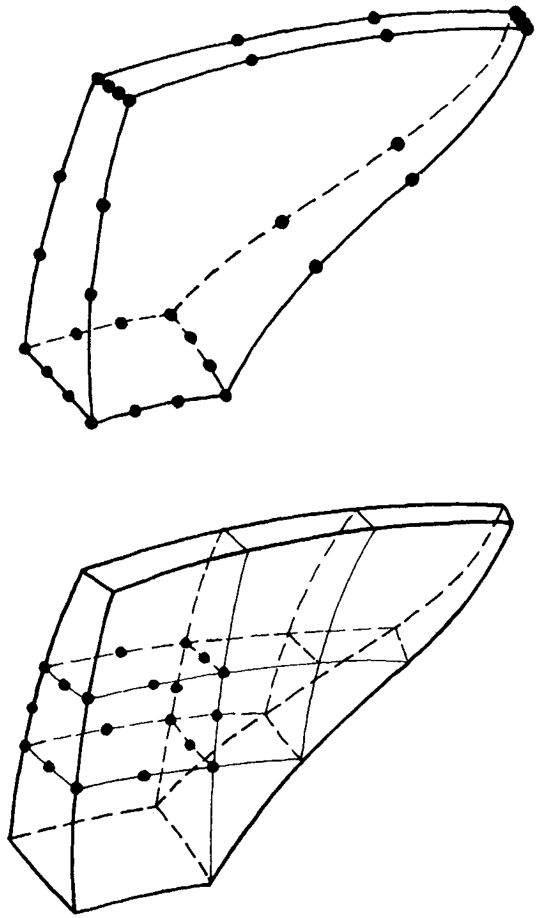
Tetrapolar alternator: Induction lines for $J = 2$.
(J: density of current)
Reproduced by courtesy of Professor R. Glowinski and Mr. A. Marrocco.



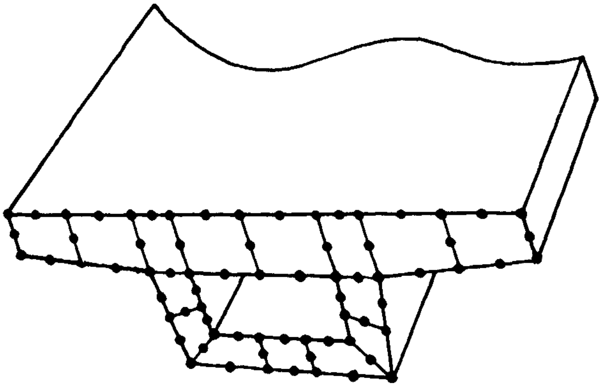
Tetrapolar alternator: Induction lines for $J = 7.5$.
(J: density of current)
Reproduced by courtesy of Professor R. Glowinski and Mr. A. Marrocco.



Tetrapolar alternator: Induction lines for $J = 10$.
(J: density of current)
Reproduced by courtesy of Professor R. Glowinski and Mr. A. Marrocco.



Arch dam in a rigid valley – Various element subdivisions.
Reproduced from Fig. 9.8 of Professor Zienkiewicz' book: "*The Finite Element Method in Engineering Science*", McGraw-Hill, London, 1971, by courtesy of Professor O.C. Zienkiewicz, and with permission of the Publisher.



A thick box bridge reduced to a two-dimensional problem with isoparametric, quadratic, elements.

Reproduced from Fig. 13.2 of Professor Zienkiewicz' book: "*The Finite Element Method in Engineering Science*", McGraw-Hill, London, 1971, by courtesy of Professor O.C. Zienkiewicz, and with permission of the Publisher.

BIBLIOGRAPHY

The following list includes all titles referred to in the text. With minor exceptions, the journal abbreviations follow the usage of the Index of the *Mathematical Reviews*, Volume 51, No. 7 (June 1976).

ADAMS, R.A. (1975): *Sobolev Spaces*, Academic Press, New York.

ADINI, A.; CLOUGH, R.W. (1961): Analysis of plate bending by the finite element method, NSF report G. 7337.

AGMON, S. (1965): *Lectures on Elliptic Boundary Value Problems*, Van Nostrand, Princeton.

AHMAD, S.; IRONS, B.M.; ZIENKIEWICZ, O.C. (1970): Analysis of thick and thin shell structures by curved finite elements, Internat. J. Numer. Methods Engrg. **2**, 419–451.

ALLMAN, D.J. (1976): A simple cubic displacement element for plate bending, Internat. J. Numer. Methods Engrg. **10**, 263–281.

ARCANGELI, R.; GOUT, J.L. (1976): Sur l'évaluation de l'erreur d'interpolation de Lagrange dans un ouvert de R^n, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numer. **10**, 5–27.

ARGYRIS, J.H. (1954–1955): Energy theorems and structural analysis, part I: General Theory, Aircraft Engineering **26**, 347–356, 383–387, 394; **27**, 42–58, 80–94, 125–134 (also published as a book, Butterworths Scientific Publications, London, 1960).

ARGYRIS, J.H.; FRIED, I. (1968): The LUMINA element for the matrix displacement method (Lagrangian interpolation). The Aeronautical Journal of the Royal Aeronautical Society **72**, 514–517.

ARGYRIS, J.H.; FRIED, I.; SCHARPF, D.W. (1968): The TUBA family of plate elements for the matrix displacement method, The Aeronautical Journal of the Royal Aeronautical Society **72**, 701–709.

ARGYRIS, J.H.; HAASE, M.; MALEJANNAKIS, G.A. (1973): Natural geometry of surfaces with specific reference to the matrix displacement analysis of shells. I, II and III, *Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series B*, **76**, 361–410.

ARGYRIS, J.H.; LOCHNER, N. (1972): On the application of the SHEBA shell element, Comput. Methods Appl. Mech. Engrg. **1**, 317–347.

ATTEIA, M. (1975): Fonctions "spline" et méthode d'éléments finis, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 13–40.

ATTEIA, M. (1977): Evaluation de l'erreur dans la méthode des éléments finis, Numer. Math. **28**, 295–306.

AUBIN, J.P. (1967a): Approximation des Espaces de Distributions et des Opérateurs Différentiels, Mémoire 12, Bull. Soc. Math. France.

AUBIN, J.P. (1967b): Behavior of the error of the approximate solutions of boundary value problems for linear elliptic operators by Galerkin's and finite difference methods, Ann. Scuola Norm. Sup. Pisa **21**, 599–637.

AUBIN, J.P. (1968a): Evaluation des erreurs de troncature des approximations des espaces de Sobolev, J. Math. Anal. Appl. **21**, 356–368.

AUBIN, J.P. (1968b): Interpolation et approximations optimales et "spline functions", J. Math. Anal. Appl. **24**, 1–24.

AUBIN, J.P. (1969): Approximation des problèmes aux limites non homogènes et régularité de la convergence, Calcolo **6**, 117–139.

AUBIN, J.P. (1972): *Approximation of Elliptic Boundary-Value Problems*, Wiley-Interscience, New York.

AUBIN, J.P.; BURCHARD, H.G. (1971): Some aspects of the method of the hypercircle applied to elliptic variational problems, in *SYNSPADE 1970* (B. Hubbard, Editor), Academic Press, New York.

AUSLENDER, A. (1976): *Optimisation-Méthodes Numériques*, Masson, Paris.

BABUŠKA, I. (1963): The theory of small changes in the domain of existence in the theory of partial differential equations and its applications, in *Differential Equations and their Applications*, pp. 13–26, Academic Press, New York.

BABUŠKA, I. (1970): Approximation by hill functions, Comment Math. Univ. Carolinae **11**, 787–811.

BABUŠKA, I. (1971a): The rate of convergence for the finite element method, SIAM J. Numer. Anal. **8**, 304–315.

BABUŠKA, I. (1971b): Error-bounds for finite element method, Numer. Math. **16**, 322–333.

BABUŠKA, I. (1972a): A finite element scheme for domains with corners, Numer. Math. **20**, 1–21.

BABUŠKA, I. (1972b): Approximation by hill functions II, Comment. Math. Univ. Carolinae **13**, 1–22.

BABUŠKA, I. (1972c): The finite element method for infinite domains. I, Math. Comput. **26**, 1–11.

BABUŠKA, I. (1973a): The finite element method with Lagrangian multipliers, Numer. Math. **20**, 179–192.

BABUŠKA, I. (1973b): The finite element method with penalty, Math. Comput. **27**, 221–228.

BABUŠKA, I. (1974a): Method of weak elements, Technical Note BN-809, University of Maryland.

BABUŠKA, I. (1974b): Solution of problems with interfaces and singularities, in *Mathematical Aspects of Finite Elements in Partial Differential Equations* (C. de Boor, Editor), pp. 213–277, Academic Press, New York.

BABUŠKA, I. (1976): Singularities problem in the finite element method, Technical Note BN-835, Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park.

BABUŠKA, I., AZIZ, A.K. (1972): Survey Lectures on the Mathematical Foundations of the Finite Element Method, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 3–359, Academic Press, New York.

BABUŠKA, I.; AZIZ, A.K. (1976): On the angle condition in the finite element method, SIAM J. Numer. Anal. **13**, 214–226.

BABUŠKA, I.; KELLOGG, R.B. (1975): Nonuniform error estimates for the finite element method, SIAM J. Numer. Anal. **12**, 868–875.

Babuška, I.; Oden, J.T.; Lee, J.K. (1977): Mixed-hybrid finite element approximations of second-order elliptic boundary-value problems, Comput. Methods Appl. Mech. Engrg. **11**, 175–206.

Babuška, I.; Rosenzweig, M.B. (1972): A finite element scheme for domains with corners, Numer. Math. **20**, 1–21.

Babuška, I.; Zlámal, M. (1973): Nonconforming elements in the finite element method with penalty, SIAM J. Numer. Anal. **10**, 863–875.

Baiocchi, C. (1971): Sur un problème à frontière libre traduisant le filtrage de liquides à travers des milieux poreux, C.R. Acad. Sci. Paris **273**, 1215–1217.

Baiocchi, C. (1972): Su un problema di frontiera libera connesso a questioni di idraulica, Ann. Mat. Pura Appl. **XCII**, 107–127.

Baiocchi, C. (1974): Problèmes à frontière libre en hydraulique, C.R. Acad. Sci. Paris **278**, 1201–1204.

Baiocchi, C. (1975): Free boundary problems in the theory of fluid flow through porous media (address given at the International Congress of Mathematicians, Vancouver, August 21–29, 1974), Publication No. 84, Laboratorio di Analisi Numerica del C.N.R., Pavia.

Baiocchi, C.; Comincioli, V.; Magenes, E.; Pozzi, G.A. (1973): Free boundary problems in the theory of fluid flow through porous media: Existence and uniqueness theorems, Ann. Mat. Pura Appl. **XCVII**, 1–82.

Baker, G.A. (1973): Simplified proofs of error estimates for the least squares method for Dirichlet's problem, Math. Comput. **27**, 229–235.

Barlow, J. (1976): Optimal stress locations in finite element models, Internat. J. Numer. Methods Engrg. **10**, 243–251.

Barnhill, R.E. (1976a): Blending function finite elements for curved boundaries, in The Mathematics of Finite Elements and Applications (J.R. Whiteman, Editor), pp. 67–76, Academic Press, London.

Barnhill, R.E. (1976b): Blending function interpolation: a survey and some new results (to appear in the Proceedings of the Conference on Numerical Methods of Approximation Theory, Oberwolfach, May 29, 1975).

Barnhill, R.E.; Birkhoff, G.; Gordon, W.J. (1973): Smooth interpolation in triangles, J. Approximation Theory **8**, 114–128.

Barnhill, R.E.; Brown, J.H. (1975): Curved nonconforming elements for plate problems, Report No. 8, University of Dundee.

Barnhill, R.E.; Brown, J.H.; McQueen, N.; Mitchell, A.R. (1976): Computable finite element error bounds for Poisson's equation, Internat. J. Numer. Methods Engrg. (to appear).

Barnhill, R.E.; Gregory, J.A. (1975a): Compatible smooth interpolation in triangles, J. Approximation Theory **15**, 214–225.

Barnhill, R.E.; Gregory, J.A. (1975b): Polynomial interpolation to boundary data on triangles, Math. Comput. **29**, 726–735.

Barnhill, R.E.; Gregory, J.A. (1976a): Sard kernel theorems on triangular domains with application to finite element error bounds, Numer. Math. **25**, 215–229.

Barnhill, R.E.; Gregory, J.A. (1976b): Interpolation remainder theory from Taylor expansions on triangles, Numer. Math. **25**, 401–408.

Barnhill, R.E.; Whiteman, J.R. (1973): Error analysis of finite element methods with triangles for elliptic boundary value problems, in *the Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 83–112, Academic Press, London.

BARNHILL, R.E.; WHITEMAN, J.R. (1975): Error analysis of Galerkin methods for Dirichlet problems containing boundary singularities, J. Inst. Math. Appl. **15** (1975), 121–125.

BARROS NETO, J. (1965): Inhomogeneous boundary value problems in a half space, Ann. Scuola Norm. Sup. Pisa **19**, 331–365.

BARSOUM, R.S. (1976): On the use of isoparametric finite elements in linear fracture mechanics, Internat. J. Numer Methods Engrg. **10**, 25–37.

BATHE, K.-J.; WILSON, E.L. (1973): Solution methods for eigenvalue problems in structural mechanics, Internat. J. Numer. Methods Engrg. **6**, 213–226.

BATOZ, J.L.; CHATTOPADHYAY, A.; DHATT, G. (1976): Finite element large deflection analysis of shallow shells, Internat. J. Numer. Methods Engrg. **10**, 39–58.

BAZELEY, G.P.; CHEUNG, Y.K.; IRONS, B.M.; ZIENKIEWICZ, O.C. (1965): Triangular elements in bending – conforming and nonconforming solutions, in *Proceedings of the Conference on Matrix Methods in Structural Mechanics*, Wright Patterson A.F.B., Ohio.

BEGIS, D.; GLOWINSKI, R. (1974): Application de la méthode des éléments finis à la résolution d'un problème de domaine optimal, in *Computing Methods in Applied Sciences and Engineering, Part 2* (R. Glowinski and J.L. Lions, Editors), pp. 403–434, Lecture Notes in Computer Science **11**, Springer-Verlag, Berlin.

BEGIS, D.; GLOWINSKI, R. (1975): Application de la méthode des éléments finis à l'approximation d'un problème de domaine optimal. Méthodes de résolution des problèmes approchés, Appl. Math. Optim. **2**, 130–169.

BELL, K. (1969): A refined triangular plate bending element, Internat. J. Numer. Methods Engrg. **1**, 101–122.

BENSOUSSAN, A.; LIONS, J.L. (1973): Nouvelle formulation de problèmes de contrôle impulsionnel et applications, C.R. Acad. Sci. Paris **276**, 1189–1192.

BENSOUSSAN, A.; LIONS, J.L. (1974): Sur l'approximation numérique d'inéquations quasi-variationnelles stationnaires, in *Computing Methods in Applied Sciences and Engineering, Part 2* (R. Glowinski and J.L. Lions, Editors), pp. 326–338, Lecture Notes in Computer Science, Vol. 11, Springer-Verlag, Berlin.

BERCOVIER, M. (1976): *Régularisation Duale des Problèmes Variationnels Mixtes. Application aux Eléments Finis Mixtes et Extension à Quelques Problèmes non Linéaires*, Doctoral Thesis, Université de Rouen.

BERCOVIER, M.; LIVNE, E. (1976): A 4 CST quadrilateral element for incompressible and nearly incompressible materials, Technical Note MB/76/3, Computation Center, Hebrew University, Jerusalem.

BERGAN, P.G.; CLOUGH, R.W. (1973): Large deflection analysis of plates and shallow shells using the finite element method, Internat. J. Numer. Methods Engrg. **5**, 543–556.

BERGER, A.E. (1973): L^2-error estimates for finite elements with interpolated boundary conditions, Numer. Math. **21**, 345–349.

BERGER, A.E. (1976): The truncation method for the solution of a class of variational inequalities, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, 29–42.

BERGER, A.E.; SCOTT, R.; STRANG, G. (1972): Approximate boundary conditions in the finite element method, in *Symposia Mathematica*, Vol. 10, pp. 295–313, Academic Press, New York.

BERNADOU, M. (1976): Méthodes conformes d'éléments finis pour des problèmes de coques avec intégration numérique (to appear).

BERNADOU, M.; CIARLET, P.G. (1976): Sur l'ellipticité du modèle linéaire de coques de W.T. Koiter in *Computing Methods in Applied Sciences and Engineering* (R. Glowinski and J.L. Lions, Editors), pp. 89–136, Lecture Notes in Economics and Mathematical Systems, Vol. 134, Springer-Verlag, Berlin.

BERNADOU, M.; DUCATEL, Y. (1976): Méthodes conformes d'élements finis pour des problèmes elliptiques du quatrième ordre avec intégration numérique, Rapport de Recherche No. 195, I.R.I.A. Laboria, Rocquencourt.

BERS, L.; JOHN, F.; SCHECHTER, M. (1964): *Partial Differential Equations*, John Wiley, New York.

BIRKHOFF, G. (1969): Piecewise bicubic interpolation and approximation in polygons, in *Approximation with Special Emphasis on Spline Functions* (I.J. Schoenberg, Editor), pp. 185–121, Academic Press, New York.

BIRKHOFF, G. (1971): Tricubic polynomial interpolation, Proc. Nat. Acad. Sci. U.S.A. **68**, 1162–1164.

BIRKHOFF, G. (1972): Piecewise analytic interpolation and approximation in triangulated polygons, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 363–385, Academic Press, New York.

BIRKHOFF, G.; DE BOOR, C.; SWARTZ, B.; WENDROFF, B. (1966): Rayleigh–Ritz approximation by piecewise cubic polynomials, SIAM J. Numer. Anal. **3**, 188–203.

BIRKHOFF, G.; FIX, G.J. (1974): Higher-order linear finite element methods, Technical Report 1, Office of Naval Research, Arlington, Virginia.

BIRKHOFF, G.; GULATI, S. (1974): Optimal few-point discretizations of linear source problems, SIAM J. Numer. Anal. **11**, 700–728.

BIRKHOFF, G.; MANSFIELD, L. (1974): Compatible triangular finite elements, J. Math. Anal. Appl. **47**, 531–553.

BIRKHOFF, G.; SCHULTZ, M.H.; VARGA, R.S. (1968): Piecewise Hermite interpolation in one and two variables with applications to partial differential equations, Numer. Math. **11**, 232–256.

BLAIR, J.J. (1976): Higher order approximations to the boundary conditions for the finite element method, Math. Comput. **30**, 250–262.

BOGNER, F.K.; FOX, R.L.; SCHMIT, L.A. (1965): The generation of interelement compatible stiffness and mass matrices by the use of interpolation formulas, in *Proceedings of the Conference on Matrix Methods in Structural Mechanics*, Wright Patterson A.F.B., Ohio.

BOISSERIE, J.M.; PLANCHARD, J. (1971): Le problème de l'assemblage dans la méthode des éléments finis, Bull. Direction Etudes Recherches, Sér. C: Math.-Informat., 33–42.

BOSSAVIT, A. (1971): Une méthode de décomposition de l'opérateur biharmonique, Note HI 585/2, Electricité de France.

BOSSAVIT, A. (1973): Sur l'assemblage des éléments finis par la méthode frontale, Bull. Direction Etudes Recherches, Sér. C: Math.-Informat. **2**, 47–60.

BOSSAVIT, A.; FREMOND, M. (1976): The frontal method based on mechanics and dynamic programming, Comput. Methods Appl. Mech. Engrg. **8**, 153–178.

BOURGAT, J.F. (1976): Numerical study of a dual iterative method for solving a finite element approximation of the biharmonic equation, Comput. Methods Appl. Mech. **9**, 203–218.

BRAMBLE, J.H. (1970): *Variational Methods for the Numerical Solution of Elliptic Problems*, Chalmers Institute of Technology and the University of Göteborg.

BRAMBLE, J.H. (1972): On the approximation of eigenvalues of non-selfadjoint operators, in *Proceedings Equa Diff 3*, J.E. Purkyně University, Brno.

BRAMBLE, J.H. (1975): A survey of some finite element methods proposed for treating the Dirichlet problem, Advances in Math. **16**, 187–196.

BRAMBLE, J.H.; DUPONT, T.; THOMÉE, V. (1972): Projection methods for Dirichlet's problem in approximating polygonal domains with boundary-value corrections, Math. Comput. **26**, 869–879.

BRAMBLE, J.H.; HILBERT, S.R. (1970): Estimation of linear functionals on Sobolev spaces with application to Fourier transforms and spline interpolation, SIAM J. Numer. Anal. **7**, 113–124.

BRAMBLE, J.H.; HILBERT, S.R. (1971): Bounds for a class of linear functionals with applications to Hermite interpolation, Numer. Math. **16**, 362–369.

BRAMBLE, J.H.; NITSCHE, J.A. (1973): A generalized Ritz-least-squares method for Dirichlet problems, SIAM J. Numer. Anal. **10**, 81–93.

BRAMBLE, J.H.; NITSCHE, J.A.; SCHATZ, A.H. (1975): Maximum-norm interior estimates for Ritz–Galerkin methods, Math. Comput. **29**, 677–688.

BRAMBLE, J.H.; OSBORN, J.E. (1972): Approximation of Steklov eigenvalues of non-selfadjoint second order elliptic operators, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 387–408, Academic Press, New York.

BRAMBLE, J.H.; OSBORN, J.E. (1973): Rate of convergence estimates for nonselfadjoint eigenvalue approximations. Math. Comput. **27**, 525–549.

BRAMBLE, J.H.; SCHATZ, A.H. (1970): Rayleigh–Ritz–Galerkin methods for Dirichlet's problem using subspaces without boundary conditions, Comm. Pure Appl. Math. **23**, 653–675.

BRAMBLE, J.H.; SCHATZ, A.H. (1971): Least squares methods for 2mth order elliptic boundary-value problems, Math. Comput. **25**, 1–32.

BRAMBLE, J.H.; SCHATZ, A.H. (1974): Higher order local accuracy by averaging in the finite element method, in *Mathematical Aspects of Finite Elements in Partial Differential Equations* (C. de Boor, Editor), pp. 1–14, Academic Press, New York.

BRAMBLE, J.H.; SCHATZ, A.H. (1976): Estimates for spline projections, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, 5–37.

BRAMBLE, J.H.; THOMÉE, V. (1974): Interior maximum norm estimates for some simple finite element methods, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 5–18.

BRAMBLE, J.H.; ZLÁMAL, M. (1970): Triangular elements in the finite element method, Math. Comput. **24**, 809–820.

BRAUCHLI, J.H.; ODEN, J.T. (1971): Conjugate approximation functions in finite element analysis, Quart. Appl. Math. **29**, 65–90.

BREZIS, H.; SIBONY, M. (1968): Méthodes d'approximation et d'itération pour les opérateurs monotones, Arch. Rational Mech. Anal. **1**, 59–82.

BREZIS, H.; STAMPACCHIA, G. (1968): Sur la régularité de la solution d'inéquations elliptiques, Bull. Soc. Math. France **96**, 153–180.

BREZIS, H.; STAMPACCHIA, G. (1973): Une nouvelle méthode pour l'étude d'écoulements stationnaires, C.R. Acad. Sci. Paris, Sér. A, **276**, 129–132.

BREZZI, F. (1974a): Sur une méthode hybride pour l'approximation du problème de la torsion d'une barre élastique, Ist. Lombardo Accad. Sci. Lett. Rend. A **108**, 274–300.

BREZZI, F. (1974b): On the existence, uniqueness and approximation of saddle-point problems arising from Lagrangian multipliers, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 129–151.

BREZZI, F. (1975): Sur la méthode des éléments finis hybrides pour le problème biharmonique, Numer. Math. **24**, 103–131.

BREZZI, F.; HAGER, W.W.; RAVIART, P.-A. (1977): Error estimates for the finite element solution of variational inequalities – Part 1: Primal theory, Numer. Math. **28**, 431–443.

BREZZI, F.; JOHNSON, C.; MERCIER, B. (1977): Analysis of a mixed finite element method for elasto-plastic plates, Math. Comput. (to appear).

BREZZI, F.; MARINI, L.D. (1975): On the numerical solution of plate bending problems by hybrid methods, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-3**, 5–50.

BREZZI, F.; RAVIART, P.-A. (1976): Mixed finite element methods for 4th order elliptic equations, Rapport interne No. 9, Centre de Mathématiques Appliquées, Ecole Polytechnique, Palaiseau.

BRISTEAU, M.-O. (1975): *Application de la Méthode des Eléments Finis à la Résolution Numérique d'Inéquations Variationnelles d'Evolution de Type Bingham*, Doctoral Thesis (3ème Cycle), Université Pierre et Marie Curie, Paris.

BROWDER, F.E. (1965): Existence and uniqueness theorems for solutions of nonlinear boundary value problems, Proc. Amer. Math. Soc., Symposia in Appl. Math. **17**, 24–49.

CAREY, G.F. (1974): A unified approach to three finite element theories for geometric nonlinearity, Comput. Methods Appl. Mech. Engrg. **4**, 69–79.

CARLSON, R.E.; HALL, C.A. (1971): Ritz approximations to two-dimensional boundary value problems, Numer. Math. **18**, 171–181.

CARLSON, R.E.; HALL, C.A. (1973): Error bounds for bicubic spline interpolation, J. Approximation Theory **4**, 41–47.

CARROLL, W.E.; BARKER, R.M. (1973): A theorem for optimum finite-element idealizations, Internat. J. Solids and Structures **9**, 883–895.

CARTAN, H. (1967): *Calcul Différentiel*, Hermann, Paris.

CAVENDISH, J.C.; GORDON, W.J.; HALL, C.A. (1976): Ritz–Galerkin approximations in blending function spaces, Numer. Math. **26**, 155–178.

CEA, J. (1964): Approximation variationnelle des problèmes aux limites, Ann. Inst. Fourier (Grenoble) **14**, 345–444.

CEA, J. (1971): *Optimisation: Théorie et Algorithmes*, Dunod, Paris.

CEA, J. (1976): Approximation variationnelle; Convergence des éléments finis; Un test, in *Journées Eléments Finis*, Université de Rennes, Rennes.

CEA, J.; GIOAN, A.; MICHEL, J. (1974): Adaptation de la méthode du gradient à un problème d'identification de domaine, in *Computing Methods in Applied Sciences and Engineering, Part 2* (R. Glowinski and J.L. Lions, Editors), pp. 391–402, Springer-Verlag, Berlin.

CHATELIN, F.; LEMORDANT, M.J. (1975): La méthode de Rayleigh–Ritz appliquée à des opérateurs différentiels elliptiques – Ordres de convergence des éléments propres, Numer. Math. **23**, 215–222.

CHERNUKA, M.W.; COWPER, G.R.; LINDBERG, G.M.; OLSON, M.D. (1972): Finite element analysis of plates with curved edges, Internat. J. Numer. Methods Engrg. **4**, 49–65.

CIARLET, P.G. (1966): *Variational Methods for Non-Linear Boundary-Value Problems*, Doctoral Thesis, Case Institute of Technology, Cleveland.

CIARLET, P.G. (1968): An $O(h^2)$ method for a non-smooth boundary value problem, Aequationes Math. **2**, 39–49.

CIARLET, P.G. (1970): Discrete variational Green's function. I, Aequationes Math. **4**, 74–82.

CIARLET, P.G. (1973): Orders of convergence in finite element methods, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 113–129, Academic Press, London.

CIARLET, P.G. (1974a): Conforming and nonconforming finite element methods for solving the plate problem, in *Conference on the Numerical Solution of Differential Equations* (G.A. Watson, Editor), pp. 21–31, Lecture Notes in Mathematics, Vol. 363, Springer-Verlag, Berlin.

CIARLET, P.G. (1974b): Quelques méthodes d'éléments finis pour le problème d'une plaque encastrée, in *Computing Methods in Applied Sciences and Engineering, Part 1* (R. Glowinski and J.L. Lions, Editors), pp. 156–176, Lecture Notes in Computer Science, Vol. 10, Springer-Verlag, Berlin.

CIARLET, P.G. (1974c): Sur l'élément de Clough et Tocher, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 19–27.

CIARLET, P.G. (1975): *Lectures on the Finite Element Method*, Tata Institute of Fundamental Research, Bombay.

CIARLET, P.G. (1976a): *Numerical Analysis of the Finite Element Method*, Séminaire de Mathématiques Supérieures, Presses de l'Université de Montréal.

CIARLET, P.G. (1976b): Conforming finite element methods for the shell problems, in The Mathematics of Finite Elements and Applications II (J.R. Whiteman, Editor), pp. 105–123, Academic Press, London.

CIARLET, P.G. (1976c): On questions of existence in shell theory, J. Indian Math. Soc. **40**, 131–143.

CIARLET, P.G.; GLOWINSKI, R. (1975): Dual iterative techniques for solving a finite element approximation of the biharmonic equation, Comput. Methods Appl. Mech. Engrg. **5**, 277–295.

CIARLET, P.G.; NATTERER, F.; VARGA, R.S. (1970): Numerical methods of high-order accuracy for singular nonlinear boundary value problems, Numer. Math. **15**, 87–99.

CIARLET, P.G.; RAVIART, P.-A. (1972a): General Lagrange and Hermite interpolation in R^n with applications to finite element methods, Arch. Rational Mech. Anal. **46**, 177–199.

CIARLET, P.G.; RAVIART, P.-A. (1972b): Interpolation theory over curved elements, with applications to finite element methods, Comput. Methods Appl. Mech. Engrg. **1**, 217–249.

CIARLET, P.G.; RAVIART, P.-A. (1972c): The combined effect of curved boundaries and numerical integration in isoparametric finite element methods, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 409–474, Academic Press, New York.

CIARLET, P.G.; RAVIART, P.-A. (1973): Maximum principle and uniform convergence for the finite element method, Comput. Methods Appl. Mech. Engrg. **2**, 17–31.

CIARLET, P.G.; RAVIART, P.-A. (1974): A mixed finite element method for the biharmonic equation, in *Mathematical Aspects of Finite Elements in Partial Differential Equations* (C. de Boor, Editor), pp. 125–145, Academic Press, New York.

CIARLET, P.G.; RAVIART, P.-A. (1975): L'effet de l'intégration numérique dans les méthodes d'éléments finis (to appear).

CIARLET, P.G.; SCHULTZ,M.H.; VARGA, R.S. (1967): Numerical methods of high-order accuracy for nonlinear boundary value problems. III. Eigenvalue problems, Numer. Math. **9**, 394–430.

CIARLET, P.G.; SCHULTZ, M.H.; VARGA, R.S. (1968a): Numerical methods of high-order accuracy for nonlinear boundary value problems. II. Eigenvalue problems, Numer. Math. **11**, 331–345.

CIARLET, P.G.; SCHULTZ, M.H.; VARGA, R.S. (1968b): Numerical methods of high-order accuracy for nonlinear boundary value problems. III. Eigenvalue problems, Numer. Math. **12**, 120–133.

CIARLET, P.G.; SCHULTZ, M.H.: VARGA, R.S. (1968c): Numerical methods of high-order accuracy for nonlinear boundary value problems. IV. Periodic boundary conditions, Numer. Math. **12**, 266–279.

CIARLET, P.G.; SCHULTZ, M.H.; VARGA, R.S. (1969): Numerical methods of high-order accuracy for nonlinear boundary value problems. V. Monotone operator theory, Numer. Math. **13**, 51–77.

CIARLET, P.G.; VARGA, R.S. (1970): Discrete variational Green's function. II. One dimensional problem, Numer. Math. **16**, 115–128.

CIARLET, P.G.; WAGSCHAL, C. (1971): Multipoint Taylor formulas and applications to the finite element method, Numer. Math. **17**, 84–100.

CIAVALDINI, J.F.; NEDELEC, J.C. (1974): Sur l'élément de Fraeijs de Veubeke et Sander, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 29–45.

CIAVALDINI, J.F.; TOURNEMINE, G. (1977): A finite element method to compute stationary steady state flows in the hodograph plane, J. Indian Math. Soc. (to appear).

CLEMENT, P. (1974): Méthode des éléments finis appliquée à des problèmes variationnels de type indéfini, Doctoral Thesis, Ecole Polytechnique Fédérale de Lausanne, Lausanne.

CLEMENT, P. (1975): Approximation by finite element functions using local regularization, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 77–84.

CLEMENT, P.; DESCLOUX, J. (1972): On the rigid displacement condition, Internat. J. Numer. Methods Engrg. **4**, 583–586.

CLOUGH, R.W. (1960): The finite element method in plane stress analysis, in Proceedings of the Second ASCE Conference on Electronic Computation, Pittsburg, Pennsylvania.

CLOUGH, R.W.; TOCHER, J.L. (1965): Finite element stiffness matrices for analysis of plates in bending, in *Proceedings of the Conference on Matrix Methods in Structural Mechanics*, Wright Patterson A.F.B. Ohio.

COATMELEC, C. (1966): Approximation et interpolation des fonctions différentiables de plusieurs variables, Ann. Sci. Ecole Norm. Sup. **83**, 271–341.

COURANT, R. (1943): Variational methods for the solution of problems of equilibrium and vibrations, Bull. Amer. Math. Soc. **49**, 1–23.

COURANT, R.; HILBERT, D. (1953): *Methods of Mathematical Physics, Vol. I*, Interscience, New York.

COURANT, R.; HILBERT, D. (1962): *Methods of Mathematical Physics, Vol. II*, Interscience, New York.

COUTRIS, N. (1973): Flexions élastique et élastoplastique d'une coque mince, J. Mécanique 12, 463–475.

CROUZEIX, M.; LE ROUX, A.Y. (1976): Ecoulement d'une fluide irrotationnel, in *Journées Eléments Finis*, Université de Rennes, Rennes.

CROUZEIX, M.; RAVIART, P.-A. (1973): Conforming and nonconforming finite element methods for solving the stationary Stokes equations I, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. R-3, 33–76.

CROUZEIX, M.; THOMAS, J.M. (1973): Eléments finis et problèmes elliptiques dégénérés, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. R-3, 77–104.

DAILEY, J.W.; PIERCE, J.G. (1972): Error bounds for the Galerkin method applied to singular and nonsingular boundary value problems, Numer. Math. 19, 266–282.

DAVIS, P.J.; RABINOWITZ, P. (1974): *Methods of Numerical Integration*, Academic Press, New York.

DAWE, D.J. (1972): Shell analysis using a simple facet element, Journal of Strain Analysis 7, 266–270.

DELEZE, M.; GOEL, J.-J. (1976): Tétraèdre comme élément fini de Classe C^1, à seize paramètres, contenant les polynômes de degré deux, Report, Institut de Mathématiques, Université de Fribourg, Fribourg.

DENY, J.; LIONS, J.L. (1953–1954): Les espaces du type de Beppo Levi, Ann. Institut Fourier (Grenoble) V, 305–370.

DESCLOUX, J. (1972a): On finite element matrices, SIAM J. Numer. Anal. 9, 260–265.

DESCLOUX, J. (1972b): Finite elements and numerical stability, in *Proceedings EquaDiff 3*, pp. 21–29, J.E. Purkyně University, Brno.

DESCLOUX, J. (1973): Two basic properties of finite elements, Report, Ecole Polytechnique Fédérale de Lausanne.

DESCLOUX, J. (1975): Interior regularity and local convergence of Galerkin finite element approximations for elliptic equations, in *Topics in Numerical Analysis II* (J.J.H. Miller, Editor), pp. 27–41, Academic Press, New York.

DESCLOUX, J.; NASSIF, N. (1977): Interior L^∞ estimates for finite element approximations of solutions of elliptic equations, Rev. Française Automat. Informat. Recherche Opérationnelle, Sér. Rouge Anal. Numér. (to appear).

DIEUDONNE, J. (1967): *Fondements de l'Analyse Moderne*, Paris, Gauthier-Villars.

DOUGLAS, J., Jr.; DUPONT, T. (1973): Superconvergence for Galerkin Methods for the two point boundary problem via local projections, Numer. Math. 21 (1973), 270–278.

DOUGLAS, J., Jr.; DUPONT, T. (1975): A Galerkin method for a nonlinear Dirichlet problem, Math. Comput. 29, 689–696.

DOUGLAS, J., Jr.; DUPONT, T. (1976a): Interior penalty procedures for elliptic and parabolic Galerkin methods in *Computing Methods in Applied Sciences* (R. Glowinski and J.L. Lions, Editors), pp. 207–216, Lecture Notes in Physics, Vol. 58, Springer-Verlag, Berlin.

DOUGLAS, J., Jr.; DUPONT, T. (1976b): Galerkin approximations for the two point boundary problem using continuous, piecewise polynomial spaces (to appear).

DOUGLAS, J., Jr.; DUPONT, T.; PERCELL, P.; SCOTT, R. (1976): A family of C^1 finite elements with optimal approximation properties for various Galerkin methods for 2nd and 4th order problems (to appear).

DOUGLAS, J., Jr.; DUPONT, T.; WAHLBIN, L. (1975a): The stability in L^q of the L^2-projection into finite element function spaces, Numer. Math. **23**, 193–197.

DOUGLAS, J., Jr.; DUPONT, T.; WAHLBIN, L. (1975b): Optimal L_∞ error estimates for Galerkin approximations to solutions of two point boundary value problems, Math. Comput. **29**, 475–483.

DOUGLAS, J., Jr.; DUPONT, T.; WHEELER, M.F. (1974a): A Galerkin procedure for approximating the flux on the boundary for elliptic and parabolic boundary value problems, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 47–59.

DOUGLAS, J., Jr.; DUPONT, T.; WHEELER, M.F. (1974b): An L^∞ estimate and a superconvergence result for a Galerkin method for elliptic equations based on tensor products of piecewise polynomials, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 61–66.

DUCHON, J. (1976a): Interpolation des fonctions de deux variables suivant le principe de la flexion des plaques minces, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, No. 12, 5–12.

DUCHON, J. (1976b): Splines minimizing rotation - invariant semi-norms in Sobolev spaces (to appear in the Proceedings of Mehrdimensionale konstructive Functiontheorie, Oberwolfach, 1976).

DUPUIS, G. (1971): Application of Ritz method to thin elastic shell analysis, J. Appl. Mech., 1–9.

DUPUIS, G.; GOËL, J.-J. (1970a): Finite elements with a high degree of regularity, Internat. J. Numer. Methods Engrg. **2**, 563–577.

DUPUIS, G.; GOËL, J.-J. (1970b): A curved finite element for thin elastic shells, Internat. J. Solids and Structures **6**, 1413–1428.

DUVAUT, G.; LIONS, J.L. (1972): *Les Inéquations en Mécanique et en Physique*, Dunod, Paris.

EHRLICH, L.W. (1971): Solving the biharmonic equation as coupled finite difference equations, SIAM J. Numer. Anal. **8**, 278–287.

EKELAND, I.; TEMAM, R. (1974): *Analyse Convexe et Problèmes Variationnels*, Dunod, Paris.

ERGATOUDIS, I.; IRONS, B.M.; ZIENKIEWICZ, O.C. (1968): Curved, isoparametric, "quadrilateral" elements for finite element analysis, Internat. J. Solids and Structures **4**, 31–42.

FALK, R.S. (1974): Error estimates for the approximation of a class of variational inequalities, Math. Comput. **28**, 963–971.

FALK, R.S. (1975): Approximation of an elliptic boundary value problem with unilateral constraints, Revue Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 5–12.

FALK, R.S. (1976a): An analysis of the finite element method using Lagrange multipliers for the stationary Stokes equation, Math. Comput. **30**, 241–249.

FALK, R.S. (1976b): A Ritz method based on a complementary variational principle, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, 39–48.

FALK, R.S. (1976c): A finite element method for the stationary Stokes equation using trial functions which do *not* have to satisfy div $v = 0$, Math. Comput. **30**, 698–702.

FALK, R.S. (1976d): Approximation of the biharmonic equation by a mixed finite element method, SIAM J. Numer. Anal. (to appear).

FALK, R.S.; KING, J.T. (1976): A penalty and extrapolation method for the stationary Stokes equations, SIAM J. Numer. Anal. **13**, 814, 829.

FALK, R.S.; MERCIER, B. (1977): Error estimates for elasto-plastic problems, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 135–144.

FELIPPA, C.A. (1966): *Refined Finite Element Analysis of Linear and Nonlinear Two-Dimensional Structures*, Doctoral Thesis, University of California, Berkeley.

FELIPPA, C.A.; CLOUGH, R.W. (1970): The finite element method in solid mechanics, in *Numerical Solution of Field Problems in Continuum Mechanics* (G. Birkhoff & R.S. Varga, Editors), pp. 210–252, American Mathematical Society, Providence.

FICHERA, G. (1972): Existence theorems in elasticity-Boundary value problems of elasticity with unilateral constraints, in *Encyclopedia of Physics* (S. Flügge, Chief Editor), Vol. VIa/2: *Mechanics of Solids* II (C. Truesdell, Editor), pp. 347–424, Springer-Verlag, Berlin.

FIX, G.J. (1969): Higher-order Rayleigh-Ritz approximations, Journal of Mathematics and Mechanics **18**, 645–658.

FIX, G.J. (1972a): On the effects of quadrature in the finite element method, in *Advances in Computational Methods in Structural Mechanics and Design* (J.T. Oden, R.W. Clough, Y. Yamamoto, Editors), pp. 55–68, The University of Alabama Press, Huntsville.

FIX, G.J. (1972b): Effects of quadrature errors in finite element approximation of steady state, eigenvalue and parabolic problems, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 525–556, Academic Press, New York.

FIX, G.J. (1973): Eigenvalue approximation by the finite element method, Advances in Math. **10**, 300–316.

FIX, G.J. (1976): Hybrid finite element methods, SIAM Rev. **18**, 460–484.

FIX, G.J.; GULATI, S.; WAKOFF, G.I. (1973): On the use of singular functions with finite element approximations, J. Computational Phys. **13**, 209–228.

FIX, G.J.; LARSEN, K. (1971): On the convergence of SOR iterations for finite element approximations to elliptic boundary value problems, SIAM J. Numer. Anal. **8**, 536–547.

FIX, G.J.; STRANG, G. (1969): Fourier analysis of the finite element method in Ritz–Galerkin theory, Studies in Appl. Math. **48**, 265–273.

FORTIN, M. (1972a): *Calcul Numérique des Ecoulements des Fluides de Bingham et des Fluides Newtoniens Incompressibles par des Méthodes d'Eléments Finis*, Doctoral Thesis, Université de Paris VI.

FORTIN, M. (1972b): Résolution des équations des fluides incompressibles par la méthode des éléments finis, in *Proceedings of the Third International Conference on the Numerical Methods in Fluid Mechanics* (Paris, July 03–07, 1972). Springer-Verlag.

FORTIN, M. (1976): Résolution numérique des équations de Navier–Stokes par des éléments finis de type mixte, in *Journées Eléments Finis*, Université de Rennes, Rennes.

FRAEIJS DE VEUBEKE, B. (1965a): Bending and stretching of plates, in *Proceedings of the*

Conference on Matrix Methods in Structural Mechanics, Wright Patterson A.F.B., Ohio.

FRAEIJS DE VEUBEKE, B. (1965b): Displacement and equilibrium models in the finite element method, in *Stress Analysis* (O.C. Zienkiewicz & G.S. Holister, Editors), pp. 145–197, Wiley, New York.

FRAEIJS DE VEUBEKE, B. (1968): A conforming finite element for plate bending, Internat. J. Solids and Structures **4**, 95–108.

FRAEIJS DE VEUBEKE, B. (1973): Diffusive equilibrium models, Lecture Notes, University of Calgary, Calgary.

FRAEIJS DE VEUBEKE, B. (1974): Variational principles and the patch test, Internat. J. Numer. Methods Engrg. **8**, 783–801.

FREHSE, J. (1976): Eine gleichmäßige asymptotische Fehlerabschätzung zur Methode der finiten Elemente bei quasilinearen elliptischen Randwertproblemen, in *Theory of Nonlinear Operators. Constructive Aspects*, Tagungsband der Akademie der Wissenschaften, Berlin.

FREHSE, J.; RANNACHER, R. (1976): Optimal uniform convergence for the finite element approximation of a quasilinear elliptic boundary value problem (to appear in Proceedings of the U.S.-Germany Symposium "Formulations and Computational Algorithms in Finite Element Analysis", M.I.T., 1976).

FREHSE, J.; RANNACHER, R. (1977): Asymptotic L^∞-error estimates for linear finite element approximations of quasilinear boundary value problems, SIAM J. Numer. Anal. (to appear).

FREMOND, M. (1971a): Etude de Structures Visco-Elastiques Stratifiées Soumises à des Charges Harmoniques, et de Solides Elastiques reposant sur ces Structures, Doctoral Thesis, Université Pierre et Marie Curie (Paris VI), Paris.

FREMOND, M. (1971b): Formulations duales des énergies potentielles et complémentaires. Application à la méthode des éléments finis, C.R. Acad. Sci. Paris, Sér. A, **273**, 775–777.

FREMOND, M. (1972): Utilisation de la dualité en élasticité. Compléments sur les énergies de Reissner. Equilibre d'une dalle élastique reposant sur une structure stratifiée, Annales de l'Institut Technique du Bâtiment et des Travaux Publics, Supplément au No. 294, 54–66.

FREMOND, M. (1973): Dual formulations for potential and complementary energies. Unilateral boundary conditions. Applications to the finite element method, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 175–188, Academic Press, London.

FREMOND, M. (1974): La méthode frontale pour la résolution des systèmes linéaires, in *International Computing Symposium 1973* (A. Günther *et al.*, Editors), pp. 337–343, North-Holland, Amsterdam.

FRIED, I. (1971a): Discretization and round-off errors in the finite element analysis of elliptic boundary value problems, Doctoral Thesis, Massachusetts Institute of Technology, Cambridge.

FRIED, I. (1971b): Basic computational problems in the finite element analysis of shells, Internat. J. Solids and Structures **7**, 1705–1715.

FRIED, I. (1973a): Bounds on the spectral and maximum norms of the finite element stiffness, flexibility and mass matrices, Internat. J. Solids and Structures **9** (1973), 1013–1034.

FRIED, I. (1973b): The l_2 and l_∞ condition numbers of the finite element stiffness and mass matrices, and the pointwise convergence of the method, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 163–174, Academic Press, London.

FRIED, I. (1973c): Shear in C^0 and C^1 bending finite elements, Internat. J. Solids and Structures **9**, 449–460.

FRIED, I.; YANG, S.K. (1972): Best finite elements distribution around a singularity, AIAA J. **10**, 1244–1246.

FRIED, J.; YANG, S.K. (1973): Triangular, nine-degrees-of-freedom, C^0 plate bending element of quadratic accuracy, Quart. Appl. Math. XX, 303–312.

FRIEDRICHS, K.O. (1962): A finite-difference scheme for the Neumann and the Dirichlet problem, A.E.C. Research and Development Report, Institute of Mathematical Sciences, New York University, New York.

FUTAGAMI, T. (1976): *Several Mathematical Methods in Water Pollution Control: The Finite Element & Linear Programming Method*, Doctoral Thesis, Kyoto University, Kyoto.

GABAY, D.; MERCIER, B. (1976): A dual algorithm for the solution of nonlinear variational problems via finite element approximation, Comput. Math. Appl. (to appear).

GALLAGHER, R.H. (1973): The finite element method in shell stability analysis, Computers & Structures **3**, 543–557.

GARTLING, D.K.; BECKER, E.B. (1976): Finite element analysis of viscous, incompressible fluid flow. Part 1: Basic methodology, Comput. Methods Appl. Mech. Engrg. **8**, 51–60.

GELLERT, M.; LAURSEN, M.E. (1976): Formulation and convergence of a mixed finite element method applied to elastic arches of arbitrary geometry and loading, Comput. Methods Appl. Mech. Engrg. **7**, 285–302.

GIRAULT, V. (1976a): Nonelliptic approximation of a class of partial differential equations with Neumann boundary conditions, Math. Comput. **30**, 68–91.

GIRAULT, V. (1976b): A combined finite element and Markes and Cell method for solving Navier–Stokes equations, Numer. Math. **26**, 39–59.

GIRAULT, V. (1976c): A mixed finite element method for the stationary Stokes equations (to appear).

GLOWINSKI, R. (1973): Approximations externes, par éléments finis de Lagrange d'ordre un et deux, du problème de Dirichlet pour l'opérateur biharmonique. Méthodes itératives de résolution des problèmes approchés, in *Topics in Numerical Analysis* (J.J.H. Miller, Editor), pp. 123–171, Academic Press, London.

GLOWINSKI, R. (1975): Analyse numérique d'inéquations variationnelles d'ordre 4, Rapport No. 75002, Laboratoire d'Analyse Numérique, Université Pierre et Marie Curie, Paris.

GLOWINSKI, R. (1976a): Sur l'approximation d'une inéquation variationnelle elliptique de type Bingham, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, No. 12, 13–30.

GLOWINSKI, R. (1976b): *Numerical Analysis of some Nonlinear Elliptic Boundary Value Problems*, Presses de l'Université de Montréal (to appear).

GLOWINSKI, R.; LIONS, J.-L.; TREMOLIERES, R. (1976a): *Analyse Numérique des Inéquations Variationnelles*, Vol. 1: *Théorie Générale, Premières Applications*, Dunod, Paris.

GLOWINSKI, R.; LIONS, J.-L.; TREMOLIERES, R. (1976b): *Analyse Numérique des In-*

équations Variationnelles, Vol. 2: *Applications aux Phénomènes Stationnaires et d'Evolution*, Dunod, Paris.

GLOWINSKI, R.; MARROCCO, A. (1974): Analyse numérique du champ magnétique d'un alternateur par éléments finis et sur-relaxation ponctuelle non linéaire, Comput. Methods Appl. Mech. Engrg. **3**, 55–85.

GLOWINSKI, R.; MARROCCO, A. (1975): Sur l'approximation par éléments finis d'ordre un, et la résolution par pénalisation-dualité, d'une classe de problèmes de Dirichlet non linéaires, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 41–76.

GLOWINSKI, R., PIRONNEAU, O. (1976a): Sur la résolution numérique du problème de Dirichlet pour l'opérateur biharmonique par une méthode "quasi-directe", C.R. Acad. Sci. Paris, Sér. A, **282**, 223–226.

GLOWINSKI, R.; PIRONNEAU, O. (1976b): Sur la résolution numérique du problème de Dirichlet pour l'opérateur biharmonique par la méthode du gradient conjugué. Applications, C.R. Acad. Sci. Paris, Sér. A, **282**, 1315–1318.

GLOWINSKI, R.; PIRONNEAU, O. (1976c): Sur la résolution par une méthode "quasi-directe", et par diverses méthodes itératives, d'une approximation par éléments finis mixtes du problème de Dirichlet pour l'opérateur biharmonique, Rapport No. 76010, Laboratoire d'Analyse Numérique, Université Pierre et Marie Curie, Paris.

GLOWINSKI, R.; PIRONNEAU, O. (1976d): Sur la résolution, via une approximation par éléments finis mixtes, du problème de Dirichlet pour l'opérateur biharmonique, par une méthode "quasi-directe" et diverses méthodes itératives, Rapport LABORIA No. 197, IRIA-Laboria, Le Chesnay.

GOËL, J.-J. (1968): *Utilisation Numérique de la Méthode de Ritz, Application au Calcul de Plaque*, Doctoral Thesis, Ecole Polytechnique de l'Université de Lausanne, Lausanne.

GOËL, J.-J. (1968b): Construction of basic functions for numerical utilisation of Ritz's method, Numer. Math. **12**, 435–447.

GOPALACHARYULU, S. (1973): A higher order conforming, rectangular plate element, Internat. J. Numer. Methods Engrg. **6**, 305–309.

GOPALACHARYULU, S. (1976): Author's reply to the discussion by Watkins, Internat. J. Numer. Methods Engrg. **10**, 472–474.

GORDEZIANI, D.G. (1974): On the solvability of some boundary value problems for a variant of the theory of thin shells, Dokl. Akad. Nauk SSSR **215**, No. 6, 677–680.

GORDON, W.J.; HALL, C.A. (1973): Transfinite element methods: blending-function interpolation over arbitrary curved element domains, Numer. Math. **21**, 109–129.

GOUT, J.L. (1976): Estimation de l'erreur d'interpolation d'Hermite dans R^n (to appear).

GOUYON, R. (1963): *Calcul Tensoriel*, Vuibert, Paris.

GREGOIRE, J.P.; NEDELEC, J.C.; PLANCHARD, J. (1976): A method of finding the eigenvalues and eigenfunctions of self-adjoint elliptic operators, Comput. Methods Appl. Mech. Engrg. **8**, 201–214.

GRISVARD, P. (1976): Behavior of the solutions of an elliptic boundary value problem in a polygonal or polyhedral domain, in *Numerical Solution of Partial Differential Equations*. III (SYNSPADE 1975) (B. Hubbard, Editor), pp. 207–274, Academic Press, New York.

GUGLIELMO, F. Di (1970): Méthode des éléments finis: Une famille d'approximation des espaces de Sobolev par les translatées de p fonctions, Calcolo **7**, 185–234.

GUGLIELMO, F. Di (1971): Résolution approchée de problèmes aux limites elliptiques par des schémas aux éléments finis à plusieurs fonctions arbitraires, Calcolo **8**, 185–213.

HABER, S. (1970): Numerical evaluation of multiple integrals, SIAM Rev. **12**, 481–526.

HARVEY, J.W.; KELSEY, S. (1971): Triangular plate bending elements with enforced compatibility, AIAA J. **9**, 1023–1026.

HASLINGER, J.; HLAVÁČEK, I. (1975): Curved elements in a mixed finite element method close to the equilibrium model, Apl. Mat. **20**, 233–252.

HASLINGER, J.; HLAVÁČEK, I. (1976a): A mixed finite element method close to the equilibrium model, Numer. Math. **26**, 85–97.

HASLINGER, J.; HLAVÁČEK, I. (1976b): A mixed finite element method close to the equilibrium model applied to plane elastostatics, Apl. Mat. **21**, 28–42.

HEDSTROM, G.W.; VARGA, R.S. (1971): Application of Besov spaces to spline approximation, J. Approximation Theory **4**, 295–327.

HELFRICH, H.-P. (1976): Charakterisierung des K-Funktionales zwischen Hilberträumen und nichtuniforme Fehlerschranken, Bonn. Math. Schr. **89**, 31–41.

HENNART, J.P.; MUND, E.H. (1976): Singularities in the finite element approximation of two dimensional diffusion problems, Nuclear Science and Engineering (to appear).

HENSHELL, R.D. (1973): On hybrid finite elements, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 299–311, Academic Press, London.

HENSHELL, R.D.; SHAW, K.G. (1975): Crack tip finite elements are unnecessary, Internat. J. Numer. Methods Engrg. **9**, 495–507.

HERBOLD, R.J. (1968): *Consistent Quadrature Schemes for the Numerical Solution of Boundary Value Problems by Variational Techniques*, Doctoral Thesis, Case Western Reserve University, Cleveland.

HERBOLD, R.J.; SCHULTZ, M.H.; VARGA, R.S. (1969): The effect of quadrature errors in the numerical solution of boundary value problems by variational techniques, Aequationes Math. **3**, 247–270.

HERBOLD, R.J.; VARGA, R.S. (1972): The effect of quadrature errors in the numerical solution of two-dimensional boundary value problems by variational techniques, Aequationes Math. **7**, 36–58.

HERMANN, L. (1967): Finite element bending analysis for plates, Journal of Mechanics Division, ASCE, **93**, EM5.

HESS, J.L. (1975a): Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method, Comput. Methods Appl. Mech. Engrg. **5**, 145–196.

HESS, J.L. (1975b): Improved solution for potential flow about arbitrary axisymmetric bodies by the use of a higher-order surface source method, Comput. Methods Appl. Mech. Engrg. **5**, 297–308.

HILBERT, S. (1973): A mollifier useful for approximations in Sobolev spaces and some applications to approximating solutions of differential equations, Math. Comput. **27**, 81–89.

HINATA, M.; SHIMASAKI, M.; KIYONO, T. (1974): Numerical solution of Plateau's problem by a finite element method, Math. Comput. **28**, 45–60.

HINTON, E.; CAMPBELL, J.S. (1974): Local and global smoothing of discontinuous finite element functions using a least squares method, Internat. J. Numer. Methods Engrg. **8**, 461–480.

HLAVÁČEK, I.; NEČAS, J. (1970): On inequalities of Korn's type. I. Boundary-value problems for elliptic systems of partial differential equations, Arch. Rational Mech. Anal. **36**, 305–311.

HOPPE, V. (1973): Finite elements with harmonic interpolation functions, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 131–142, Academic Press, London.

HSIAO, G.C.; WENDLAND, W. (1976): A finite element method for some integral equations of the first kind, J. Math. Anal. Appl. (to appear).

IRONS, B.M. (1974a): Un nouvel élément de coques générales – "semiloof", in *Computing Methods in Applied Sciences and Engineering, Part 1* (R. Glowinski and J.L. Lions, Editors), pp. 177–192, Springer-Verlag, New York.

IRONS, B.M. (1974b): A technique for degenerating brick-type isoparametric elements using hierarchical midside nodes, Internat. J. Numer. Methods Engrg. **8**, 203–209.

IRONS, B.M.; RAZZAQUE, A. (1972a): Experience with the patch test for convergence of finite elements, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 557–587, Academic Press, New York.

IRONS, B.M.; RAZZAQUE, A. (1972b): Shape function formulations for elements other than displacement models, paper presented at the International Conference on Variational Methods in Engineering, Southampton, 1972.

JAMET, P. (1976a): Estimations d'erreur pour des éléments finis droits presque dégénérés, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, 43–61.

JAMET, P. (1976b): Estimation de l'erreur d'interpolation dans un domaine variable et application aux éléments finis quadrilatéraux dégénérés, in *Méthodes Numériques en Mathématiques Appliquées*, pp. 55–100, Presses de l'Université de Montréal.

JAMET, P.; RAVIART, P.-A. (1974): Numerical solution of the stationary Navier-Stokes equations by finite element methods, in *Computing Methods in Applied Sciences and Engineering, Part 1* (R. Glowinski and J.-L. Lions, Editors), Lecture Notes in Computer Science, Vol. 10, Springer-Verlag.

JENKINS, H.; SERRIN, J. (1968): The Dirichlet problem for the minimal surface equation in higher dimensions, J. Reine Angew. Math. **229**, 170–187.

JOHN, F. (1965): Estimates for the derivatives of the stresses in a thin shell and interior shell equations, Comm. Pure Appl. Math. **18**, 235–267.

JOHNSON, C. (1972): Convergence of another mixed finite-element method for plate bending problems, Report No. 1972–27, Department of Mathematics, Chalmers Institute of Technology and the University of Göteborg, Göteborg.

JOHNSON, C. (1973): On the convergence of a mixed finite-element method for plate bending problems. Numer. Math. **21**, 43–62.

JOHNSON, C. (1975): On finite element methods for curved shells using flat elements, in *Numerische Behandlung von Differentialgleichungen*, pp. 147–154, International Series of Numerical Mathematics, Vol. 27, Birkhäuser Verlag, Basel and Stuttgart.

JOHNSON, C.; THOMEE, V. (1975): Error estimates for a finite element approximation of a minimal surface, Math. Comput. **29**, 343–349.

JOHNSON, M.W.; Jr.; MCLAY, R.W. (1968): Convergence of the finite element method in the theory of elasticity, J. Appl. Mech., Ser. E, **35**, 274–278.

JONES, E. (1964): A generalization of the direct-stiffness method of structure analysis, AIAA J., **2**, 821–826.

JOURON, C. (1975): Résolution numérique du problème des surfaces minima, Arch. Rational Mech. Anal. **59**, 311–341.

KELLOGG, R.B.; OSBORN, J.E. (1976): A regularity result for the Stokes problem in a convex polygon, J. Functional Analysis **21**, 397–431.

KESAVAN, S.; VANNINATHAN, M. (1977): Sur une méthode des éléments finis mixtes pour l'équation biharmonique, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 255–270.

KIKUCHI, F. (1973): Some considerations of the convergence of hybrid stress methods, in *Theory and Practice in Finite Element Structural Analysis*, pp. 25–42, University of Tokyo Press, Tokyo.

KIKUCHI, F. (1975a): On the validity of an approximation available in the finite element shell analysis, Computers & Structures **5**, 1–8.

KIKUCHI, F. (1975b): On the validity of the finite element analysis of circular arches represented by an assemblage of beam elements, Comput. Methods Appl. Mech. Engrg. **5**, 253–276.

KIKUCHI, F. (1975c): Approximation in finite element models, Report No. 531, Institute of Space and Aeronautical Science, University of Tokyo.

KIKUCHI, F. (1975d): Convergence of the ACM finite element scheme for plate bending problems, Publ. Res. Inst. Math. Sci., Kyoto University, **11**, 247–265.

KIKUCHI, F. (1975e): On a finite element scheme based on the discrete Kirchoff assumption, Numer. Math. **24**, 211–231.

KIKUCHI, F. (1976a): Theory and examples of partial approximation in the finite element method, Internat. J. Numer. Methods Engrg. **10**, 115–122.

KIKUCHI, F. (1976b): An iterative finite element scheme for bifurcation analysis of semi-linear elliptic equations, Report No. 542, Institute of Space and Aeronautical Science, University of Tokyo.

KIKUCHI, F.; ANDO, Y. (1972a): Rectangular finite element for plate bending analysis based on Hellinger–Reissner's variational principle, J. Nuclear Sci. and Tech. **9**, 28–35.

KIKUCHI, F.; ANDO, Y. (1972b): Convergence of simplified hybrid displacement method for plate bending, J. Fac. Engrg. Univ. Tokyo Ser. B **XXXI**, 693–713.

KIKUCHI, F.; ANDO, Y. (1972c): Some finite element solutions for plate bending problems by simplified hybrid displacement method, Nuclear Engineering and Design **23**, 155–178.

KIKUCHI, F.; ANDO, Y. (1972d): A new variational functional for the finite-element method and its application to plate and shell problems, Nuclear Engineering and Design **21**, 95–113.

KIKUCHI, F.; ANDO, Y. (1973a): On the convergence of a mixed finite element scheme for plate bending, Nuclear Engineering and Design **24**, 357–373.

KIKUCHI, F.; ANDO, Y. (1973b): Application of simplified hybrid displacement method to large deflection analysis of elastic-plastic plates and shells, J. Fac. Engrg. Univ. Tokyo Ser. B **XXXII**, 117–135.

KING, J.T. (1974): New error bounds for the penalty method and extrapolation, Numer. Math. **23**, 153–165.

KOITER, W. T. (1966): On the nonlinear theory of thin elastic shells, Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series B, **69**, 1–54.

KOITER, W.T. (1970): On the foundations of the linear theory of thin elastic shells. I, II, Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series B, 73, 169–195.

KOITER, W. T.; SIMMONDS, J. C. (1972): Foundations of shell theory, in *Proceedings of the Thirteenth International Congress of Theoretical and Applied Mechanics*, Moscow, pp. 150–176.

KOLAKOWSKI, H.; DRYJA, M. (1974): A boundary value problem for equations of elastic cylindrical shell, Bull. Acad. Polon. Sci. Sér. Sci. Tech. **XXII**, 37–42.

KONDRAT'EV, V.A. (1967): Boundary value problems for elliptic equations in domains with conical or angular points, Trudy Moskov. Mat. Obšč. **16**, 209–292.

KOUKAL, S. (1973): Piecewise polynomial interpolations in the finite element method, Apl. Mat. **18**, 146–160.

LADYŽENSKAJA, O.A. (1963): *The Mathematical Theory of Viscous Incompressible Flow*, Gordon and Breach, New York.

LADYŽENSKAJA, O.A.; URAL'CEVA, N.N. (1968): *Linear and Quasilinear Elliptic Equations*, Academic Press, New York.

LANCHON, H. (1972): Torsion élastoplastique d'un arbre cylindrique de section simplement ou multiplement connexe, Doctoral Thesis, Université Pierre et Marie Curie (Paris VI).

LANDAU, L.; LIFCHITZ, E. (1967): *Théorie de l'Elasticité*, Mir, Moscou.

LASCAUX, P.; LESAINT, P. (1975): Some nonconforming finite elements for the plate bending problem, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér **R-1**, 9–53.

LAURENT, P.J. (1972): *Approximation et Optimisation*, Hermann, Paris.

LAX, P.D.; MILGRAM, A.N. (1954): Parabolic equations, Annals of Mathematics Studies No. 33, 167–190, Princeton University Press, Princeton.

LEAF, G.K.; KAPER, H.G. (1974): L^∞-error bounds for multivariate Lagrange approximation, SIAM J. Numer. Anal. **11**, 363–381.

LEAF, G.K.; KAPER, H.G.; LINDEMAN, A.J. (1976): Interpolation and approximation properties of rational coordinates over quadrilaterals, J. Approximation Theory **16**, 1–15.

LELONG-FERRAND, J. (1963): *Géométrie Différentielle*, Masson, Paris.

LERAY, J.; LIONS, J.L. (1965): Quelques résultats de Visik sur les problèmes elliptiques non linéaires par les méthodes de Minty-Browder, Bull. Soc. Math. France **93**, 97–107.

LE ROUX, M.N. (1974): Equations intégrales pour le problème du potentiel électrique dans le plan, C.R. Acad. Sci. Paris, Sér. A, **278**, 541–544.

LE ROUX, M.N. (1977): Méthode d'éléments finis pour la résolution numérique de problèmes extérieurs en dimension deux, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 27–60.

LESAINT, P. (1973): Finite element methods for symmetric hyperbolic equations, Numer. Math. **21**, 244–255.

LESAINT, P. (1975): *Sur la Résolution des Systèmes Hyperboliques du Premier Ordre par des Méthodes d'Eléments Finis*, Doctoral Thesis, Université Pierre et Marie Curie, Paris.

LESAINT, P. (1976): On the convergence of Wilson's nonconforming element for solving the elastic problem, Comput. Methods Appl. Mech. Engrg. **7**, 1–16.

LEWY, H.; STAMPACCHIA, G. (1969): On the regularity of the solution of a variational inequality, Comm. Pure Appl. Math. **22**, 153–188.

LICHNEROWICZ, A. (1967): *Eléments de Calcul Tensoriel*, Armand Colin, Paris (8th edition).

LICHNEWSKY, A. (1974a): Principe du maximum local et solutions généralisées de problèmes du type hypersurfaces minimales, Bull. Soc. Math. France **102**, 417–434.

LICHNEWSKY, A. (1974b): Sur le comportement au bord des solutions généralisées du problème non paramétrique des surfaces minimales, J. Math. Pures Appl. **53**, 397–425.

LINDBERG, G.M.; OLSON, M.D. (1970): Convergence studies of eigenvalue solutions using two finite plate bending elements, Internat. J. Numer. Methods Engrg. **2**, 99–116.

LIONS, J.L. (1962): *Problèmes aux Limites dans les Equations aux Dérivées Partielles*, Presses de l'Université de Montréal, Montréal.

LIONS, J.L. (1968), *Contrôle Optimal des Systèmes Gouvernés par des Equations aux Dérivées Partielles*, Dunod–Gauthier-Villars, Paris.

LIONS, J.L. (1969): *Quelques Méthodes de Résolution des Problèmes aux Limites Non Linéaires*, Dunod, Paris.

LIONS, J.L. (1975a): Sur la théorie du contrôle (address given at the International Congress of Mathematicians, Vancouver, August 21–29, 1974), in *Actes du Congrès International des Mathématiciens*, pp. 139–154, Canadian Mathematical Congress.

LIONS, J.L. (1975b): On free surface problems: Methods of variational and quasi variational inequalities, in *Computational Mechanics* (J.T. Oden, Editor), pp. 129–148, Lecture Notes in Mathematics, Vol. 461, Springer-Verlag, Berlin.

LIONS, J.L. (1976): *Sur Quelques Questions d'Analyse, de Mécanique et de Contrôle Optimal*, Presses de l'Université de Montréal.

LIONS, J.L.; MAGENES, E. (1968): *Problèmes aux Limites non Homogènes et Applications, Vol. 1*, Dunod, Paris.

LIONS, J.L.; STAMPACCHIA, G. (1967): Variational inequalities, Comm. Pure Appl. Math. **20**, 493–519.

LOUIS, A. (1976): *Fehlerabschätzungen für Lösungen quasilinearer elliptischer Differentialgleichungen mittels Finiter Elemente*, Doctoral Thesis, Universität in Mainz.

LUKÁŠ, I.L. (1974): Curved boundary elements – General forms of polynomial mappings, in *Computational Methods in Nonlinear Mechanics* (J.T. Oden *et al.*, Editors), pp. 37–46, The Texas Institute for Computational Mechanics, Austin.

MANSFIELD, L.E. (1971): On the optimal approximation of linear functionals in spaces of bivariate functions, SIAM J. Numer. Anal. **8**, 115–126.

MANSFIELD, L.E. (1972a): Optimal approximation and error bounds in spaces of bivariate functions, J. Approximation Theory **5**, 77–96.

MANSFIELD, L.E. (1972b): On the variational characterization and convergence of bivariate splines, Numer. Math. **20**, 99–114.

MANSFIELD, L.E. (1974): Higher order compatible triangular finite elements, Numer. Math. **22**, 89–97.

MANSFIELD, L.E. (1976a): Mixed finite element methods for elliptic equations, Report No. 76–24, Institute for Computer Applications in Science and Engineering, NASA Langley Research Center, Hampton, Virginia.

MANSFIELD, L.E. (1976b): Approximation of the boundary in the finite element solution of fourth order problems (to appear).

MANSFIELD, L.E. (1976c): Interpolation to boundary data in tetrahedra with applications to compatible finite elements, J. Math. Anal. Appl. **56**, 137–164.

MATSUI, T.; MATSUOKA, O. (1976): A new finite element scheme for instability analysis of thin shells, Internat. J. Numer. Methods Engrg. **10**, 145–170.

MCLAURIN, J.W. (1974): A general coupled equation approach for solving the biharmonic boundary value problem, SIAM J. Numer. Anal. **11**, 14–33.

MCLAY, R.W. (1963): *An Investigation into the Theory of the Displacement Method of Analysis for Linear Elasticity*, Doctoral Thesis, University of Wisconsin, Madison.

MCLEOD, R.; MITCHELL, A.R. (1972): The construction of basis functions for curved elements in the finite element method, J. Inst. Math. Appl. **10**, 382–393.

MCLEOD, R.; MITCHELL, A.R. (1975): The use of parabolic arcs in matching curved boundaries in the finite element method, J. Inst. Math. Appl. **16**, 239–246.

MCNEICE, G.M.; MARCAL, P.V. (1973): Optimization of finite element grids based on minimum potential energy, Transactions of the Amer. Soc. Mech. Engrs., 95 Ser. B, No. 1, 186–190.

MEINGUET, J. (1975): Realistic estimates for generic constants in multivariate pointwise approximation, in *Topics in Numerical Analysis II* (J.J.H. Miller, Editor), pp. 89–107, Academic Press, New York.

MEINGUET, J.; DESCLOUX, J. (1977): An operator-theoretical approach to error estimation, Numer. Math. **27**, 307–326.

MELKES, F. (1970): The finite element method for non-linear problems, Apl. Mat. **15**, 177–189.

MELOSH, R.J. (1963): Basis of derivation of matrices for the direct stiffness method, AIAA J. **1**, 1631–1637.

MERCIER, B. (1974): Numerical solution of the biharmonic problem by mixed finite elements of class C^0, Boll. Un. Mat. Ital. **10**, 133–149.

MERCIER, B. (1975a): Approximation par éléments finis et résolution, par un algorithme de pénalisation-dualité, d'un problème d'élasto-plasticité, C.R. Acad. Sci. Paris, Sér. A, **280**, 287–290.

MERCIER, B. (1975b): Une méthode de résolution du problème des charges limites utilisant les fluides de Bingham, C.R. Acad. Sci. Paris, Sér. A, **281**, 525–527.

MIKHLIN, S.G. (1964): *Variational Methods in Mathematical Physics*, Pergamon, Oxford (original Russian edition: 1957).

MIKHLIN, S.G. (1971): *The Numerical Performance of Variational Methods*, Wolters-Noordhoff, Groningen.

MIRANDA, C. (1970): *Partial Differential Equations of Elliptic Type*, Springer-Verlag, New York.

MITCHELL, A.R. (1976): Basis functions for curved elements in the mathematical theory of finite elements in *The Mathematics of Finite Elements and Applications II* (J.R. Whiteman, Editor), pp. 43–58, Academic Press, London.

MITCHELL, A.R.; MARSHALL, J.A. (1975): Matching of essential boundary conditions in the finite element method, in *Topics in Numerical Analysis II* (J.J.H. Miller, Editor), pp. 109–120, Academic Press, New York.

MITTELMANN, H.D. (1977): On pointwise estimates for a finite element solution of nonlinear boundary value problems, SIAM J. Numer. Anal. **14**, 773–778.

MIYOSHI, T. (1972): Convergence of finite elements solutions represented by a non-conforming basis, Kumamoto J. Sci. (Math.) **9**, 11–20.

MIYOSHI, T. (1973a): A finite element method for the solutions of fourth order partial differential equations, Kumamoto J. Sci. (Math.) **9**, 87–116.

MIYOSHI, T. (1973b): Finite element method of mixed type and its convergence in linear shell problems, Kumamoto J. Sci. (Math), **10**, 35–58.

MIYOSHI, T. (1976a): A mixed finite element method for the solution of the von Karman Equations, Numer. Math. **26**, 255–269.

MIYOSHI, T. (1976b): Lumped mass approximation to the nonlinear bending of elastic plates (to appear).

MIYOSHI, T. (1976c): Some aspects of a mixed finite element method applied to fourth order partial differential equations in *Computing Methods in Applied Sciences* (R. Glowinski and J.L. Lions, Editors), pp. 237–256, Lecture Notes in Physics, Vol. 58, Springer-Verlag, Berlin.

MIYOSHI, T. (1977): Application of a mixed finite element method to a nonlinear problem of elasticity (to appear in Proceedings of the Symposium on the Mathematical Aspects of the Finite Element Methods, Rome, December, 1975).

MOAN, T. (1974): A note on the convergence of finite element approximations for problems formulated in curvilinear coordinate systems, Comput. Methods Appl. Mech. Engrg. **3**, 209–235.

MOCK, M.S. (1975): A global *a posteriori* error estimate for quasilinear elliptic problems, Numer. Math. **24**, 53–61.

MOCK, M.S. (1976): Projection methods with different trial and test spaces, Math. Comput. **30**, 400–416.

MORGAN, J.; SCOTT, R. (1975): A nodal basis for C^1 piecewise polynomials of degree $n \geq 5$, Math. Comput. **29**, 736–740.

MORGAN, J.; SCOTT, R. (1976): The dimension of the space of C^1 piecewise polynomials (to appear).

MORLEY, L.S.D. (1968): The triangular equilibrium element in the solution of plate bending problems, Aero. Quart. **19**, 149–169.

MORREY, Jr., C.B. (1966): *Multiple Integrals in the Calculus of Variations*, Die Grundlehren der math. Wissenschaften, Band 130, Springer-Verlag, New York.

MOSCO, U.; SCARPINI, F. (1975): Complementarity systems and approximations of variational inequalities, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-1**, 5–8.

MOSCO, U.; STRANG, G. (1974): One-sided approximation and variational inequalities, Bull. Amer. Math. Soc. **80** (1974), 308–312.

NAGHDI, P.M. (1963): Foundations of elastic shell theory, in *Progress in Solid Mechanics*, Vol. 4, pp. 1–90, North-Holland, Amsterdam.

NAGHDI, P.M. (1972): *The Theory of Shells and Plates, Handbuch der Physik, Vol. VI* No. a-2, pp. 425–640, Springer-Verlag, Berlin.

NATTERER, F. (1975a): Über die punktweise Konvergenz finiter Elemente, Numer. Math. **25**, 67–77.

NATTERER, F. (1975b): Berechenbare Fehlerschranken für die Methode der Finiten Elemente, pp. 109–121, International Series of Numerical Mathematics, Vol. 28, Birkhäuser Verlag, Basel.

NATTERER, F. (1976): Optimale L_2-Konvergenz finiter Elemente bei Variationsungleichungen, Bonn. Math. Schr. **89**, 1–12.

NATTERER, F. (1977): Uniform convergence of Galerkin's method for splines on highly nonuniform meshes (to appear).

NEČAS, J. (1967): *Les Méthodes Directes en Théorie des Equations Elliptiques*, Masson, Paris.

NEDELEC, J.C. (1976): Curved finite element methods for the solution of singular integral equations on surfaces in R^3, Comput. Methods Appl. Mech. Engrg. **8**, 61–80.

NEDELEC, J.C.; PLANCHARD, J. (1973): Une méthode variationnelle d'éléments finis pour la résolution numérique d'un problème extérieur dans R^3, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-3**, 105–129.

NICOLAIDES, R.A. (1972): On a class of finite elements generated by Lagrange interpolation, SIAM J. Numer. Anal. **9**, 435–445.

NICOLAIDES, R.A. (1973): On a class of finite elements generated by Lagrange interpolation. II, SIAM J. Numer. Anal. **10**, 182–189.

NIELSON, G.M. (1973): Bivariate spline functions and the approximation of linear functionals, Numer. Math. **21**, 138–160.

NITSCHE, J.A. (1968): Ein kriterium für die quasi-optimalitat des Ritzchen Verfahrens, Numer. Math. **11**, 346–348.

NITSCHE, J.A. (1969): Orthogonalreihenentwicklung nach linearen Spline-Funktionen, J. Approximation Theory **2**, 66–78.

NITSCHE, J.A. (1970): Linear Spline-Funktionen und die Methoden von Ritz für elliptische Randwertprobleme, Arch. Rational Mech. Anal. **36**, 348–355.

NITSCHE, J.A. (1971): Über ein Variationsprinzip zur Lösung von Dirichlet-Problemen bei Verwendung von Teilräumen, die keinen Randbedingungen unterworfen sind, Abh. Math. Sem. Univ. Hamburg **36**, 9–15.

NITSCHE, J.A. (1972a): Interior error estimates of projection methods, in *Proceedings EquaDiff 3*, pp. 235–239, J.E. Purkyně University, Brno.

NITSCHE, J.A. (1972b): On Dirichlet problems using subspaces with nearly zero boundary conditions, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 603–627, Academic Press, New York.

NITSCHE, J.A. (1974): Convergence of nonconforming methods, in *Mathematical Aspects of Finite Elements in Partial Differential Equations* (C. de Boor, Editor), pp. 15–53, Academic Press, New York.

NITSCHE, J.A. (1975): L_∞-convergence of finite element approximation, Second Conference on Finite Elements, Rennes.

NITSCHE, J.A. (1976a): Der Einfluss von Randsingularitäten beim Ritzschen Verfahren, Numer. Math. **25**, 263–278.

NITSCHE, J.A. (1976b): Über L_∞-Abschätzungen von Projektionen auf finite Elemente, Bonn. Math. Schr. **89**, 13–30.

NITSCHE, J.A. (1977): L_∞-convergence of finite element approximations (to appear in Proceedings of the Symposium on the Mathematical Aspects of the Finite Element Methods, Rome, December, 1975).

NITSCHE, J.A. (1976c): On L_∞-convergence of finite element approximations to the solution of a nonlinear boundary value problem (to appear in Proceedings of the Conference on Numerical Analysis, Dublin, August 16–20, 1976).

NITSCHE, J.A.; SCHATZ, A.H. (1974): Interior estimates for Ritz–Galerkin methods, Math. Comput. **28**, 937–958.

NITSCHE, J.C.C. (1975): *Vorlesungen über Minimalflächen*, Die Grundlehren der Mathematischen Wissenschaften in Einzeldarstellungen, Band 199, Springer-Verlag, Berlin.

NOOR, M.A.; WHITEMAN, J.R. (1976): Error bounds for finite element solutions of mildly nonlinear elliptic boundary value problems, Numer. Math. **26**, 107–116.

NOVOZHILOV, V.V. (1970): *Thin Shell Theory*, Wolters-Noordhoff, Groningen.

ODEN, J.T. (1972a): *Finite Elements of Nonlinear Continua*, McGraw-Hill, New York.

ODEN, J.T. (1972b): Generalized conjugate functions for mixed finite element approximations of boundary value problems, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 629–669, Academic Press, New York.

ODEN, J.T. (1973a): Theory of conjugate projections in finite element analysis, in *Lectures on Finite Element Methods in Continuum Mechanics* (J.T. Oden & E.R.A. Oliveira, Editors), pp. 41–75, The University of Alabama at Huntsville Press.

ODEN, J.T. (1973b): Approximations and numerical analysis of finite deformations of elastic solids, in *Nonlinear Elasticity*, pp. 175–228, Academic Press, New York.

ODEN, J.T. (1973c): Some contributions to the mathematical theory of mixed finite element approximation, in *Theory and Practice in Finite Element Structural Analysis*, pp. 3–23, University of Tokyo Press, Tokyo.

ODEN, J.T. (1975) Mathematical aspects of finite-element approximations in continuum mechanics, in *Mechanics Today*, Vol. II (S. Nemat-Nasser, Editor), pp. 159–250, Pergamon Press, New York.

ODEN, J.T. (1976a): Some new results on the theory of hybrid finite element methods (to appear in Proceedings of the Symposium on the Mathematical Aspects of the Finite Element Methods, Rome, December, 1975).

ODEN, J.T. (1976b): Galerkin approximations of a class of nonlinear boundary-value problems and evolution problems in elasticity, in *Computing Methods in Applied Sciences* (R. Glowinski and J.L. Lions, Editors), pp. 175–192, Lecture Notes in Physics, Vol. 58, Springer-Verlag, Berlin.

ODEN, J.T.; LEE, J.K. (1975): Theory of mixed and hybrid finite-element approximations in linear elasticity (IUTAM/IUM Symposium on Applications of Methods of Functional Analysis to Problems of Mechanics), Lecture Notes in Mathematics, Springer-Verlag, Berlin.

ODEN, J.T.; LEE, J.K. (1977): Dual-mixed-hybrid finite element method for second-order elliptic problems (to appear).

ODEN, J.T.; REDDY, J.N. (1974): On dual-complementary variational principles in mathematical physics, Internat. J. Engrg. Sci. **12**, 1–29.

ODEN, J.T.; REDDY, J.N. (1975): Some observations on properties of certain mixed finite element approximations, Internat. J. Numer. Methods. Engrg. **9**, 933–938.

ODEN, J.T.; REDDY, J.N. (1976a): *An Introduction to the Mathematical Theory of Finite Elements*, Wiley Interscience, New York.

ODEN, J.T.; REDDY, J.N. (1976b): *Variational Methods in Theoretical Mechanics*, Springer-Verlag, Heidelberg.

ODEN, J.T.; REDDY, J.N. (1976c): On mixed finite element approximations, SIAM J. Numer. Anal. **13**, 393–404.

OGANESJAN, L.A.; RUKHOVETS, P.A. (1969): Investigation of the convergence rate of variational-difference schemes for elliptic second order equations in a two-dimensional domain with a smooth boundary, Ž. Vyčisl. Mat. i Mat. Fyz. **9**, 1102–1120.

OLIVEIRA, E.R. DE ARANTES E (1968): Theoretical foundations of the finite element method, Internat. J. Solids and Structures **4**, 929–952.

OLIVEIRA, E.R. DE ARANTES E (1969): Completeness and convergence in the finite element method, in *Proceedings of the Second Conference on Matrix Methods in Structural Mechanics*, pp. 1061–1090, Wright-Patterson AFB, Ohio.

OLIVEIRA, E.R. DE ARANTES E (1976): The patch test and the general convergence criteria of the finite element method, Internat. J. Solids and Structures (to appear).

OSBORN, J.E. (1974): Spectral approximation for compact operators, Technical Report 74–26, Department of Mathematics, University of Maryland, College Park.

OSBORN, J.E. (1976a): Approximation of the eigenvalues of a nonselfadjoint operator arising in the study of the stability of stationary solutions of the Navier–Stokes equations, SIAM J. Numer. Anal. **13**, 185–197.

OSBORN, J.E. (1976b): Regularity of solutions of the Stokes problem in a polygonal domain, in *Numerical Solution of Partial Differential Equations – III* (SYNSPADE 1975) (B. Hubbard, Editor), pp. 393–411, Academic Press, New York.

PAYNE, L.E. (1970): Some isoperimetric inequalities for harmonic functions, SIAM J. Math. Anal. **1**, 354–359.

PELISSIER, M.C. (1975): *Sur Quelques Problèmes Non Linéaires en Glaciologie*, Doctoral Thesis, Université Paris XI, Orsay.

PERCELL, P. (1976): On cubic and quartic Clough–Tocher finite elements, SIAM J. Numer. Anal. **13**, 100–103.

PETROVSKY, I.G. (1954): *Lectures on Partial Differential Equations*, Interscience, New York.

PIAN, T.H.H. (1971): Formulations of finite element methods for solid continua, in *Recent Advances in Matrix Methods* (R.H. Gallagher, Y. Yamada, J.T. Oden, Editors), pp. 49–83, The University of Alabama Press, Huntsville.

PIAN, T.H.H. (1972): Finite element formulation by variational principles with relaxed continuity requirements, in *The Mathematical Foundations of the Finite Element Method* (A.K. Aziz, Editor), pp. 671–687, Academic Press, New York.

PIAN, T.H.H.; TONG, P. (1969a): Basis of finite element methods for solid continua, Internat. J. Numer. Methods Engrg. **1**, 3–28.

PIAN, T.H.H.; TONG, P. (1969b): A variational principle and the convergence of a finite element method based on assumed stress distribution, International J. Solids and Structures **5**, 463–472.

PIERCE, J.G.; VARGA, R.S. (1972a): Higher order convergence results for the Rayleigh–Ritz method applied to eigenvalue problems. 1: Estimates relating Rayleigh–Ritz and Galerkin approximations to eigenfunctions, SIAM J. Numer. Anal. **9**, 137–151.

PIERCE, J.G.; VARGA, R.S. (1972b): Higher order convergence results for the Rayleigh–Ritz method applied to eigenvalue problems: 2. Improved error bounds for eigenfunctions, Numer. Math. **19**, 155–169.

PINI, F. (1974): Approximation by finite element functions using global regularization, Report, Département de Mathématiques, Ecole Polytechnique Fédérale de Lausanne.

POCESKI, A. (1975): A mixed finite element method for bending of plates, Internat. J. Numer. Methods Engrg. **9**, 3–15.

PÓLYA, G. (1952): Sur une interprétation de la méthode des différences finies qui peut fournir des bornes supérieures ou inférieures, C.R. Acad. Sci. Paris **235**, 995–997.

PRAGER, W. (1975): A note on the optimal choice of finite element grids, Comput. Methods Appl. Mech. Engrg. **6**, 363–366.

RABIER, P. (1977): Interpolation harmonique, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 159–180.

RACHFORD, H.H., Jr.; WHEELER, M.F. (1974): An H^{-1}-Galerkin procedure for the two-point boundary value problem, in *Mathematical Aspects of Finite Elements in*

Partial Differential Equations (C. de Boor, Editor), pp. 353–382, Academic Press, New York.

RADÓ, T. (1930): The problem of the least area and the problem of Plateau, Math. Z. **32**, 763–796.

RAJAGOPALAN, K. (1976): Comment on: A note on the optimal choice of finite element grids, Comput. Methods Appl. Mech. Engrg. **8**, 361–362.

RANNACHER, R. (1976a): Punktweise Konvergenz der Methode der finiten Elemente beim Plattenproblem, Manuscripta Math. **19**, 401–416.

RANNACHER, R. (1976b): Zur L^∞-Konvergenz linearer finiter Elemente beim Dirichlet problem, Math. Z. **149**, 69–77.

RANNACHER, R. (1977): Some asymptotic error estimates for finite element approximation of minimal surfaces, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 181–196.

RAPPAZ, J. (1976): Approximation par la Méthode des Eléments Finis du Spectre d'un Opérateur Non Compact Donné par la Stabilité Magnétohydrodynamique d'un Plasma, Doctoral Thesis, Ecole Polytechnique Fédérale, Lausanne.

RAPPAZ, J. (1977): Approximation of the spectrum of a non-compact operator given by the magnetohydrodynamic stability of a plasma, Numer. Math. **28**, 15–24.

RAVIART, P.-A. (1972): Méthode des Eléments Finis, Lecture Notes (D.E.A. Analyse Numérique), Laboratoire d'Analyse Numérique, Université Pierre et Marie Curie (Paris VI).

RAVIART, P.-A. (1975): Hybrid finite element methods for solving 2nd order elliptic equations, in *Topics in Numerical Analysis. II* (J.J.H. Miller, Editor), pp. 141–155, Academic Press, New York.

RAVIART, P.-A. (1976): On some applications of mixed finite element methods (to appear in Proceedings of the "Colloque Franco-Brésilien sur les Méthodes Numériques de l'Ingénieur", August 1976, Rio de Janeiro).

RAVIART, P.-A.; THOMAS, J.M. (1977a): A mixed finite element method for 2nd order elliptic problems (to appear in Proceedings of the Symposium on the Mathematical Aspects of the Finite Element Methods, Rome, December, 1975).

RAVIART, P.-A.; THOMAS, J.M. (1977b): Primal hybrid finite element methods for 2nd order elliptic equations, Math. Comput. **31**, 391–413.

RAZZAQUE, A. (1973): Program for triangular bending elements with derivatives smoothing, Internat. J. Numer. Methods Engrg. **6**, 333–343.

REDDY, J.N. (1973): *A Mathematical Theory of Complementary-Dual Variational Principles and Mixed Finite-Element Approximations of Linear Boundary-Value Problems in Continuum Mechanics*, Doctoral Thesis (TICOM Report 73-7), The University of Texas at Austin, Austin.

REDDY, J.N. (1976): On mixed-hybrid finite element approximations of the biharmonic equation (to appear in Proceedings of the Second SIAM-SIGNUM 1975 Fall meeting).

REDDY, J.N.; ODEN, J.T. (1973): Convergence of mixed finite-element approximations of a class of linear boundary-value problems, J. Struct. Mech. **2**, 83–108.

RHAM, G. DE (1955): *Variétés Differentiables*, Hermann, Paris.

RIESZ, F.; NAGY, B.SZ. (1952): *Leçons d'Analyse Fonctionnelle*, Budapest, Akadémiai Kiadó.

ROBINSON, J. (1973): Basis for isoparametric stress elements, Comput. Methods Appl. Mech. Engrg. **2**, 43–63.

ROSE, M.E. (1975): Weak-element approximations to elliptic differential equations, Numer. Math. **24**, 185–204.

ROUGEE, P. (1969): *Equilibre des Coques Elastiques Minces Inhomogènes en Théorie non Linéaire*, Doctoral Thesis, Université de Paris.

ROUX, J. (1976): Résolution numérique d'un problème d'écoulement subsonique de fluides compressibles, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, No. 12, 31–50.

SAMUELSSON, (1973): Mixed finite element methods in theory and application, in *Proceedings of the Finite Element Course* (Tirrenia), Istituto di elaborazione della informazione, Pisa.

SANDER, G. (1964): Bornes supérieures et inférieures dans l'analyse matricielle des plaques en flexion-torsion, Bull. Soc. Roy. Sci. Liège **33**, 456–494.

SARD, A. (1963), *Linear Approximation*, Math. Survey 9, American Mathematical Society, Providence, R.I.

SCARPINI, F.; VIVALDI, M.A. (1977): Error estimates for the approximation of some unilateral problems, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 197–208.

SCHATZ, A.H. (1974): An observation concerning Ritz–Galerkin methods with indefinite bilinear forms, Math. Comput. **28**, 959–962.

SCHATZ, A.H.; WAHLBIN, L.B. (1976): Maximum norm error estimates in the finite element method for Poisson equation on plane domains with corners (to appear).

SCHATZ, A.H.; WAHLBIN, L.B. (1977): Interior maximum norm estimates for finite element methods, Math. Comput. **31**, 414–442.

SCHEURER, B. (1977): Existence et approximation de point-selle pour certains problèmes non linéaires (to appear).

SCHOLZ, R. (1976): Approximation von Sattelpunkten mit finiten Elementen, Bonn. Math. Schr. **89**, 53–66.

SCHOLZ, R. (1977): L_∞-convergence of saddle-point approximations for second order problems, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **11**, 209–216.

SCHULTZ, M.H. (1969a): Error bounds for the Rayleigh–Ritz–Galerkin Method, J. Math. Anal. Appl. **27**, 524–533.

SCHULTZ, M.H. (1969b): L^∞-multivariate approximation theory, SIAM J. Numer. Anal. **6**, 161–183.

SCHULTZ, M.H. (1971): L^2 error bounds for the Rayleigh–Ritz–Galerkin method, SIAM J. Numer. Anal. **8**, 737–748.

SCHULTZ, M.H. (1972): Quadrature–Galerkin approximations to solutions of elliptic differential equations, Proc. Amer. Math. Soc. **33**, 511–515.

SCHULTZ, M.H. (1973): Error bounds for a bivariate interpolation scheme, J. Approximation Theory **8**, 189–194.

SCHWARTZ, L. (1966): *Théorie des Distributions*, Hermann, Paris.

SCHWARTZ, L. (1967): *Cours d'Analyse*, Hermann, Paris.

SCOTT, R. (1973a): *Finite Element Techniques for Curved Boundaries*, Doctoral Thesis, Massachusetts Institute of Technology, Cambridge.

SCOTT, R. (1973b): Finite element convergence for singular data, Numer. Math. **21**, 317–327.

SCOTT, R. (1974): C^1 continuity via constraints for 4th order problems, in *Mathematical Aspects of Finite Elements in Partial Differential Equations* (C. de Boor, Editor), pp. 171–193, Academic Press, New York.

SCOTT, R. (1975): Interpolated boundary conditions in the finite element method, SIAM J. Numer. Anal. **12**, 404–427.

SCOTT, R. (1976a): Optimal L^∞ estimates for the finite element method on irregular meshes, Math. Comput. **30**, 681–697.

SCOTT, R. (1976b): A survey of displacement methods for the plate bending problem (to appear in Proceedings of the U.S.-Germany Symposium on Formulations and Computational Algorithms in Finite Element Analysis, Massachusetts Institute of Technology, Cambridge, August 09–13, 1976).

SHAH, J.M. (1970): Two-dimensional polynomial splines, Numer. Math. **15**, 1–14.

SHILOV, G.E. (1968): *Generalized Functions and Partial Differential Equations*, Gordon and Breach, New York.

SHOIKET, B.A. (1974): On existence theorems in linear shell theory, J. Appl. Math. Mech. **38**, 527–531.

SILVESTER, P.; HSIEH, M.S. (1971): Finite-element solution of 2-dimensional exterior-field problems, Proc. Inst. Elec. Engrs. **118**, 1743–1748.

SMITH, J. (1968): The coupled equation approach to the numerical solution of the biharmonic equation by finite differences. I, SIAM J. Numer. Anal. **5**, 323–339.

SMITH, J. (1973): On the approximate solution of the first boundary value problem for $\nabla^4 u = f$, SIAM J. Numer. Anal. **10**, 967–982.

SMITH, K.T. (1961): Inequalities for formally positive integro-differential forms, Bull. Amer. Math. Soc. **67**, 368–370.

SOBOLEV, S.L. (1950): *Application of Functional Analysis in Mathematical Physics*, Leningrad (English translation: American Mathematical Society, Providence, 1963).

STAKGOLD, I. (1968): *Boundary Value Problems of Mathematical Physics*, Vol. II, The MacMillan Company, New York.

STAMPACCHIA, G. (1964): Formes bilinéaires coercitives sur les ensembles convexes, C.R. Acad. Sci. Paris Sér. A, **258**, 4413–4416.

STEIN, E.; AHMAD, R. (1974): On the stress computation in finite element models based upon displacement approximations, Comput. Methods Appl. Mech. Engrg. **4**, 81–96.

STEPHAN, E.; WEISSGERBER, V. (1976): Zur Approximation von Schalen mit Hybriden Elementen, Preprint Nr. 300, Fachbereich Mathematik, Technische Hochschule Darmstadt, Darmstadt.

STRANG, G. (1971): The finite element method and approximation theory, in *Numerical Solutions of Partial Differential Equations II* (B.E. Hubbard, Editor), pp. 547–583. Academic Press, New York.

STRANG, G. (1972a): Approximation in the finite element method, Numer. Math. **19**, 81–98.

STRANG, G. (1972b): Variational crimes in the finite element method, in *The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations* (A.K. Aziz, Editor), pp. 689–710, Academic Press, New York.

STRANG, G. (1973): Piecewise polynomials and the finite element method, Bull. Amer. Math. Soc. **79**, 1128–1137.

STRANG, G. (1974a): The dimension of piecewise polynomials, and one-sided approximation, in *Conference on the Numerical Solution of Differential Equations* (G.A. Watson, Editor), pp. 144–152, Lecture Notes in Mathematics, Vol. 363, Springer-Verlag, New York, 1974.

STRANG, G. (1974b): The finite element method-Linear and nonlinear applications (address given at the International Congress of Mathematicians, Vancouver, August 21–29, 1974).

STRANG, G.; BERGER, A. (1971): The change in solution due to change in domain, in *Proceedings of the A.M.S. Symposium on Partial Differential Equations* (Berkeley, 1971), Academic Press, New York.

STRANG, G.; FIX, G.J. (1971): A Fourier analysis of the finite element method, in *Proceedings of the CIME Summer School*, Crimonese, Rome.

STRANG, G.; FIX, G.J. (1973): *An Analysis of the Finite Element Method*, Prentice-Hall, Englewood Cliffs.

STRICKLIN, J.A.; HAISLER, W.E.; TISDALE, P.R.; GUNDERSON, R. (1969): A rapidly converging triangular plate element, AIAA J. **7**, 180–181.

STROUD, A.H. (1971): *Approximate Calculation of Multiple Integrals*, Prentice Hall, Englewood Cliffs.

SYNGE, J.L. (1957): *The Hypercircle in Mathematical Physics*, Cambridge University Press.

TAYLOR, C.; HOOD, P. (1973): A numerical solution of the Navier–Stokes equations using the finite element technique, Computers and Fluids **1**, 73–100.

TEMAM, R. (1971): Solutions généralisées de certaines équations du type hypersurfaces minima, Arch. Rational. Mech. Anal. **44**, 121–156.

TEMAM, R. (1973): *On the Theory and Numerical Analysis of the Navier–Stokes Equations*, Lecture Notes #9, Department of Mathematics, University of Maryland, College Park.

TEMAM, R. (1977): *Navier Stokes Equations*, North-Holland, Amsterdam.

TEMAM, R.; THOMASSET, F. (1976): Numerical solution of Navier–Stokes equations by a finite element method (to appear in Proceedings of the Conference on Numerical Methods in Fluid Mechanics, Rapallo 1976).

THATCHER, R.W. (1976): The use of infinite grid refinements at singularities in the solution of Laplace's equation, Numer. Math. **25**, 163–178.

THOMAS, J.M. (1975): Méthode des éléments finis équilibres, in *Journées Eléments Finis 1975*, Université de Rennes.

THOMAS, J.M. (1976): Méthode des éléments finis hybrides duaux pour les problèmes elliptiques du second ordre, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **10**, No. 12, 51–79.

THOMAS, J.M. (1977): *Sur l'Analyse Numérique des Méthodes d'Eléments Finis Hybrides et Mixtes*, Doctoral Thesis, Université Pierre et Marie Curie.

THOMASSET, F. (1974): *Etude d'une Méthode d'Eléments Finis de Degré 5; Application aux Problèmes de Plaques et d'Ecoulement de Fluides*, Doctoral Thesis (3ème cycle), Université de Paris-Sud, Orsay.

THOMÉE, V. (1973a): Approximate solution of Dirichlet's problem using approximating polygonal domain, in *Topics in Numerical Analysis* (J.J.H. Miller, Editor), pp. 311–328, Academic Press, New York.

THOMÉE, V. (1973b): Polygonal domain approximation in Dirichlet's problem, J. Inst. Math. Appl. **11**, 33–44.

TIMOSHENKO, S.; WOINOWSKY-KREIGER, S. (1959): *Theory of Plates and Shells*, McGraw-Hill.

TOMLIN, G.R. (1972): An optimal successive overrelaxation technique for solving second order finite difference equations for triangular meshes, Internat. J. Numer. Methods Engrg. **5**, 25–39.

TONTI, E. (1970): On the formal structure of continuum mechanics, part I: Deformation theory, Meccanica V, n° 1.

TORBE, I.; CHURCH, K. (1975): A general quadrilateral plate element, Internat. J. Numer. Methods Engrg. **9**, 855–868.

TREVES, F. (1967): *Topological Vector Spaces, Distributions and Kernels*, Academic Press, New York.

TURCKE, D.J.; MCNEICE, G.M. (1972): A variational approach to grid optimisation in the finite element method, in *Proceedings International Conference on Variational Methods in Engineering, Southampton, Vol. 1*, pp. 4/114–4/130.

TURNER, M.J.; CLOUGH, R.W.; MARTIN, H.C.; TOPP, L.J. (1956): Stiffness and deflection analysis of complex structures, J. Aero. Sci. **23**, 805–823.

VALIRON, G. (1950): *Equations Fonctionnelles. Applications*, Masson, Paris (2nd edition).

VARGA, R.S. (1966): Hermite interpolation-type Ritz methods for two-point boundary value problems, in *Numerical Solution of Partial Differential Equations* (J.H. Bramble, Editor), pp. 365–373, Academic Press, New York.

VARGA, R.S. (1971): *Functional Analysis and Approximation Theory in Numerical Analysis*, Regional Conference Series in Applied Mathematics, SIAM, Philadelphia, Pennsylvania.

VEIDINGER, L. (1972): On the order of convergence of the Rayleigh–Ritz method with piecewise linear trial functions, Acta Math. Acad. Sci. Hungar. **23**, 507–517.

VEIDINGER, L. (1974): On the order of convergence of a finite element scheme, Acta Math. Acad. Sci. Hungar. **25**, 401–412.

VEIDINGER, L. (1975): On the order of convergence of a finite element method in regions with curved boundaries, Acta Math. Acad. Sci. Hungar. **26**, 419–431.

VEKUA, I.N. (1965): Theory of thin shallow shells of variable thickness, Akad. Nauk Gruzin. SSR Trudy Tbilissi Mat. Inst. Razmadze **30**, 3–103.

VO-KHAC KHOAN (1972a): *Distributions, Analyse de Fourier, Opérateurs aux Dérivées Partielles, Vol. 1*, Vuibert, Paris.

VO-KHAC KHOAN (1972b): *Distributions, Analyse de Fourier, Opérateurs aux Dérivées Partielles, Vol. 2*, Vuibert, Paris.

WACHSPRESS, E.L. (1971): A rational basis for function approximation, J. Inst. Math. Appl. **8**, 57–68.

WACHSPRESS, E.L. (1973): A rational basis for function approximation, II. Curved sides, J. Inst. Math. Appl. **11**, 83–104.

WACHSPRESS, E.L. (1975): *A Rational Finite Element Basis*, Academic Press, New York.

WAIT, R.; MITCHELL, A.R. (1971): Corner singularities in elliptic problems by finite element methods, J. Computational Phys. **8**, 45–52.

WALSH, J. (1971): Finite-difference and finite-element methods of approximation, Proc. Roy. Soc. London Ser. A **323**, 155–165.

WASHIZU, K. (1968): *Variational Methods in Elasticity and Plasticity*, Pergamon, Oxford.

WHITEMAN, J.R. (1975): *A Bibliography for Finite Elements*, Academic Press, New York.

WILSON, E.L.; TAYLOR, R.L. (1971): Incompatible displacement models, in *Proceedings of the Symposium on Numerical and Computer Methods in Structural Engineering* (O.N.R.; University of Illinois, September, 1971).

WOLF, J.P. (1975): Alternate hybrid stress finite element models, Internat. J. Numer. Methods Engrg. **9**, 601–615.

YAMAMOTO, Y.; SUMI, Y. (1976): Stress intensity factors for three-dimensional cracks (to appear in the Proceedings of the 14th International Congress on Theoretical and Applied Mechanics, Delft, 1976).

YAMAMOTO, Y.; TOKUDA, N. (1973): Determination of stress intensity factors in cracked plates by the finite element method, Internat. J. Numer. Methods Engrg. **6**, 427–439.

ŽENÍŠEK, A. (1970): Interpolation polynomials on the triangle, Numer. Math. **15**, 283–296.

ŽENÍŠEK, A. (1972): Hermite interpolation on simplexes in the finite element method, in *Proceedings EquaDiff 3*, pp. 271–277, J.E. Purkyně University, Brno.

ŽENÍŠEK, A. (1973): Polynomial approximation on tetrahedrons in the finite element method, J. Approximation Theory **7**, 334–351.

ŽENÍŠEK, A. (1974): A general theorem on triangular finite $C^{(m)}$-elements, Rev. Française Automat. Informat. Recherche Opérationnelle Sér. Rouge Anal. Numér. **R-2**, 119–127.

ZIENKIEWICZ, O.C. (1971): *The Finite Element Method in Engineering Science*, McGraw-Hill, London.

ZIENKIEWICZ, O.C. (1973): Finite elements. The background story, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 1–35, Academic Press, London.

ZIENKIEWICZ, O.C. (1974): Constrained variational principles and penalty function methods in finite element analysis, in *Conference on the Numerical Solution of Differential Equations* (G.A. Watson, Editor), pp. 207–214, Lecture Notes in Mathematics, Vol. 363, Springer-Verlag, New York.

ZIENKIEWICZ, O.C.; TAYLOR, R.L.; TOO, J.M. (1971): Reduced integration technique in general analysis of plates and shells, Internat. J. Numer. Methods Engrg. **3**, 275–290.

ZLÁMAL, M. (1968): On the finite element method, Numer. Math. **12**, 394–409.

ZLÁMAL, M. (1970): A finite element procedure of the second order of accuracy, Numer. Math. **16**, 394–402.

ZLÁMAL, M. (1973a): The finite element method in domains with curved boundaries, Internat. J. Numer. Methods Engrg. **5**, 367–373.

ZLÁMAL, M. (1973b): Curved elements in the finite element method. I. SIAM J. Numer. Anal. **10**, 229–240.

ZLÁMAL, M. (1973c): Some recent advances in the mathematics of finite elements, in *The Mathematics of Finite Elements and Applications* (J.R. Whiteman, Editor), pp. 59–81, Academic Press, London.

ZLÁMAL, M. (1973d): A remark on the "Serendipity family", Internat. J. Numer. Methods Engrg **7**, 98–100.

ZLÁMAL, M. (1974): Curved elements in the finite element method. II, SIAM J. Numer. Anal. **11**, 347–362.

GLOSSARY OF SYMBOLS

General notation

$v(\cdot)$, $v(\cdot,\cdot)$, etc...: function v of one variable, two variables, etc...
$v(\cdot, b)$: partial mapping $x \to v(x, b)$.
$\operatorname{supp} v = \{x \in X;\ v(x) \neq 0\}^-$: support of a function v.
$\operatorname{osc}(v; A) = \sup_{x,y \in A} |v(x) - v(y)|$.
v_A or $v_{|A}$: restriction of a function v to the set A.
$P(A) = \{P_{|A};\ \forall p \in P\}$, where P is any space of functions defined over a domain which contains the set A.
$\operatorname{tr} v$, or simply v: trace of a function v.
$R(v) = \dfrac{a(v, v)}{(v, v)}$: Rayleigh quotient.
$C(a)$, $C(a, b)$, etc...: any "constant" which depends solely on a, a and b, etc...
$\mathring{A}$: interior of a set A.
∂A: boundary of a set A.
$\bar{A}$ or A^-: closure of a set A.
card A: number of elements of a set A.
diam A: diameter of a set A.
$\complement A$, or $\complement_X A$, or $X - A$: Complement set of the subset A of the set X.
$\Rightarrow$: implies.

Derivatives and differential calculus

$Dv(a)$, or $v'(a)$: first (Fréchet) derivative of a function v at a point a.
$D^2v(a)$, or $v''(a)$: second (Fréchet) derivative of a function v at a.
$D^kv(a)$: k-th (Fréchet) derivative of a function v at a point a.
$D^kv(a)h^k = D^kv(a)(h_1, h_2, \ldots, h_k)$ if $h_1 = h_2 = \cdots = h_k = h$.
$\mathcal{R}_k(v; b, a) = v(b) - \left\{v(a) + Dv(a)(b-a) + \cdots + \frac{1}{k!} D^kv(a)(b-a)^k\right\}$.

$$\left.\begin{aligned}\partial_i v(A) &= Dv(a)e_i,\\ \partial_{ij}v(a) &= D^2v(a)(e_i, e_j),\\ \partial_{ijk}v(a) &= D^3v(a)(e_i, e_j, e_k).\end{aligned}\right\}\quad \text{(also used for vector-valued functions)}$$

$J_F(\hat{x}) = \det(\partial_j F_i(\hat{x})) =$ Jacobian of a mapping $F: \hat{x} \in \mathbf{R}^n \to F(\hat{x}) = (F_i(x))_{i=1}^n \in \mathbf{R}^n$.

$\operatorname{div} \boldsymbol{v} = \sum_{i=1}^n \partial_i v$.

$\nabla v(a) = (\partial_i v)_{i=1}^n$, also denoted $\nabla v(a)$, grad $v(a)$.

$\Delta v = \sum_{i=1}^n \partial_{ii} v$, $\Delta \boldsymbol{v} = (\Delta v_i)_{i=1}^n$.

$|\alpha| = \sum_{i=1}^n \alpha_i$, for a multi-index $\alpha = (\alpha_1, \ldots, \alpha_n) \in N^n$.

$\partial^\alpha v(a) = D^{|\alpha|}v(a)(\overbrace{e_1, \ldots, e_1}^{\alpha_1 \text{ times}}, \overbrace{e_2, \ldots, e_2}^{\alpha_2 \text{ times}}, \ldots, \overbrace{e_n, \ldots, e_n}^{\alpha_n \text{ times}})$.

$\nu = (\nu_1, \nu_2, \ldots, \nu_n)$: unit outer normal vector.

$\partial_\nu = \sum_{i=1}^n \nu_i \partial_i$: (outer) normal derivative operator.

$\tau = (\tau_1, \tau_2)$: unit tangential vector along the boundary of a plane domain.

$\partial_\tau v(a) = Dv(a)\tau = \sum_{i=1}^2 \tau_i \partial_i v(a)$.

$\partial_{\nu\tau} v(a) = D^2 v(a)(\nu, \tau) = \sum_{i,j=1}^2 \nu_i \tau_j \partial_{ij} v(a)$.

$\partial_{\tau\tau} v(a) = D^2 v(a)(\tau, \tau) = \sum_{i,j=1}^2 \tau_i \tau_j \partial_{ij} v(a)$.

$(V_I)_{I=1}^{12} = \{\partial^\alpha v_\beta, |\alpha| \leq 1,\ \beta = 1, 2,\ \partial^\alpha v_3,\ |\alpha| \leq 2\}$ (notation for admissible displacements $\boldsymbol{v} = (v_1, v_2, v_3)$ in shell theory).

Differential geometry

$(a_{\alpha\beta})$: first fundamental form of a surface.
$a = \det(a_{\alpha\beta})$.
$(b_{\alpha\beta})$: second fundamental form of a surface.
$(c_{\alpha\beta})$: third fundamental form of a surface.
$\Gamma^\alpha_{\beta\gamma}$: Christoffel symbols.
$v_{|\beta}, v_{|\alpha\beta}, \ldots$: covariant derivatives along a surface.
$ds = \sqrt{a}\, d\xi$: surface element.
$\frac{1}{R}$: curvature of a plane curve.

General notation for vector spaces.

$B(a;r)=\{x\in X;\ \|x-a\|\leq r\}$.
$\mathcal{L}(X;Y)$: space of continuous linear mappings from X into Y.
$\mathcal{L}(X)=\mathcal{L}(X;X)$.
$\mathcal{L}_k(X;Y)$: space of continuous k-linear mappings from X^k into Y.
$\mathcal{L}_2(X_1\times X_2;Y)$: space of continuous bilinear mappings from $X_1\times X_2$ into Y.
X': dual of a space X.
$\|\cdot\|^*$: norm in the space X'.
$\langle\cdot,\cdot\rangle$: duality pairing between a space and its dual.
$x+Y=\{x+y;\ y\in Y\}$.
$X+Y=\{x+y;\ x\in X,\ y\in Y\}$.
$X\oplus Y=\{x+y;\ x\in X,\ y\in Y\}$ when $X\cap Y=\{0\}$.
X/Y: quotient space of X by Y.
$\bigvee\{e_\lambda,\ \lambda\in\Lambda\}$: vector space spanned by the vectors e_λ, $\lambda\in\Lambda$.
I: identity mapping.
$\hookrightarrow$: inclusion with continuous injection.
$\overset{c}{\subset}$: inclusion with compact injection.
$\dim X$: dimension of the space X.
$\ker A=\{x\in X;\ Ax=0\}$.

Notation for specific vector spaces

$(u,v)=\int_\Omega uv\,dx$ (inner product in $L^2(\Omega)$).
$(\boldsymbol{u},\boldsymbol{v})=\int_\Omega \boldsymbol{u}\cdot\boldsymbol{v}\,dx$ (inner product in $(L^2(\Omega))^n$).
$\mathscr{C}^m(A)$: space of functions m times continuously differentiable on a subset A of $\mathbf{R}^n$.
$\mathscr{C}^\infty(A)=\bigcap_{m=0}^{\infty}\mathscr{C}^m(A)$.

$$\mathscr{C}^{m,\alpha}(A)=\{v\in C^m(\bar{\Omega});\ \forall\beta,|\beta|=m,\exists\Gamma_\beta,\ \forall x,y\in A,\\ |\partial^\beta v(x)-\partial^\beta v(y)|\leq\Gamma_\beta\|x-y\|^\alpha\}.$$

$$\|v\|_{\mathscr{C}^{m,\alpha}(A)}=\|v\|_{m,\infty,A}+\max_{|\beta|=m}\sup_{\substack{x,y\in A\\ x\neq y}}\frac{|\partial^\beta v(x)-\partial^\beta v(y)|}{\|x-y\|^\alpha}.$$

$\mathscr{D}(\Omega)=\{v\in\mathscr{C}^\infty(\Omega);\ \operatorname{supp} v$ is a compact subset of $\Omega\}$.
$\mathscr{D}'(\Omega)$: space of distributions over Ω.
$H^m(\Omega)=\{v\in L^2(\Omega);\ \forall\alpha,\ |\alpha|\leq m,\ \partial^\alpha v\in L^2(\Omega)\}$.
$H_0^m(\Omega)=$ closure of $\mathscr{D}(\Omega)$ in $H^m(\Omega)$.

$\|v\|_{m,\Omega}=\left(\sum_{|\alpha|\le m}\int_\Omega |\partial^\alpha v|^2\,dx\right)^{1/2}$.

$|v|_{m,\Omega}=\left(\sum_{|\alpha|=m}\int_\Omega |\partial^\alpha v|^2\,dx\right)^{1/2}$.

$\|\boldsymbol{v}\|_{m,\Omega}=\left(\sum_{i=1}^n \|v_i\|_{m,\Omega}^2\right)^{1/2}$ (for functions $\boldsymbol{v}=(v_i)_{i=1}^n$ in $(H^m(\Omega))^n$).

$|\boldsymbol{v}|_{m,\Omega}=\left(\sum_{i=1}^n |v_i|_{m,\Omega}^2\right)^{1/2}$ (for functions $\boldsymbol{v}=(v_i)_{i=1}^n$ in $(H^m(\Omega))^n$).

$W^{m,p}(\Omega)=\{v\in L^p(\Omega);\ \forall\alpha,\ |\alpha|\le m,\ \partial^\alpha v\in L^p(\Omega)\}$.

$W_0^{m,p}(\Omega)=$ closure of $\mathcal{D}(\Omega)$ in $W^{m,p}(\Omega)$.

$\|v\|_{m,p,\Omega}=\left(\sum_{|\alpha|\le m}\int_\Omega |\partial^\alpha v|^p\,dx\right)^{1/p},\quad 1\le p<\infty$.

$\|v\|_{m,\infty,\Omega}=\max_{|\alpha|\le m}\left\{\operatorname{ess.sup}_{x\in\Omega}|\partial^\alpha v(x)|\right\}$ (also used to denote the norm in $C^m(\bar\Omega)$).

$\|v\|^*_{m,p,\Omega}=$ norm in the dual space of $W^{m,p}(\Omega)$.

$|v|_{m,p,\Omega}=\left(\sum_{|\alpha|=m}\int_\Omega |\partial^\alpha v|^p\,dx\right)^{1/p},\quad 1\le p<\infty$.

$|v|_{m,\infty,\Omega}=\max_{|\alpha|=m}\left\{\operatorname{ess.sup}_{x\in\Omega}|\partial^\alpha v(x)|\right\}$.

$$\left.\begin{aligned}&\dot v=\{w\in W^{k+1,p}(\Omega);\ (w-v)\in P_k(\Omega)\},\\ &\|\dot v\|_{k+1,p,\Omega}=\inf_{p\in P_k(\Omega)}\|v+p\|_{k+1,p,\Omega},\ v\in\dot v,\\ &|\dot v|_{k+1,p,\Omega}=|v|_{k+1,p,\Omega},\ v\in\dot v.\end{aligned}\right\}\ \text{notation in the quotient space } W^{k+1,p}(\Omega)/P_k(\Omega)$$

$[v]_{m,\Omega}=\left(\sum_{i=1}^n\int_\Omega |D^m v(x)(e_i^m)|^2\,dx\right)^{1/2}$.

$[v]_{m,p,\Omega}=\left(\sum_{i=1}^n\int_\Omega |D^m v(x)(e_i^m)|^p\,dx\right)^{1/p}$.

$|v|_{\varphi;m,\Omega}=\left\{\int_\Omega \varphi\sum_{|\beta|=m}|\partial^\beta v|^2\,dx\right\}^{1/2}$ (weighted semi-norm).

$|v|_{m,\infty,K}=\sup_{x\in K}\|D^m v(x)\|_{\mathcal{L}_m(\mathbf{R}^n;\mathbf{R})}$ (for $v: K\subset\mathbf{R}^n\to\mathbf{R}$).

$|F|_{m,\infty,\hat K}=\sup_{\hat x\in\hat K}\|D^m F(\hat x)\|_{\mathcal{L}_m(\mathbf{R}^n;\mathbf{R}^n)}$ (for $F:\hat K\subset\mathbf{R}^n\to\mathbf{R}^n$).

$[F]_{m,\infty,\hat K}=\max_{1\le i\le n}\sup_{\hat x\in\hat K}\|D^m F(\hat x)(e_i)^m\|$ (for $F:\hat K\subset\mathbf{R}^n\to\mathbf{R}^n$).

$H^m(K)$, $W^{m,p}(K)$, $\|\cdot\|_{m,p,K}$, etc...: alternate notation for $H^m(\mathring K)$, $W^{m,p}(\mathring K)$, $\|\cdot\|_{m,p,\mathring K}$, etc... ($K$: a subset of $\mathbf{R}^n$ with interior $\mathring K$).

$H^{1/2}(\Gamma)=\{r\in L^2(\Gamma);\ \exists v\in H^1(\Omega);\ \operatorname{tr} v=r \text{ on } \Gamma\}$.

$\|r\|_{H^{1/2}(\Gamma)} = \inf\{\|v\|_{1,\Omega};\ v \in H^1(\Omega),\ \operatorname{tr} v = r \text{ on } \Gamma\}$.
$H^{-1/2}(\Gamma)$: dual space of $H^{1/2}(\Gamma)$.
$\|\cdot\|_{H^{-1/2}(\Gamma)}$: norm of $H^{-1/2}(\Gamma)$.
$\langle\cdot,\cdot\rangle_\Gamma$: duality pairing between the spaces $H^{-1/2}(\Gamma)$ and $H^{1/2}(\Gamma)$.
$W_0^1(\mathbf{R}^3)$ = completion of $\mathcal{D}(\mathbf{R}^3)$ with respect to the norm $|\cdot|_{1,\mathbf{R}^3}$.
$H(\operatorname{div};\Omega) = \{\boldsymbol{q} \in (\mathrm{L}^2(\Omega))^n;\ \operatorname{div} \boldsymbol{q} \in \mathrm{L}^2(\Omega)\}$.
$\|\boldsymbol{q}\|_{H(\operatorname{div};\Omega)} = (|\boldsymbol{q}|_{0,\Omega}^2 + |\operatorname{div} \boldsymbol{q}|_{0,\Omega}^2)^{1/2}$.

Elasticity

λ, μ: Lamé's coefficient of a material.
$E = \dfrac{\mu(3\lambda + 2\mu)}{\lambda + \mu}$: Young's modulus.
$\sigma = \dfrac{\lambda}{2(\lambda + \mu)}$: Poisson's coefficient.
$\epsilon_{ij}(\boldsymbol{v}) = \frac{1}{2}(\partial_j v_i + \partial_i v_j)$: components of the (linearized) strain tensor.
σ_{ij}: components of the stress tensor.
e: thickness of a plate, or a shell.
A: area of a cross section of an arch.
I: moment of inertia of a cross-section of an arch.
$(\gamma_{\alpha\beta})$: strain tensor (of the middle surface of a shell).
$(\bar{\rho}_{\alpha\beta})$: change of curvature tensor (of the middle surface of a shell).

Some spaces of polynomials

P_k: space of all polynomials in $x_1, \dots, x_n$ of degree $\leq k$.
$P_3' = \{p \in P_3;\quad \phi_{ijk}(p) = 0,\quad 1 \leq i < j < k \leq n+1\}$, with $\phi_{ijk}(p) = 12p(a_{ijk}) + 2\sum_{l=i,j,k} p(a_l) - 3\sum_{\substack{l,m=i,j,k\\ l\neq m}} p(a_{llm})$ (cf. the n-simplex of type (3')).
$P_3'' = \{p \in P_3;\quad \psi_{ijk}(p) = 0,\quad 1 \leq i < j < k \leq n+1\}$, with $\psi_{ijk}(p) = 6p(a_{ijk}) - 2\sum_{l=i,j,k} p(a_l) - \sum_{l=i,j,k} Dp(a_l)(a_l - a_{ijk})$ (cf. the Hermite n-simplex of type (3')).
$P_5'(K) = \{p \in P_5(K);\ \partial_\nu p \in P_3(K') \text{ for each side } K' \text{ of } K\}$
$\quad = \{p \in P_5(K);\quad \chi_{ij}(\partial_\nu p) = 0,\quad 1 \leq i < j \leq 3\}$, with $\chi_{ij}(v) = 4(v(a_i) + v(a_j)) - 8v(a_{ij}) + Dv(a_i)(a_j - a_{ij}) + Dv(a_j)(a_j - a_{ij})$ (cf. the Bell triangle).
Q_k: space of all polynomials in $x_1, \dots, x_n$, of degree $\leq k$ with respect to each variable x_i, $1 \leq i \leq n$.

$Q_2' = \{p \in Q_2;\ 4p(a_9) + \sum_{i=1}^{4} p(a_i) - 2\sum_{i=5}^{8} p(a_i) = 0\}$ (cf. the rectangle of type (2')).

$Q_3' = \{p \in Q_3;\ \psi_i(p) = 0, 1 \leq i \leq 4\}$, with $\psi_1(p) = 9p(a_{13}) + 4p(a_1) + 2p(a_2) + p(a_3) + 2p(a_4) - 6p(a_5) - 3p(a_6) - 3p(a_{11}) - 6p(a_{12})$, etc... (cf. the rectangle of type (3')).

$T_3(K)$: space of tricubic polynomials (i.e., whose restrictions along any parallel to any side of a triangle K are polynomials of degree ≤ 3 in one variable).

Notation special to $\mathbf{R}^n$

e_i, $1 \leq i \leq n$: canonical basis of $\mathbf{R}^n$, also denoted e^i, for $n = 3$.

$\|v\| = \left(\sum_{i=1}^{n} |v_i^2|\right)^{1/2}$: Euclidean norm of the vector $v = (v_i)_{i=1}^n$.

$\|B\| = \sup_{v \in \mathbf{R}^n} \frac{\|Bv\|}{\|v\|}$: norm of the matrix B, induced by the Euclidean vector norm.

$\boldsymbol{a} \cdot \boldsymbol{b}$: Euclidean scalar product in $\mathbf{R}^n$ of the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$.

$\boldsymbol{a} \times \boldsymbol{b}$: vector product of the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$.

$\det B$: determinant of a square matrix B.

$\operatorname{meas}(A) = \mathrm{d}x$-measure of a set $A \subset R^n \left(= \int_A \mathrm{d}x \right)$.

$\mathrm{d}\gamma$ = superficial measure along a Lipschitz-continuous boundary of an open subset of $\mathbf{R}^n$.

$\lambda_j = \lambda_j(x)$: barycentric coordinates of a point $x \in \mathbf{R}^n$, $1 \leq j \leq n+1$.

$a_{ij} = \dfrac{a_i + a_j}{2}$, $i < j$.

$a_{iij} = \dfrac{2a_i + a_j}{3}$, $i \neq j$.

$a_{ijk} = \dfrac{a_i + a_j + a_k}{3}$, $i \neq j$, $j \neq k$, $k \neq i$.

$L_k(K) = \left\{x = \sum_{j=1}^{n+1} \lambda_j a_j;\ \sum_{j=1}^{n+1} \lambda_j = 1,\ \lambda_j \in \left\{0, \frac{1}{k}, \ldots, \frac{k-1}{k}, 1\right\},\ 1 \leq j \leq n+1\right\}$.

$\hat{M}_k = \left\{x = \left(\frac{i_1}{k}, \frac{i_2}{k}, \ldots, \frac{i_n}{k}\right) \in \mathbf{R}^n;\ i_j \in \{0, 1, \ldots, k\},\ 1 \leq j \leq n\right\}$.

$M_k(K) = F_K(M_k)$, F_K: $x \to F_K(x) = B_K x + b_K$, B_K: diagonal matrix.

Finite Elements (most common notation)

(K, P, Σ) or (K, P_K, Σ_K): finite element.

$P = P_K$: space of functions p, or $p_K: K \to \mathbf{R}$.
$\Sigma = \Sigma_K$: set of degrees of freedom of a finite element.
$\varphi_i = \varphi_{i,K}$, $1 \leq i \leq N$: degrees of freedom of a finite element.
$p_i = p_{i,K}$, $1 \leq i \leq N$: basis functions of a finite element.
$\mathcal{N}_K$: set of nodes of a finite element.
$s = s_K$: maximal order of directional derivatives found in the set Σ.
$\Pi v = \Pi_K v = P$-, or P_K-, interpolant of a function v.
dom $\Pi = \mathscr{C}^s(K)$.
$h_K = \operatorname{diam}(K)$.
$\rho_K = \sup\{\operatorname{diam}(S);\ S \text{ is a ball contained in } K\}$.
$\hat{x} \in \hat{K} \to x = F(\hat{x}) \in K$: bijection between points of $\hat{K}$ and $K = F(\hat{K})$ (F: bijection).
$\hat{v}: \hat{K} \to \mathbf{R} \to v = \hat{v} \cdot F^{-1}: K \to \mathbf{R}$: bijection between functions defined over $\hat{K}$ and $K = F(\hat{K})$ (F: bijection).
$F \in (\hat{P})^n \Leftrightarrow F_i \in \hat{P}$, $1 \leq i \leq n$, with $\hat{P}$: space of functions $\hat{p}: \hat{K} \subset \mathbf{R}^n \to \mathbf{R}$.

$$\left.\begin{array}{l} \tilde{K} = \tilde{F}(\hat{K}), \text{ where } \tilde{F} \in (P_1(\hat{K}))^n \text{ and } \tilde{F}(\hat{a}_i) = a_i,\ 1 \leq i \leq n+1, \\ h_K = \operatorname{diam}(\tilde{K}), \\ \rho_K = \text{diameter of the sphere inscribed in } \tilde{K}. \end{array}\right\} \begin{array}{l}\text{for isopara-}\\ \text{metric simpli-}\\ \text{cial elements}\end{array}$$

$\int_K \varphi(x)\,dx \sim \sum_{l=1}^{L} \omega_l \varphi(b_l)$: quadrature formula with weights ω_l and nodes b_l.

$\hat{E}(\hat{\varphi}) = \int_{\hat{K}} \hat{\varphi}(\hat{x})\,d\hat{x} - \sum_{l=1}^{L} \hat{\omega}_l \hat{\varphi}(\hat{b}_l)$: quadrature error functional on $\hat{K}$.

$E_K(\varphi) = \int_K \varphi(x)\,dx - \sum_{l=1}^{L} \omega_{l,K} \varphi(b_{l,K})$: quadrature error functional on $K = F_K(\hat{K})$, with $\omega_{l,K} = \hat{\omega}_l J_{F_K}(\hat{b}_l)$, $b_{l,K} = F_K(\hat{b}_l)$.

Finite element spaces (most common notation)

$\mathcal{T}_h$: triangulation of a set $\bar{\Omega}$.
X_h: finite element space without boundary conditions.
$X_{0h} = \{v_h \in X_h;\ v_h = 0 \text{ on } \Gamma\}$.
$X_{00h} = \{v_h \in X_h;\ v_h = \partial_\nu v_h = 0 \text{ on } \Gamma\}$.
V_h: finite element space with boundary conditions.
Σ_h = set of degrees of freedom of a finite element space X_h.
φ_h or φ_{kh}, $1 \leq k \leq M$: degrees of freedom of a finite element space X_h.
$(w_k)_{k=1}^M$: basis in a finite element space X_h or V_h.
$\mathcal{N}_h$: set of nodes of a finite element space X_h.
$\Pi_h v$: X_h-interpolant of a function v.
dom $\Pi_h = \mathscr{C}^s(\bar{\Omega})$, $s = \max_{K \in \mathcal{T}_h} s_K$.

Various sets of hypotheses concerning the finite element method

(FEM 1): Existence of a triangulation.

(FEM 2): The spaces P_K, $K \in \mathcal{T}_h$, contain polynomials or "nearly polynomials".

(FEM 3): There exists a basis in the finite element space V_h whose functions have "small" support.

($\mathcal{T}_h$1): $\bar{\Omega} = \bigcup_{K \in \mathcal{T}_h} K$.

($\mathcal{T}_h$2): $\forall K \in \mathcal{T}_h$, $\mathring{K} \neq \emptyset$.

($\mathcal{T}_h$3): $K_1 \neq K_2 \Rightarrow \mathring{K}_1 \cap \mathring{K}_2 = \emptyset$.

($\mathcal{T}_h$4): For all $K \in \mathcal{T}_h$, the boundary ∂K is Lipschitz-continuous.

($\mathcal{T}_h$5): Condition on adjacent finite elements.

(H1): Regularity of a family of triangulations.

(H2): All finite elements (K, P_K, Σ_K), $K \in \bigcup_h \mathcal{T}_h$, are affine-equivalent to a single reference finite element.

(H3): All finite elements (K, P_K, Σ_K), $K \in \bigcup_h \mathcal{T}_h$, are of class $\mathscr{C}^0$.

(H4): The family of triangulations satisfies an inverse assumption.

(H1*): The family (K, P_K, Σ_K), $K \in \bigcup_h \mathcal{T}_h$, is almost affine.

(H2*): All finite elements (K, P_K, Σ_K), $K \in \bigcup_h \mathcal{T}_h$, are of class $\mathscr{C}^1$.

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Note: An asterisk in the left margin indicates a specific finite element.