# CURRICULUM VITAE

# MICHAEL G. CRANDALL

**Personal Data:**


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| Birthdate: | November 29, 1940 |
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**Educational Record:**

B.S. (Engineering Physics), University of California-Berkeley, June 1962
M.A. (Mathematics), University of California-Berkeley, June 1964
Ph.D. University of California-Berkeley, September 1965

**Positions Held:**

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|---|---|
| Instructor, University of California-Berkeley | 1965–1966 |
| Assistant Professor, Stanford University | 1966–1969 |
| Assistant Professor, UCLA | 1969–1970 |
| Associate Professor, UCLA | 1970–1973 |
| Visiting Associate Professor, Mathematics Research Center, University of Wisconsin-Madison | 1971–1972 |
| Professor, UCLA | 1973–1976 |
| Professor, Department of Mathematics and Mathematics Research Center, University of Wisconsin-Madison | 1974–1984 |
| Hille Professor of Mathematics, University of Wisconsin-Madison | 1984–1990 |
| Visiting Professor, Universities of Paris 6 and 9 (various periods) | |
| Professor, University of California, Santa Barbara | 1988– |

**Other Experience:**

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| Occasional Acting Director of Mathematics Research Center | 1980–1988 |
| Director, Autumn College on Semigroup Theory & Applications, ICTP, Trieste | 1984–1985 |
| Member at large, Council of the AMS | 1984–1987 |
| Director, IAC, Program in Nonlinear Sciences, UCSB | 1988–1992 |
| Chair of the Graduate Council, UCSB (Academic Senate parallel to Dean of Graduate Division) | 1992-1993 |
| Chairman, Department of Mathematics, UCSB | 1993–1996 |
| Trustee, American Mathematical Society | 1996–2001 |
| United States National Committee on Mathematics | 1996–2000 |
| Trustee, Institute for Pure and Applied Mathematics, UCLA | 1997-2001 |

**Some Honors:**

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|---|---|
| Invited Lecture, International Congress of Mathematicians | 1974 |
| Invited Hour Lecture, American Mathematical Society | 1982 |
| J. P. La Salle Memorial Lecture, Brown University | 1984 |
| Houses Professorship, University of Wisconsin-Madison | 1984 |
| University of Arkansas Lecturer in Mathematics | 1986 |
| Progress in Mathematics Lecture of the AMS | 1990 |
| Distinguished Visitor, Louisiana State University | October 1990 |
| Miller Research Professor, UC Berkeley | Fall 1996 |
| Distinguished Visitor, University of Wisconsin, Madison | Fall 1997 |
| Steele Prize, American Mathematical Society | 1999 |
| Docteur Honoris Causa, Université Paris -Dauphine | 1999 |
| American Academy of Arts and Sciences | 2000 |

**Other Professional Activities:**

Editorial Board of J. Nonlinear Analysis Theory, Method, Applications, 1976–1988
Associate Editor, Annales de L'Institut Henri Poincaré–Analyse Non Lineaire, 1983-
Editorial Board, Applicable Analysis, 1985 – 1998
Editorial Board, Differential and Integral Equations, 1989 – 1998
Managing Editor, Communications in Partial Differential Equations, 1989 – 1993
Editorial Board, Communications in Partial Differential Equations, 1994 –
Editorial Board, Electronic Journal of Differential Equations, 1993 –
Editorial Board, Advances in Differential Equations, 1994 – 1999
Editorial Board, journal of Evolution Equations, 2000 –
Advisor to mathematics component of U. Kentucky Epscore program, 1986 -1987
AMS Committee to Select Speakers for Western Regional Meetings, 1974 – 1976
AMS Committee on Committees, 1985 –1987
AMS Notices Editorial Committee, 1989–1993
AMS Western Sectional Program Committee, 1990
AMS Western Sectional Program Committee, Chair, 1991
AMS Progress in Mathematics Committee, 1993
AMS Progress in Mathematics Committee, Chair 1994
AMS/MAA Committee on Cooperation, 1995
AMS Policy Committee on Publications, 1996 - 1998
AMS Committee to Review the Committee on the Profession, 1996
AMS Committee to Review Operation of Journals, 1996
AMS Policy Committee on Science Policy, 1999
AMS Steele Prize Committee, 2000 - 2003
AMS Nominating Committee, 2006 - 2009

**Publications List:**

1. (Dissertation) Two families of periodic solutions of the plane four-body problem, Amer. J. Math. 89 (1967), 275–318.
2. On the extension problem for dissipative operators (with R. S. Phillips), J. Functional Analysis 2 (1968), 147–176.
3. Boundary value problems for symmetric positive differential operators of odd order, J. Math. Mech. 18 (1968), 155–172.
4. Norm preserving extensions of linear transformations on Hilbert spaces, Proc. Amer. Math. Soc. 21 (1969), 335–340.
5. On the differentiability of weak solutions of a differential equation in Banach space (with A. Pazy), J. Math. Mech. 18 (1969), 1007–1016.
6. Semi-groups of nonlinear contractions and dissipative sets (with A. Pazy), J. Functional Analysis 3 (1969), 376–418.
7. Semi-groups of contractions and monotonicity, Theory and Applications of Monotone Operators; Proceedings of a NATO Advanced Study Institute, Venice, Italy, June 17–30, 1968, 1–17.
8. Perturbations of nonlinear maximal monotone sets in Banach space (with H. Brezis and A. Pazy), Comm. Pure Appl. Math. 23 (1970), 123–144.
9. Nonlinear Sturm-Liouville eigenvalue problems and topological degree (with P. H. Rabinowitz), J. Math. Mech. 19 (1970), 1083–1102.
10. On accretive sets in Banach spaces (with A. Pazy), J. Functional Analysis 5 (1970), 204–217.
11. Multiple solutions of a nonlinear integral equation (with P. H. Rabinowitz), Arch. Rational Mech. Anal. 37 (1970), 262–267.
12. Differential equations on convex sets, J. Math. Soc. Japan 22 (1970), 443–455.
13. Bifurcation from simple eigenvalues (with P. H. Rabinowitz), J. Functional Analysis 8 (1971), 321–340.
14. A theorem and counterexample in the theory of semigroups of nonlinear transformations (with Thomas Liggett), Trans. Amer. Math. Soc. 160 (1971), 263–278.
15. Generation of semi-groups of nonlinear transformations on general Banach spaces (with Thomas Liggett), Amer. J. Math. 11 (1971), 265–298.
16. Semigroups of nonlinear transformations in Banach Spaces, Contributions to Nonlinear Functional Analysis (E. H. Zarantonello, ed.), Academic Press, New York (1971).
17. Nonlinear evolution equations in Banach spaces (with A. Pazy), Israel J. Math. 11 (1972), 57–94.
18. A generalized domain for semigroup generators, Proc. Amer. Math. Soc. 37 (1973), 434-440.
19. A generalization of Peano's existence theorem and flow invariance, Proc. Amer. Math. Soc. 36 (1972), 151–155.
20. The semigroup approach to first order quasilinear equations in several space variables,

Israel J. Math. 12 (1972), 108–122.

21. Bifurcation, perturbation of simple eigenvalues and linearized stability (with P. H. Rabinowitz), Arch. Rational Mech. Anal. 52 (1973), 161–180.
22. Some continuation and variational methods for positive solutions of nonlinear elliptic eigenvalue problems (with P. H. Rabinowitz), Arch. Rational Mech. Anal. 58 (1975), 207–218.
23. A semilinear elliptic equation in $L^1(R^N)$ (with Ph. Benilan and H. Brezis), Ann. Scuola Norm. Sup. Pisa, Serie V 2 (1975), 523–555.
24. Semigroups of nonlinear transformations and evolution equations, Proc. Internat. Cong. Math., Vancouver (1974), 257–262.
25. An introduction to evolution governed by accretive operators, Dynamical Systems - an International Symposium, Vol. 1 (L. Cesari, J. Hale, J. LaSalle, eds.), Academic Press, New York (1976), 131–165.
26. On the relation of the operator $\partial/\partial s + \partial/\partial t$ to evolution governed by accretive operators (with L. C. Evans), Israel J. Math. 21 (1975), 261–278.
27. A singular semilinear problem in $L^1(R)$ (with L. C. Evans), Trans. Amer. Math. Soc. 225 (1977), 145–153.
28. The Hopf bifurcation theorem (with P. H. Rabinowitz), Mathematics Research Center TSR 1604, University of Wisconsin–Madison (1976).
29. The Hopf bifurcation theorem in infinite dimension, Arch. Rational Mech. Anal. 67 (1977), 53–72. (A revised version of part of [28].)
30. The principle of exchange of stability (with P. H. Rabinowitz), Dynamical Systems (A. Bednarek and L. Cesari, eds.), Academic Press, New York (1977), 27–43.
31. On the range of accretive operators (with A. Pazy), Israel J. Math. 27 (1977), 235–246.
32. On a Dirichlet problem with a singular nonlinearity (with P. H. Rabinowitz and L. Tartar), Comm. Part. Diff. Eq. 2 (1977), 193–222.
33. An abstract nonlinear Volterra integrodifferential equation (with J. A. Nohel and S.-O. Londen), J. Math. Anal. Appl. 64 (1978), 701–735.
34. An introduction to constructive aspects of bifurcation and the implicit function theorem, Applications of Bifurcation Theory (P. H. Rabinowitz, ed.), Academic Press, New York (1977), 1–35.
35. Ordinary differential equations in infinite dimensions and accretive operators, Transactions of the Twenty-Third Conference of Army Mathematicians, Report 78-1, U. S. Army Research Office, Research Triangle Park, NC (1978), 487–492.
36. An abstract functional differential equation and a related nonlinear Volterra equation (with J. A. Nohel), Israel J. Math. 29 (1978), 313–328.
37. On some existence theorems for semilinear elliptic equations (with H. Amann), Indiana Univ. Math. J. 27 (1978), 779–790.
38. Nonlinear Evolution Equations (ed.), Academic Press, New York (1978).
39. Uniqueness of solutions of the initial-value problem for $u_t - \Delta\phi(u) = 0$ (with H. Brezis), J. Math. Pures Appl. 58 (1979), 153–163.

40. An approximation of integrable functions by step functions with an application (with A. Pazy), Proc. Amer. Math. Soc. 76 (1979), 74–80.
41. Remarks on generators of analytic semigroups (with A. Pazy and L. Tartar), Israel J. Math. 32 (1979), 363–374.
42. Some relations between nonexpansive and order preserving mappings (with L. Tartar), Proc. Amer. Math. Soc. 78 (1980), 385–390.
43. Monotone difference approximations for scalar conservation laws (with A. Majda), Math. Comp. 34 (1980), 1–21.
44. The continuous dependence on $\phi$ of solutions of $u_t - \Delta\phi(u) = 0$ (with Ph. Benilan), Indiana Univ. Math. J. 30 (1981), 162–177.
45. The method of fractional steps for conservation laws (with A. Majda), Numer. Math. 34 (1980), 285–314.
46. The mathematical theory of bifurcation (with P. H. Rabinowitz, notes by Buzano and Canuto), Bifurcation Phenomena in Mathematical Physics and Related Topics, NATO Advanced Study Institute Series, Series C, Mathematical and Physical Sciences, 54, Reidel, Dordrecht (1980), 3–46.
47. Regularizing effects of homogeneous evolution equations (with Ph. Benilan), Contributions to Analysis and Geometry (supplement to Amer. J. Math.) D. N. Clark, C. Pecelli and R. Sackstoder, eds., Johns Hopkins University Press, Baltimore (1981), 23–39.
48. Condition d′unicité pour les solutions generalisées des équations de Hamilton-Jacobi du premier ordre (with P. L. Lions), C. R. Acad. Sci. Paris 292 (1981), 183–186.
49. Regularizing effects for $u_t = \Delta\phi(u)$ (with M. Pierre), Trans. Amer. Math. Soc. 274 (1982), 159–168.
50. Regularizing effects for $u_t + A\phi(u) = 0$ in $L^1$ (with M. Pierre), J. Functional Analysis 45 (1982), 194–212.
51. Stabilization of solutions of a degenerate nonlinear diffusion problem (with D. Aronson and L. A. Peletier), J. Nonlin. Anal. Theory, Methods and Appl. 6 (1982), 1001–1022.
52. Viscosity solutions of Hamilton-Jacobi equations (with P. L. Lions), Trans. Amer. Math. Soc. 277 (1983), 1–42.
53. Quasinonlinear evolution equations (with P. Souganidis), Mathematics Research Center TSR 2352, University of Wisconsin–Madison (1982).
54. Solutions of the porous medium equation in $\mathbf{R}^N$ under optimal conditions on initial values (with Philippe Benilan and Michel Pierre), Indiana Univ. Math. J. 33 (1984), 51–87.
55. Some properties of viscosity solutions of Hamilton-Jacobi equations (with L. C. Evans and P. L. Lions), Trans. Amer. Math. Soc. 282 (1984), 487–502.
56. Two approximations of solutions of Hamilton-Jacobi equations (with P. L. Lions), Math. Comp. 43 (1984), 1–19.
57. Developments in the theory of nonlinear first-order partial differential equations, (with P. Souganidis), Differential Equations, I. W. Krontes and R. T. Lewis, eds., North Holland Mathematics Studies 92, North Holland, Amsterdam (1984), 131–143.

58. Solutions de viscosité non borneés des équations de Hamilton-Jacobi du premier ordre (with P. L. Lions), C. R. Acad. Sc. Paris 298 (1984), 217–220.
59. Viscosity solutions of Hamilton-Jacobi equations at the boundary (with Richard Newcomb), Proc. Amer. Math. Soc. 94 (1985), 283 - 290.
60. Nonlinear semigroups and evolution governed by accretive operators, Proceedings of Symposia in Pure Mathematics 45, F. Browder ed., American Mathematical Society, Providence, 1986, 305 - 337.
61. Solutions de viscosite pour les equations de Hamilton-Jacobi dans des espaces de Banach (with P.-L. Lions), C. R. Acad. Sc. Paris 300 (1985), 67 - 70.
62. Convergence of difference approximations of quasilinear evolution equations (with P. Souganidis), Nonlin. Anal. Th. Meth. Appl. 10 (1986), 425 - 445.
63. A remark on semilinear perturbations of abstract parabolic problems, Nonlin. Anal. Th. Meth. Appl. 9 (1985), 1331 - 1336.
64. On existence and uniqueness of solutions of Hamilton-Jacobi equations (with P. Lions), Nonlin. Anal. Th. Meth. Appl. 10 (1986), 353 - 370.
65. Hamilton-Jacobi equations in infinite dimensions, Part I. Uniqueness of viscosity solutions (with P. Lions), J. Func. Anal. 62 (1985), 379 - 396.
66. Hamilton-Jacobi equations in infinite dimensions, Part II. Existence of viscosity solutions (with P. Lions), J. Func. Anal. 65 (1986), 368 - 405.
67. Unbounded viscosity solutions of Hamilton-Jacobi equations (with P. Lions), Illinois J. Math. 31 (1987), 665 - 688.
68. Hamilton-Jacobi equations in infinite dimensions, Part III. (with P. L. Lions), J. Func. Anal. 68 (1986), 214 - 247.
69. Uniqueness of viscosity solutions revisited (with P. L. Lions and H. Ishii), J. Math. Soc. Japan 39 (1987), 581-596.
70. **Semigroups, theory and applications, Volumes 1 & 2**, Pitman Research Notes in Mathematics 141 (coeditor with H. Brezis and F. Kappel)
71 On nonlinear equations of evolution (with P. Souganidis), Nonlin. Anal. Th. Meth. Appl. 13 (1989), 1375–1392.
72. **Directions in Partial Differential Equations** (Mathematics Research Center Symposium), Academic Press (1987) (coeditor with R. Turner and P. H. Rabinowitz).
73. Solutions de viscosité pour les équations de Hamilton-Jacobi en dimension infinie intervenant dans le contrôle optimal de problems de'évolution (with P.-L. Lions), C.R. Acad. Sci. Paris 305 (1987), 233-236.
74. Some $L^1$ existence and dependence results for some semilinear elliptic equations under nonlinear boundary conditions with applications to degenerate parabolic equations (with P. Sacks and Ph. Benilan), J. Applied Math. Optimization 17 (1988), 203-224.
75. Maximal solutions and universal bounds for some quasilinear evolution equations of parabolic type (with P. L. Lions and P. Souganidis), Arch. Rat. Mech. Anal. 105 (1989), 163-190.
76. Existence and uniqueness of viscosity solutions of degenerate quasilinear elliptic equa-

tions in $\mathbb{R}^n$ (with Y.Tomita and R. Newcomb), Applicable Analysis 34 (1989), 1-23.

77. M. G. Crandall and P. L. Lions, Hamilton-Jacobi equations in infinite dimensions: J. Func. Anal. Part IV. Unbounded linear terms, 90 (1990), 237–283.
78. Semidifferentials, quadratic forms, and viscosity solutions of fully nonlinear elliptic equations of second order, Ann. I.H.P. Anal. Non. Lin. 6 (1989), 419–435.
79. Quadratic growth of solutions of fully nonlinear second order equations in Rn (with P.L. Lions), *J. Diff. and Int. Equations*, 3 (1990), pp. 601-616.
80. The maximum principle for semicontinuous functions (with H. Ishii), *Diff. and Int. Equations* 3 (1990), pp. 1001-1014.
81. The Maximum principle, semicontinuity and nonlinear pde's, Proceedings of the 29th IEEE Conference on Decision and Control, Honolulu, 1990.
82. Completely Accretive Operators (with Ph. Benilan), Semigroup Theory and Evolution Equations, P. Clement, E. Mitidieri and B. de Pagter, eds., Lecture Notes in Mathematics 135, Marcel Dekker, New York, 1991, pp. 41-76.
83. Hamilton-Jacobi equations in infinite dimensions: Part V. B- continuous solutions (with P. L. Lions), J. Func. Anal. 97 (1991), 417-465.
84. Crandall, M. G., H. Ishii and P. L. Lions, User's Guide to viscosity solutions of second order partial differential equations, Bull. Amer. Math. Soc. (N.S.) 27 (1992), 1-67,
85. Viscosity solutions of a degenerate linear equation (with Z. Huan), Diff. Int. Equations 5 (1992),1247-1265.
86. Crandall, M. G., M. Kocan and A. Święch, On partial sup-convolutions, a lemma of P. L. Lions and viscosity solutions in Hilbert spaces, Adv. Math. Sci. Appl. 3 (1993/94), (Special Issue dedicated to Y. Komura), 1-15.
87. Hamilton-Jacobi equations in infinite dimensions: Part VI. Nonlinear $A$ and Tataru's method refined (with P. L. Lions), Lecture Notes in Pure and Appl. Math. 155, Dekker, New York, 1994, p 51 -89..
88. Hamilton-Jacobi equations in infinite dimensions: Part VII. The HJB equation is not always satisfied (with P. L. Lions), J. Funct. Anal. 125 (1994), 111–148.
89. On viscosity solutions of fully nonlinear equations with measurable ingredients (with L. Caffarelli, M. Kocan and A. Święch), Comm. Pure Appl. Math. 49 (1996), 365-397.
90. On the equivalence of various weak notions of solutions of elliptic pdes with measurable ingredients (with M. Kocan, P. Soravia and A. Święch), Progress in elliptic and parabolic partial differential equations (Capri, 1994), 136–162, Pitman Res. Notes Math. Ser., 350, Longman, Harlow, 1996.
91. Convergent difference schemes for nonlinear parabolic equations and mean curvature motion (with P. L. Lions), Numer. Math. 75 (1996), no. 1, 17–41.
92. Viscosity solutions: a primer. Viscosity solutions and applications (Montecatini Terme, 1995), 1–43, Lecture Notes in Math. 1660, Springer, Berlin, 1997.
93. Remarks on nonlinear uniformly parabolic equations (with K. Fok, M. Kocan, A. Święch), Indiana U. Math. J., 47 (1998), 1293-1326.
94. Existence results for Dirichlet problems for uniformly elliptic fully nonlinear equations

(with M. Kocan, P. L. Lions A. Święch), Electronic J. Differential Equations, No. 24 (1999), 22 pgs.

95. $L^p$-theory for fully nonlinear uniformly parabolic equations (with M. Kocan, A. Święch), Comm. Partial Differential Equations,: 25 (2000), 1997-2053.
97. Optimal lipschitz extensions and the infinity Laplacian (with L. C. Evans and R. Gariepy), Calculus of Variations and PDE, 13, no 2, 123-139 and DOI 10.1007/s005260000065
98. A remark on infinity harmonic functions (with L. C. Evans), Electronic J. Differential Equations, Conf. 06 (2001), 123-129.
99. Another way to say harmonic (with J. Zhang), Trans. Amer. Math. Soc. 355 (2003), no. 1, 241–263.
100. An efficient derivation of the Aronsson equation, Arch. Rat. Math. Mech., 167 (2003), 271-279.
101. A note on generalized maximum principles for elliptic and parabolic pde (with A Swiech), Evolution equations, Lecture Notes in Pure and Applied Math., 234, Dekker, New York, (2003), 121-127.
102. Another way to say caloric (with P. Y. Wang), J. Evol. Eq. 3 (2003), 653-672.
103. A tour of the theory of absolutely minimizing functions (with G. Aronsson and P. Juutinen), Bull. Amer. Math. So. (N. S.) 41 (2004), 439-505.
104. A visit with the $\infty$-Laplace equation, 5–122, Lecture Notes in Math., 1927, Springer, Berlin, 2008
105. Uniqueness of $\infty$-harmonic Functions and the Eikonal Equation (with G. Gunnarsson and P. Y. Wang), Comm. Partial Differential Equations 32 (2007), no. 10-12, 1587–1615.
106. Derivation of the Aronsson equation for $C^1$ Hamiltonians (with C. Wang and Y. Yu), Trans. Amer. Math. Soc. 361 (2009), no. 1, 103–124.
107. The problem of two sticks (with L. Caffarelli), preprint
108. Distance functions and almost global solutions of eikonal equations (with L. Caffarelli), preprint.