

# CURRICULUM VITAE

Peter A. Forsyth

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## EDUCATION:

- 1977-79      Ph.D.  
University of Western Ontario  
London, Ontario, Canada
- 1975-77      M.Sc.  
Australian National University  
Canberra, Australia
- 1971-75      B.Sc.  
University of Western Ontario  
London, Ontario, Canada

## EXPERIENCE:

- 1993 - present    Professor  
School of Computer Science,  
University of Waterloo, Waterloo, Ontario, Canada.
- Cross appointed to Applied Mathematics, Statistics and Actuarial Science,  
                    and Earth Sciences.
- 2009 - 2011      Associate Director (Computing and Infrastructure)  
School of Computer Science  
University of Waterloo
- 2006 - 2008      Scientific Director  
Institute for Quantitative Finance and Insurance  
University of Waterloo
- 2002 - 2005      Associate (Vice) Director  
School of Computer Science  
University of Waterloo

1995 - 1998	Director Institute for Computer Research University of Waterloo
1991 - 1993	Associate Chair (Graduate Studies) Department of Computer Science University of Waterloo
1987 - 1993	Associate Professor Department of Computer Science, University of Waterloo
1985 - 1987	President Dynamic Reservoir Systems, Calgary, Alberta, Canada.
1979 - 1985	Senior Simulation Scientist (and other positions) Computer Modelling Group, Calgary, Alberta, Canada.

### **Research Interests**

Computational finance, numerical methods for optimal stochastic control, sparse matrix algorithms, nonlinear partial integro-differential equations.

### **Courses Taught**

#### **Undergraduate courses**

- Introduction to Scientific Computing. Third year course covers interpolation, FFT and application to image processing and compression, numerical linear algebra, ordinary differential equations. Matlab based.
- Numerical Linear Algebra. Fourth year/graduate course covers sparse matrix data structures, basic graph theory, direct methods, ordering, iterative methods. C++ based.
- Numeric Computation for Dynamical Simulation. Fourth year/graduate course, covers numerical algorithms for solution of differential equations in the context of simulation models. Runge-Kutta, BDF methods, DAE's, application to electronic circuits.
- Applications Software Engineering. Fourth year non-specialist course covers software design, testing, maintenance, configuration control. Use of tools, case studies.

#### **Graduate courses**

- Numerical Solution of Partial Differential Equations. Finite volume, finite element methods, M-matrices, LED discretizations, shocks, flux limiters.

- Preconditioners for Sparse Matrices. GMRES, CGSTAB, QMR acceleration. Incomplete factorization, level of fill, drop tolerance, applications.
- CFD Applications. Computational methods for high speed compressible flow, incompressible Navier-Stokes, multiphase subsurface flow.
- Computational Finance. Monte Carlo methods, low discrepancy sequences, finite volume PDE methods, techniques for drift-dominated real options, path-dependent options (Asian, shout, Parisian), discrete delta, gamma hedging simulation, penalty methods for American options.

### Short courses

- Numerical methods for Hamilton Jacobi Bellman equations. This mini-course (five lectures) has been given in Singapore (2009) and Holland (2010).
- Numerical PDE methods for path dependent options. Two day short course, combines lectures and Matlab exercises. Co-taught with Ken Vetzal. This course has been given in New York City (2001, 2003, 2004, 2005), Tokyo (2001), Toronto (2002), Ithaca, NY (2001, 2002) and Waterloo (2006, 2007, 2009, 2010).
- Convertible bonds: pricing theory and algorithms. One day short course, lectures and software demonstrations. Co-taught with Ken Vetzal, Elie Ayache. Given in New York City (2003), Paris (2004).

### Commercially Developed Software

**Dynamic Reservoir Simulator** (developed with P.H. Sammon, A. Behie). Black oil reservoir simulation model for primary production, waterflooding, and coning. Duke Energy currently supports and markets this software. This package has been purchased by over thirty petroleum companies.

**IMEX** (developed with A. Behie, P.H. Sammon). Adaptive implicit black oil model. This code continues to be marketed and supported by the Computer Modelling Group, Calgary. Over 200 licenses sold.

### Licensed Software Developed at Waterloo

**WATSIT** (developed with J. Kightley, S. Clift, E. D’Azevedo). Iterative sparse matrix solution package. This library has been purchased by such organizations as: HydroGeoLogic Inc. (Herndon, VA), Westinghouse Hanford (Richland, WA), Boeing (Seattle), Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, Sandia National Laboratory, Phillips Petroleum (Bartlesville), TRW Safety Systems (Los Vegas), Desert Research Institute (Los Vegas), and Atomic Energy of Canada (Pinawa). This software has also been distributed to a number of academic sites.

**PCG5** This sparse iterative solver is embedded in simulation software (Visual Modflow, Modflow Surfact) developed by HydroGeoLogic Inc (Herndon, VA). Since 2005, about 100 licenses have been sold.

## Consulting Experience

Research related consulting for such organizations as: TGINet/Cornell (Tokyo), SunLife of Canada, NOVA Corporation (Calgary), the Electric Power Research Institute (Mountain View, CA), Smithville Bedrock Remediation Corporation (Smithville Ont.), Los Alamos National Laboratory, Phillips Petroleum (Bartlesville), US Environmental Protection Agency, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, NASA ICASE (Langley, VA), and HydroGeoLogic (Herndon, VA).

## Editorial Boards

- Journal of Computational Finance (Editor-in-Chief, 2008-, Associate Editor, 2003-2008)
- Applied Mathematical Finance (Associate Editor, 2004-)
- Encyclopedia of Quantitative Finance (section co-editor (with D. Lamberton), PDEs and Numerical Methods, 2007-2008).
- Applied Numerical Mathematics (guest co-editor, special issue on Iterative Methods, 2008).
- Advances Water Resources (Associate Editor, 1998-2001)

## Recent Research Service

- Member, MITACS Research Management Committee (2008-11).
- Scientific Director, Institute for Quantitative Finance and Insurance (Waterloo, now WATRISQ, 2006-2008).
- Member of organizing committee, Fields Institute numerical analysis year (2001-2002).
- NSF Panel member (*Computational Mathematics* (2001)).
- Grant selection committee member, CITO, *Modelling and simulation*, 1998-2000.
- Director, Insitute for Computer Research (Waterloo, 1995-1998). Organized over twenty-five short courses with industrial participants; also coordinated Waterloo submissions to ORDCF and CFI related to Bell Canada University Laboratory research initiative (total funding received from Bell, ORDCF and CFI in excess of \$20 million over three years).
- Workshops, Conferences Co-organized
  - Conference on Computational Methods in Finance, University of Waterloo, July, 2007

- Workshop on Real Options in Telecommunications, University of Waterloo, May 2003
- Workshop on Computational Methods and Applications in Finance, Fields Institute, University of Toronto, February 2002

## Graduate Student Supervision

### PhD

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| <p>Y. Huang (2011)<br/>         J. Wang (2010)<br/>         Z. Chen (2008)<br/>         A. Belanger (2008,<br/>             co-supervisor G. Labahn)<br/>         S. Kennedy (2007,<br/>             co-supervisor G. Labahn)<br/>         S. Clift (2007)</p> | <p>Y. d'Halluin (2004)<br/>         H. Windcliff (2003)<br/>         D. Pooley (2003)<br/>         R. Zvan (2000,<br/>             co-supervisor K. Vetzal)<br/>         A. Unger (1995,<br/>             co-supervisor E. Sudicky)</p> |
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### MMath

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| <p>X. Guan (2012)<br/>         C. Morley (2011,<br/>             co-supervisor G. Labahn)<br/>         J. Babbitt (2011,<br/>             co-supervisor G. Labahn)<br/>         D. Fagnan (2011,<br/>             co-supervisor G. Labahn)<br/>         Y. Sohrabi (2011)<br/>         W. Xiao (2010)<br/>         D. Saraph (2010,<br/>             co-supervisor G. Labahn)<br/>         B. Wang (2010)<br/>         J. Aquan-Asee (2009,<br/>             co-supervisor G. Labahn)<br/>         M. Yu (2007)<br/>         J. Kraus (2007, TU Munich,<br/>             co-supervisors, Zagst, Grau)<br/>         L. Xiao (2006,<br/>             co-supervisor, K. Vetzal)<br/>         J. Wang (2005)<br/>         P. Lizak (2004)<br/>         A. Grau (2003)<br/>         C. Cheng (2002)<br/>         M.C. Lam (2002)</p> | <p>W. Morland (2001)<br/>         H. Windcliff (2000)<br/>         Y. d'Halluin (2000,<br/>             co-supervisor G. Labahn)<br/>         M. Fitzgerald(1999)<br/>         D. Pooley(1999,<br/>             co-supervisor R.B. Simpson)<br/>         L. Wang (1998)<br/>         T. Zvi (1998)<br/>         E. Carr (1997)<br/>         S. Friedman (1996)<br/>         H. Li (1996)<br/>         R. Zvan (1996)<br/>         B.Y. Shao (1994)<br/>         S. Clift (1993)<br/>         Y. Qian (1993)<br/>         J. Dickinson (1993)<br/>         P. Chin (1991,<br/>             co-supervisor W.L. Seward)<br/>         M.C. Kropinski (1990)<br/>         F.W. Letniowski (1989)<br/>         T. Natalisa (1988)<br/>         W.S. Nugroho (1988)</p> |
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## Students Currently Supervised

P. Azimzadeh (MMath)  
S. Hang (MMath)  
Z. Wang (MMath)

M. Ma (MMath)  
K. Ma (PhD)  
S. Tse (PhD, co-supervised)

## PhD Examining Committees

J. Witte (Mathematics, Oxford) 2012.  
H.T. Hwang (Earth Sciences) 2012.  
V. Surkov (CS, Toronto) 2009.  
A. Rohani (ECE) 2006.  
H. Li (Mathematics, Calgary) 2006.  
R. Maji (Earth Sciences) 2005.  
M. Steigleider (Computer Science) 2005.  
M. Ayatollah (ECE) 2004.  
K. Lau (Computer Science, UHKST) 2004.  
A. Borji (ECE) 2004.  
W. Annable (Earth Sciences) 2003.  
Y. Wang (ECE) 2000.  
V. Van (ECE) 1999.  
J. VanderKwaak (Earth Sciences) 1999.

P. Zwart (Mechanical Engineering) 1999.  
J. Grad (Applied Mathematics) 1997.  
K. MacQuarrie (Earth Sciences) 1997.  
L. Zhang (Earth Sciences) 1997.  
I. Murray (Applied Math) 1994.  
M. Ibaraki (Earth Sciences) 1994.  
C. Mendoza (Earth Sciences) 1992.  
R. Heywood (Mechanical Engineering) 1992.  
R. Therrien (Earth Sciences) 1992.  
A. Bajor (Chem. Eng., Toronto) 1990.  
S. Ormiston (Mechanical Engineering) 1990.  
W. Drennan (Applied Mathematics) 1988.  
E. Fraga (Computer Science) 1988.

## Administrative Duties

Member, School Advisory Committee on Appointments (2011-)  
Member, CS Graduate Committee (2011-)  
Member, University Committee on Information Systems and Technology (2009-10).  
Chairman, CS Computing Facility Committee (2009-2011).  
Member, Engineering Faculty Promotion and Tenure Committee (2007-08).  
Scientific Director, Institute for Quantitative Finance and Insurance (2006-2008),  
Associate Director, Computing and Financial Management Program (2005-2008).  
Member, School of Computer Science Promotion and Tenure Committee (2005-07, 2009-10).  
Member, School of Computer Science Director Selection Committee (2005).  
Member, Dean of Mathematics Selection Committee (2004-2005).  
Member, University Senate (2004-2007).  
Associate Director, School of Computer Science (2002-2005).  
Member, External Relations Committee (2002-2005).  
Member, CS Computing Facility Committee (2002-2005).  
Member, CS Budget Committee (2002-2005).  
Member, Science Faculty Promotion and Tenure Committee (2001-2002).  
Member, Computer Science Governance Committee (2001).  
Member, Eyton Chair selection Committee (2000-2001).

Member, Mathematics Faculty Promotion and Tenure Committee (1998-2001)  
Member, Graduate Committee (CS) (1997-2002)  
Member, Engineering Faculty Promotion and Tenure Committee, (1996-97)  
Member, Chair selection Committee (CS), (1996-1997).  
Member, Promotion and Tenure Committee(CS) (1995-97)  
Director, Institute for Computer Research (1995-98)  
Associate Chairman, Graduate Studies (1991 - 1993)  
Chairman, Graduate Committee (CS) (1991 - 1993)  
Member, Promotion and Tenure Committee (CS) (1991 - 1992)  
Member, Graduate Committee (CS) (1990-91)  
Chairman, PhD Comprehensive Committee (1989-90)  
Member, PhD Comprehensive Committee (1988-89)  
Member, Curriculum Committee, (1987-90)  
Member, Graduate Committee (Applied Mathematics) (1987-90)

### Research Grants

- 2011-2014** Scotiabank. Implied Volatility Surfaces, Local Volatility Models and Low Dimensional Hedging Strategies for Arithmetic and Geometric Baskets. \$25,000/year.
- 2010-2015** NSERC Discovery grant. \$40,000/year. (Moved from Computer Science Committee to the Mathematics committee, which has a lower average grant size compared to the CS committee).
- 2009-2011** Credit Suisse Research Grant \$70,200/year (co-PI with Y. Li and A. Heunis).
- 2008-2011** Tata Consultancy Services Research Grant. \$25,000/year (co-PI with G. Labahn).
- 2006-2011** Morgan Stanley Equity Market Microstructure Research Grant. \$20,000/year.
- 2005-2010** NSERC Discovery grant. \$64,000/year.
- 2003-2005** ITO33, Paris. Numerical methods for jump diffusion and jump volatility models, \$23,000/year (co-PI with K. Vetzal).
- 2001-2005** NSERC Discovery grant. \$57,000/year.
- 2000-2003** Bell Canada University Labs. Computational Finance: Real options, telecommunications, and corporate finance \$135,000/year (co-PI) (with K. Vetzal(co-PI), P. Boyle, G. Labahn, K.S. Tan).
- 1999-2002** NSERC Strategic, Royal Bank. Computational Finance: algorithms for option pricing and hedging. \$128,000/year (PI) (with K. Vetzal, P. Boyle, G. Labahn).
- 1998-2001** NSERC Strategic. New computational approaches for modelling surface water-groundwater systems. \$131,000/year (with E. Sudicky (PI), E. Frind, N. Kouwen, D. Rudolph, R. Soulis, J. Sykes, H. Whiteley).

- 1998-2000** CITO. Computational support for modelling in Engineering & Finance. \$50,000/year (with W.P. Tang, R.B. Simpson, A. George, P. Boyle, K. Vetzal).
- 1997-2001** NSERC operating grant. \$45,000/year.
- 1996-98** Smithville Environmental Restoration Project, ITRC and WCGR. Simulation of DNAPL contaminants in fractured rock. \$60,000/year (with E. Sudicky).
- 1995-1998** US EPA. Simulation of groundwater flow at the Smithville site. \$80,000/year (with E. Sudicky (PI), K. Novakowski).
- 1995-1998** Information Technology Research Center. Research into numerical solution of partial differential equations. \$75,000/year (with A. George, R. Simpson, W.P. Tang).
- 1995** Haley and Aldrich (Boston), Gartner-Lee (Markham), Waterloo Center for Groundwater Research. Simulation and video animation of NAPL extraction methods. \$29,000 (with E. Sudicky).
- 1995** Solvents in Groundwater Consortium. Simulation of vacuum extraction methods for VOC's. \$20,000 (with E. Sudicky).
- 1994** Waterloo Center for Groundwater Research. Visualization of DNAPL contamination. \$13,600 (with E. Sudicky).
- 1994** NSERC Equipment Grant. Video recording equipment for scientific visualization. \$42,000 (with R.H. Bartels).
- 1993** Solvents in Groundwater Consortium. Three dimensional simulation of NAPL contamination. \$19,000 (with E. Sudicky).
- 1993-1995** Information Technology Research Center. Research into numerical solution of partial differential equations. \$40,000/year (with R. Simpson, W.P. Tang).
- 1993-1997** NSERC operating grant. \$28,000/year.
- 1990-1993** NSERC operating grant. \$25,000/year.
- 1988-1990** NSERC operating grant. \$23,000/year.
- 1988-1992** Information Technology Research Center. Research into numerical solution of partial differential equations. \$80,000/year (with R. Simpson, W.P. Tang, W.L. Seward).
- 1985** Energy Mines and Resources. Development of new software technology for reservoir simulation. \$80,000 (with A. Behie, P. Sammon).

### **List of Research Contributions - Peter A. Forsyth**

## Refereed Journal Publications

1. P.A. Forsyth, J.S. Kennedy, S.T. Tse, H. Windcliff, “*Optimal trade execution: a mean quadratic variation approach,*” (Accepted in Journal of Economic Dynamics and Control, 2012, 24 pages).
2. Y. Huang, P.A. Forsyth, G. Labahn, “*Combined fixed point and policy iteration for HJB equations in finance,*” (Accepted in SIAM Journal on Numerical Analysis, 2012, 23 pages).
3. Y. Huang, P.A. Forsyth, G. Labahn, “*Iterative methods for the solution of a singular control formulation of a GMWB pricing problem,*” (Accepted in Numerische Mathematik, 2012, 32 pages).
4. J. Wang and P.A. Forsyth, “*Comparison of mean variance like strategies for optimal asset Allocation problems.*” International Journal of Theoretical and Applied Finance 15:2 (2012) (33 pages: DOI: 10.1142/S0219024912500148).
5. I. Huang and P.A. Forsyth, “*Analysis of a penalty method for pricing a Guaranteed Minimum Withdrawal Benefit (GMWB).*” IMA Journal on Numerical Analysis 32 (2012) 320-351.
6. Y. Huang, P.A. Forsyth, G. Labahn, “*Methods for American options under regime switching,*” SIAM Journal on Scientific Computing 33 (2011) 2144-2168.
7. P.A. Forsyth, “*A Hamilton Jacobi Bellman approach to optimal trade execution.*” Applied Numerical Mathematics 61 (2011) 241-265.
8. J. Wang and P.A. Forsyth, “*Continuous time mean variance asset allocation: a time consistent strategy.*” European Journal of Operational Research 209 (2011) 184-201.
9. Z. Chen, P.A. Forsyth “*Implications of a regime-switching model on natural gas storage valuation and optimal operation,*” Quantitative Finance 10 (2010) 159-176.
10. J. Wang, P.A. Forsyth. “*Numerical Solution of the Hamilton Jacobi Bellman Formulation for continuous time mean variance asset allocation.*” Journal of Economic Dynamics and Control 34 (2010) 207-230.
11. A. C. Belanger, P.A. Forsyth, G. Labahn, “*Valuing the guaranteed minimum death benefit clause with partial withdrawals,*” Applied Mathematical Finance 16 (2009) 451-496.
12. J.S. Kennedy, P.A. Forsyth, K.R. Vetzal, “*Dynamic hedging under jump diffusion with transaction costs,*” Operations Research 57 (2009) 541-559.
13. Y. Huang, P.A. Forsyth, K.R. Vetzal, “*Valuing guarantees on spending funded by endowments,*” Canadian Applied Mathematics Quarterly 17 (2009) 661-702.

14. Z. Chen, K.R. Vetzal, P.A. Forsyth, “*The effect of Modelling Parameters on the Value of GMWB Guarantees,*” Insurance Mathematics and Economics 43 (2008) 165-173.
15. A.C. Belanger, P.A. Forsyth, “*Infinite reload options: pricing and analysis,*” J. Computational and Applied Mathematics 222 (2008) 54-81.
16. Z. Chen, P.A. Forsyth, “*A Numerical scheme for the impulse control formulation for pricing variable annuities with a Guaranteed Minimum Withdrawal Benefit (GMWB),*” Numerische Mathematik 109 (2008) 535-569.
17. S.S. Clift, P.A. Forsyth, “*Numerical solution of two asset jump diffusion models,*” Applied Numerical Mathematics 58 (2008) 743-782.
18. J. Wang, P.A. Forsyth, “*Maximal use of central differencing for Hamilton-Jacobi-Bellman PDEs in Finance,*” SIAM Journal on Numerical Analysis 46 (2008) 1580-1601.
19. Y.S. Wu, P.A. Forsyth, “*Efficient schemes for reducing numerical dispersion in modeling multiphase transport through porous and fractured Media,*” Vadose Zone Journal 7 (2008) 340-349.
20. Z. Chen, P.A. Forsyth, “*A semi-Lagrangian approach for natural gas storage valuation and optimal operation,*” SIAM J. Scientific Computing 30 (2007) 339-368.
21. P.A. Forsyth, G. Labahn, “*Numerical methods for controlled Hamilton-Jacobi-Bellman PDEs in finance,*” Journal of Computational Finance 11:2 (2007/2008: Winter) 1-44.
22. I.R. Wang, J.W.I. Wan, P.A. Forsyth, “*Robust numerical valuation of European and American options under the CGMY process,*” J. Computational Finance 10:4 (2007: Summer) 31-69.
23. H. Windcliff, J. Wang, P.A. Forsyth, K. Vetzal, “*Hedging with a correlated asset: solution of a nonlinear pricing PDE,*” J. Computational and Applied Mathematics 200 (2007) 86-115.
24. Y. d’Halluin, P.A. Forsyth, K.R. Vetzal, “*Wireless network capacity investment,*” European J. Operational Research 176 (2007) 584-609.
25. C. He, J.S. Kennedy, T. Coleman, P.A. Forsyth, Y. Li, K. Vetzal, “*Calibration and hedging under jump diffusion,*” Review of Derivatives Research 9 (2006) 1-35.
26. H. Windcliff, P.A. Forsyth, K.R. Vetzal, “*Numerical methods and volatility models for valuing cliquet options,*” Applied Mathematical Finance 13 (2006) 353-386.
27. H. Windcliff, P.A. Forsyth, K.R. Vetzal, “*Pricing methods and hedging strategies for volatility derivatives,*” J. Banking and Finance 30 (2006) 409-431.

28. Y. d'Halluin, P.A. Forsyth, G. Labahn, "A semi-Lagrangian approach for American Asian options under jump diffusion," *SIAM J. Scientific Computing* 27 (2005) 315-345.
29. Y. d'Halluin, P.A. Forsyth, K.R. Vetzal, "Robust numerical methods for contingent claims under jump diffusion processes," *IMA J. Numerical Analysis* 25 (2005) 87-112.
30. H. Windcliff, P.A. Forsyth, K.R. Vetzal, "Analysis of the stability of the linear boundary condition for the Black-Scholes equation," *J. Computational Finance*, 8:1 (Fall, 2004) 65-92.
31. Y. d'Halluin, P.A. Forsyth, G. Labahn, "A penalty method for American options with jump diffusion processes," *Numerische Mathematik*, 97:2 (2004) 321-352.
32. R. Zvan, P.A. Forsyth, K.R. Vetzal, "Negative coefficients in two factor option pricing models," *J. Computational Finance*, 7:1 (Fall, 2003) 37-73.
33. E. Ayache, P.A. Forsyth, K.R. Vetzal, "The valuation of convertible bonds with credit risk," *J. Derivatives*, 11 (Fall, 2003) 9-29.
34. D.M. Pooley, K.R. Vetzal, P.A. Forsyth "Remedies for non-smooth payoffs in option pricing," *J. Computational Finance*, 6:4 (Summer, 2003) 25-40.
35. D.M. Pooley, P.A. Forsyth, K.R. Vetzal, "Numerical convergence properties of option pricing PDEs with uncertain volatility," *IMA J. Numerical Analysis*, 23 (2003) 241-267.
36. H. Windcliff, K.R. Vetzal, P.A. Forsyth, A. Verma, T. Coleman, "An object oriented framework for valuing shout options on high-performance architectures," *J. Economic Dynamics and Control*, 27 (2003) 1133-1161.
37. P.A. Forsyth, K.R. Vetzal, R. Zvan, "Convergence of Lattice and PDE methods for valuing path dependent options using interpolation," *Review of Derivatives Research*, 5 (2002) 273-314.
38. Y. d'Halluin, P.A. Forsyth, K.R. Vetzal, "Managing telecommunication networks under uncertainty," *IEEE/ACM Transactions on Networking*, 10 (2002) 579-588.
39. H. Windcliff, P.A. Forsyth, M.K. Le Roux, K.R. Vetzal, "Understanding the behaviour and hedging of segregated funds offering the reset feature," *North American Actuarial J.*, 6 (2002) 107-125.
40. P.A. Forsyth, K.R. Vetzal, "Quadratic convergence for valuing American options using a penalty method," *SIAM J. Scientific Computing*, 23 (2002) 2095-2122.
41. Y. d'Halluin, P.A. Forsyth, K.R. Vetzal, G. Labahn, "A numerical PDE approach for pricing callable bonds," *Applied Mathematical Finance*, 8 (2001) 49-77.
42. H.A. Windcliff, P.A. Forsyth, K.R. Vetzal, "Valuation of segregated funds: shout options with maturity extensions," *Insurance: Mathematics and Economics*, 29 (2001) 1-21.

43. H. Windcliff, P.A. Forsyth, K.R. Vetzal, "*Shout options: a framework for pricing contracts which can be modified by the investor,*" J. Computational Applied Mathematics, 134 (2001) 213-241.
44. R. Zvan, P.A. Forsyth, K.R. Vetzal, "*A finite volume approach for contingent claims valuation,*" IMA J. Numerical Analysis 21 (2001) 703-731.
45. Y.S. Wu, P.A. Forsyth, "*On the selection of primary variables in the numerical formulation for modelling multiphase flow in porous media,*" J. Contaminant Hydrology, 48 (2001) 277-304.
46. P.A. Forsyth, K.R. Vetzal, "*Implicit solution of uncertain volatility/transaction cost option pricing models with discretely observed barriers,*" Applied Numerical Mathematics 36 (2001) 427-445.
47. D. Pooley, P.A. Forsyth, K.R. Vetzal, R.B. Simpson, "*Unstructured meshing techniques for two asset barrier options,*" Applied Mathematical Finance 7 (2000) 33-60.
48. R. Zvan, K.R. Vetzal, P.A. Forsyth, "*PDE methods for pricing barrier options,*" J. Economic Dynamics and Control 24 (2000) 1563-1590.
49. R.G. McLaren, P.A. Forsyth, E.A. Sudicky, J.E. VanderKwaak, F.W. Schwartz, J.H. Kessler, "*Flow and transport in fractured Tuff at Yucca Mountain: numerical experiments on fast fracture flow mechanisms,*" J. Contaminant Hydrology 43 (2000) 211-238.
50. R. Zvan, P.A. Forsyth, K.R. Vetzal, "*Discrete Asian barrier options,*" J. Computational Finance 3 (Fall, 1999) 41-68.
51. K.R. Vetzal, P.A. Forsyth, "*Discrete Parisian and delayed barrier options: A general numerical approach,*" Advances in Futures Options Research 10 (1999) 1-16.
52. P.A. Forsyth, K.R. Vetzal, R. Zvan, "*A finite element approach to the pricing of discrete lookbacks with stochastic volatility,*" Applied Mathematical Finance 6 (1999) 87-106.
53. E. Graham, P.A. Forsyth, "*Preconditioned conjugate gradient methods for very ill-conditioned three dimensional linear elasticity problems,*" International J. Numerical Methods in Engineering 44 (1999) 77-98.
54. K.J. Slough, E.A. Sudicky, P.A. Forsyth, "*Numerical simulation of multiphase flow and phase partitioning in discretely fractured geologic media,*" J. Contaminant Hydrology 40 (1999) 107-136.
55. K.J. Slough, E.A. Sudicky, P.A. Forsyth, "*Grid refinement for modelling multiphase flow in discretely-fractured porous media,*" Advances Water Resources 23 (1999) 261-269.
56. R. Zvan, P.A. Forsyth, K.R. Vetzal, "*Penalty methods for American options with stochastic volatility,*" J. Computational and Applied Mathematics 91 (1998) 199-218.

57. R. Zvan, P.A. Forsyth, K.R. Vetzal, “*Robust numerical methods for PDE models of Asian options*,” J. Computational Finance, 1 (Winter, 1998) 39-78.
58. P.A. Forsyth, A.J. Unger, E. Sudicky, “*Nonlinear iteration methods for nonequilibrium multiphase subsurface flow*,” Advances Water Resources 21 (1998) 433-451.
59. P.A. Forsyth, E. Sudicky, “*Discrete wellbore simulations of pump and treat strategies for remediation of LNAPL contaminated aquifers*,” J. Contaminant Hydrology 31 (1998) 57-81.
60. A.J. Unger, P.A. Forsyth, E. Sudicky, “*Influence of alternative dissolution models and subsurface heterogeneity on DNAPL disappearance times*,” J. Contaminant Hydrology 30 (1998) 217-242.
61. P.A. Forsyth, M.C. Kropinski, “*Monotonicity considerations for saturated-unsaturated subsurface flow*,” SIAM J. Scientific Computing 18 (1997) 1328-1354.
62. H. Jiang, P.A. Forsyth, “*Robust numerical methods for Transonic flows*,” International J. Numerical Methods in Fluids 24 (1997) 457-476.
63. P.A. Forsyth, H. Jiang, “*Nonlinear iteration methods for high speed laminar compressible Navier-Stokes equations*,” Computers & Fluids 26 (1997) 249-268.
64. Y.S. Wu, P.A. Forsyth, H. Jiang, “*A consistent approach for applying numerical boundary conditions for multiphase subsurface flow*,” J. Contaminant Hydrology 23 (1996) 157-184.
65. Q. Fan, P.A. Forsyth, J. McMacken, W.P. Tang, “*Performance issues for iterative solvers in device simulation*,” SIAM J. Scientific Computing 17 (1996) 100-117.
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“*Analysis of a penalty method for Guaranteed Minimum Withdrawal Benefits*,” Workshop on Computational Finance, Fields Institute, Toronto, 2010.

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