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CURRICULUM VITAE

ARIE LEIZAROWITZ

Date and place of birth	April 26, 1953, Tel-Aviv.
Marital status	Married, two children.
Identification number	051711406.

ACADEMIC DEGREES

1974 B.Sc. in Physics, Tel-Aviv University.

1980 M.Sc. in Applied Mathematics, Tel-Aviv University.

1984 Ph.D. in Mathematics, The Weizmann Institute of Science.

PROFESSIONAL EXPERIENCE

1984-86	Research Associate, The Institute for Mathematics and Its Applications, The University of Minnesota.
1986-1988	Assistant Professor, Department of Mathematics, Carnegie Mellon University, Pittsburgh.
1988-1995	Senior Lecturer, Department of Mathematics, Technion.
1995-	Associate Professor, Department of Mathematics, Technion.
1989 (summer)	Visiting research member, Division of Applied Mathematics, Brown University, Providence.
1989, 1990 (summer)	Visiting research member, GERAD (HEC), The University of Montreol.
1992 (summer)	Visiting Professor, The University of Geneva.
1993 (summer)	Visiting Professor, The University of Geneva.
1993 (summer)	Visiting Professor, The Center for Nonlinear Analysis, Carnegie Mellon University.
1995	Visiting the Institute of Advanced Research and Studies (CINVESTAV), Mexico City.
1996	Visiting the department of Mathematics in The

	University of South Australia, Adelaide , Australia.
2000 (summer)	Visiting Professor, The Center for Nonlinear Analysis, Carnegie Mellon University.

TEACHING EXPERIENCE (Courses taught)

1979-80 Tel-Aviv University, (calculus).
1984-85 University of Minnesota, (calculus).
1986-88 Carnegie Mellon University, (control theory, linear algebra, functional analysis, ordinary differential equations).
1988-02 Technion, (control theory, functions of complex variables, ordinary differential equations, partial differential equations, dynamical systems, probability theory, calculus).

INVITED TALKS IN INTERNATIONAL CONFERENCES

December 1987	*The 26th Conference on Decision & Control*, Los Angeles. "Infinite horizon optimization for finite state Markov chain".
March 1990	*Optimization & Nonlinear Analysis Workshop*, Haifa. "Variational problems on unbounded multidimensional domains".
May 1990	*The Israeli Mathematical Society Meeting*, Haifa. "Infinite horizon optimal control of random evolution systems".
May 1990	*Lyapunov Exponent Meeting*, Oberwolfach, West Germany. "Eigenvalue representation of the top Lyapunov exponent and the p-moment Lyapunov exponent of certain Markov processes".
July 1992	*Fifth International Symposium on Dynamic Games and Applications*, Geneva, Grimentz July 13-17, "Overtaking equilibria in infinite horizon differential games".
October 1992	*The Second Gentner Symposium on Applicable Analysis*, Gosen, Berlin, "Overtaking optimal regulation and tracking of piecewise diffusion linear systems".
October 1993	*International Conference on* CONTROL THEORY AND ITS APPLICATIONS, Maale HaChamisha, Israel. "Convergence of solutions to equations arising in neural networks".
May 1995	*AMS and IMU joint meeting*, Jerusalem. "Optimization of infinite horizon Markov Decision Processes".
July 1995	*Workshop on Stochastic Control*, CINVESTAV (Institute of

	advanced research and studies), Mexico-City. "Overtaking optimality for finite state Markov Decision Processes" and "Almost-sure optimality for Markov Decision Processes".
March 1998	*Calculus of Variations and related topics*, Haifa. "On radially symmetric minimizers of a variational problem on the plane".
June 1999	*The 7th Mediterranean Conference on Control and Automation*, Haifa. "On the existence of optimal strategies for multichain Markov Decision Processes".
Sept. 2000	*INTAS Workshop on Extremal Problems, Convexity and, Applications*, Rehovot. "On second order two-dimensional variational problems on unbounded domains".
October 2000	*International Workshop on Decision and Control in managment sciences*, Montreol. "Average optimal policies in multichain finite state compact action Markov Decision Processes".

ADMINISTRATIVE DUTIES

1990-92 Faculty Colloquium Chairman.
1992-93 Principal Undergraduate Students Advisor.
1996-02 Member of various committees in the mathematics department.

GRADUATE STUDENTS

Hagit Gabbay, *Postural control under periodic disturbance of the support surface*, M.Sc., 1992. (Coadvisor Gideon Ishai, Department of Biomedical Engineering).

Iris Rosenberg, *On complex eigenvalues of convex processes*, M.Sc., 1995.

Nataly Tsipenyuk, *Existence and convergence of solutions for discrete control system on infinite interval*, M.Sc., 1998.

PUBLIC PROFESSIONAL ACTIVITIES

Refereeing for the journals *SIAM Journal on Control, Stochastics, Applied Mathematics & Optimization, Journal of Mathematical Analysis and Applications, Mathematics of Opeations Research, Linear Algebra and Its Applications, Journal of Optimization Theory and Applications*, for NSF project proposals and reviewing for Math. Reviews.

AWARDS

1980 The M.Sc. degree was received with a special distinction.

1984 J.F. Kennedy Prize of the Feinberg Graduate School at the Weizmann Institute of Science for best Ph.D. thesis.

FELLOWSHIPS

1984-86 Weizmann Post-Doctoral Fellowship.

1986-88 The Zeev Nehari Fellowship. (Named Assistant Professor position in Carnegie Mellon University.)

GRANTS

1988-90 The Toronto Academic Lecturship Fund at Technion.

1990 The Canadian NSERC (National Science and Engineering Research Council) Grant for summer support.

1991-94 The Ministry of Science Grant supporting the research "On certain dynamical systems and set-valued mappings", jointly with Doctor A. Zaslavski.

1992-95 The Basic Research Foundation of The Israeli Academy of Sciences, jointly with Professor Moshe Marcus.

1995-98 The United States-Israel Binational Science Foundation (BSF) supporting the research "Simultaneous stabilization and robust stability of systems under uncertainty conditions", jointly with Professor Ezra Zeheb and Professor Jacob Kogan.

LIST OF PUBLICATION

M.Sc. Thesis, *Oscillation criteria and growth of nonoscillatory solutions of higher order differential equations*, Tel-Aviv University, 1980. Advisor Doctor M. Bareket.

Ph.D. Thesis, *Control problems on infinite horizon*, Weizmann Institute of Science, 1984. Advisor Professor Z. Artstein.

Papers in print

1. M. Bareket & A. Leizarowitz, Oscillation criteria and growth of nonoscillatory solutions of higher order differential equations. *Journal of Mathematical Analysis & Applications*, 86, 479-492, 1982.

2. A. Leizarowitz, Infinite horizon autonomous systems with unbounded cost. *Applied Mathematics & Optimization*, 13, 19-43, 1985.

3. A. Leizarowitz, Existence of overtaking optimal trajectories for problems with convex integrands. *Mathematics of Operations Research*, 10, 450-461, 1985.

4. A. Leizarowitz, Convergence of viable solutions of differential inclusions with convex compact graphs. *SIAM Journal on Control & Optimization*, 23, 514-522, 1985.

5. Z. Artstein & A. Leizarowitz, Tracking periodic signals with the overtaking criterion. *IEEE Transaction on Automatic Control*, AC-30, 1122-1126, 1985.

6. A. Leizarowitz, Tracking nonperiodic trajectories with the overtaking criterion. *Applied Mathematics & Optimization*, 14, 155-171, 1986.

7. A. Leizarowitz, Infinite horizon stochastic regulation and tracking with the overtaking criterion. *Stochastics*, 22, 117-150, 1987.

8. A. Leizarowitz, Infinite horizon optimization for finite state Markov chain. *SIAM Journal on Control & Optimization*, 25, 1601-1618, 1987.

9. A. LEIZAROWITZ, Control problems with random and progressively known targets. *Journal of Optimization Theory & Applications*, targets. *Journal of Optimization Theory & Applications*, 59, 445-465, 1988.

10. A. LEIZAROWITZ, Controlled diffusion processes on infinite horizon with the overtaking criterion. *Applied Mathematics & Optimization*, 17, 61-78, 1988.

11. A. LEIZAROWITZ, On almost sure optimization for stochastic control systems. *Stochastics*, 23, 85-107, 1988.

12. A. LEIZAROWITZ, Estimates and exact expressions for Lyapunov exponents of stochastic linear differential equations. *Stochastics*, 24, 335-356, 1988.

13. A. LEIZAROWITZ, Optimal trajectories of infinite horizon deterministic control systems. *Applied Mathematics & Optimization*, 19, 11-32, 1989.

14. A. LEIZAROWITZ, On the Lyapunov exponent of a harmonic oscillator driven by a finite state Markov process. *SIAM Journal on Applied Mathematics*, 49, 404-419, 1989.

15. A. LEIZAROWITZ & V. MIZEL, One dimensional infinite-horizon variational problems arising in viscoelasticity. *Archive for Rational Mechanics & Analysis*, 106, 161-194, 1989.

16. A. LEIZAROWITZ, Optimal control for diffusions in R^d- a min-max max-min formula for the minimal growth rate. *Journal of Mathematical Analysis & Applications*, 149, 180-209, 1990.

17. A. LEIZAROWITZ, Exact results for the Lyapunov exponents of certain linear Ito systems. *SIAM Journal on Applied Mathematics*, 50, 1156-1165, 1990.

18. A. LEIZAROWITZ, A square shape of the graph of finite iterates of multivalued functions. *Proceedings of the American Mathematical Society*, 110, 471-477, 1990.

19. A. Leizarowitz, Eigenvalue representations for the Lyapunov exponents of certain Markov processes. In *Lyapunov Exponents, Oberwolfach 1990*, Springer-Verlag Lecture Notes in Mathematics, 1486, 51-64, 1992.

20. A. Haurie & A. Leizarowitz, Overtaking optimal regulation and tracking of piecewise diffusion linear systems. *SIAM Journal on Control and Optimization*, 30, 816-837, 1992.

21. A. Leizarowitz, On infinite products of stochastic matrices. *Linear Algebra and Its Applications*, 168, 189-219, 1992.

22. A. Leizarowitz, Variational problems on unbounded two-dimensional domains. *Mathematical Models and Methods in Applied Sciences*, 2, 183-201, 1992.

23. A. Haurie, A. Leizarowitz & Ch. van Delft, Boundedly optimal control of piecewise deterministic systems. *European Journal of Operational Research*, 73, 237-251, 1994.

24. A. Leizarowitz, Eigenvalues of convex processes and convergence properties of differential inclusions. *Set-Valued Analysis*, 2, 505-527, 1994.

25. D. Carlson, A. Haurie & A. Leizarowitz, Overtaking equilibria for switching regulator and tracking games, in Advances in Dynamic Games and Applications, T. Basar and A. Haurie Editors. *Annals of the International Society of Dynamic Games*, Vol. 1, pp. 247-268, Birkhauser, Boston, 1994.

26. J. Kogan & A. Leizarowitz, Frequency domain criterion for robust stability of interval time-delay systems. *Automatica*, Vol. 31, No. 3, pp. 463-469, 1995.

27. J. Kogan & A. Leizarowitz, Exponential stability of linear systems with commensurate time-delays. *Mathematics of Control, Signals and Systems*, Vol. 8, pp. 65-82, 1995.

28. A. Haurie, A. Leizarowitz & Ch. van Delft, Turnpike in flow control models of unreliable manufacturing systems, *European Journal of Operational Research*, 82, 338-351, 1995.

29. A. Leizarowitz, Overtaking and almost-sure optimality for infinite horizon Markov Decision Processes. *Mathematics of Operations Research*, Vol. 21, No. 1, pp. 158-181, 1996.

30. A. Leizarowitz & A. Zaslavski, Infinite horizon variational problems with nonconvex integrands. *SIAM Journal on Control and Optimization*, Vol. 34, pp. 1099-1134, 1996.

31. A. Leizarowitz, Convergence of solutions to differential equations arising in neural networks. *Journal of Optimization Theory and Applications*, Vol. 94, pp. 533-560, 1997.

32. A. Leizarowitz & A. Zaslavski, Optimal solutions of linear control systems with nonperiodic convex integrands. *Mathematics of Operations Research*, Vol. 22, pp. 726-746, 1997.

33. L. Naimark, J. Kogan, A. Leizarowitz & E. Zeheb, On rational stabilizing controllers for interval delay systems. In , *Lecture Notes in Control and Information Sciences*, No. 228, pp. 184-204, Springer-Verlag, London, 1998.

34. J. Hocherman, J. Kogan, A. Leizarowitz & E. Zeheb, Robust stability of quasipolynomials with annular uncertainties. *Multidimensional systems and signal processing*, Vol. 9, pp. 77-92, 1998.

35. A. Leizarowitz & A. Zaslavski, Optimal solutions of linear periodic systems with convex integrands. *Applied Mathematics and Optimization*, Vol. 37, pp. 127-149, 1998.

36. V. Gaitsgory & A. Leizarowitz, Limit occupational measures set for a control system and averaging of singularly perturbed control systems. *Journal of Mathematical Analysis & Applications*, Vol. 233, pp. 461-475, 1999.

37. A. Leizarowitz, J. Kogan & E. Zeheb, On simultaneous stabilization of linear plants. *Latin America Applied Research*, Vol. 29, pp. 167-174, 1999.

38. A. Leizarowitz & M. Marcus, On radially symmetric minimizers of second order two-dimensional variational problems, in *Calculus of*

Variations and Differential Equations, Chapman & Hall, CRC, Res. Notes Math., Vol. 410, pp. 136-147, 2000.

39. P. G. HOWLETT & A. LEIZAROWITZ, Optimal strategies for vehicle control problems with finite control sets. *Dynamics of Continuous, Discrete and Impulsive Systems, Series B: Applications and Algorithms*, Vol. 8, pp. 41-69, 2001.

40. ARIE LEIZAROWITZ, Order reduction is invalid for singularly perturbed control problems with vector fast variable. *Mathematics of Control, Systems and Signals*, Vol. 15, pp. 101-119, 2002.

41. A. LEIZAROWITZ, On optimal policies of multichain finite state compact action Markov Decision Processes, in *Decision & Control in Management Science* in honor of Alain Haurie, ed. George Zaccour, Kluwer Academic Publishers, pp. 79-96, 2002.

Accepted papers

42. A. LEIZAROWITZ & A. ZASLAVSKI, Infinite horizon discrete time optimal control problems. To appear in *Journal of Mathematical Sciences.*

43. Z. ARTSTEIN & A. LEIZAROWITZ, Singularly perturbed control systems with one-dimensional fast dynamics. To appear in *SIAM Journal on Control and Optimization.*

44. ARIE LEIZAROWITZ, On the order reduction approach for singularly perturbed optimal control systems. To appear in *Set-Valued Analysis.*

Papers published in conference minutes

1. Infinite horizon optimization for finite state Markov chain. *The IEEE Conference on Decision & Control*, 1987.

2. Variational problems on unbounded multidimensional domains. *Optimization & Nonlinear Analysis Workshop*, Haifa, 1990.

3. On boundedly optimal control of piecewise deterministic systems, jointly with A. Haurie and Ch. van Delft. *The Aachen Meeting on Operations Research*, July 1991.

Submitted papers

1. A. Leizarowitz, An algorithm to identify and compute average optimal policies in multichain Markov decision processes.

Books

- D. Carlson, A. Haurie & A. Leizarowitz, *Infinite Horizon Optimal Control. Deterministic and Stochastic Systems.* Springer-Verlag, Inc., 1991.