

CURRICULUM VITAE
MARK L. PSIAKI

Professor

Sibley School of Mechanical and Aerospace Engineering
Cornell University, Ithaca, N.Y. 14853-7501
Phone: (607) 255-9100, Facsimile: (607) 255-1222
e-mail: mlp4@cornell.edu
web: <http://gps.mae.cornell.edu/>

AREAS OF INTEREST

Estimation and filtering; GPS/Galileo/GNSS receivers and applications; navigation; spacecraft attitude and orbit determination; remote sensing of the upper atmosphere and related inverse problems; control system design and analysis; guidance; numerical trajectory optimization; dynamic modeling of satellites, rockets, aircraft, wheeled vehicles, and automated machinery.

EDUCATION

Ph.D. 1987, Mechanical and Aerospace Engineering, Princeton University.
M.A. 1984, Mechanical and Aerospace Engineering, Princeton University.
B.A. 1979, Physics (magna cum laude), Princeton University.

EMPLOYMENT

1986-Present: Cornell University, Sibley School of Mechanical and Aerospace Engineering; Acting Assistant Professor (7/86-8/87), Assistant Professor (9/87-10/93), Associate Professor (11/93-3/06), Professor (4/06-present)
2014-2015 NRC Senior Research Associate, Air Force Research Lab/Space Vehicles Directorate, Kirtland AFB, Albuquerque, NM.
2001 & 1994-1995: The Technion, Haifa Israel. Visiting Associate Professor of Aerospace Engineering.
1982-1986: Princeton University, Department of Mechanical and Aerospace Engineering; Graduate Student and Assistant in Instruction.
1979-1982: RCA Astro-Electronics, East Windsor, NJ; Mechanical Design Engineer.

AWARDS AND HONORS

Best Paper Award, 1997 AIAA Guid., Nav., & Control Conf. (out of 211 papers).
Best Paper Award, 1998 AIAA/AAS Astrodynamics Specialist Conf. (out of 75 papers).
Best Paper Award, 2002 AIAA/AAS Astrodynamics Specialist Conf. (out of 136 papers).
Best Paper Award, 2005 AIAA Guid., Nav., & Control Conf. (tied for 1st out of 431 papers).
Best Paper Award, 2007 AIAA Guid., Nav., & Control Conf. (out of 366 papers).
Best Paper Award, 2009 AIAA Guid., Nav., & Control Conf. (out of 631 papers).
ION 2005 Burka Award for Best Paper in Vol. 52 of *Navigation*.
ION 2013 Tycho Brahe Award.
Fellow of the ION, 2014-present.
Associate Fellow of the AIAA, 1997-present.
Pride at Boeing Accomplishment Award for work on the iGPS program, 2007.

2 Lady Davis Fellowships, The Technion, Haifa, Israel, 1994-1995 and 2001.
NRC Senior Research Associateship, AFRL, Kirtland AFB, NM, 2014-2015.
13 Best-presentation-in-session awards at various ION GNSS Conferences.
NASA ICB award for a Real-Time Software Receiver, 2007.
Dennis Shepherd Teaching Award, Cornell School of Mech. & Aero. Engr., 2000.
J.P. and Mary Barger '50 Excellence in Teaching Award, Cornell College of Engr., 2001.
Michael Tien '72 Excellence in Teaching Award, Cornell College of Engr., 2007.
Ralph S. Watts '72 Excellence in Teaching Award, Cornell College of Engr., 2010.
McCormick Freshman Advising Award, Cornell College of Engr., 2002.
National Science Foundation Fellow, 1982-1985.
Guggenheim Honorary Fellow, Princeton University, 1982-1984.
George Van Ness Lothrop Honorific Fellow, Princeton University, 1985-1986.

RESEARCH GRANTS & CONTRACTS (with Psiaki as **PI** except where noted)

"Real-Time Trajectory Optimization on Parallel Processors," sponsored by the NASA Langley Research Center, July 1989-June 1992.

"Development of an Airborne Testbed for GPS Receivers and Related Avionics Technology," sponsored by various Cornell corporate and alumni supporters, Aug. 1998-May 1999.

"Magnetometer-Based Orbit and Attitude Determination with Simultaneous Correction of the Earth's Magnetic Field Model," NASA/GSFC, Jan. 1999-Dec. 1999.

"SIERRA – Sounding of the Ion Energization Region: Resolving Ambiguities," NASA OSS, with P. Kintner (**PI**), R. Arnoldy, K. Lynch, & J. Labelle Jan. 1999-Dec. 2002.

"Three-Axis Satellite Attitude Control Using Only Magnetic Torquers," AFOSR, with R. D'Andrea, March 1999-Oct. 1999.

"SIERRA Wire Boom Deployment System Student Projects," sponsored by various Cornell corporate and alumni supporters, Aug. 1999-May 2000.

"GPS-Based Approaches to Orbit Determination and Differential Positioning of the Space Solar Power System," NASA/GSFC, Oct. 1999-May 2000.

"Acquisition of Instrumentation to Develop GPS Receivers and Investigate Ionospheric Effects on GPS," ONR, with P. Kintner (**PI**) & M. Kelley, April 2000-March 2001.

"Development of Orbit Determination Filters and Gyro-less Attitude Determination Filters that Rely on Magnetometer Data," NASA/GSFC, June 2000-May 2002.

"Design and Experimental Testing of Three-Axis Satellite Attitude Control Systems That Use Only Magnetic Torquers," AFOSR, with M. Guelman of the Technion, Jan. 2001-Aug. 2002.

"Development of GPS Software Receiver Algorithms for use in High-Altitude Spacecraft Navigation," NASA/GSFC, July 2001-June 2003.

"Development of GPS Translator Instrumentation," NASA OSS, with P. Kintner (**PI**), May 2002-April 2005.

"GPS-Like Phasing Control of the Space Solar Power System Transmission Array," NASA/GSFC, March 2002-Feb. 2003.

- "Euler Dynamics-Based Estimation Algorithms for Spacecraft Attitude and Rate Determination," NASA/GSFC, April 2002-May 2004.
- "Dual Frequency GPS Software Receiver Development for Ionospheric Scintillation Measurement," NASA OSS, with P. Kintner, June 2002-May 2006.
- "Cascades: The Changing Aurora: In Situ and Camera Analysis of Dynamic Electron Precipitation Structures," NASA OSS, with P. Kintner (**PI**), Jan. 2003-Dec. 2005.
- "Validation of a New Electric Field Instrument and Analysis of Fluctuating Electric and Magnetic Fields in a Region of Alfvénic Activity," NASA OSS, with P. Kintner (**PI**), March 2003-Feb. 2005.
- "Relative Navigation of Formations of High-Earth-Orbiting Satellites Using Dual-Frequency Civilian GPS Technology," NASA/GSFC, July 2003-June 2007.
- "Relative Navigation of High-Earth-Orbiting Satellites Using Dual Frequency Civilian GPS Technology," NASA/GSFC, with S. Mohiuddin, Graduate Student Researchers Program fellow and student **PI**, July 2004-June 2007.
- "In-Orbit Inspection Technology Demonstrator (In-Tech)," AFOSR, with M. Peck (**PI**) and M. Campbell, April 2005-March 2007.
- "Acquisition of Instrumentation to Develop GPS Receivers and Investigate Ionospheric Effects on GPS: Transition to Dual-Frequency Civilian Codes," ONR DURIP, with P. Kintner (**PI**) and M. Kelley, May 2005-April 2006.
- "Development of Inexpensive, Robust, Civilian Dual-Frequency GPS Technology and Instrumentation for Space Flight Experiments," NASA OSS, with P. Kintner (**PI**), June 2005-June 2008.
- Work Statement for Cornell University Participation in "Rocket Observations of Pulsating Aurora", NASA OSS, with P. Kintner (**PI**), June 2005-May 2008.
- "Development of a Limb Scanning Occultation Receiver for Ionospheric/Atmospheric Remote Sensing using Galileo and Modernized GPS Signals", NASA OSS, with P. Kintner, May 2006-May 2011.
- "Team Cornell: Autonomous Vehicle for Operations in Urban Environments", DARPA, with M. Campbell (**PI**), E. Garcia, D.P. Huttenlocher, H. Lipson, and B. Selman, Sept. 2006-Sept. 2007.
- "Cascades-2: Reflight of 'Cascades: The Changing Aurora: In Situ and Camera Analysis of Dynamic Electron Precipitation Structures'," NASA OSS, with P. Kintner (**PI**), March 2007-Feb. 2010.
- "Ultra-Precise Orbit, Clock, Ionosphere, and Troposphere Estimation for iGPS", Boeing Integrated Defense Systems, Aug. 2007-Feb. 2008.
- "Collaborative Research: NSWP -- Scintillation-Scale Ionospheric Imaging using GPS and other RF Data in Inverse Diffraction Algorithms", NSF, with P. Kintner, Sept. 2007-Aug. 2012.

- "Connected Autonomous Space Environment Sensors (CASES)" subcontract from ASTRA, Inc. for Cornell's part of Phase-I STTR from AFOSR, with Paul Kintner (**PI**), Sept. 2007-May 2008.
- "Rocket Experiment for Neutral Upwelling (RENU)", NASA OSS, with P. Kintner and M. Lessard (**PI**), May 2008-April 2012.
- "Ultra-Precise Orbit, Clock, Ionosphere, and Troposphere Estimation for iGPS, Phase II", Boeing Integrated Defense Systems, April 2008-Sept. 2008.
- "Developing New Space Weather Monitors: Acquisition of a GPS L5 Signal Simulator, L5 Antennas, and Associated Hardware", ONR, with P. Kintner (**PI**), April 2008-April 2009.
- "Development of Inexpensive, Robust, Civilian Dual-Frequency GPS Technology and Instrumentation for Space Flight Experiments: MicroGPS", NASA OSS, with Paul Kintner (**PI**), May 2008-April 2012.
- "Ultra-Precise Orbit, Clock, Ionosphere, and Troposphere Estimation for iGPS, Phase III", Boeing Defense, Space & Security, Oct. 2008-March 2012.
- "Connected Autonomous Space Environment Sensors (CASES)" subcontract to ASTRA, Inc. for Cornell's part of Phase-II STTR from AFOSR, with Paul Kintner (**PI**), Feb. 2009-Oct. 2010.
- "Magnetospher-Ionosphere Coupling in the Alfvén Resonator (MICA)" NASA OSS, with Paul Kintner (**PI**), July 2010-June 2013.
- "GPS Autonomous Micro-Monitor" subcontract from ASTRA, Inc. for Cornell's part of Phase-I SBIR from the U.S. Air Force, May 2012-Aug. 2012.
- "Studies of Ionospheric Irregularities: Origins and Effect," ONR, with P. Kintner and S. Powell (successive **PIs**), Feb. 2009-Feb. 2015.
- "Studying Heater-Induced Ionospheric Irregularities with Radar and Optics," with David Hysell (**PI**), BAE Systems, Aug. 2009-Sept. 2014.
- "Rocket Experiment for Neutral Upwelling 2 (RENU2)", NASA OSS, with D. Hysell and M. Lessard (**PI**), May 2013-April 2017.
- "Using Satellite Communications Signals for Orbit Determination", Space Systems/Loral, July 2013-Dec. 2013.

INSTRUCTIONAL GRANTS (with Psiaki as **PI** except where noted)

- "Process Control Laboratory Development Grant," ALCOA, with P. Clancy & P. Clark, July 1986-June 1989.
- "SAE Air Cargo Team RC Aircraft Competition," various corporations and Cornell alumni, Aug. 1987-May 1992 and Aug. 1995-May 1998.
- "System Dynamics Instructional Laboratory Equipment Grant and Endowment," Kresge foundation and various Cornell alumni, with J. Booker, J. Koechling, & F. Moon, Jan. 1992-May 1998.

"Nonlinear Dynamics: Application to Engineering Design," NSF, with F. Moon (**PI**) & R. Rand, Oct. 1993-Sept. 1996.

"Instructional Equipment Grant for Data Acquisition and Control Computers," Ted O'Hart, a Cornell alumnus, with F. Gouldin, Jan. 1998-June 1998.

"Experimental Model-Based Control Design Using Multibody Codes," NSF, with R. D'Andrea (**PI**), June 1998-May 2000.

CONSULTING

AeroAstro, L.L.C. - ALEXIS spacecraft attitude determination Kalman filter/smoothen development, post-flight evaluation, and modification to cope with launch damage (1990-1995).

The Boeing Co. iGPS system development (2004-2008).

Boyce/Thompson Res. Inst. - Modeling and design of an outdoor ozone regulator for a botany experiment (1994).

Broadcom/Global Locate, Inc. Expert testimony/advice on patent infringement law suits between SiRF and Global Locate (2007).

Coherent Navigation, Inc. iGPS system development (2008-2014).

Ithaco, Inc. - LACE spacecraft attitude determination Kalman filter development and post-flight evaluation. MAGNAV spacecraft orbit determination system conception, development, and evaluation (1987-1991), GPS-based orbit and attitude determination system evaluation and development (1998-1999).

Los Alamos Nat'l. Lab. - ALEXIS spacecraft attitude determination Kalman filter/smoothen evaluation and modification (1997-1998).

Telonics, Inc. Development of a GPS point positioning algorithm that uses ambiguous pseudoranges from short duration signal tracks (2007).

PROFESSIONAL ACTIVITY

AGU: Member, 2014-present.

AIAA: Associate Fellow; Member of the guidance, navigation and control technical committee, 1992-1995. Chairman of the best paper awards sub-committee 1994-1995. Member of the best paper awards committee, 1998-1999, Associate editor of the Journal of Guidance, Control, and Dynamics, 2001-2005.

ASME: Faculty advisor of Cornell student section, 1988-1991.

ION (Institute of Navigation) Professional Member, 2000-2014; Fellow, 2014-present; Session organizer for ION GNSS Confs. in 2004, 2007, 2013, 2014, & 2015; member of Parkinson award committee, 2011; Member of working group to establish ION standard for exchange of GNSS Software-Defined Radio (SDR) metadata, 2014-present.

Reviewer for J. of Guidance, Control, & Dynamics, J. of the Astronautical Sciences, Automatica, IEEE Trans. on Aerospace and Electronic Systems, IEEE Trans. on Automatic Control, Navigation, Optimal Control Appl. and Methods, and other journals and conferences.

Member of international program committee, Itzhack Bar-Itzhack Memorial Symposium on Estimation, Navigation, and Spacecraft Control, October 2012, Haifa, Israel.

PERSONAL

Born Nov. 16, 1956 in Patterson, New Jersey.

U.S. citizen.

Married with 9 children.

Pianist, New Life Presbyterian Church, 1988-1996.

PATENTS

B.M. Ledvina, M.L. Psiaki, S.P. Powell, and P.M. Kintner, Jr., "Real-Time Software Receiver," U.S. Patent No. 7,010,060, issued on March 7, 2006.

B.M. Ledvina, M.L. Psiaki, S.P. Powell, and P.M. Kintner, Jr., "Real-Time Software Receiver," U.S. Patent No. 7,305,021, issued on Dec. 4, 2007.

C.E. Cohen, R.W. Brumley, M.L. Psiaki, G.M. Gutt, W.J. Bencze, B.M. Ledvina, B.G. Ferrell, and D.A. Whelan, "Methods and Apparatus for a Navigation System with Reduced Susceptibility to Interference and Jamming," U.S. Patent No. 7,372,400, issued on May 13, 2008.

C.E. Cohen, T.E. Humphreys, B.M. Ledvina, W.J. Bencze, M.L. Psiaki, and B.T. Galusha, "Practical Method for Upgrading Existing GNSS User Equipment with Tightly Integrated NAV-COM Capability," U.S. Patent No. 7,978,130, issued on July 12, 2011.

M.L. Psiaki, "Spoofing Detection for Civilian GNSS Signals," U.S. Patent No. 8,712,051 B2, issued on April 29, 2014.

M.L. Psiaki, S.P. Powell, B.W. O'Hanlon, "Methods and Apparatus for Detecting Spoofing in Global Navigation Satellite System Signals using Carrier Phase Measurements and Known Antenna Motions," filed as Application No. PCT/US13/60808 on Sept. 20, 2013, patent pending.

M.L. Psiaki, I.T. Miller, and B.M. Ledvina, "Vehicle Navigation using Non-GPS LEO Signals and On-Board Sensors," filed as Application No. 14/188,604 on Feb. 24, 2014.

PUBLICATIONS

REFEREED JOURNAL ARTICLES

1. M.L. Psiaki and R.F. Stengel, "Analysis of Aircraft Control Strategies for Microburst Encounter," *Journal of Guidance, Control, and Dynamics*, Vol. 8, No. 5, Sept.-Oct. 1985, pp. 553-559. (also in *Proc. 1984 AIAA Aerospace Sciences Meeting*)

2. M.L. Psiaki and R.F. Stengel, "Optimal Flight Paths Through Microburst Wind Profiles," *Journal of Aircraft*, Vol. 23, No. 8, August 1986, pp. 629-635. (also in *Proc. 1985 AIAA Guidance, Navigation, and Control Conf.*)
3. M.L. Psiaki, F. Martel, and P.K. Pal, "Three-Axis Attitude Determination via Kalman Filtering of Magnetometer Data," *Journal of Guidance, Control, and Dynamics*, Vol. 13, No. 3, May-June 1990, pp. 506-514. (also in *Proc. 1988 Flight Mechanics/Estimation Theory Symposium, NASA/GSFC*)
4. M.L. Psiaki and R.F. Stengel, "Optimal Aircraft Performance During Microburst Encounter," *Journal of Guidance, Control, and Dynamics*, Vol. 14, No. 2, March-April 1991, pp. 440-446. (also in *Proc. 1988 AIAA Guidance, Navigation, and Control Conf.*)
5. M.L. Psiaki and K. Park, "A Parallel Solver for Trajectory Optimization Search Directions," *Journal of Optimization Theory and Applications*, Vol. 73, No. 3, June 1992, pp. 519-546.
6. M.L. Psiaki and K. Park, "Thrust Laws for Microburst Wind Shear Penetration," *Journal of Guidance, Control, and Dynamics*, Vol. 15, No. 4, July-Aug. 1992, pp. 968-975. (also in *Proc. 1989 AIAA Guidance, Navigation, and Control Conf.*)
7. M.L. Psiaki and Y.P. Luh, "Nonlinear System Stability Boundary Approximation by Polytopes in State Space," *International Journal of Control*, Vol. 57, No. 1, Jan. 1993, pp. 197-224. (also in *Proc. 1990 AIAA Guidance, Navigation, and Control Conf.*)
8. M.L. Psiaki, L. Huang, and S.M. Fox, "Ground Tests of Magnetometer-Based Autonomous Navigation (MAGNAV) for Low-Earth-Orbiting Spacecraft," *Journal of Guidance, Control, and Dynamics*, Vol. 16, No. 1, Jan.-Feb. 1993, pp. 206-214. (also in *Proc. 1991 AIAA Guidance, Navigation, and Control Conf.*)
9. M.L. Psiaki and K. Park, "Parallel Orthogonal Factorization Null-Space Method for Dynamic Quadratic Programming," *Journal of Optimization Theory and Applications*, Vol. 85, No. 2, May 1995, pp. 409-434.
10. M.L. Psiaki, "Autonomous Orbit and Magnetic Field Determination Using Magnetometer and Star Sensor Data," *Journal of Guidance, Control, and Dynamics*, Vol. 18, No. 3, May-June 1995, pp. 584-592. (also in *Proc. 1993 AIAA Guidance, Navigation, and Control Conf.*)
11. M.L. Psiaki and K. Park, "Augmented Lagrangian Nonlinear Programming Algorithm that uses SQP and Trust Region Techniques," *Journal of Optimization Theory and Applications*, Vol. 86, No. 2, August 1995, pp. 311-325.
12. M. Guelman and M.L. Psiaki, "Electric Propulsion for Orbit Transfer in a Resistive Medium," *Journal of the Astronautical Sciences*, Vol. 44, No. 1, Jan.-March, 1996, pp. 79-97.
13. M.L. Psiaki, J. Theiler, J. Bloch, S. Ryan, R.W. Dill, and R.E. Warner, "ALEXIS Spacecraft Attitude Reconstruction with Thermal/Flexible Motions Due to Launch Damage," *Journal of Guidance, Control, and Dynamics*, Vol. 20, No. 5, Sept.-Oct.

- 1997, pp. 1033-1041. (also in *Proc. 1997 AIAA Guidance, Navigation, and Control Conf.*; received BEST PAPER AWARD for the conference)
14. M.L. Psiaki, "Autonomous Low-Earth-Orbit Determination from Magnetometer and Sun Sensor Data," *Journal of Guidance, Control, and Dynamics*, Vol. 22, No. 2, March-April 1999, pp. 296-304. (also in *Proc. 1998 AIAA Guidance, Navigation, and Control Conf.*)
 15. M.L. Psiaki, "Autonomous Orbit Determination for Two Spacecraft from Relative Position Measurements," *Journal of Guidance, Control, and Dynamics*, Vol. 22, No. 2, March-April 1999, pp. 305-312. (also in *Proc. 1998 AIAA/AAS Astrodynamics Specialist Conf.*; received BEST PAPER AWARD for the conference)
 16. M.L. Psiaki, "Square-Root Information Filtering and Fixed-Interval Smoothing with Singularities," *Automatica*, Vol. 35, No. 7, July 1999, pp. 1323-1331. (also in *Proc. 1998 American Control Conf.*)
 17. M.L. Psiaki, "Attitude-Determination Filtering via Extended Quaternion Estimation," *Journal of Guidance, Control, and Dynamics*, Vol. 23, No. 2, March-April 2000, pp. 206-214. (also in *Proc. 1999 Flight Mechanics Symposium, NASA/GSFC*)
 18. M.L. Psiaki, P.M. Kintner, Jr., and S.P. Powell, "Rapid Energy Dissipation in a Yo-Yo-Type Wire Boom Deployment System," *Journal of Guidance, Control, and Dynamics*, Vol. 23, No. 3, May-June 2000, pp. 483-490. (also in *Proc. 1999 AIAA Guidance, Navigation, and Control Conf.*)
 19. M.L. Psiaki, S.P. Powell, and P.M. Kintner, Jr., "Accuracy of the Global Positioning System-Derived Acceleration Vector," *Journal of Guidance, Control, and Dynamics*, Vol. 23, No. 3, May-June 2000, pp. 532-538. (also in *Proc. 1999 AIAA Guidance, Navigation, and Control Conf.*)
 20. M.L. Psiaki, "Magnetic Torquer Attitude Control via Asymptotic Periodic Linear Quadratic Regulation," *Journal of Guidance, Control, and Dynamics*, Vol. 24, No. 2, March-April 2001, pp. 386-394. (also in *Proc. 2000 AIAA Guidance, Navigation, and Control Conf.*)
 21. M.L. Psiaki, "Attitude Sensing Using a Global-Positioning-System Antenna on a Turntable," *Journal of Guidance, Control, and Dynamics*, Vol. 24, No. 3, May-June 2001, pp. 474-481. (also in *Proc. 2000 AIAA Guidance, Navigation, and Control Conf.*)
 22. M.L. Psiaki, E.M. Klatt, P.M. Kintner, Jr., and S.P. Powell, "Attitude Estimation for a Flexible Spacecraft in an Unstable Spin," *Journal of Guidance, Control, and Dynamics*, Vol. 25, No. 1, Jan.-Feb. 2002, pp. 88-95. (also in *Proc. 41st Israel Annual Conference on Aerospace Sciences, 2001.*)
 23. M.L. Psiaki, "Satellite Orbit Determination Using a Single-Channel Global Positioning System Receiver," *Journal of Guidance, Control, and Dynamics*, Vol. 25, No. 1, Jan.-Feb. 2002, pp. 137-144. (also in *Proc. 2000 AIAA/AAS Astrodynamics Specialist Conf.*)

24. H. Jung and M.L. Psiaki, "Tests of Magnetometer/Sun-Sensor Orbit Determination Using Flight Data," *Journal of Guidance, Control, and Dynamics*, Vol. 25, No. 3, May-June 2002, pp. 582-590. (also in *Proc. 2001 AIAA Guidance, Navigation, and Control Conf.*)
25. M.L. Psiaki and Y. Oshman, "Spacecraft Attitude Rate Estimation From Geomagnetic Field Measurements," *Journal of Guidance, Control, and Dynamics*, Vol. 26, No. 2, March-April 2003, pp. 244-252. (also in *Proc. 2002 AIAA/AAS Astrodynamics Specialist Conf.*; received BEST PAPER AWARD for the conference)
26. M.L. Psiaki, "Global Magnetometer-Based Spacecraft Attitude and Rate Estimation," *Journal of Guidance, Control, and Dynamics*, Vol. 27, No. 2, March-April 2004, pp. 240-250. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 11-14, 2003, Austin, TX.)
27. M.L. Psiaki, "Nanosatellite Attitude Stabilization Using Passive Aerodynamics and Active Magnetic Torquing," *Journal of Guidance, Control, and Dynamics*, Vol. 27, No. 3, May-June 2004, pp. 347-355. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 11-14, 2003, Austin, TX.)
28. B.M. Ledvina, M.L. Psiaki, S.P. Powell, and P.M. Kintner, "Bit-Wise Parallel Algorithms for Efficient Software Correlation Applied to a GPS Software Receiver," *IEEE Transactions on Wireless Communications*, Vol. 3, No. 5, Sept. 2004, pp. 1469-1473. (also in the *Proc. ION National Technical Meeting*, Jan. 22-24, 2003, Anaheim, CA., pp. 767-782.)
29. H. Jung, M.L. Psiaki, W.J. Scott, and C.L. Boitnott, "Attitude Sensing Using a GPS Antenna on a Turntable, Experimental Tests," *Navigation*, Vol. 51, No. 3, Fall 2004, pp. 221-229. (also in *Proc. ION GPS 2002*, pp. 1108-1116.)
30. M.L. Psiaki, S.P. Powell, E.M. Klatt, and P.M. Kintner, Jr., "Practical Design and Flight Test of a Yo-Yo Wire Boom Deployment System," *Journal of Guidance, Control, and Dynamics*, Vol. 28, No. 1, Jan.-Feb. 2005, pp. 85-95. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 11-14, 2003, Austin, TX.)
31. M. Guelman, R. Waller, A. Shiryaev, and M. Psiaki, "Design and Testing of Magnetic Controllers for Satellite Stabilization," *Acta Astronautica*, Vol. 56, Nos. 1-2, Jan. 2005, pp. 231-239. (also in *Small Satellites for Earth Observation, Digest of the 4-th International Symposium of the International Academy of Astronautics*, April 7-11, 2003, Berlin, Germany)
32. T.E. Humphreys, M.L. Psiaki, E.M. Klatt, S.P. Powell, and P.M. Kintner, Jr., "Magnetometer-Based Attitude and Rate Estimation for a Spacecraft with Wire Booms," *Journal of Guidance, Control, and Dynamics*, Vol. 28, No. 4, July-Aug. 2005, pp. 584-593. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 16-19, 2004, Providence, RI.)
33. M.L. Psiaki, "Estimation of a Spacecraft's Attitude Dynamics Parameters Using Flight Data," *Journal of Guidance, Control, and Dynamics*, Vol. 28, No. 4, July-

- Aug. 2005, pp. 594-603. (also in *Proc. Flight Mechanics Symposium*, Oct. 28-30, 2003, NASA Goddard Space Flight Center, Greenbelt, MD.)
34. M.L. Psiaki, "Backward-Smoothing Extended Kalman Filter," *Journal of Guidance, Control, and Dynamics*, Vol. 28, No. 5, Sept.-Oct. 2005, pp. 885-894. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 16-19, 2004, Providence, RI, under the title: "The Super-Iterated Extended Kalman Filter")
 35. M.L. Psiaki, S.P. Powell, H. Jung, and P.M. Kintner, "Design and Practical Implementation of Multifrequency RF Front Ends Using Direct RF Sampling," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 53, No. 10, Oct. 2005, pp. 3082-3089. (also in *Proc. ION GPS/GNSS 2003*, Sept. 9-12, 2003, Portland, OR, pp. 90-102.)
 36. M.L. Psiaki, D.M. Akos, and J. Thor, "A Comparison of Direct Radio Frequency Sampling and Conventional GNSS Receiver Architectures," *Navigation*, Vol. 52, No. 2, Summer 2005, pp. 71-81. (Received ION 2006 Burka Award. also in *Proc. ION GPS/GNSS 2003*, Sept. 9-12, 2003, Portland, OR, pp. 1941-1952 under a slightly different title; received best presentation award in its session of 8 papers.)
 37. M.L. Psiaki, "Real-Time Generation of Bit-Wise Parallel Representations of Over-Sampled PRN Codes," *IEEE Transactions on Wireless Communications*, Vol. 5, No. 3, March 2006, pp. 487-491.
 38. M.L. Psiaki, "Null-Space Square-Root Information Filtering and Smoothing for Singular Problems," *Journal of Guidance, Control, and Dynamics*, Vol. 29, No. 3, May-June 2006, pp. 695-703. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 15-18, 2005, San Francisco, CA.)
 39. M.L. Psiaki, "Batch Algorithm for Global-Positioning-System Attitude Determination and Integer Ambiguity Resolution", *Journal of Guidance, Control, and Dynamics*, Vol. 29, No. 5, Sept.-Oct. 2006, pp. 1070-1079. (also Paper No. AAS 05-477 in *Proc. The Malcolm D. Shuster Astronautics Symposium*, June 13-15, 2005, Grand Island, New York.)
 40. M.L. Psiaki, "Estimation Using Quaternion Probability Densities on the Unit Hypersphere", *Journal of the Astronautical Sciences*, Vol. 54, Nos. 3-4, July-Dec. 2006, pp. 415-431. (also Paper No. AAS 05-461 in *Proc. The Malcolm D. Shuster Astronautics Symposium*, June 13-15, 2005, Grand Island, New York.)
 41. M.L. Psiaki and M. Wada, "Derivation and Simulation Testing of a Sigma-Points Smoother," *Journal of Guidance, Control, and Dynamics*, Vol. 30, No. 1, Jan.-Feb. 2007, pp. 78-86. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 21-24, 2006, Keystone, CO.)
 42. M.L. Psiaki and S. Mohiuddin, "Global Positioning System Integer Ambiguity Resolution Using Factorized Least-Squares Techniques," *Journal of Guidance, Control, and Dynamics*, Vol. 30, No. 2, March-April 2007, pp. 346-356. (also in *Proc. Flight Mechanics Symposium*, Oct. 18-20, 2005, NASA/Goddard Space Flight Center, Greenbelt, MD.)

43. S. Mohiuddin and M.L. Psiaki, "High-Altitude Satellite Relative Navigation Using Carrier-Phase Differential Global Positioning System Techniques," *Journal of Guidance, Control, and Dynamics*, Vol. 30, No. 5, Sept.-Oct. 2007, pp. 1427-1436. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 15-18, 2005, San Francisco, CA.)
44. M.L. Psiaki and S. Mohiuddin, "Modeling, Analysis, and Simulation of GPS Carrier Phase for Spacecraft Relative Navigation," *Journal of Guidance, Control, and Dynamics*, Vol. 30, No. 6, Nov.-Dec. 2007, pp. 1628-1639. (also in *Proc. AIAA Guidance, Navigation, and Control Conf.*, Aug. 15-18, 2005, San Francisco, CA; received BEST PAPER AWARD for the conference in a 2-way tie for first)
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- "Numerical Nonlinear Trajectory Optimization on a Parallel Processor," Dept. of Mechanical Engineering, New Jersey Institute of Technology, Newark, NJ, 1990.
- "Parallel Trajectory Optimization," Spacecraft Guidance and Control Branch, NASA Langley Research Center, 1991.
- "Nonlinear Dynamic Programming on a Hypercube via Stage-Wise Parallelism," TIMS/ORSA Joint National Meeting, Nashville, TN, May 1991.
- "Magnetometer-Based Autonomous Navigation for Low-Earth-Orbiting Spacecraft," Dept. of Aerospace Engineering, Stanford University, Oct. 1991.
- "Magnetometer-Based Autonomous Navigation for Low-Earth-Orbiting Spacecraft," Defense Systems Division, Boeing Aerospace Company, Seattle, Washington, Nov. 1991.
- "An Augmented Lagrangian Nonlinear Programming Algorithm for Use in Parallel Trajectory Optimization," Computer Services Division, Boeing Aerospace Company, Seattle, Washington, Nov. 1991.
- "An Algorithm for Trajectory Optimization on a Distributed-Memory Parallel Processor," Workshop on Trajectory Optimization Methods and Applications, AIAA Atmospheric Flight Mechanics Conf., Hilton Head, S.C., Aug. 1992.
- "Testing of a Parallel Trajectory Optimization Algorithm," Workshop on Trajectory Optimization Methods and Applications, AIAA Atmospheric Flight Mechanics Conf., Monterey, CA, Aug. 1993.
- "Min/Max Robust Controller Design," Dept. of Electrical Engineering, The Technion, Haifa, Israel, 1994.
- "Development of a MATLAB Toolbox for Trajectory Optimization and Planning," *1995 Workshop on Trajectory Optimization Methods and Applications*, NASA CP-10187, collocated with the AIAA Atmospheric Flight Mechanics Conf., Baltimore, MD, Aug. 1995, pp. 85-107.
- "General Extended Kalman Filter/Smoother Theory and the ALEXIS Attitude Reconstruction Software System," Astrophysics and Radiation Measurements Group, Los Alamos National Laboratory, Sept. 1995.

- "Development of MATLAB Code for Numerical Trajectory Optimization," Workshop on Trajectory Optimization, AIAA Atmospheric Flight Mechanics Conf., New Orleans, LA, Aug. 1997.
- "ALEXIS Spacecraft Attitude Reconstruction with Thermal/Flexible Motions Due to Launch Damage," Astrophysics and Radiation Measurements Group, Los Alamos National Laboratory, Aug. 1997.
- "Autonomous LEO Orbit Determination From Magnetometer and Sun Sensor Data," Guidance and Controls Branch, NASA Goddard Space Flight Center, Sept. 1998.
- "Autonomous Orbit Determination for Two Spacecraft from Relative Position Measurements," Guidance and Controls Branch, NASA Goddard Space Flight Center, Sept. 1998.
- "Periodic Spacecraft Attitude Control Using Magnetic Torquers," AFOSR Dynamics and Control Contractor/Grantees Meeting, Wright-Patterson Air Force Base, August 1999.
- "Quasi 3-Axis Magnetic Torque Attitude Control for Small Satellites," AFRL/AFOSR Techsat 21 Program Review, Kirtland Air Force Base, March 2000.
- "Satellite Orbit Determination Using a Single-Channel GPS Receiver," Thayer School of Engineering, Dartmouth College, April 2000.
- "A Single-Antenna-Based Approach to GPS Attitude Determination," Dept. of Mechanical & Aerospace Engineering, Princeton University, April 2000.
- "Attitude Determination Filtering via Extended Quaternion Estimation," Dept. of Control Engineering, Aalborg University, Aalborg, Denmark, October 2000.
- "Weak GPS Signal Acquisition and Tracking in a Software Receiver (Technologies for use in HEO & GEO)," Guidance and Controls Branch, NASA Goddard Space Flight Center, Jan. 2001.
- "GPS-Based Spacecraft Attitude and Orbit Determination," Rafael, Israel Armament Development Authority, Leshem Institute, Misgav, Israel, May 2001.
- "GPS-Based Spacecraft Attitude and Orbit Determination," Israel Association for Automatic Control Symposium on Applications of Control in Space, Herzliya, Israel, May 2001.
- "GPS-Based Spacecraft Attitude and Orbit Determination," Faculty of Aerospace Engineering, The Technion, Haifa, Israel, May 2001.
- "GPS-Based Spacecraft Attitude and Orbit Determination," Sibley School of Mechanical and Aerospace Engineering, Cornell Univ., Feb. 2002.
- "Exploiting Euler Dynamics in order to use the Earth's Magnetic Field for 3-Axis Attitude Determination or Control," Surrey Space Centre, University of Surrey, Guildford, U.K., April 2002.
- "A Global Strategy for Magnetometer-Based 3-Axis Spacecraft Attitude Determination," Guidance and Controls Branch, NASA Goddard Space Flight Center, June 2002.

- "Extended Kalman Filter and Batch Filter Methods for Tracking Weak GPS Signals," Guidance and Controls Branch, NASA Goddard Space Flight Center, June 2002.
- "Magnetic Techniques for 3-Axis Satellite Attitude Determination & Control," AFOSR Dynamics and Control Grantee/Contractors Meeting, Pasadena, CA, August 2002.
- "Applied Satellite Attitude Dynamics for Estimation and Design of Deployment Mechanisms," Dept. of Theoretical and Applied Mechanics, Cornell Univ., Sept. 2002.
- "Methods for Acquiring and Tracking Weak GPS Signals," GPS BlackJack Receiver Group and Sun-Earth Connections Space Sciences Group, NASA JPL, Jan. 2003.
- "Estimation Algorithms and Applications to Spacecraft and GPS Systems," Department of Aerospace and Engineering Mechanics, University of Minnesota, Oct. 2004.
- "Estimation Algorithms and Applications to Spacecraft and GPS Systems," Department of Aerospace and Ocean Engineering, Virginia Tech, Dec. 2004.
- "Two Attitude Determination Topics: A New GPS Algorithm and an Estimation Methodology for Quaternion Probability Densities," Guidance and Controls Branch, NASA Goddard Space Flight Center, May 2005.
- "Precise Spacecraft Relative Position Estimation using CDGPS Techniques with Integer Ambiguities: Modeling, Analysis, Simulation, & Algorithm Design," Guidance and Controls Branch, NASA Goddard Space Flight Center, May 2005.
- "Global Navigation Satellite Systems: Genesis, State of the Art, and Future Directions," plenary lecture at the 46th Israel Annual Conference on Aerospace Sciences, Tel Aviv & Haifa, Israel, March 2006.
- "Open-Architecture Software Receivers for Modernized GPS & Galileo," AFRL at Hanscom AFB, March 2006.
- "Searching for Galileo," Dept. of Electrical and Computer Engineering, Cornell Univ., Oct. 2006.
- "GNSS Software Receivers: Technology & Applications," Electronics & Telecommunications Research Institute, Daejeon, S. Korea, Oct. 2006.
- "Development & Application of Nonlinear Estimation Algorithms," Electronics & Telecommunications Research Institute, Daejeon, S. Korea, Oct. 2006.
- "Development & Application of Nonlinear Estimation Algorithms," School of Mech. & Aero. Engr. Seoul National University, Oct. 2006.
- "Searching for Galileo," Dept. of Electronics Engr., Konkuk University, Seoul, S. Korea, Oct. 2006.
- "Technologies for Absolute & Relative Spacecraft Position/Velocity Estimation in GEO, HEO, & Lunar Orbits," Guidance and Controls Branch, NASA Goddard Space Flight Center, Nov. 2006.
- "Collection, Analysis, and Modeling of GPS Scintillation Data from Equatorial Regions," Department of Geomatics Engineering, University of Calgary, Canada, Aug. 2007.
- "Civil GPS Spoofing," Office of the Secretary of Defense, Arlington, VA, Feb. 2009.

- "Civilian GPS Spoofing Detection based on Dual-Receiver Correlation of Military Signals," Coherent Navigation, Inc., San Mateo, CA, March 2011.
- "Civilian GPS Spoofing Detection based on Dual-Receiver Correlation of Military Signals," GPS Lab, Department of Aeronautics & Astronautics, Stanford University, March 2011.
- "Nonlinear Model-Based Estimation Algorithms: Tutorial and Recent Developments," Department of Aerospace Engineering and Engineering Mechanics, University of Texas at Austin, March 2011.
- "Civilian GPS Spoofing Detection based on Dual-Receiver Correlation of Military Signals," Wireless Networking & Communications Group, Department of Electrical & Computer Engineering, University of Texas at Austin, April 2011.
- "Mixed Real/Integer Kalman Filtering & Smoothing with Applications to Orbit Determination," Center for Space Research, University of Texas at Austin, June 2011.
- "GPS Investigations of Equatorial Ionospheric Scintillation: Receiver Development, Data Collection Campaigns, Inverse Diffraction, & Nonlinear Tomography," JOINT GPS Observations and Tools session, CEDAR/GEM Workshop, Santa Fe, NM, June 2011.
- "Studies of Ionospheric Irregularities: Origins and Effects," ONR Space Peer Review, Arlington, VA, Sept. 2011.
- "Developing Defenses Against Jamming & Spoofing of Civilian GNSS Receivers," Panel Discussion on Improving Security of GNSS Receivers, *Proc. ION GNSS 2011*, Sept. 20-23, 2011, Portland, OR, pp. 3407-3417.
- "The Blind Tricyclist Problem and a Comparative Study of Nonlinear Filters," Dept. of Mechanical and Aerospace Engineering, State University of New York at Buffalo, April 2012.
- "Securing Civilian GNSS Services in the Presence of Jamming & Spoofing," plenary lecture, Itzhack Y. Bar-Itzhack Memorial Symposium on Estimation, Navigation, and Spacecraft Control, Haifa, Israel, Oct. 14-17, 2012.
- "Securing Civilian GNSS Services in the Presence of Jamming & Spoofing," Dept. of Aerospace Engineering, University of Michigan, January 2013.
- "How a Spacecraft Attitude Determination Specialist got involved in Remote Sensing of the Atmosphere," NOAA, Boulder, CO, May 2014.
- "Developing Defenses Against Jamming & Spoofing of Civilian GNSS Receivers," GNSS Vulnerabilities and Threats Panel, ION GNSS+ 2014, Tampa, FL, Sept. 2014.
- "Differentiating Between Real and Fake GNSS Signals," GPS World Magazine Webinar w/140-150 attendees, Sept. 2014.
- "GPS & Ionosonde Data Fusion for Ionospheric Tomography," Space Weather Center of Excellence, Air Force Research Lab, Kirtland AFB, NM, Nov. 2014.

“Ionosphere Profile Estimation Using Ionosonde & GPS Data in an Inverse Refraction Calculation,” American Geophysical Union (AGU) Fall Meeting, San Francisco, CA, Dec. 2014.

“The Blind Tricyclist Problem and a Comparative Study of Nonlinear Filters,” Dept. of Aerospace Engineering Sciences, University of Colorado Boulder, Feb. 2015.

EXTENSIVE REPORTS

Y.P. Luh and M.L. Psiaki, "Polytope Approximations of Attracting Basin Boundaries: The Linear/Convex Case," Cornell Univ. Mech. and Aero. Engineering Report No. MSD-90-03, June 1990.

M.L. Psiaki, "Optimal Fixed-Gain Output Feedback for Periodic Linear Systems, An Optimization Problem and Suggested Algorithms", Cornell Univ. Mech. and Aero. Engineering Report No. MSD-91-01, August 1991.

SUPERVISED POSTDOCTORAL RESEARCH

Dr. Mani Fisher - Min-Max Robust Controller Design and Kalman Filtering of Turbulent Boundary Layer Systems, 1992-1994.

Dr. Brent M. Ledvina GPS Software Receivers for Ionospheric Research (advised and supported jointly with P. Kintner), 2004-2005.

Dr. Todd E. Humphreys Ultra-Precise Orbit, Clock, Ionosphere, and Troposphere Estimation for iGPS, 2007-2008.

SUPERVISED GRADUATE RESEARCH & PROJECTS

Ph.D. Yih-Ping Luh - "Nonconvex Polytope Approximation of Attracting Basin Boundaries for Nonlinear Systems," 1991.

Kihong Park - "Parallel Trajectory Optimization Algorithm Design and Testing," 1994.

Hee Jung - "Estimation Problems for Satellite Orbit and Attitude Determination and for GPS-Based Remote Ionospheric Sensing," 2005.

Todd Humphreys "Modeling Ionospheric Scintillation and its Effects on GPS Carrier Tracking Loops and two other Applications of Modeling and Estimation," 2008.

Shan Mohiuddin "New Estimation Algorithms with Applications to Relative and Absolute Orbit Determination", 2010.

Joanna Hinks "A New Generalized Consider Covariance Analysis and Other Tools for Challenging Estimation Scenarios", 2012.

Ryan Mitch "Model-Based Estimation Techniques Applied to Global Navigation Satellite System Jammers", 2014.

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|---------|-------------------|--|
| | Ryan Dougherty | "Low-Cost Orbit Determination using Existing low-power K-Band Communications Signals," 2015*. |
| | Karen Chaing | "Model-Based Estimation Applications for GNSS Remote Sensing," 2015*. |
| | Brady O'Hanlon | 8 th -year student, currently on leave. |
| | Tunc Ertan | Current 3 rd -year student. |
| | Yoav Baumgarten | Current 2 st -year student. |
| M.S. | Kihong Park - | "Auto Pilot Design for Safe Landing in Microburst," 1990. |
| | Lejin Huang - | "Magnetometer-Based Navigation for Earth-Orbiting Satellite," 1993. |
| | Jeffrey Hoppert - | "Design of a High Accuracy Dynamic Error Correction System for Xerographic Printing Applications," 1999. |
| | Maria Hagan - | "Satellite Attitude Control for Steady State Disturbance Using Only Magnetic Torquers," 2000. |
| M. Eng. | Andrew Chien | Two-tank controller experiment development, 1989. |
| | Nejam Malik | Automated frequency-response measurement system, 1989. |
| | Paul Hummel | Orbit generation using a Fourier-based asymptotic approximation, 1993. |
| | Rainer Immel | "System Identification and Experimental Testing of a Robust Controller Design," 1997. |
| | John Conklin | "Bending-Torsion Flutter of an Elastic Wing," 1998. |
| | Jeffrey Hoke | "Unmanned Aerial Vehicles," 1999. |
| | Hans-Georg Horst | "Actuator and Controller Design for an Airfoil Flutter Suppression," 1999. |
| | Mark Krangle | "Investigation of GPS Technology for use in Falling Sphere Experiment," 2000 (advised jointly with P. Kintner). |
| | Rex Miller | Software development for a GPS receiver, 2000 (advised jointly with P. Kintner). |
| | Warren Scott | "Attitude Determination Through Revolving Antenna GPS," 2001. |
| | Chris Boitnott | "Digital Automatic Gain Control and Bit Selection for GPS," 2003. |
| | Vijay Iyer | "Development of a High-Speed Data Acquisition System and Investigation of Antenna Arrangements to Minimize Signal Amplitude Variation for a GPS Antenna Mounted on a Turntable," 2004. |
| | Elton Cheung | "Digital Automatic Gain Control and Bit Selection for Direct RF Sampling," 2004. |

* Both students successfully defended in July 2014 Final dissertation revisions are expected by early 2015.

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|---|--|
| David Johnson | "L1 GPS Software Receiver," 2004 (advised jointly with P. Kintner). |
| Dong June Sing & Song Du | "Implementation of GPS Correlator on FPGA," (2006). |
| Xiaowen Lu & Jindi Meng | "The Development of Tri-Band Beacon Software Receiver using GPS Technology," (2006). |
| Hung-chun Chen & Yingsung Lin | "Implementation of a GPS Baseband Receiver on FPGA," (2007) |
| Sapna Khadabadi, Atul Maurya, & Isan Doshi | "C++ Implementation of Flight Software for Satellite Relative Navigation Using CDGPS," (2007) |
| Robert Johannesson | "Cross-Correlation Mitigation in GPS Signal Acquisition for a Real-Time Software Receiver," (2007) |
| David Xue | "L5 GPS Signal Receiver" (2009) |
| Wahn N. Melton Hyunwoo Noh Jasper Schneider | "Programmable Ultra Wide-Band RF Front-End for a Software Radio" (2010) |
| Andrew H. Vo | "FPGA-Based Acquisition and DSP-Based Tracking of the GPS L5 Signal" (2010) |
| Richard A. Merluzzi | "GNSS Multipath Measurement and Mitigation with a Moving Antenna" (2013) |
| Taylor Thomas | "Development of Phase-Lock Loop for Tracking GPS Signals acquired by Dual-Antenna System" (2014) |

PRINCIPAL COURSES TAUGHT

System Dynamics, MAE 3260: Junior level required course. Theory and applications of mechanical vibrations and introduction to feedback control. Covers time- and frequency-domain analysis of linear 1-, 2-, and multi-degree-of-freedom mechanical systems. Introduces students to numerical simulation of dynamic systems, to nonlinear dynamics and chaos, and to classical P, PI, and PID controllers. Course includes an extensive hardware laboratory and a set of MATLAB exercises. Prof. Psiaki developed the hardware laboratory from scratch. It included digital oscilloscopes, digital signal analyzers, electromagnetic shakers, PC-based data acquisition and control systems, wind tunnels, and high-speed rotating machinery. Taught in the Spring terms of 1988, 1994, 1996-2000, 2002-2007, and 2009-2013 and in the co-op term of 1998.

GPS: Theory & Design, MAE 4150/ECE 4150: Senior level elective. First full course about the Global Positioning System. An analysis of GPS operating principles and engineering practice with a culminating project. Topics include orbital mechanics, reference frames, navigational algorithms, receiver analysis, error investigation, dilution of precision, antennas, differential GPS, and velocity estimation.. Taught in the Fall term of 2012.

Feedback Control Systems, MAE 4780/ECE 4710: Senior level elective. First full course in automatic control. Covers classical control design and analysis techniques for continuous-time SISO systems, including root-locus and frequency-response-based techniques. Course included an extensive simulation laboratory run in MATLAB. Developed an extensive set of simulation laboratory exercises from scratch, all based on control of a robotic bicycle. Taught in the Fall terms of 1988, 1991, and 1993.

Theory of Linear Systems, MAE 5210: Graduate level elective. Concentrates on the theory of linear dynamic input-output systems. Both continuous-time and discrete-time systems are covered. Topics include system response, state-space realizations of transfer functions, canonical forms, the Cayley-Hamilton theorem, controllability, observability, pole placement, linear quadratic regulators, observers, observer-based controller design, realization theory, and stability. Concentrates on time-invariant systems, but several topics in time-varying systems are also covered. Taught in the Fall terms of 2001, 2004, 2006, 2008, and 2010.

Microprocessor Applications, MAE 575: Graduate level elective. Introduction to micro-processor based data acquisition and control systems. Covers principles of digital electronics, micro computer architecture, ADC and DAC interfaces, assembly-language and real-time programming, and interface with mechanical engineering experiments. Course includes an extensive hardware laboratory. Taught in the Fall terms of 1987, 1989, and 1990.

Feedback Control Systems Design and Implementation, MAE 578: Graduate level elective. Digital control laboratory experience requiring MAE 478/EE 471 as a prerequisite theory course. Covers whatever additional theory is needed to enable students to design, implement, and test feedback controllers on actual systems. Emphasis is on laboratory work with actual controlled systems and PC-based controllers. Principles taught include sampled data systems, z-transforms, feedback linearization, digital control hardware, use of a real-time programming package, system identification, and pulse-width modulation. Experiments include single-DOF DC motor position and speed control, frequency-domain system identification, position and trajectory control of a 2-link manipulator, and liquid level control of 2 coupled tanks. Developed the course and the hardware laboratory from scratch. Taught in the Spring terms of 1989-1993 and 1996.

Model-Based Estimation, MAE 6760: Graduate level elective. This course covers a variety of ways in which models and experimental data can be used to estimate model quantities that are not directly measured. In other words, this course concerns itself with methods for solving the class of inverse problems that take the following form: given partial information about a system, what is the behavior of the whole system? The two main estimation methods that are presented are a) batch least-squares estimation for general problems and b) Kalman filtering for dynamic systems problems. The course also deals with the issue of observability, which amounts to a consideration of whether a given inverse problem has a unique solution. Techniques for linear and nonlinear models are taught. Both theory and application are presented, but the emphasis is on the latter. Examples for the course are drawn from various fields, including particle and rigid-body dynamics, GPS-based navigation, and signal tracking via phase-locked

loops. An example involving partial differential equation models is also considered. Taught in the Fall terms of 1999, 2000, 2002, 2003, 2005, 2009, and 2011.

SIGNIFICANT ADMINISTRATIVE ASSIGNMENTS AT CORNELL

Co-Director, Process Control laboratory, 1987-1996.

Director of Kresge Endowment Fund, System Dynamics teaching laboratory, 1994-present.

Director of Graduate Studies, Field of Mechanical Engineering, 1996-1999.

Dynamics, Systems, and Control Faculty Group Leader, 2001-2007, & 2012-2014.

Chairman of ad hoc committee to write Mechanical Engineering Program ABET self-study and manage successful Oct. 2010 ABET re-accreditation review, 2008-2010.

Chairman of University ROTC Relations Committee, 2008-2013.

Faculty Fellow, Keeton House, 2009-2014.

Faculty Advisor to Men's Lightweight Crew, 2006-present.