CURRICULUM VITAE

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Professional Address:

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Home Address:

Alexandria, Virginia

Education:

1966 Ph.D. Purdue University, Adviser: Michael Golomb

Employment:

1966–68	Assistant Professor, Mathematics Research Center, University of Wisconsin
1968–70	Assistant Professor, Case-Western Reserve University
1970–72	Assistant Professor, Northwestern University
1972–76	Associate Professor, Northwestern University
1976–2012	Professor, Northwestern University
2012–	Professor Emeritus, Northwestern University
2013–2021	Adjunct Professor, George Washington University
2021–2023	Visiting Scholar, George Washington University

Visiting Positions

1974–75	Visiting Fellow, Oxford
1978–79	Visiting Professor, University of Texas at Austin
1982–83	Visiting Scientist, Bell Laboratories, Murray Hill
1985	Visiting Scholar, University of Chicago (Spring)
1994–97	Adjunct Visiting Professor, Rush Medical College

Short Term Visits

1970	MRC, University of Wisconsin
1979	MRC, University of Wisconsin
1980	Yale University
1981	Bell Laboratories
1983	IMA, University of Minnesota
1986	Bell Laboratories
1986	University of Chicago
1997	Courant Institute
1997	University of Texas

Academic Honors/Awards/Recognition

1961–65	National Science Foundation Graduate Fellow
1974–75	British Science Council Senior Fellow
1996	Purdue University School of Science Distinguished Alumnus Award
2017	Marquis Lifetime Achievement Award

Professional Activities

1966–	Member, American Mathematical Society
1982–	Member, Society for Industrial and Applied Mathematics
1968–2023	Reviewer, Mathematical Reviews (351 signed reviews)
1981–1987	Consultant, Bell Laboratories
1985–1987	Consultant, National Research Council Advisory Panels
2002–2011	Associate editor, Journal of Nonlinear Analysis
2001–2014	Associate editor, Journal of Computational Electronics
1990–2015	Advisory Committee/Program Committee, International Workshops on Computational Electronics
2004–2012	Invited nominator, Kyoto Prize

Books:

1. (with S.D. Fisher) Minimum Norm Extremals in Function Spaces, Lecture Notes in Mathematics 479, Springer-Verlag, Berlin, 1975.
2. Approximation of Nonlinear Evolution Systems, Academic Press, New York, 1983.
3. Analysis of Charge Transport: Mathematical Theory of Semiconductor Devices, Springer-Verlag, Heidelberg, 1996.
4. (editor) Modelling and Computation for Applications in Mathematics, Science, and Engineering, Oxford University Press, 1998.
5. (editor, with G.-Q. Chen and G. Gasper) Nonlinear Partial Differential Equations and Related Analysis, Contemporary Mathematics Series, vol. 371, American Math. Soc., Providence, 2005.

Publications:

1. On the L_2 n-width of certain classes of functions of several variables, Journal of Mathematical Analysis and Applications 20 (1967), 110–123.
2. Asymptotic estimates of the L_2 n-width, Journal of Mathematical Analysis and Applications 22 (1968), 449–464.
3. (with L.L. Schumaker) A note on obtaining natural spline functions by the abstract approach of Atteia and Laurent, Society for Industrial and Applied Mathematics Journal of Numerical Analysis 5 (1968), 657–663.
4. (with L.L. Schumaker) On Lg-splines, Journal of Approximation Theory 2 (1969), 29–49.
5. (with L.L. Schumaker) Applications of ε-entropy to the computation of n-widths, Proceedings of the American Mathematical Society 22 (1969), 719–722.
6. (with R.S. Varga) Generalizations of spline functions and applications to nonlinear boundary value and eigenvalue problems, in *Theory and Applications of Spline Functions* (T.N.E. Greville, editor), Academic Press, New York (1969), 103–155.
7. (with L.L. Schumaker) Characterizations of functions with higher order derivatives in L_p, Transactions of the American Mathematical Society 143 (1969), 363–371.
8. On n-widths in Sobolev spaces and applications to elliptic boundary value problems, Journal of Mathematical Analysis and Applications 29 (1970), 201–215.
9. Linear, self-adjoint, multipoint boundary value problems and related approximation schemes, Numerische Mathematik 15 (1970), 433–449.
10. (with Michael Golomb) Linear ordinary differential equations with boundary conditions on arbitrary point sets, Transactions of the American Mathematical Society 153 (1971), 235–264.
11. (with L.L. Schumaker) Local bases and computation of g-splines, Methoden und Verfahren der Mathematischen Physik 5 (1971), 171–199.

12. (with J.G. Pierce) On spline functions determined by singular self-adjoint differential operators, Journal of Approximation Theory 5 (1972), 15–40.

13. Singular, self-adjoint, multipoint boundary value problems: solutions and approximations, in *Linear Operators and Approximation* (P.L. Butzer, J.P. Kahane and B. Sz-Nagy, editors), Birkhäuser-Verlag, Basel (1972), 470–486.

14. Asymptotic estimates of the n-widths in Hilbert space, Proceedings of the American Mathematical Society 33 (1972), 367–372.

15. On uniform approximation by certain generalized spline functions, Journal of Approximation Theory 7 (1973), 143–154.

16. Non-linear, singular, multipoint boundary value problems, Zeitschrift für Angewandte Mathematik und Mechanik 53 (1973), 31–38.

17. Linearization in certain non-convex minimization problems and generalized spline projections, in *Spline Functions and Approximation Theory* (A. Meir and A. Sharma, editors), Birkhäuser-Verlag, Basel (1973), 119–167.

18. (with L.L. Schumaker) Characterizations of absolute continuity and essential boundedness for higher order derivatives, Journal of Mathematical Analysis and Applications 42 (1973), 452–465.

19. Minimization problems and linear and nonlinear spline functions I: Existence, Society for Industrial and Applied Mathematics Journal of Numerical Analysis 10 (1973), 808–819.

20. Minimization problems and linear and nonlinear spline functions II: Convergence, Ibid. 10 (1973), 820–830.

21. Topics in multivariate approximation theory, in *Approximation Theory* (G.G. Lorentz, editor), Academic Press, New York (1973), 151–198.

22. (with S.D. Fisher) Existence, characterization and essential uniqueness of solutions of L^∞ minimization problems, Transactions of the American Mathematical Society 187 (1974), 391–404.

23. (with S.D. Fisher) Elliptic variational problems in L^2 and L^∞, Indiana Journal of Mathematics 23 (1974), 685–698.

24. (with James Kaplan) A unified approach to certain nonlinear initial value and boundary value problems, Journal of Mathematical Analysis and Applications 48 (1974), 31–42.

25. (with S.D. Fisher) Perfect spline solutions to L^∞ extremal problems, Journal of Approximation Theory 12 (1974), 78–90.

26. (with L.L. Schumaker) On the distance to a class of generalized splines, in *Linear Operators and Approximation* II, International Series in Numerical Mathematics 25, Birkhäuser-Verlag, Basel (1974), 503–517.

27. (with S.D. Fisher) Spline solutions to L^1 extremal problems in one and several variables, Journal of Approximation Theory 13 (1975), 73–83.

28. Smooth interpolating curves of prescribed length and minimum curvature, Proceedings of the American Mathematical Society 51 (1975), 62–66.

29. (with S.D. Fisher) Stable and unstable elastica equilibrium and the problem of minimum curvature, Journal of Mathematical Analysis and Applications 53 (1976), 367–376.

30. (with L.L. Schumaker) Local bases for a class of spline functions, Journal of Approximation Theory 16 (1976), 16–27.

31. On spline functions derivable from singular differential operators with compact resolvents, Journal of Mathematical Analysis and Applications 53 (1976), 567–577.

32. Existence and approximation of weak solutions of the Stefan problem with nonmonotone nonlinearities, in *Numerical Analysis,* Lecture Notes in Mathematics 506, Springer-Verlag, Berlin (1976), 148–156.

33. Galerkin methods for the existence and approximation of weak solutions of nonlinear Dirichlet problems with discontinuities, in *Approximation Theory*, Lecture Notes in Mathematics 556, Springer-Verlag, Berlin (1976), 274–290.

34. Generalized boundary value problems and the evolution equation, Proceedings of the London Mathematical Society 34 (1977), 145–154.

35. (with S.D. Fisher) Uniqueness of optimal controls in L^∞, Journal of Optimization Theory and Applications 21 (1977), 469–476.

36. Nonlinear equations of evolution and a generalized Stefan problem, Journal of Differential Equations 26 (1977), 240–261.

37. Existence and approximation of weak solutions of nonlinear Dirichlet problems with discontinuous coefficients, Society for Industrial & Applied Mathematics Journal of Mathematical Analysis 9 (1978), 730–742.

38. The method of lines and the nonlinear Klein-Gordon equation, Journal of Differential Equations 30 (1978), 20–30.

39. Convergence of successive iterative semidiscretizations for FitzHugh-Nagumo reaction diffusion systems, Society for Industrial and Applied Mathematics Journal of Numerical Analysis 17 (1980), 192–206.

40. Horizontal line analysis of the multidimensional porous medium equation, Springer Lecture Notes in Mathematics 773 (G. Watson, editor), Springer-Verlag, Berlin (1980), 64–82.

41. Uniform convergence of the horizontal line method for solutions and free boundaries in Stefan evolution inequalities, Mathematical Methods in the Applied Sciences 2 (1980), 149–167.

42. (with M. Golomb) Linearized elastica and classical cubic spline interpolation, in *Approximation Theory* III (E.W. Cheney, editor), Academic Press, New York (1980), 435–442.

43. Convergence for operators of hyperbolic type, in *Approximation Theory and Applications* (Z. Ziegler, editor), Academic Press, New York (1981), 147–158.

44. (with M. Golomb) Equilibria of the curvature functional and manifolds of nonlinear interpolating spline curves, Society for Industrial and Applied Mathematics Journal of Mathematical Analysis 13 (1982), 421–458.

45. Convergent approximations in parabolic variational inequalities II: Hamilton-Jacobi inequalities, Applied Mathematics and Optimization 8 (1982), 265–274.

46. (with M. Rose) Error estimates for the multidimensional two-phase Stefan problem, Mathematics of Computation 39 (1982), 377–414.

47. (with R.E. Bank and D.J. Rose) Analytical and numerical aspects of semi-conductor device modeling, *Computing Methods in Applied Sciences and Engineering* V (R. Glowinski and J. Lions, editors), North Holland Publishing, Amsterdam (1982), 593–597.

48. Quasi-linear parabolic and hyperbolic systems: contractive semidiscretizations and convergence of the discrete viscosity method, Journal of Mathematical Analysis and Applications 90 (1982), 185–206.

49. Analysis of nonlinear elliptic systems arising in reaction/diffusion modeling, in *Elliptic Problem Solvers* II (G. Birkhoff and A. Schoenstadt, editors), Academic Press, New York (1984), 507–520.

50. Fixed point and implicit function theorems and their applications, Anniversary Volume on *Approximation Theory and Functional Analysis* (P. Butzer, R. Stens, B. Sz-Nagy, editors), Birkhäuser-Verlag, Basel (1984), 495–509.

51. Fully discrete stability and invariant rectangular regions for reaction-diffusion systems, Society for Industrial and Applied Mathematics Journal of Numerical Analysis 21 (1984), 1054–1065.

52. Consistency in semiconductor modeling: An existence/stability analysis for the stationary Van Roosbroeck system, Society for Industrial and Applied Mathematics Journal of Applied Mathematics 45 (1985), 565–590.

53. Approximate Newton methods and homotopy for stationary operator equations, Constructive Approximation 1 (1985), 271–285.

54. The role of semiconductor device diameter and energy band bending in the convergence of Picard iteration for Gummel's map, Institute for Electrical and Electronic Engineers Transactions on Electron Devices 32 (1985), 2045–2051.

55. An adaptive Newton algorithm based on numerical inversion: regularization as postconditioner, Numerische Mathematik 47 (1985), 123–138.

56. Isolated solution structure and Newton/continuation methods for stationary operator equations, Journal of Approximation Theory 48 (1986), 294–302.

57. Evolution systems in semiconductor device modeling: a cyclic uncoupled line analysis for the Gummel map, Mathematical Methods in the Applied Sciences 9 (1987), 455–492.

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59. (with C.L. Gardner and D.J. Rose) Numerical methods for the hydrodynamic device model: Subsonic flow, Institute for Electrical and Electronic Engineers Transactions on Computer Aided Design of Integrated Circuits and Systems 8 (1989), 501–507.

60. Newton's method for gradient equations based upon the fixed point map: Convergence and complexity study, Numerische Mathematik 55 (1989), 619-632.

61. (with W.M. Coughran) Modular algorithms for transient semiconductor device simulation, Part I: Analysis of the outer iteration, *Lectures in Applied Mathematics 25* (R. E. Bank, editor), American Mathematical Society, Providence (1990), 107–149.

62. Algorithmic aspects of the hydrodynamic and drift-diffusion models, in *Mathematical Modelling and Simulation of Electrical Circuits and Semiconductor Devices* (R.E. Bank, R. Bulirsch and K. Merten, editors), Birkhäuser-Verlag, Basel (1990), 217–236.

63. (with T. Kerkhoven) L_∞ stability of finite element approximations to elliptic gradient equations, Numerische Mathematik 57 (1990), 561–575.

64. An operator Newton method for the two-phase Stefan problem based on smoothing, Journal of Approximation Theory 62 (1990), 282–296.

65. (with E. Fatemi and S. Osher) Solution of the hydrodynamic device model using high-order, non-oscillatory shock capturing algorithms, Institute for Electrical and Electronic Engineers Transactions on Computer Aided Design of Integrated Circuits and Systems 10 (1991), 232–242.

66. (with T. Kerkhoven) A finite element approximation theory for the drift-diffusion semiconductor model, Society for Industrial and Applied Mathematics Journal of Numerical Analysis 28 (1991) 403–422.

67. Drift-diffusion systems: Variational principles and fixed point maps for steady state semiconductor models in *Computational Electronics* (K. Hess, J. P. Leburton and U. Ravaioli, editors), Kluwer Publishing, Boston (1991), 15–20.

68. (with E. Fatemi, C.L. Gardner, S. Osher and D.J. Rose) Simulation of a steady-state electron shock wave in a submicron semiconductor device using high-order upwind methods, in *Computational Electronics* (K. Hess, J. P. Leburton and U. Ravaioli, editors), Kluwer Publishing, Boston (1991), 27–32.

69. Numerical approximation of PDE system fixed point maps via Newton's method, Journal of Applied and Computational Mathematics 38 (1991), 211–230.

70. Energy models for device simulation, Proceedings, International Semiconductor Device Research Symposium, University of Virginia, Charlottesville, (1991), 439–440.

71. (with Chi-Wang Shu) Essentially non-oscillatory methods for two-dimensional hydrodynamic models, in *Proceedings, International Workshop on Computational Electronics*, Beckman Institute, Urbana (1992), 83–86.

72. (with Carl Gardner and Chi-Wang Shu) The ENO Method for the hydrodynamic model for semiconductor devices, in *High Performance Computing: Grand Challenges in Computer Simulation* (A. Tentner, editor), The Society for Computer Simulation, San Diego (1993), 96–101.

73. (with Z. Chen, B. Cockburn and C.-W. Shu) Finite element computation of the hydrodynamic model of semiconductor devices, in *Proceedings, Sixth SIAM Conference on Parallel Processing for Scientific Computing* (F. Sincovec *et al,* editors), SIAM, Philadelphia (1993), 228–236.

74. (with Chi-Wang Shu) Energy Models for one-carrier transport in semiconductor devices, in *Semiconductors, Part II*, IMA Volumes in Mathematics and its Applications, v. 59 (W. Coughran, J. Cole, P. Lloyd and J. White, editors), Springer-Verlag, New York (1994), 185–207.

75. The mathematical study and approximation of semiconductor models, in *Advances in Numerical Analysis: Large Scale Matrix Problems and the Numerical Solution of Partial Differential Equations* (J. Gilbert and D. Kershaw, editors), Oxford University Press (1994), 157–204.

76. (with Chi-Wang Shu) Transport effect, hyperbolicity, and shock capturing algorithms for device simulations, in *Proceedings, Third International Workshop on Computational Electronics*, Portland, Oregon, May, 1994, 252–255.

77. (with Z. Chen, B. Cockburn and C.L. Gardner) Quantum hydrodynamic simulation of hysteresis in the resonant tunneling diode, Journal of Computational Physics 117 (1995), 274–280.

78. An asymptotically linear fixed point extension of the inf-sup theory of Galerkin approximation, Numerical Functional Analysis and Optimization 16 (1995), 345–361.

79. (with Chi-Wang Shu) Transport effects and characteristic modes in the modeling and simulation of submicron devices, Institute for Electrical and Electronic Engineers Transactions on Computer Aided Design of Integrated Circuits and Systems 14 (1995), 917–923.

80. (with Z. Chen, B. Cockburn and C.-W. Shu) Mixed-RKDG finite element methods for the 2-D hydrodynamic model for semiconductor device simulation, VLSI DESIGN 3 (1995), 145–158.

81. (with Chi-Wang Shu) The response of the hydrodynamic model to heat conduction, mobility, and relaxation expressions, VLSI DESIGN 3 (1995), 131–143.

82. (with D.P. Chen, R.S. Eisenberg, and C.-W. Shu) Hydrodynamic model of temperature change in open ionic channels, Biophysical Journal 69 (1995), 2304–2322

83. The approximation problem for drift-diffusion systems, Society for Industrial and Applied Mathematics Review 37 (1995), 552–572.

84. (with Bo Zhang) On a steady-state quantum hydrodynamic model for semiconductors, Nonlinear Analysis 26 (1996), 845–856.

85. (with Chi-Wang Shu) Energy transport systems for semiconductors: Analysis and simulation, *Proceedings of the First World Congress of Nonlinear Analysts* (V. Lakshmikantham, editor), Walter de Gruyter Publishing, Berlin (1996), 3835–3846.

86. (with J. Park) Qualitative properties of solutions of steady-state Poisson-Nernst-Planck systems: Mathematical study, Society for Industrial and Applied Mathematics Journal of Applied Mathematics 57 (1997), 609–630.

87. (with V. Barcilon, D.P. Chen, and R.S. Eisenberg) Qualitative properties of solutions of steady-state Poisson-Nernst-Planck systems: Perturbation and simulation study, Society for Industrial and Applied Mathematics Journal of Applied Mathematics 57 (1997), 631–648.

88. (with Gui-Qiang Chen and Bo Zhang) Particle hydrodynamic moment models in biology and microelectronics: singular relaxation limits, Nonlinear Analysis 30 (1997), 233–244.

89. (with Gui-Qiang Chen and Chi-Wang Shu) Analysis and simulation of extended hydrodynamic models: The multi-valley Gunn oscillator and MESFET symmetries, VLSI DESIGN 6 (1998), 277–282.

90. (with Gui-Qiang Chen, Chi-Wang Shu, and Dehua Wang) Two carrier semiconductor device models with geometric structure, in *Modelling and Computation for Applications in Mathematics, Science, and Engineering*, Oxford University Press (1998), 103–140.

91. (with Gui-Qiang Chen and Bo Zhang) Existence and the singular relaxation limit for the inviscid hydrodynamic energy model, in *Modelling and Computation for Applications in Mathematics, Science, and Engineering*, Oxford University Press (1998), 189–215.

92. (with Carlo Cercignani, Irene Gamba and Chi-Wang Shu) Applicability of the high field model: An analytical study via asymptotic parameters defining domain decomposition, VLSI DESIGN 8 (1998), 135–141.

93. (with Carlo Cercignani, Irene Gamba and Chi-Wang Shu) Applicability of the high field model: A preliminary numerical study, VLSI DESIGN 8 (1998), 275–282.

94. (with Carlo Cercignani, Irene Gamba and Chi-Wang Shu) A domain decomposition method: A simulation study, in *Proceedings of the 1998 Sixth International Workshop on Computational Electronics*, Osaka University Press, 1998, pp. 174–177.

95. (with Gregory Fasshauer) Multistep approximation algorithms: Improved convergence rates through postconditioning with smoothing kernels, Advances in Computational Mathematics 10 (1999), 1–27.

96. (with Carlo Cercignani, Irene Gamba and Chi-Wang Shu) Device benchmark comparisons based on kinetic, hydrodynamic and high field models, Computer Methods in Applied Mechanics and Engineering 181 (2000), 381–392.

97. (with Bernardo Cockburn and Chi-Wang Shu) The utility of modeling and simulation in determining transport performance properties of semiconductors, in *Discontinuous Galerkin Methods: Theory, Computation, and Applications* (B. Cockburn, G. Karniadakis, and C.-W. Shu, editors), Lecture Notes in Computational Science and Engineering, vol. 11, Springer-Verlag, Heidelberg (2000), pages 147–156.

98. (with Gui-Qiang Chen and Dehua Wang) Compressible Euler-Maxwell equations, Transport Theory and Statistical Physics 29 (2000), 311–331.

99. (with Carlo Cercignani, Irene Gamba and Chi-Wang Shu) A domain decomposition method for Silicon devices, Transport Theory and Statistical Physics 29 (2000), 525–536.

100. (with Gregory Fasshauer and Eugene Gartland) Algorithms defined by Nash iteration: Some implementations via multilevel collocation and smoothing, Journal of Computational and Applied Mathematics 119 (2000), 161–183.

101. Analytical and computational advances for hydrodynamic models of classical and quantum charge transport, VLSI DESIGN 10 (2000), 453–466.

102. (with Carl Gardner and Robert Eisenberg) Electrodiffusion model of rectangular current pulses in ionic channels of cell membranes, Society for Industrial and Applied Mathematics Journal of Applied Mathematics 61 (2000), 792–802.

103. (with Gregory Fasshauer and Eugene Gartland) Newton iteration for partial differential equations and the approximation of the identity, Numerical Algorithms 25 (2000), 181–195.

104. A trapping principle for discontinuous elliptic systems of mixed monotone type, Journal of Mathematical Analysis and Applications 262 (2001), 700–721.

105. (with K. Banoo, M. Lundstrom, J.-H. Rhew, and C.-W. Shu) Simulating quasi-ballistic transport in Si nanotransistors. VLSI DESIGN 13 (2001), 5–13.

106. (with Siegfried Carl) Trapping region for discontinuous quasilinear elliptic systems of mixed monotone type, Nonlinear Analysis 51 (2002), 843–863.

107. (with Siegfried Carl) Trapping regions for elliptic systems with discontinuous coupling vector fields, in *Nonsmooth/Nonconvex Mechanics, with Applications in Engineering* (C.C. Banagiotopoulos, editor), Ziti, Thessaloniki, 2002, pp. 15–22.

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112. (with Siegfried Carl) Trapping regions for discontinuously coupled dynamic systems, in *Proceedings of the International Conference on Acoustics Mechanics and the Related Topics of Mathematical Analysis, Frejus, France*, World Scientific, New Jersey, 2002, pp. 71–77.

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115. (with Nikolay Stoykov, Allen Taflove, and Lauren Pierce), Computational modeling evidence of a non-thermal electromagnetic interaction mechanism with living cells: microwave nonlinearity in the cellular sodium ion channel, Institute for Electrical and Electronic Engineers Transactions on Microwave Theory and Techniques, special issue on Medical Applications and Biological Effects of RF/Microwaves, 52 (2004), 2040–2045. Correction: (ibid) 56 (2008), 1009.

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151. (with R. Sacco, G. Guidoboni, G. Bonifazi, N.M. Marazzi, A.C. Verticcio Vercellin, M.S. Lang, and A. Harris) A theoretical approach for the electrochemical characterization of ciliary epithelium. Life 10 (2020), art. no. 8. doi: 10.3390/life10020008.

152. The multidimensional damped wave equation: Maximal weak solutions for nonlinear forcing via semigroups and aproximation, Numerical Functional Analysis and Optimization 41 (2020), 1970-1989. DOI: 10.1080/01630563.2020.1813759.

153. A variational and regularization framework for stable strong solutions of nonlinear boundary value problems, Numerical Functional Analysis and Optimizationi 44 (2023), 394-419. https://doi.org/10.1080/01630563.2023.2178010

154. Linear reduction and homotopy control for steady drift-diffusion systems in narrow convex domains, arXiv:2412.01918, December, 2024.

Book and Career Reviews

1. of T.J. Rivlin, *An Introduction to the Approximation of Functions* (Blaisdell, 1969) Technometrics 15, no. 2, (1970), 425–426.
2. of A. Sard and S. Weintraub, *A Book of Splines* (Wiley, 1971) in Math. Comp. 27 (1973), 205–208.
3. of I.J. Schoenberg, *Cardinal Spline Interpolation* (SIAM, Philadelphia, 1973) in Computing Reviews 15 (1974), 323–324.
4. of A. Bellini-Morante, *Applied Semigroups and Evolution Equations* (Clarendon Press, 1979) in SIAM Review 23 (1981), 408–409.
5. of L. Schumaker, *Spline Functions*: Basic Theory (Wiley, 1981) in Bull. Amer. Math. Soc. 5 (1982), 238–247.
6. (with C. de Boor) Professional Biography: Michael Golomb, Society for Industrial and Applied Mathematics Journal on Mathematical Analysis 13 (1983), V–XIV.
7. of P. Markowich, *The Stationary Semiconductor Device Equations* (Springer, 1986), for the Brazilian Mathematical Society (1986).
8. of I. Rubinstein, *Electro-Diffusion of Ions* (SIAM, 1990) in SIAM Review 33 (1991), 682–684.

Conferences Organized

1. NSF Regional Conference on Approximation Theory and Spline Functions, I. J. Schoenberg, principal lecturer, Northwestern University, June, 1971.
2. Emphasis Year Conference on Scientific, Statistical, and Symbolic Computing, Northwestern University, March, 1987 (George Gasper and Shelby Haberman, co-organizers).
3. SIAM Annual Meeting, 1988, member, Organizing Committee (Donald Saari, Chair), Minneapolis.
4. Varga Conference on Approximation Theory and Numerical Linear Algebra, Kent State University, March, 1989, Chair, Organizing Committee.
5. Urbana Int. Workshop on Computational Electronics, May, 1990, member, Program Committee.
6. Urbana Int. Workshop on Computational Electronics, May, 1992, member, Program Committee.
7. Leeds Int. Workshop on Computational Electronics, July, 1993, member, Program Committee.
8. Portland Int. Workshop on Computational Electronics, May, 1994, member, Advisory Committee.
9. Tempe Int. Workshop on Computational Electronics, October, 1995, member, Program Committee.
10. Workshop on Application of Mathematical Computation to Science and Engineering, Northwestern University, May, 1996.
11. Notre Dame Int. Workshop on Computational Electronics, May, 1997, member, Advisory Committee.
12. Osaka Int. Workshop on Computational Electronics, October, 1998, member, Advisory Committee.

13. Glasgow Int. Workshop on Computational Electronics, May, 2000, member, Advisory Committee.

14. Urbana Int. Workshop on Computational Electronics, October, 2001, member, Program and Advisory Committees.

15. Midwest Conference on Partial Differential Equations (G.-Q. Chen and G. Gasper, co-organizers), Northwestern University, October, 2002.

16. Rome Int. Workshop on Computational Electronics, May, 2003, member, Program Committee.

17. International Conference on Nonlinear Evolution Equations and Applications (G.-Q. Chen and G. Gasper, co-organizers), Northwestern University, June, 2003.

18. Purdue Int. Workshop on Computational Electronics, October, 2004, member, Advisory Committee.

19. Vienna Int. Workshop on Computational Electronics, May, 2006, member, Advisory Committee.

20. Amherst Int. Workshop on Computational Electronics, October, 2007, member, Advisory Committee.

21. International Conference on Nonlinear PDE and Related Analysis/Applications, (G.-Q. Chen, Jared Wunsch, and Steve Zelditch, co-organizers), Northwestern University, March, 2010.

22. Pisa Int. Workshop on Computational Electronics, October, 2010, member, Advisory Committee.

23. Madison Int. Workshop on Computational Electronics, May, 2012, member, Advisory and Program Committees.

24. Purdue Int. Workshop on Computational Electronics, September, 2015, member, Advisory Committee.

Lectures

1968	Seminar: Case Western Reserve University, February
	Seminar: IBM Watson Research Center, February
	Symposium: Spline Functions and Approximation Theory, University of Wisconsin, Madison, October, invited speaker
1969	Seminar: Bowling Green University, March
	Seminar: Northwestern University, March
	Seminar: Kent State University, December
1970	Seminar: Cleveland State University, February
	Seminar: University of Wisconsin, June
	Symposium: Functional Analysis and Approximation in Numerical Analysis, Boston University, July, invited speaker
1971	Workshop: Linear Operators and Approximation, Oberwolfach, Germany, August, invited speaker
1972	Seminar: University of Southern California, January
	Conference: Approximation Theory, University of Alberta, June, invited speaker

Conference: Numerical Analysis, University of Dublin, August, session speaker

Seminar: Kent State University, November

1973 Conference: Approximation Theory, University of Texas, January, invited speaker

Conference: Functional Analysis and Approximation Theory, Kent State University, June, invited speaker

Seminar: Brown University, November

1974 Conference: Approximation Theory, University of Wisconsin, August, invited speaker

Seminar: Brunel University (England), November

1975 University-Industry Conference: Oxford University, March, invited speaker

Seminar: Oxford University, March

Seminar: University of Liverpool (England), March

Seminar Series (four lectures): University of Bath (England), May

Conference: Numerical Analysis, University of Dundee, July, invited speaker

Seminar: University of Chicago, October

1976 Seminar: University of Chicago, March

Conference: Numerical Analysis and Spline Functions, University of Bonn, June, invited speaker

Seminar: University of Aachen (Germany), June

1977 Symposium: Differential Equations and Optimal Control, University of Oklahoma, March, session speaker

Workshop: Multivariate Approximation Theory, University of Durham, England, July, invited speaker

Seminar: University of Chicago, October

1978 Seminar: Case Western Reserve University, February

Seminar: Kent State University, February

Seminar: University of Texas, Arlington, March

Seminar: Texas A&M University, September

Seminar: Texas A&M University, December

1979 Seminar: University of Houston, April

Seminar: Purdue University, May

Workshop: Variational Inequalities, Texas A&M University, May, invited speaker

Conference: Numerical Analysis, University of Dundee, Scotland, June, invited speaker

Seminar: University of Wisconsin, August

Conference: Engineering Mechanics, Northwestern University, September, invited speaker

1980	Golomb Conference, Purdue University, April, invited speaker
	Haifa Workshop on Numerical Methods, Technion, Haifa, June, invited speaker
	Seminar: Yale University, July
1981	Seminar: Bell Laboratories, Murray Hill, December
1982	Minisymposium, SIAM Anniversary Meeting, Stanford University, July
	Seminar: Bell Laboratories, Murray Hill, June
1983	AMS Special Session, Denver, January
	Elliptic Problem Solving Conference, Naval Postgraduate School, Monterey, January, invited speaker
	Seminar: Brown University, February
	Seminar: Univ. of Chicago, April
	Conference on Functional Analysis and Approximation, Oberwolfach, August, invited speaker
	Seminar: University of Delaware, November
	Seminar: IBM T.J. Watson Research Center, Yorktown Heights, November
1984	Seminar: Kent State University, February
	Seminar: Bell Laboratories, Murray Hill, March
	Seminar: York University, Canada, March
	Colloquium: Texas A&M, April
	VLSI Modeling Conference, Boston, November, invited speaker
1985	Seminar: University of Chicago, May (two lectures)
	Seminar: Cornell University, July
	Seminar: University of Michigan, December
1986	Seminar: Argonne National Lab., February
	Seminar: IBM T.J. Watson Research Center, Yorktown Heights, July
	Minisymposium organizer and speaker, SIAM Annual Meeting, Boston, July
	Seminar: University of Illinois, Urbana, December
1987	Seminar: Kent State University, March
	Seminar: Brown University, March
	Seminar: Purdue University, April
	AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design, University of Minnesota, May, invited speaker
	Seminar: UCLA, August
1988	Rheinboldt Conference on Recent Trends in Nonlinear Computational Mathematics and Mechanics, University of Pittsburgh, March, invited speaker
	Seminar: Bell Laboratories, June

	Minisymposium, SIAM Annual Meeting, Minneapolis, July
	Oberwolfach Conference on Device Modeling, November, invited speaker
1989	Meeting on Semiconductor Device Modeling, Washington, D.C., January, invited speaker
	Varga Conference on Approximation Theory and Numerical Linear Algebra, March, invited speaker
	Seminar: Minnesota Supercomputer Institute, October
	Seminar: Kent State University, November
1990	Seminar: Brown University, March
	Seminar: University of Notre Dame, March
	Urbana Workshop on Computational Electronics, May, invited speaker
	International Symposium on Computational Mathematics, Matsuyama, Japan, August, invited speaker
	Seminar: Bell Laboratories, Murray Hill, November
	Seminar: University of Virginia, December
1991	Seminar: Duke University, March
	Seminar: University of Minnesota, May
	Minisymposium, SIAM Annual Meeting, Washington, D.C., July
	Conference on Numerical Optimization Methods in Differential Equations and Control, North Carolina State University, July, invited speaker
	IMA Summer Program on Semiconductors, July, invited speaker
	International Semiconductor Device Research Symposium, University of Virginia, December, session speaker
1992	Seminar: Duke University, January
	Seminar: Kent State University, July
	Invited lecturer (five lectures), Summer School on Numerical Analysis, Lancaster, England, July
	Special Session, World Congress of Nonlinear Analysts, Tampa, August
1993	SCS Simulation Multiconference, Arlington, VA, March
	Minisymposium, SIAM Annual Meeting, Philadelphia, July
	Seminar: Purdue University, September (two lectures)
1994	Finite Element Mathematics Workshop, Pennsylvania State University, November
1995	Tempe Int. Workshop on Computational Electronics, Arizona State University, October
1996	Distinguished Alumnus Award Lecture, Purdue University, April
	Second World Congress of Nonlinear Analysts, Athens, July (Hour Speaker)
	Urbana Workshop on Future Topics in Computational Electronics, September
	Seminar: Brown University, December

1997	Seminar: New York University, January
	Seminar: University of Texas, December
1998	Seminar: University of California, Santa Barbara, February
	Maui Workshop on Mathematical Aspects of Plasma and Fluid Dynamics (mafpd-4), July, invited speaker
1999	Varga Seventieth Birthday Conference, Kent State University, March, invited speaker
	Conference on Discontinuous Galerkin Methods, Newport, RI, May, invited speaker
	International Congress on Industrial and Applied Mathematics, Edinburgh, July, invited minisymposium organizer and speaker
	O'Malley Sixtieth Birthday Conference, RPI, Troy, NY, October, invited speaker
2000	Seminar: Brown University, June
2001	Seminar: University of Pittsburgh, March
	Seminar: Boston University, March
	Seminar: North Carolina State University, March
	Finite Element Mathematics Workshop, University of Delaware, March
	Seminar: Illinois Institute of Technology, April
	Mafpd-5, Oberwolfach, April, invited speaker
	SIAM Minisymposium on Electrodiffusion, San Diego, July, session speaker
	Urbana Int. Workshop on Computational Electronics (IWCE-8), University of Illinois, October, invited speaker
2002	Seminar: Northern Illinois University, February
	Colloquium: Florida Institute of Technology, March
	SIMAI (Italian) Biannual Conference, invited speaker, Sardenia, May
	Invited lecturer (three lectures), Short Course on Semiconductor Modeling, Scuola Normale, Pisa, Italy, June
	AMS-UMI Special Session on Transport Theory, Pisa, Italy, June
	Seminar: Arizona State University, October
2003	SIAM Minisymposium, San Diego, February
2004	Fourth World Congress of Nonlinear Analysis (Hour Speaker), Orlando, July
	Seminar: UCLA, September
	Mafpd-6 (with Y. Mori and C. Peskin), invited speaker, Kyoto, September
	Seminar: UIC, October
2005	Minisymposium, SIAM Annual Meeting, New Orleans, July, session speaker
2006	Vienna Int. Workshop on Computational Electronics (IWCE-11), Technical University of Vienna, May, session speaker

2007	Colloquium, DePaul University, April
	NSF-CBMS invited hour speaker, University of Iowa, May
2008	Fifth World Congress of Nonlinear Analysis (Hour Speaker), Orlando, July
2009	Seminar, Georgia Institute of Technology, April
	IMA Workshop on Conservation Laws and their Applications, Minneapolis, July, invited plenary speaker
2010	Pisa Int. Workshop on Computational Electronics (IWCE-14), University of Pisa, October, session speaker
2011	Mathematical Biosciences Workshop, Ohio State University, April, invited plenary speaker
	Seminar: University of Massachusetts, September
2012	Seminar: Temple University, January
	Seminar: University of Illinois at Chicago, January
	Seminar: Florida Atlantic University, February
	Colloquium: Florida Atlantic University, February
	Seminar: Colorado State University, March
	Colloquium: Colorado State University, March
	Colloquium: George Mason University, September
	Workshop, Weierstrass Institute, Berlin, September, invited plenary speaker
2013	Seminar: George Washington University, March
2014	Seminar: University of Maryland, College Park, April
	Workshop: Fields Institute, Toronto, July, invited speaker
	Colloquium: University of Maryland, Baltimore County, October
	Colloquium: Pennsylvania State University, October
2015	Workshop: IMA Minneapolis, July, invited speaker
2016	Seminar: University of Pittsburgh, November
2017	Seminar: University of Massachusetts, April

Courses Taught:

1968-69 Case Western Reserve University
Undergraduate: Calculus I,II
Graduate: Matrix Theory
Graduate: Approximation Theory

1969-70 Case Western Reserve University
Undergraduate: Calculus I,II
Graduate: Matrix Theory
Graduate: Numerical Linear Algebra

1970-71 Northwestern University
Undergraduate: Modern Math. I,II
Graduate: Advanced Matrix Theory I
Graduate: Advanced Matrix Theory II

1971-72 Northwestern University
Undergraduate: Honors Calculus I,II,III
Graduate: Appl. Funct. Anal. I,II,III

1972-73 Northwestern University
Undergraduate: Calculus 1,4
Graduate: Appl. Funct. Anal. I,II

1973-74 Northwestern University
Undergraduate: Calculus 2,3
Graduate: Appl. Funct. Anal. I,II

1974-75 On leave, Oxford University
Graduate: Numerical Study of Partial Differential Equations (one term)

1975-76 Northwestern University
Undergraduate: Calculus 3,4,5
Graduate: Seminar in Appl. Math.

1976-77 Northwestern University
Undergraduate: Calculus 1,2
Graduate: Differential Eqs. Math. Phys. I,II,III

1977-78 Northwestern University
Undergraduate: Calculus 1,2
Graduate: Differential Eqs. Math. Phys. I,II
Graduate: Appl. Funct. Anal. I

1978-79 On leave, University of Texas
Undergraduate: Ordinary Differential Eqs., Matrix Theory
Graduate: Hilbert Spaces and Appl. Math.

1979-80 Designations B,C are undergraduate courses; D,E are graduate level
All teaching is at Northwestern University
B14-1,2, Calculus I,II
D27-1, Partial Differential Equations
B21, (Computer graphics integrated) Ordinary Differential Eqs.

1980-81 B14-1, Calculus I
E10-1,2, PDE Seminar
C05, Complex Variables

1981-82 B14-2,3, Calculus II,III
C11-1,2,3, Introduction to Applied Mathematics I,II,III

1982–83 On leave, Bell Laboratories

1983–84 B16, Calculus of Several Variables
B18, Calculus of Several Variables
C11-1,2,3 Introduction to Applied Mathematics I,II,III

1984–85 B16, Calculus of Several Variables
C11-1,2, Introduction to Applied Mathematics I,II
484-A05, Computer Methods in the Natural Sciences

1985–86 B16, Calculus of Several Variables
B18, Calculus of Several Variables
C11-1,2, Introduction to Applied Mathematics I,II

1986–87 E11-1,2, Emphasis Year Seminars
C11-1,2,3, Introduction to Applied Mathematics I,II,III

1987–88 C11-1,2,3, Introduction to Applied Mathematics I,II,III
B21, Ordinary Differential Equations

1988–89 E10, Seminar in Analysis
C11-1,2,3, Introduction to Applied Mathematics I,II,III

1989–90 B21, Ordinary Differential Equations
C11-1,2,3, Introduction to Applied Mathematics I,II,III

1990–91 B14-2, Calculus II
C11-1,2,3, Introduction to Applied Mathematics I,II,III

C34, Linear Algebra for Applications

1991–92 B14-3, Calculus III
C11-1,2,3, Introduction to Applied Mathematics I,II,III

1992–93 E10, Seminar in Partial Differential Equations
C11-1,2, Introduction to Applied Mathematics I,II

1993–94 B21, Ordinary Differential Equations
B17, Sequences and Series Linear Algebra
C05, Complex Variables for Applications
B21, Ordinary Differential Equations

1994–95 C91-1, ISP Accelerated Mathematics I
C91-3, ISP Accelerated Mathematics III
C05, Complex Variables for Applications
B21, Ordinary Differential Equations

1995–96 C91-1, ISP Accelerated Mathematics I
B17, Sequences and Series Linear Algebra
C91-3, ISP Accelerated Mathematics III
B15, Multivariate and Vector Integral Calculus

1996–97 C91-1, ISP Accelerated Mathematics I
B21, Ordinary Differential Equations
C91-3, ISP Accelerated Mathematics III
C05, Complex Variables for Applications

1997–98 C91-1, ISP Accelerated Mathematics I
D26, Partial Differential Equations
C91-3, ISP Accelerated Mathematics III
B21, Ordinary Differential Equations

1998–99 C91-1, ISP Accelerated Mathematics I
C91-3, ISP Accelerated Mathematics III
C40-3, MENU Analysis III

1999–2000 C91-1, ISP Accelerated Mathematics I
C91-3, ISP Accelerated Mathematics III
C40-3, MENU Analysis III

2000–2001 Designations 1,2,3 are undergraduate courses; 4,5 are graduate level
All teaching is at Northwestern University
391-1, ISP Accelerated Mathematics I
391-3, ISP Accelerated Mathematics III

2001–2002 412-1, Introduction to Analysis, I
412-2, Introduction to Analysis, II
305, Complex Variables for Applications

2002–2003 412-1, Introduction to Analysis, I
510, Seminar in Analysis, I
412-2, Introduction to Analysis, II

2003–2004 412-1, Introduction to Analysis, I
412-2, Introduction to Analysis, II
215, Multivariate and Vector Integral Calculus
305, Complex Variables for Applications

2004–2005 310-1, Introduction to Real Analysis, I
310-2, Introduction to Real Analysis, II
310-3, Introduction to Real Analysis, III
305, Complex Variables for Applications

2005–2006 320-1, Introduction to Real Analysis, I
320-2, Introduction to Real Analysis, II
250, Elementary Differential Equations

2006–2007 320-2, Introduction to Real Analysis, II
240, Linear Algebra
320-3, Introduction to Real Analysis, III
250, Elementary Differential Equations

2007–2008 234, Multivariate and Vector Integral Calculus
240, Linear Algebra
420-3, Partial differential Equations
250, Elementary Differential Equations

2008–2009 234, Multivariate and Vector Integral Calculus
230 (2 sections), Vector Differential Calculus
250, Elementary Differential Equations

2009–2010 351, Fourier Analysis and Boundary Value Problems
224, Integral Calculus of One Variable Functions
250, Elementary Differential Equations
420-3, Partial Differential Equations

2010–2011 351, Fourier Analysis and Boundary Value Problems
230, Differential Calculus of Multivariable Functions
234, Multivariate and Vector Integral Calculus
325, Complex Variables for Applications

2011–2012 351, Fourier Analysis and Boundary Value Problems
105-106, Freshman Seminar
325, Complex Variables for Applications
250, Elementary Differential Equations

2012–2013 Designations beginning with 1-4 are undergraduate courses; those beginning with 6 are graduate level. All teaching is at George Washington University.
2184, Introduction to Linear Algebra

2013–2014 6240, Topics in Analysis and Functional Analysis
6201, Real Analysis I
2971W, Math Reasoning
2184, Introduction to Linear Algebra

2014–2015 6201, Real Analysis I
4239W, Real Analysis I
3343, Partial Differential Equations
2184, Introduction to Linear Algebra

2015–2016 4239W/6201, Real Analysis I

2016–2017 4239W, Real Analysis I

2018–2019 2184, Introduction to Linear Algebra

2019–2020 2184, Introduction to Linear Algebra

Department Committees

Budget Committee 1981–82, 2001–02

Colloquium Committee 1971–72; 1980–81; 1995–96

Computer Committee 1983–85 (Chairman); 1987–96

Emphasis Year Committee 1994–95, 2001–02

Graduate Committee 1976–77; 1981–82; 1983–84; 1990–93; 1994–95; 2002–2003

Personnel Committee 1972–73 (Chairman); 1979–80; 1985–86 (Chairman);
1990–91; 1992–93; 1995–97; 2003–06

Strategic Planning Committee 1993–94

Undergraduate Committee 1993–94; 1998–02 (Chairman and Director of Undergraduate Studies)