

ROBIN CHHABRA

Carleton University
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EMPLOYMENT

- Carleton University, Canada
Canada Research Chair, Tier 2, in Autonomous Space Robotics and Mechatronics 2018/10-
Assistant Professor, Mechanical and Aerospace Engineering 2018/01-
Director, Autonomous Space Robotics and Mechatronics Laboratory (ASRoM-Lab) 2018/01-
- MacDonald, Dettwiler and Associates (MDA), Canada
Engineer, Guidance, Navigation and Control - Space Robotics & Space Systems 2014/07-2017/12
- University of Calgary, Canada
Postdoctoral Fellow, Mathematics and Statistics - Geometric Mechanics 2014/01-2014/06
Course Instructor, Mathematics and Statistics - Multivariate Calculus 2014/01-2014/04
- University of Toronto, Canada
Research Assistant, Mathematics - Geometric Mechanics and Control 2010/01-2013/12
Research Assistant, Institute for Aerospace Studies - Robotics & Mechatronics 2007/01-2013/12
Course Instructor, Institute for Aerospace Studies - Aerospace Laboratory 1&2 2009/09-2010/04

EDUCATION

- **Doctor of Philosophy**, Aerospace Science and Engineering - Space Robotics 2013
Minor: Mathematics - Geometric Mechanics and Control
University of Toronto, Canada
Advisors: M. Reza Emami & Yael Karshon
- **Master of Applied Science**, Aerospace Science and Engineering - Mechatronics 2008
University of Toronto, Canada
Advisor: M. Reza Emami
- **Bachelor of Applied Science** (with Honours), Aerospace Engineering 2006
Sharif University of Technology, Iran
Thesis Advisor: Fariborz Saghafi

AWARDS AND HONOURS

- **Certificate of Reviewing**, Mechatronics journal (Elsevier)
In recognition of the review made for Mechatronics journal 2017/12
- **Certificate of Outstanding Contribution in Reviewing**, Mechatronics journal (Elsevier)
In recognition of the contributions made to the quality of Mechatronics journal 2017/12
- **Honorary Acknowledgement of Service and Leadership**, MDA
In recognition of the contributions and leadership as a multibody dynamics engineer on the L&SE, ExoMars and LSM programs 2016/06
- **University of Toronto fellowship**, University of Toronto 2007-2013
- **Departmental International Tuition Award**, University of Toronto 2007-2010
- **Frank Howard Guest Bursary on Academic Achievements**, University of Toronto 2008/04

RESEARCH FUNDING AND GRANTS

UNDER REVIEW

- **Innovation for Defence Excellence and Security (IDEaS)**, (Co-Investigator-\$1,500,000) 2019-2022
Hierarchical Robust Autonomy of Cooperative Reconfigurable Multi-agent Robotic Systems.
- **NSERC Discovery Grant** (PI-\$300,000) 2019-2024
Resilient Space Robotics: Towards Autonomy of Next-generation Space Missions.
- **Ontario Research Fund (ORF)**. (PI-\$60,000) 2018
A Robotic Hardware-in-the-loop Test Facility for Space Technologies.

AWARDED

- **Canada Research Chair (CRC)**, Tier 2. (PI-\$500,000) 2018-2023
Advanced Autonomy of Next-generation Space Missions.

- **Unrestricted Research Fund from OVPRI at Carleton** (PI-\$50,000) 2018-2023
- **Canada Foundation for Innovation (CFI)**, John R. Evans Leaders Fund. (PI-\$60,000) 2018
A Robotic Hardware-in-the-loop Test Facility for Space Technologies.
- **Start-up Fund** (PI-\$50,000) 2018-
- **NSERC General Research Fund (GRF)** (PI-\$10,000) 2018-2023
- **Mitacs Accelerate International** (PI-\$15,000) 2018/08-2018/12
Rapid Operations Planning for Space Robotics Using Machine Learning.

COMPLETED

- **Canadian Space Agency (CSA)** (Co-Investigator-\$50,000) 2016/03-2017/12
On-orbit Calibration of SSRMS FMS. (MDA-International Space Station program)
- **Canadian Space Agency (CSA)** (Co-Investigator-\$20,000) 2016/03-2016/07
Optimization of Point Turn Kinematics. (MDA-Mars Exploration Science Rover program)
- **Canadian Space Agency (CSA)** (Co-Investigator-\$75,000) 2015/01-2016/01
LELR Control Enhancement. (MDA-Lunar Exploration Analogue Deployment program)
- **Canadian Space Agency (CSA)** (Co-Investigator-\$300,000) 2014/07-2015/12
SPOTS Orbital Dynamics. (MDA-International Space Station program)

ADMINISTRATIVE ACTIVITIES

- **Member**, NSERC PhD Evaluation Committee, Carleton University 2018/09-2018/12
- **Member**, Curriculum Committee - Aerospace, Carleton University 2018/07-2019/06
- **Member**, Dynamics and Controls Strand Committee, Carleton University 2018/07-2019/06
- **Member**, Space Station Operation and Training Simulator Committee, MDA 2016/07-2017/12
- **Project Lead**, Orbital Effects on Capture and Release of Visiting Vehicles at ISS, MDA 2014/10-2017/12
- **Representative**, Graduate Student Union, University of Toronto 2008-2009
- **Executive Member**, Aerospace Engineering Student Union, Sharif University of Technology 2002-2005

PROFESSIONAL MEMBERSHIPS

- **Member**, Institute of Electrical and Electronics Engineers (IEEE) 2016/01-
IEEE Young Professionals 2016/01-
IEEE Robotics and Automation Society 2016/01-
IEEE Systems Council 2018/01-
- **Member**, American Society of Mechanical Engineers (ASME) 2018/01-
- **Member**, American Institute of Aeronautics and Astronautics (AIAA) 2018/01-
- **Panelist**, Ontario Aerospace Council, Research and Technology Committee 2019/03

ORGANIZED EVENTS

- **Tour of Laboratories at Carleton University**, Ontario Ministry of Economic Development, Job Creation and Trade 2018/08/03

ATTENDED MEETINGS

- EU Delegation on Space Application Technologies, Carleton University, Ottawa 2018/09/12
Discussed my research on space technologies and its terrestrial applications
- Autonomous and Connected Systems Meeting, Carleton University, Ottawa 2018/07/18
Presented my research on guidance, navigation and control of space robotics
- Brown Bag Lunch, Autonomous Systems Research Centre, Carleton University, Ottawa 2018/04/25
Met with executives of companies active in autonomous and connected vehicles
- 2018 Ontario Aerospace Council (OAC) Research and Technology Event, Toronto 2018/03/07-08
Presented Carleton University's research capabilities in aerospace sector

SUPERVISORY ACTIVITIES

PHD STUDENTS (ONGOING)

1. Khaled Helal (Co-supervised with Prof. El Sayed), Carleton University 2019/01-
High Fidelity Dynamic Aeroelasticity Response Analysis and Active Vibration Control of High Precision Aero-Structures Subject to Aerodynamic Gust

2. Mahmoud Elessawy (Co-supervised with Prof. El Sayed), Carleton University 2018/09-
Observer-based Hybrid Control of Hyper-flexible Light Space Manipulators

MASC STUDENTS (ONGOING)

1. Patrick Rouso, Carleton University 2018/09-
Optimal Momentum Strategy for Angular Synchronization of Chaser-manipulator System with Non-cooperative Debris
2. Borna Monazzah Moghaddam, Carleton University 2018/09-
Optimal Trajectory Planning and Control of Space Manipulators for Proximity Operations in Space Debris Removal Missions

BASC STUDENTS (COMPLETED)

1. Ken Zheng Zhong (contributed to mentoring), University of Toronto 2012-2013
Development of an integrated design and simulation environment for concurrent base-arm motion control of space manipulators
2. Murilo Gonçalves Quevedo (contributed to mentoring), University of Toronto 2013
Design and development of a free-base robot including structural analysis, selection of materials and off-the-shelf parts, assembly, and testing

ENGINEERS (COMPLETED)

1. Alex Jacob, MSc (supervised in a research study), MDA 2017
An alternative dynamics formulation to address SPOTS limitations for DSXR application, a study of geometry of elastic multi-bodies
2. Tomohisa Oki, PhD (supervised in a research study), MDA 2017
An alternative dynamics formulation to address SPOTS limitations for DSXR application, a study of geometry of elastic multi-bodies

INTERNS AND JUNIOR ENGINEERS (COMPLETED)

1. Phoenix Roy (mentored), MDA 2017
Contact dynamics in SPOTS
2. Angelica Hassan (mentored), MDA 2016
Payload insertion into Dragon trunk using SSRMS in FMA mode
3. Mohammed Kagalwala (mentored), MDA 2016
Spacecraft dynamics and control

RESEARCH INTERESTS

Dynamical reduction and nonlinear control of underactuated space systems; Nonlinear and affine nonholonomic constraints; Nonholonomically constrained systems with symmetry; Path planning and control of constrained space robotic systems at singularity; Lie Groupoids for kinematics; Nonlinear modal analysis of elastic space robotic systems; Orbital perturbations for elastic multibody systems; Robust and adaptive geometric control of planetary exploration rovers; Higher order Lagrangian systems with symmetry; Geometric modeling of multi-physics systems; Multi-objective optimization; Fuzzy-based concurrent design; Hardware-in-the-loop simulation.

RESEARCH CONTRIBUTIONS

PUBLICATIONS

Journal Papers in Preparation

1. R. Chhabra, "Robust Control of Uncertain Hamiltonian Systems with Constraints," To be submitted to International Journal of Robust and Nonlinear Control, 2018.
2. R. Chhabra, M. R. Emami and Y. Karshon, "Lie Groupoids for General Kinematic Chains," To be submitted to Arnold Mathematical Journal, 2018.

Refereed Journal Papers

3. R. Chhabra, M. R. Emami and Y. Karshon, "Reduction of Hamiltonian Mechanical Systems with Affine Constraints: A Geometric Unification," ASME Journal of Computational and Nonlinear Dynamics, doi:10.1115/1.4034729, 2016.
4. L. M. Bates, R. Chhabra and J. Śniatycki, "Elastica as a Dynamical System," Journal of Geometry and Physics, vol. 110, pp. 348-381, 2016.

5. R. Chhabra and M. R. Emami, "Symplectic Reduction of Holonomic Open-chain Multi-body Systems with Constant Momentum," *Journal of Geometry and Physics*, vol. 89, pp. 82-110, 2015.
6. R. Chhabra and M. R. Emami, "A Unified Approach to Input-output Linearization and Concurrent Control of Underactuated Open-chain Multi-body Systems with Holonomic and Nonholonomic Constraints," *Journal of Dynamical and Control Systems*, vol. 22(1), pp. 129-168, 2016.
7. R. Chhabra and M. R. Emami, "Nonholonomic Dynamical Reduction of Open-chain Multi-body Systems: A Geometric Approach," *Mechanism and Machine Theory*, vol. 82, pp. 231-255, 2014.
8. R. Chhabra and M. R. Emami, "A Linguistic Approach to Concurrent Design," *Journal of Intelligent and Fuzzy Systems*, vol. 28, no. 5, pp. 1985-2001, 2015.
9. R. Chhabra and M. R. Emami, "A Holistic Approach to Concurrent Engineering and Its Application to Robotics," *Concurrent Engineering: Research and Applications*, vol. 22, no. 1, pp. 48-61, 2014.
10. R. Chhabra and M. R. Emami, "A Generalized Exponential Formula for Forward and Differential Kinematics of Open-chain Multi-body Systems," *Mechanism and Machine Theory*, vol. 73, pp. 61-75, 2014.
11. R. Chhabra and M. R. Emami, "A Holistic Concurrent Design Approach to Robotics using Hardware-in-the-loop Simulation," *Mechatronics*, vol. 23, no. 3, pp. 335-345, April 2013.
12. R. Chhabra and M. R. Emami, "Holistic System Modeling in Mechatronics," *Mechatronics*, vol. 21, no. 1, pp. 166-175, February 2011.

Refereed Conference Proceedings

13. R. Chhabra, "Dynamical Reduction and Output-tracking Control of the Lunar Exploration Light Rover (LELR)," *IEEE Aerospace Conference, Big Sky, Montana, USA, March 5-12, 2016*.
14. R. Chhabra, M.R. Emami, "A Mechatronic Approach to Robot Manipulator Design using Hardware-in-the-loop Simulation," *RSI/ISM International Conference on Robotics and Mechatronics (ICRoM2013), Tehran, Iran, February 13-15, 2013*.
15. R. Chhabra and M. R. Emami, "Concurrent Synthesis of Robot Manipulators using Hardware-in-the-loop Simulation," *IEEE International Conference on Robotics and Automation (ICRA), Kobe, Japan, May 12-17, 2009*.
16. R. Chhabra and M. R. Emami, "Linguistic Mechatronics," *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM), Xian, China, July 2-5, 2008*.

Book Chapters

17. M. R. Emami and R. Chhabra, "Concurrent Engineering of Robot Manipulators," In: *Robot Manipulators New Achievements*, A. Lazinica and h. Kawai (Ed.), ISBN: 978-953-307-090-2, InTech, pp. 211-240, April 2010.

Dissertations

18. R. Chhabra, "A Unified Geometric Framework for Kinematics, Dynamics and Concurrent Control of Free-base, Open-chain Multi-body Systems with Holonomic and Nonholonomic Constraints," *PhD Thesis, University of Toronto Institute for Aerospace Studies, Canada, December 2013*.
19. R. Chhabra, "Concurrent Design of Reconfigurable Robots using a Robotic Hardware-in-the-loop Simulation," *MASc Thesis, University of Toronto Institute for Aerospace Studies, Canada, September 2008*.
20. R. Chhabra, "A Fuzzy Control Strategy for Tail-sitters," *BASc Thesis, Sharif University of Technology, Iran, June 2006*.

INVITED TALKS

1. Resilient Space Robotics: Towards Autonomy of Space Missions, MDA, Brampton, ON, Canada.
2018/10/24
2. Feedback Linearization and Output Control of LELR Based on Dynamical Reduction of Nonholonomic Systems, MDA, Brampton, ON, Canada.
2015/02/13.
3. From Geometric Modelling and Control to Concurrent Design of Mechatronic Multi-bodies, Maplesoft Company, Waterloo, ON, Canada.
2014/04/25
4. Dynamical Reduction and Control of Holonomic and Nonholonomic Open-chain Multi-body Systems, in the 8th International Young Researchers Workshop on Geometry, Mechanics and Control, Barcelona, Spain.
2013/12/11

5. A Three-step Dynamical Reduction of Nonholonomic Open-chain Multi-body Systems, in the Symplectic Seminar, Department of Mathematics, University of Toronto, Toronto, ON, Canada. 2013/11/25

INTERNAL REPORTS

Orbital mechanics toolbox and capture/release missions

1. R. Chhabra, "Effect of altitude in the release of visiting vehicles at ISS¹," MDA internal report, L&SE², June 2017.
2. R. Chhabra, "HTV³ FFC⁴ Loads Analysis," MDA internal report, L&SE, August 2016.
3. R. Chhabra, "An Investigation on Relative Rates of GF⁵ with Respect to LEE⁶ in Dual-Berthed Release," MDA internal report, L&SE, April 2016.
4. R. Chhabra, "Sensitivity Analysis for Dual Berthed HTV Release — Iteration 2," MDA internal report, L&SE, March 2016.
5. R. Chhabra, "Sensitivity Analysis for Dual Berthed Cygnus Release — Iteration 2," MDA internal report, L&SE, March 2016.
6. R. Chhabra, "Refined Missed Capture Analysis — Quasi-static and Dynamic Methodologies," MDA internal report, L&SE, March 2016.
7. R. Chhabra, "Orbital Mechanics in the SPOTS⁷," MDA internal Report, L&SE, November 2015.
8. R. Chhabra, "Dragon FFC Loads Analysis with the New Capture Point," MDA internal report, L&SE, November 2015.
9. R. Chhabra, "SPOTS Orbital Dynamics Correlation with NASA TRICK (Phase 3)," MDA internal report, L&SE, October 2015.
10. R. Chhabra, "SPOTS Orbital Dynamics Correlation with NASA TRICK (Phase 2)," MDA internal report, L&SE, May 2015.
11. R. Chhabra, "SPOTS Orbital Dynamics Correlation with NASA TRICK (Phase 1)," MDA internal report, L&SE, February 2015.
12. R. Chhabra, "Nonlinear Modal Analysis of Flexible Robot Arms," MDA internal report, GN&C⁸, October 2014.

LELR⁹ & MESR¹⁰

13. R. Chhabra, "WP7 — Optimization of Point Turn Kinematics," MDA internal report, MESR, June 2016.
14. R. Chhabra, "LELR Speed Controller Tuning," MDA internal report, LELR, May 2015.
15. R. Chhabra, "Torque Control of LELR Based on Feedback Linearization and Dynamical Reduction of Nonholonomic Systems," MDA internal report, LELR, February 2015.

SSRMS¹¹ FMS¹²

16. R. Chhabra, "A Hybrid GBT¹³ /FMS Thermal Filter," MDA internal report, L&SE, July 2017.
17. R. Chhabra, "SSRMS FMS Calibration Matrix Estimation," MDA internal report, L&SE, October 2016.
18. R. Chhabra, "SSRMS FMS Fine Characterization Plan," MDA internal report, L&SE, March 2016.

ExoMars

19. R. Chhabra, "Effect of Wheel Release on BEMA¹⁴ During Rover Deployment," MDA internal report, BEMA, March 2016.

¹International Space Station

²Logestic and Sustaining Engineering

³H-II Transfer Vehicle

⁴Free-Flyer Capture

⁵Grapple Fixture

⁶Latching End Effector

⁷Space Station Operations and Training Simulator

⁸Guidance, Navigation and Control

⁹Lunar Exploration Light Rover

¹⁰Mars Exploration Science Rover

¹¹Space Station Remote Manipulator System

¹²Force/Moment Sensor

¹³Gear-Box Twist

¹⁴Bogie Electro-Mechanical Assembly

SSRMS analyses

20. Chhabra, "LEE/FRGF¹⁵ Interface Separation and Stiffness at 600 lbf Rigidization Force," MDA internal report, L&SE, November 2017.
21. R. Chhabra, "Reducing Rigidization Force to 600 lbf for LEE GBL¹⁶ Capture of Fixed GFs with JEU3¹⁷ Disabled: Performance Study for POA¹⁸ , SSRMS and SPDM¹⁹ LEEs," MDA internal report, L&SE, December 2017.
22. R. Chhabra, "Revisiting the JCS²⁰ Parameters for SSRMS Joints with Higher Friction in GBL Mode," MDA internal report, L&SE, October 2017.
23. R. Chhabra, "Insertion into Dragon Trunk with SSRMS in FMA²¹ Mode," MDA internal report, L&SE, October 2017.
24. R. Chhabra, "LEE POA (S/N 202) Configuration Parameters Update to Include GBL," MDA internal report, L&SE, October 2017.
25. R. Chhabra, "Kinematic Analysis for HTV Capture," MDA internal report, L&SE, October 2015.

SPDM analyses

26. R. Chhabra, "Fault Study for SPDM LEE Lubrication Operation," MDA internal report, L&SE, February 2017.
27. R. Chhabra, "SPDM Deployer Requirements," MDA internal report, L&SE, November 2016.
28. R. Chhabra, "OTCM²² Umbilical Model in SPOTS," MDA internal report, L&SE, June 2016.
29. R. Chhabra, "Simulation Analysis of SPDM Joint Diagnostics Based on Fast Fourier Transform," MDA internal report, L&SE, January 2016.

WORKSHOPS

1. 8th International Young Researchers Workshop on Geometry, Mechanics and Control, Barcelona, Spain. 2013/12
2. Focus Program on Geometry, Mechanics and Dynamics the Legacy of Jerry Marsden, Fields Institute, Toronto, Canada. 2012/07
3. Topological Robotics, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany. 2010/10

ACADEMIC AND INDUSTRIAL RESEARCH ACTIVITIES

MECHANICAL AND AEROSPACE ENGINEERING (CARLETON UNIVERSITY)

- Founded Autonomous Space Robotics and Mechatronics Laboratory (ASRoM-Lab)
Vision: Long-term, reliable autonomy of future space missions
Mission: Developing concepts, theories, methodologies and technologies for advanced guidance, navigation and control of next-generation space robotics, based on techniques in Geometric Mechanics and Control, and experimentally testing them against realistic situations
- Conceptualizing notion of teams of chaser-manipulator systems to perform autonomous and optimal on-orbit servicing tasks, individually and collaboratively
- Geometric guidance and control of chaser-manipulator system in proximity operations
- Geometric observer-based control of hyper-flexible space manipulators

GUIDANCE, NAVIGATION AND CONTROL DEPARTMENT (MDA)

- Pre-capture mission planning of chaser-manipulator system for large space debris removal
- On-orbit calibration of force/moment sensor of the Space Station Remote Manipulator System (SSRMS) considering thermal drift
- Satellite jettison deployer design for SSRMS and Special Purpose Dexterous Manipulator (SPDM)
- Nonlinear modal analysis of free-base elastic robots in contact with the environment

¹⁵Flight-Releasable Grapple Fixture

¹⁶Gear-Box Limping

¹⁷Joint Electronic Unit

¹⁸Payload/Orbital Replacement Unit Accommodations

¹⁹Special Purpose Dexterous Manipulator

²⁰Joint Control System

²¹Force/Moment Accommodation

²²ORU/Tool Changeout Mechanisms

- Spherical harmonic model of the gravitational force and gravity gradient torque for relative dynamics of elastic multi-body systems
- Wind and air density estimation in Thermosphere for aerodynamic force/torque approximation
- Multi-body model and nonlinear control of Lunar Exploration Light Rover (LELR): dynamical reduction and feedback linearization
- Torque distribution and traction control of LELR
- Robust control of LELR with non-ideal nonholonomic constraints
- Electromechanical analysis of the Bogie Electro-Mechanical Assembly (BEMA) of ExoMars rover during rover deployment
- Developing and improving the Space Station Operations and Training Simulator
- Involved in new R&D projects: 1) control of singular manipulators, and 2) control of cooperative elastic manipulators.

MATHEMATICS AND STATISTICS (UNIVERSITY OF CALGARY)

- Hamilton's equation for second (and higher) order Lagrangian systems, and coordinate-independent variational principle on Pontryagin bundle
- Symmetries, conservation laws and dynamical reduction of second order Lagrangian systems
- Quantization of second order Lagrangian systems with symmetry
- Constrained Hamiltonian dynamics of parametrization-invariant second order Lagrangian systems
- Differential spaces, jet bundles and nonlinear output-tracking control of multi-body systems with singularity

INSTITUTE FOR AEROSPACE STUDIES (UNIVERSITY OF TORONTO)

- Lie groupoid/algebroid formalism for studying the kinematics of constrained multi-body systems
- Geometric reduction of Hamiltonian mechanical systems with affine constraints
- Lie group classification of multi-degree-of-freedom joints
- Generalization of the exponential formula for Forward and Differential Kinematics of nonholonomic open-chain multi-body systems
- Symplectic reduction of holonomic multi-body systems with non-zero momentum, as a generalization of the existing reduction methods for free-base manipulators with zero momentum
- Generalization of the dynamical reduction of nonholonomic Hamiltonian mechanical systems and its application to nonholonomic multi-body systems
- Unification of the dynamical reduction of holonomic and nonholonomic systems
- Coordinate-independent feedback linearization and nonlinear control of free-base, holonomic (with non-zero momentum) and nonholonomic multi-body systems, in the reduced phase space
- Unification of Hamilton's equation for holonomic and nonholonomic systems, using a coordinate-independent variational principle on Pontryagin bundle
- Three-step reduction of nonholonomic Hamiltonian mechanical systems with symmetry
- Development of an energy-based modeling framework for mechatronic systems using bond-graphs and introducing holistic design criteria for mechatronic design
- Development of an effective concurrent design methodology for mechatronic systems, namely Holistic Concurrent Design, based on fuzzy set theory and bond-graph modeling
- Implementation of the Holistic Concurrent Design using hardware-in-the-loop simulation

AEROSPACE ENGINEERING (SHARIF UNIVERSITY OF TECHNOLOGY)

- Kinematic, dynamic and aerodynamic model of tail-sitter using *Visual Nastran*, *Matlab* and *SolidWorks*; fuzzy control design; and development of a hardware-in-the-loop simulation for implementation and validation (*BASc project*, supervised by Professor Fariborz Saghafi)

TEACHING EXPERIENCE

INSTRUCTOR

- **(MECH4806)** Mechatronics, Carleton University, Mechanical and Aerospace Engineering (Winter 2019)
- **(MAAE3500)** Feedback Control Systems, Carleton University, Mechanical and Aerospace Engineering (Winter 2019)

- **(MATH331)** Multivariate Calculus, University of Calgary, Mathematics and Statistics (Winter 2014)
- **(AER304)** Aerospace Laboratory II, University of Toronto, Institute for Aerospace Studies (Winter 2010)
- **(AER303)** Aerospace Laboratory I, University of Toronto, Institute for Aerospace Studies (Fall 2009)
- **(J-AER-1)** Fundamentals of Aeronautics, University of Toronto, DEEP program (Summer 2008)

TEACHING ASSISTANT

- **(MAT332H5)** Introduction to Nonlinear Dynamics and Chaos, University of Toronto, Mathematics (Fall 2013)
- **(MAT244H5)** Differential Equations I, University of Toronto, Mathematics (Fall 2013)
- **(MAT133Y5)** Calculus and Linear Algebra for Commerce, University of Toronto, Mathematics (Summer 2013)
- **(MAT135Y5)** Calculus and Differential Equations, University of Toronto, Mathematics (Winter 2013)
- **(MAT224H5)** Linear Algebra II, University of Toronto, Mathematics (Winter 2012)
- **(AER304)** Aerospace Laboratory II, University of Toronto, Institute for Aerospace Studies (Winter 2012)
- **(MAT294H1)** Calculus and Differential Equations, University of Toronto, Mathematics (Fall 2011)
- **(MAT242H5)** Differential Equations I, University of Toronto, Mathematics (Fall 2011)
- **(MAT235Y1)** Calculus II, University of Toronto, Mathematics (Fall 2011 & Winter 2012)
- **(AER525)** Robotics, University of Toronto, Institute for Aerospace Studies (Fall 2008)
- **(AER303)** Aerospace Laboratory I, University of Toronto, Institute for Aerospace Studies (Fall 2007 & 2010)

CERTIFICATES, COURSES AND WORKSHOPS

- New Faculty Orientation (OVPRI) (Carleton University, 2018)
- NSERC Discovery Grant Workshop (CORIS) (Carleton University, 2018)
- Accessibility for Ontarians with Disabilities (AODA) - Customer Service Standard (Carleton University, 2018)
- Accessibility for Ontarians with Disabilities (AODA) - Employment Standard (Carleton University, 2018)
- Accessibility for Ontarians with Disabilities (AODA) - Info & Communication Standard (Carleton University, 2018)
- Worker Health & Safety Awareness Training (Carleton University, 2018)
- Violence & Harassment Training (Carleton University, 2018)
- Electrical Safety Awareness (ESA) (MDA, 2014)
- Electrostatic Discharge Control Awareness Only (ASDC Awareness Only) (MDA, 2014)
- Workplace Hazardous Materials Information System (WHMIS) (MDA, 2014)
- Occupational Health and Safety (OH&S) (MDA, 2014)
- Prospective Professors in Training (PPIT) (University of Toronto, 2012)

PEER REVIEW SERVICE

REVIEWER FOR REFERRED JOURNALS

- Mechatronics, Elsevier
- Robotica, Cambridge University Press
- Concurrent Engineering: Research and Applications, Sage
- Fuzzy Sets and Systems, Elsevier
- Transactions on Robotics, IEEE
- Acta Astronautica, Elsevier
- Nonlinear Dynamics, Springer
- Journal of Guidance, Control and Dynamics, AIAA
- Astronautical Sciences, Springer
- International Journal of Robotics and Automation, Acta Press

- International Journal of Information Technology & Decision Making, World Scientific
- International Journal of Mechanical Engineering and Mechatronics, Avestia Publishing

REVIEWER FOR GRANT APPLICATIONS

- Ontario Ministry of Economic Development and Growth (fund value: \$15M, project value: \$5.6B)
- Shastri Indo-Canadian Institute

MEMBER OF EXAMINATION BOARD FOR THESES

PHD COMPREHENSIVE EXAM AND PROPOSAL DEFENCE

- Colin Miyata, “A Novel Framework for User Safety in Human-Robot Interactions through the Use of Tactile Sensors,” PhD Thesis Proposal, Department of Mechanical and Aerospace Engineering, Carleton University, September 2018.

MASC THESIS DEFENCE

- Cassidy Westin, “Modelling and Simulation of Marine Cables with a Dynamic Winch and Sheave Contact,” MASC Thesis, Department of Mechanical and Aerospace Engineering, Carleton University, August 2018.

CHAIR

- Osama Al-Mai, “Design, Development and Calibration of Multi-Axis, Fiber-Optic, Force/Torque Sensors for Biomechanical Applications,” PhD Thesis Proposal, Department of Mechanical and Aerospace Engineering, Carleton University, August 2018.

EXTERNAL EXAMINER

- Xueyang Yao, “Discrete 2D Transforms in Polar Coordinates,” MASc Thesis, Department of Mechanical Engineering, University of Ottawa, April 2018.
- Yanzhang Wu, “Sensing Nonlinear Viscoelastic Constitutive Parameters with a Geometrically Nonlinear Timoshenko Beam: Modeling and Simulation,” MASc Thesis, Department of Mechanical Engineering, University of Ottawa, September 2018.

TECHNICAL SKILLS

- **Coding Software:** Matlab, Fortran, Linux, Python, ADA, Delphi, Pascal
- **Networking Software:** Active Directory, Microsoft Office SharePoint Server
- **Engineering Software:** Simulink, SolidWorks, Visual Nastran