Institute for Aerospace Studies
UNIVERSITY OF TORONTO

Posting date: June 26, 2024

UTIAS Teaching Assistantship Positions 2024-2025

Teaching Assistantship applications for UTIAS-based courses are now being accepted for the 2024-2025 academic year. Applicants must apply now to be considered for any position that may arise during the 2024-25 academic year. Opportunities may become available for any course at any time.

To apply, please complete the **TA Application Form** and upload your CV, transcript (if required), and any other associated documents by **11:59 p.m., Friday July 19, 2024**. Your supporting documents must be in a single pdf file.

If you are unable to access the form above, please apply using the **external TA Application Form** and email your CV, transcript (if required), and any other associated documents by **11:59 p.m., Friday July 19, 2024** to **TAapplication@utias.utoronto.ca**. Your supporting documents must be in a single pdf file.

Qualifications, Duties, and Hours of Work

All applicants are expected to include an undergraduate transcript. Applicants who did not receive their B.A.Sc. from UofT Engineering are required to include scans or URL links for their course calendar descriptions (in English) for relevant courses. You will be contacted via email if an interview is required. Familiarity with the course content, progress of lectures and preparation of material for the respective course are the necessary requirements. Teaching assistants are required to supervise laboratory sessions and/or mark and grade reports, assignments, and notebooks as necessary, and assist in the examinations. The total duty time for courses in the enclosed list is typically 20-80 hours, depending on the projected class size and marking/laboratory requirements. AER210F, AER303F, AER372S, AER406S, AER407F, AER525F, ESC194F, ESC195S, ROB301F and ROB521 require regular student contact time on the main (St. George) campus.

The hourly rate of pay is $51.93 for fall appointments, and $52.97 for winter term appointments for both graduate and undergraduate students. The rates are in accordance with the collective agreement between the University of Toronto and the Canadian Union of Public Employees, Local 3902 Unit 1 representing teaching assistants. First-time teaching assistants will be paid to attend a mandatory training session, typically during the beginning of the fall semester. Details of the training session will be posted in due course. Please note that should rates stipulated in the collective agreement vary from rates stated in this posting, the rates stated in the collective agreement shall prevail.

The University of Toronto is strongly committed to diversity within its community. The University especially welcomes applications from visible minority group members, women, Aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to further diversification of ideas.

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Course Number	Course Title	Instructor	Enrolment Estimate	Number & Type of Positions	Term of Appointment
ESC194F	Calculus I	P.C. Stangeby/ J.W. Davis	300	6 tutorial	September
ESC384F	Partial Differential Equations	M. Yano	80	2 marking	September
AER210F	Vector Calculus & Fluid Mechanics	A. Ekmekci	200	6 tutorial & 4 lab	September
AER301F	Dynamics	J.S. Kelly	80	2 marking	September
AER303F	Aerospace Laboratory I	P. Lavoie	30	2 lab	September
AER306F	Introduction to Space Flight	C.J. Damaren	30	1 marking	September
AER307F	Aerodynamics	P. Lavoie	40	1 marking	September
AER407F	Space Systems Design	C.J. Damaren	20	3 lab	September
AER501F	Advanced Mechanics of Structures	P.B. Nair	30	1 marking	September
AER506F	Spacecraft Dynamics and Control	M.R. Emami	20	1 marking	September
AER507F	Introduction to Fusion Energy	J.W. Davis	20	1 marking	September
AER515F	Combustion Processes	O.L. Gulder	20	1 marking	September
AER525F	Robotics	M.R. Emami	50	1 marking & 1 lab	September
ROB301F	Introduction to Robotics	N. Reinhart	50	1 marking & 4 lab	September
ROB310F	Mathematics for Robotics	TBD	80	1 marking	September
ROB501F	Computer Vision for Robotics	J. Kelly	50	1 marking	September
AER1202F	Advanced Flight Dynamics	H.T. Liu	20	1 marking	September
AER1216F	Fundamentals of UAVs	H.T. Liu	30	2 marking	September

AER1304F	Fundamentals of Combustion	O.L. Gulder	15	1 marking	September
AER1316F	Fundamentals of CFD	D.W. Zingg	20	1 marking	September
AER1324F	Introduction to Turbulence	S. Chaudhuri	15	1 marking	September
AER1403F	Advanced Aerospace Structures	C.A. Steeves	15	1 marking	September
AER1513F	State Estimation for Aerospace Vehicles	T.D. Barfoot	40	1 marking	September
AER1515F	Perception for Robotics	S.L. Waslander	40	1 marking	September
AER1601	Aerospace Engineering and Operations Management	S. Armstrong	20	1 marking	September
ESC195S	Calculus II	J.W. Davis	250	6 tutorial	January
AER302S	Aircraft Flight	H.T. Liu	30	1 marking	January
AER304S	Aerospace Laboratory II	C.A. Steeves	30	2 lab	January
AER310S	Gas Dynamics	C.P.T. Groth	30	1 marking	January
AER336S	Scientific Computing	M. Yano	40	1 marking	January
AER372S	Control Systems	M.R. Emami	80	2 marking & 1 lab	January
AER373S	Mechanics of Solids and Structures	C.A. Steeves	30	1 marking	January
AER406S	Aircraft Design	P.R. Grant	20	3 lab	January
AER503S	Aeroelasticity	P.R. Grant	15	1 marking	January
AER510S	Aerospace Propulsion	S. Chaudhuri	30	1 marking	January
ROB311S	Artificial Intelligence	TBD	70	1 marking	January
ROB313S	Introduction to Learning from Data	TBD	50	1 marking	January
ROB498S	Robotics Capstone Design	S.L. Waslander	50	4 lab	January
ROB521S	Mobile Robotics & Perception	T.D. Barfoot	80	1 marking & 2 lab	January
AER1217S	Design of UAVs	H. Liu	30	1 marking	January

AER1303S	Advanced Fluid Mechanics	A. Ekmekci	15	1 marking	January
AER1307S	Fundamentals of Aeroacoustics	P. Lavoie	15	1 marking	January
AER1410S	Topology Optimization	C.S. Steeves	20	1 marking	January
AER1415S	Computational Optimization	P.B. Nair	20	1 marking	January
AER1516S	Motion Planning	J.S. Kelly	50	1 marking	January
AER1604	Air Accident Investigation	E. Tasker	30	1 marking	January

NOTE
1. The positions posted above are tentative, pending final course determinations, enrolments, and subsequent appointments.
2. The above positions are posted in accordance with the CUPE 3902 Collective Agreement.

Undergraduate Aerospace, Engineering Science and Robotics Course Descriptions for 2023-24 TA Positions

AER210H1 - Vector Calculus & Fluid Mechanics

Credit Value: 0.50
Hours: 38.4L/25.6T/6.4P

The first part of this course covers multiple integrals and vector calculus. Topics covered include: double and triple integrals, derivatives of definite integrals, surface area, cylindrical and spherical coordinates, general coordinate transformations (Jacobians), Taylor series in two variables, line and surface integrals, parametric surfaces, Green's theorem, the divergence and gradient theorems, Stokes's theorem. The second part of the course provides a general introduction to the principles of continuum fluid mechanics. The basic conservation laws are derived in both differential and integral form, and the link between the two is demonstrated. Applications covered include hydrostatics, incompressible and compressible frictionless flow, the speed of sound, the momentum theorem, viscous flows, and selected examples of real fluid flows.

Prerequisite: MAT195H1
Corequisite: MAT292H1
Exclusion: CHE211H1, CHE221H1, CME261H1, CME270H1, MAT291H1 or MIE312H1
Recommended Preparation: PHY180H1
Total AUs: 54.40
Program Tags:

- AEESCBASE: Fall Session - Year 2

AER301H1 - Dynamics

Credit Value: 0.50
Hours: 38.4L/12.8T

Reference frames in relative translation and rotation, vector and matrix formulations. Dynamics of a single particle and of systems of particles. Lagrange's equations. D'Alembert's and Hamilton's principle. Orbital dynamics. Rigid body kinematics and dynamics, Lagrangian approach to vibrations of complex systems. Model analysis. Primary Reference: class notes. Reference Books: Greenwood, Principles of Dynamics; Goldstein, Classical Mechanics.

Prerequisite: AER210H1, MAT185H1 and PHY180H1
Exclusion: MIE301H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 3
- AEESCBASEZ: Fall Session – Year 3
- AEMINRAM: Introductory Courses

AER302H1 - Aircraft Flight

Credit Value: 0.50
Hours: 38.4L/12.8T

Basics of aircraft performance with an introduction to static stability and control. Topics covered include: Equations of Motion; Characteristics of the Atmosphere; Airspeed Measurement; Drag (induced drag, total airplane drag); Thurst and Power (piston engine characteristics, gas turbine performance); Climb (range payload); Tunrs; Pull-up; Takeoff; Landing (airborne distance, ground roll); Flight envelope (maneuvering envelope, gust load factors); Longitudinal and lateral static stability and control; Introduction to dynamic stability.

Prerequisite: AER307H1 and AER301H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 3
- AEESCBASEZ: TECHNICAL ELECTIVES

AER303H1 - Aerospace Laboratory I

Credit Value: 0.15
Hours: 12.8P

Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.

Corequisite: AER307H1
Total AUs: 6.40
Program Tags:

- AEESCBASEA: Fall Session – Year 3

AER304H1 - Aerospace Laboratory II

Credit Value: 0.15
Hours: 12.8P

Students will perform a number of experiments in the subject areas associated with the Aerospace Option curriculum, and prepare formal laboratory reports.

Corequisite: AER373H1
Total AUs: 6.40
Program Tags:

- AEESCBASEA: Winter Session – Year 3

AER306H1 – Introduction to Space Flight

Credit Value: 0.50
Hours: 38.4L/12.8T

An introduction to the space environment and its impact on space vehicles, orbits and mission analysis, space system payloads, spacecraft power systems, attitude control sensors, and actuators, thermal analysis and design, propulsion, space communications systems including antennas and link budgets, command and data handling, structures, mechanisms, and mass properties.

Corequisite: AER301H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 3

AER307H1 - Aerodynamics

Credit Value: 0.50
Hours: 38.4L/12.8T

Review of fundamentals of fluid dynamics, potential-flow, Euler, and Navier-Stokes equations; incompressible flow over airfoils, incompressible flow over finite wings; compressibility effects; subsonic compressible flow over airfoils; supersonic flow; viscous flow; laminar layers and turbulent boundary layers and unsteady aerodynamics. Textbook: Anderson, J.D., Fundamentals of Aerodynamics, 3rd Edition, McGraw Hill, 2001.

Prerequisite: AER210H1 or MIE312H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 3
- AEESCBASEZ: TECHNICAL ELECTIVES
- AEMECBASC: Fall Session - Year 4

AER310H1 - Gasdynamics

Credit Value: 0.50
Hours: 38.4L/12.8T

Basic introduction to compressible gasdynamics. Includes some fundamental thermodynamics, thermal and caloric equations of state, derivation of Euler's equations by control volume approach. Also, includes the theory of steady flows in ducts with area changes, adiabatic frictional flows, duct flows with heat transfer, normal and oblique shock waves, Prandtl-Meyer expansion wave, moving shock and rarefaction waves, shock tubes, and wind tunnels. The lectures are supplemented by problem sets. Reference book: Anderson, J.D., Modern Compressible Flow with Historical Perspective.

Prerequisite: AER307H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 3

AER336H1 - Scientific Computing

Credit Value: 0.50
Hours: 38.4L/12.8T

Introduces numerical methods for scientific computation which are relevant to the solution of a wide range of engineering problems. Topics addressed include interpolation, integration, linear systems, least-squares fitting, nonlinear equations and optimization, initial value problems, and partial differential equations. The assignments require programming of numerical algorithms.

Prerequisite: ESC103H1 and MAT185H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 3
- AEESCBASEF: Electives – Winter Term
- AEESCBASEL: Technical Electives
- AEESCBASER: Technical Electives
- AEESCBASEZ: TECHNICAL ELECTIVES
- AEMINAIEN: As needed to bring credit weight to 3.0:

AER372H1 - Control Systems

Credit Value: 0.50
Hours: 38.4L/12.8T/19.2P

An introduction to dynamic systems and control. Models of physical systems. Stability and feedback control theory. Analysis and synthesis of linear feedback systems by "classical" and state space techniques. Introduction to nonlinear and optimal control systems. Digital computer control. Multivariable feedback system design.

Prerequisite: MAT185H1 and MAT292H1
Exclusion: CHE322H1, ECE356H1 or MIE404H1
Total AUs: 54.40
Program Tags:

- AEESCBASEA: Winter Session – Year 3
- AEESCBASEZ: Winter Session – Year 3

AER373H1 - Mechanics of Solids and Structures

Credit Value: 0.50
Hours: 38.4L/12.8T

An Introduction to Solid and Structural Mechanics. Continuum Mechanics: Stress, strain and constitutive relations for continuous systems, Equilibrium equations, Force and Flexibility methods, Introduction to Cartesian Tensors.

Variational Principles: Virtual Work, Complementary Virtual Work, Strain Energy and Work, Principle of Stationary Value of the Total Potential Energy, Complementary Potential Energy, Reissner's Principle, Calculus of Variations, Hamilton's Principle. Beam and Plate theory. Dynamics of discrete and continuous systems.

Prerequisite: CIV102H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 3
- AEESCBASEI: Winter Session - Year 3

AER406H1 - Aircraft Design

Credit Value: 0.50
Hours: 38.4T

Teams of 3 or 4 students design, build, and fly a remotely piloted aircraft. The aircraft is designed and built to maximize a flight score, which is a complex function of many factors - payload fraction, payload type, flight time, takeoff distance, etc. Teams are provided with identical motors, batteries, radio equipment, and flight instrumentation. Weekly sessions consist of a combination of lectures and one-on-one meetings with the tutors and professor to discuss each teams' progress. Evaluations are based on the weekly reports, preliminary and final design presentations and reports, an as-built report, and measured flight performance.

Prerequisite: AER302H1, AER307H1 and AER373H1
Total AUs: 51.28
Program Tags:

- AEESCBASEA: Winter Session – Year 4

AER407H1 - Space Systems Design

Credit Value: 0.50
Hours: 38.4P

Introduction to the conceptual and preliminary design phases for a space system currently of interest in the Aerospace industry. A team of visiting engineers provide material on typical space systems design methodology and share their experiences working on current space initiatives through workshops and mock design reviews. Aspects of operations, systems, electrical, mechanical, software, and controls are covered. The class is divided into project teams to design a space system in response to a Request for Proposals (RFP) formulated by the industrial team. Emphasis is placed on standard top-down design practices and the tradeoffs which occur during the design process. Past projects include satellites such as Radarsat, interplanetary probes such as a solar sailer to Mars, a Mars surface rover and dextrous space robotic systems.

Prerequisite: AER301H1, AER372H1
Total AUs: 51.28
Program Tags:

- AEESCBASEA: Fall Session – Year 4
- AEESCBASEZ: TECHNICAL ELECTIVES
- AEMINRAM: Advanced Courses

AER501H1 - Computational Structural Mechanics and Design Optimization

Hours: 38.4L/12.8T

Introduction to the Finite Element Method and Structural Optimization. Review of linear elasticity: stress, strain and material constitutive laws, Variational Principles. The Finite Element technique: problem formulation - methods of Ritz and Galerkin, element properties - C0 and C1 formulations, static and dynamic problems: applications to bar, beam, membrane and plate problems. Structural Optimization: Overview of problems, Optimal Design problem formulation, solution strategies - gradient search techniques, Sensitivity analysis for static and dynamic problems, Optimization problems using commercial finite element codes. Text: Shames & Dym, Energy and Finite Element Methods in Structural Mechanics.

Prerequisite: AER373H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 4

AER503H1 - Aeroelasticity

Credit Value: 0.50
Hours: 38.4L/12.8T

Static aeroelastic phenomena are studied, including divergence of 2D sections and slender 3D wings, as well as control reversal of 3D wings. Various methods of solution are considered such as closed form, discrete element, and the Rayleigh-Ritz approach. A study of vibration and flutter of wings and control surfaces is presented with particular emphasis on those parameters that affect flutter speed. Classical, k, and p-k methods for flutter estimation are presented.

Prerequisite: AER307H1 and AER501H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 4

AER506H1 - Spacecraft Dynamics and Control

Credit Value: 0.50
Hours: 38.4L/12.8T

Planar "central force" motion; elliptical orbits; energy and the major diameter; speed in terms of position; angular momentum and the conic parameter; Kepler's laws. Applications to the solar system; applications to Earth satellites. Launch sequence; attaining orbit; plane changes; reaching final orbit; simple theory of satellite lifetime. Simple (planar) theory of atmospheric entry. Geostationary satellite; adjustment of perigee and apogee; east-west stationkeeping. Attitude motion equations for a torque-free rigid body; simple spins and their stability; effect of internal energy dissipation; axisymmetric spinning bodies. Spin-stabilized satellites; long-term effects; sample flight data. Dual-spin satellites; basic stability criteria; example-CTS. "active" attitude control; reaction wheels; momentum wheels; controlmoment gyros; simple attitude control systems.

Prerequisite: AER301H1 and AER372H1
Total AUs: 44.80

Program Tags:

- AEESCBASEA: Fall Session – Year 4

AER507H1 - Introduction to Fusion Energy

Credit Value: 0.50
Hours: 38.4L/12.8T

Nuclear reactions between light elements provide the energy source for the sun and stars. On earth, such reactions could form the basis of an essentially inexhaustible energy resource. In order for the fusion reactions to proceed at a rate suitable for the generation of electricity, the fuels (usually hydrogen) must be heated to temperatures near 100 million Kelvin. At these temperatures, the fuel will exist in the plasma state. This course will cover: (i) the basic physics of fusion, including reaction cross-sections, particle energy distributions, Lawson criterion and radiation balance, (ii) plasma properties including plasma waves, plasma transport, heating and stability, and (iii) fusion plasma confinement methods (magnetic and inertial). Topics will be related to current experimental research in the field.

Total AUs: 44.80
Program Tags:

- AECERNUC: Courses
- AEESCBASEA: Fall Session – Year 4
- AEESCBASEJ: Fall Session – Year 4
- AEESCBASEP: Group A Electives
- AEESCBASER: Technical Electives
- AEMINENR: Courses offered in the Fall

AER510H1 - Aerospace Propulsion

Credit Value: 0.50
Hours: 38.4L/12.8T

Scope and history of jet and rocket propulsion; fundamentals of air-breathing and rocket propulsion; fluid mechanics and thermodynamics of propulsion including boundary layer mechanics and combustion; principles of aircraft jet engines, engine components and performance; principles of rocket propulsion, rocket performance, and chemical rockets; environmental impact of aircraft jet engines.

Prerequisite: AER310H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Winter Session – Year 4

AER515H1 - Combustion Processes

Credit Value: 0.50
Hours: 38.4L/12.8T

Scope and history of combustion, and fossil fuels; thermodynamics and kinetics of combustion including heats of formation and reaction, adiabatic flame temperature, elementary and global reactions, equilibrium calculations of combustion products, and kinetics of pollutant formation mechanisms; propagation of laminar premixed flames and detonations, flammability limits, ignition and quenching; gaseous diffusion flames and droplet burning; introduction to combustion in practical devices such as rockets, gas turbines, reciprocating engines, and furnaces; environmental aspects of combustion.

Prerequisite: CHE260H1
Exclusion: MIE516H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 4

AER525H1 - Robotics

Credit Value: 0.50
Hours: 38.4L/12.8T/19.2P

The course addresses fundamentals of analytical robotics as well as design and control of industrial robots and their instrumentation. Topics include forward, inverse, and differential kinematics, screw representation, statics, inverse and forward dynamics, motion and force control of robot manipulators, actuation schemes, task-based and workspace design, mobile manipulation, and sensors and instrumentation in robotic systems. A series of experiments in the Robotics Laboratory will illustrate the course subjects.

Prerequisite: AER301H1 and AER372H1
Exclusion: ECE470H1
Total AUs: 54.40
Program Tags:

- AEESCBASEA: Fall Session – Year 4
- AEESCBASER: Technical Electives
- AEMECBASC: Fall Session - Year 4
- AEMINADVM: Advanced Courses

ESC194H1 - Calculus I

Credit Value: 0.50
Hours: 38.4L/12.8T

Topics include: theory and applications of differential and integral calculus, limits, basic theorems and elementary functions. An introduction to differential equations is also included.

Total AUs: 44.80
Program Tags:

- AEESCBASE: Fall Session - Year 1

ESC195H1 - Calculus II

Credit Value: 0.50
Hours: 38.4L/12.8T

Topics include: techniques of integration, improper integrals, sequences, series, Taylor's theorem, as well as an introduction to vector functions, functions of several variables, partial derivatives and the optimization of multivariable functions.

Prerequisite: ESC194H1
Exclusion: MAT187H1/APS163H1
Total AUs: 44.80
Program Tags:

- AEESCBASE: Winter Session - Year 1

ESC384H1 - Partial Differential Equations

Credit Value: 0.50
Hours: 38.4L/12.8T

Introduces techniques to analyze and solve partial differential equations (PDEs). Concepts covered include Fourier series, Sturm-Liouville theory, separation of variables, fundamental solutions, Green's functions, method of characteristics, and numerical methods. Applications are in model PDEs in continuum mechanics: heat, Laplace's, wave, and transport equations.

Prerequisite: MAT290H1/MAT292H1
Total AUs: 44.80
Program Tags:

- AECPEBASC: Fall Term – Year 3 or 4
- AEELEBASC: Fall Term – Year 3 or 4
- AEESCBASEA: Fall Session – Year 3
- AEESCBASEF: Fall Session – Year 3
- AEESCBASEP: Fall Session – Year 3
- AEESCBASEP: Group A Electives
- AEESCBASER: Technical Electives
- AEESCBASET: Technical Electives
- AEESCBASEZ: TECHNICAL ELECTIVES

ROB301H1 - Introduction to Robotics

Credit Value: 0.50
Hours: 38.4L/12.8T/19.2P

The course is intended to provide an introduction and a very interdisciplinary experience to robotics. The structure of the course is modular and reflects the perception-control-action paradigm of robotics. The course, however, aims for breadth, covering an introduction to the key aspects of general robotic systems, rather than depth, which is available in later more advanced courses. Applications addressed include robotics in space, autonomous terrestrial exploration, biomedical applications such as surgery and assistive robots, and personal robotics. The course culminates in a hardware project centered on robot integration.

Prerequisite: ESC204H1
Total AUs: 54.40
Program Tags:

- AEESCBASEZ: Fall Session – Year 3

ROB310H1 - Mathematics for Robotics

Credit Value: 0.50
Hours: 38.4L/12.8T

The course addresses advanced mathematical concepts particularly relevant for robotics. The mathematical tools covered in this course are fundamental for understanding, analyzing, and designing robotics algorithms that solve tasks such as robot path planning, robot vision, robot control and robot learning. Topics include complex analysis, optimization techniques, signals and filtering, advanced probability theory, and numerical methods. Concepts will be studied in a mathematically rigorous way but will be motivated with robotics examples throughout the course.

Prerequisite: MAT185H1, MAT292H1
Recommended Preparation: ESC103H1, ECE286H1
Total AUs: 44.80
Program Tags:

- AEESCBASEA: Fall Session – Year 3
- AEESCBASEZ: Fall Session – Year 3
- AEMINRAM: Introductory Courses

ROB311H1 - Artificial Intelligence

Credit Value: 0.50
Hours: 38.4L/12.8T

An introduction to the fundamental principles of artificial intelligence from a mathematical perspective. The course will trace the historical development of AI and describe key results in the field. Topics include the philosophy of AI, search methods in problem solving, knowledge representation and reasoning, logic, planning, and learning paradigms. A portion of the course will focus on ethical AI, embodied AI, and on the quest for artificial general intelligence.

Prerequisite: Prerequisite: ECE286H1/ECE302H1 and ECE345H1/ECE358H1/CSC263H1
Total AUs: 44.80
Program Tags:

- AECERAIEN: Courses
- AEESCBASEL: Winter Session – Year 3
- AEMINAIEN: Fall Session - Year 1
- AEMINRAM: Winter Courses

ROB313H1 - Introduction to Learning from Data

Credit Value: 0.50
Hours: 38.4L/25.6T

This course will introduce students to the topic of machine learning, which is key to the design of intelligent systems and gaining actionable insights from datasets that arise in computational science and engineering. The course will cover the theoretical foundations of this topic as well as computational aspects of algorithms for unsupervised and supervised learning. The topics to be covered include: The learning problem, clustering and k-means, principal component analysis, linear regression and classification, generalized linear models, bias-variance tradeoff, regularization methods, maximum likelihood estimation, kernel methods, the representer theorem, radial basis functions, support vector machines for regression and classification, an introduction to the theory of generalization, feedforward neural networks, stochastic gradient descent, ensemble learning, model selection and validation.

Prerequisite: ECE286H1, MAT185H1, MAT195H1, CSC263H1/ECE358H1
Exclusion: ECE421H1, CSC411H1, STA314H1
Total AUs: 51.20
Program Tags:

- AECERAIEN: Courses
- AEESCBASEZ: Winter Session – Year 3
- AEMINAIEN: Fall Session - Year 1
- AEMINRAM: Winter Courses

ROB498H1 - Robotics Capstone Design

Credit Value: 0.50
Hours: 64T

The Robotics Capstone Design course is structured to provide students with an opportunity to integrate and apply the technical knowledge gained throughout their degree program toward the solution of a challenging real-world robotics problem. During the half-year course, students work in small teams and have considerable freedom to explore the design space while developing a complete robotic hardware and software system. The challenge task incorporates all aspects of the "sense-plan-act" robot design paradigm, with designs assessed based on engineering quality and performance relative to a series of benchmarks. In addition, each student completes a critical reflection on their team's performance and the evolution of their experience with design during their undergraduate program. Students are supported by a teaching team comprised of domain experts.

Total AUs: 51.20
Program Tags:

ROB501H1 - Computer Vision for Robotics

Credit Value: 0.50
Hours: 38.4L/12.8T

An introduction to aspects of computer vision specifically relevant to robotics applications. Topics include the geometry of image formation, basic image processing operations, camera models and calibration methods, image feature detection and matching, stereo vision, structure from motion and 3D reconstruction. Discussion of moving object identification and tracking as time permits.

Prerequisite: ROB301H1/ECE324H1
Exclusion: CSC420H1
Recommended Preparation: CSC263H1
Total AUs: 44.80
Program Tags:

- AEESCBASEL: Technical Electives
- AEESCBASEZ: Fall Session – Year 4
- AEMINAIEN: Fall Session - Year 1

ROB521H1 - Mobile Robotics and Perception

Credit Value: 0.50
Hours: 38.4L/12.8T/19.2P

The course addresses fundamentals of mobile robotics and sensor-based perception for applications such as space exploration, search and rescue, mining, self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, etc. Topics include sensors and their principles, state estimation, computer vision, control architectures, localization, mapping, planning, path tracking, and software frameworks. Laboratories will be conducted using both simulations and hardware kits.

Prerequisite: ROB310H1, AER372H1
Total AUs: 54.40
Program Tags:

- AEESCBASEA: Winter Session – Year 4
- AEESCBASER: Technical Electives
- AEESCBASEZ: Winter Session – Year 4
- AEMINRAM: Winter Courses

Aerospace and Robotics Graduate Course Descriptions for 2023-24 TA Positions

AER 1202H Advanced Flight Dynamics

Introduction to the dynamics of aircraft. Topics considered include derivation of equations of motion; small perturbation methods; stability derivative estimation; longitudinal and lateral static stability and dynamic stability; response to control input (open-loop control); and closed-loop flight control system design.

AER 1216H Fundamentals of UAVs

Unpiloted aircraft, known as UAVs, drones or aerial robots, are very quickly becoming a major sector of the aerospace industry. They are increasingly used in aerial photography, inspection of infrastructure, delivery of small packages and other applications requiring inexpensive and flexible flight. The basic physical, scientific and engineering principles necessary to design a remote-controlled fixed-wing or quad-rotor UAV are explained in this course. These include aerodynamics, propulsion, structures and control. A key part of this course will be a group project to create a detailed design of a UAV that is capable of performing a specific function.

AER 1217H Development of Autonomous UAS

This course is the second part of the CARRE core courses, following AER1216: Fundamentals of UAVs, which covers the fundamental principles related to UAV design: structures, aerodynamics and control. AER1216 is the prerequisite of this course, unless approved by the instructor. In AER 1217, the focus is placed on the development of unmanned aerial systems (UAS), with the theme of autonomy in navigation and control, as well as flight performance analysis and evaluation.

The course curriculum will be delivered in both lectures and development projects, including flight tests. The contents include: quadrotor or fixed-wing UAV dynamics and control; sensing and estimation for UAVs; navigation and path planning; instrumentation and sensor payloads; computer vision. A development project will be given to students who will use the UAV platform to design an autonomous system to accomplish a specific flying mission, to be demonstrated by flight experiments.

Prerequisite:

AER 1216H “Fundamentals of UAVs” or equivalent with permission of the instructor

AER 1303H Advanced Fluid Mechanics

This course is intended to be a first graduate-level course in fluid mechanics, and assumes that students have had at least one introductory fluid mechanics course at the undergraduate level. The course starts with a review of vectors, tensors and related theorems; flow kinematics; derivations of the differential forms of the governing equations of fluid motion. Then the following subjects are covered: exact solutions (solutions with parallel boundaries, solutions with circular symmetry, pulsating flows, stagnation-point flows, etc); special forms of governing equations (Kelvin’s theorem, vorticity transport theorem, equations for inviscid flow (Euler); and boundary layer theory (boundary layer equations, boundary layer on a flat plate: Blasius solution, approximate solutions, effect of pressure gradient, separation, perturbation techniques, stability of boundary layers, etc.

AER 1304H Fundamentals of Combustion

This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations. Then, the following subjects are covered: chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion in one and two-phase flows; aerodynamics and stabilization of flames; ignition, extinction and combustion instabilities; non-intrusive combustion diagnostics and flame spectroscopy.

AER 1307H Fundamentals of Aeroacoustics

This course covers the fundamentals of aeracoustics as it applies to general and commercial aviation. The essentials of linear acoustics are presented and related to fluid motion to arrive at fundational theories of aeroacoustics, including Lighthill's acoustics analogy, the Ffowcs-Williams-Hawkings equation and Goldstein's equation. The concepts are applied to flows at low Mach numbers, with specific applications sound generation by turbulent flows as well as leading and trailing edge noise. The course will also cover a number of topics related to experimental methods relevant to aeroacoustics. This will include the basics of aeroacoustic test facilities, instrumentation and signal processing. The course is meant for graduate students with strong backgrounds in fluid dynamics but that may lack knowledge of acoustics.

AER 1316H Fundamentals of Computational Fluid Dynamics

This course presents the fundamentals of numerical methods for inviscid and viscous flows. The following topics are covered: finite-difference and finite-volume approximations, structured and unstructured grids, the semidiscrete approach to the solution of partial differential equations, time-marching methods for ordinary differential equations, stability of linear systems, approximate factorization, flux-vector splitting, boundary conditions, relaxation methods, and multigrid.

AER 1324H Introduction to Turbulence

This course is aimed to provide an overview of the fundamental physical processes in large Reynolds number turbulent flows.

Topics include review of tensors, probabilistic tools, and conservation laws.

Free shear flows: turbulent kinetic energy transport and dissipation.

Scales of turbulent motion: Kolmogorov hypothesis, structure functions, Kármán-Howarth equation, 4/5th law, Fourier modes, Kolmogorov-Obukhov spectrum, intermittency, and refined similarity hypothesis.

Turbulent mixing: scalar transport and dissipation. Alignments of vorticity, scalar gradient, and strain rates. Diagnostics in turbulent flows.

AER 1403H Advanced Aerospace Structures

This course will provide instruction in three areas crucial to aerospace structural design: fiber composite materials, thin walled structures, and finite element methods. All three will be taught in a manner such that their interrelation is made clear. The course will begin with a composite materials, their mechanics and application. General theories of shells and thin walled structures, which are essential to aircraft design, will next be discussed. Finally, finite element methods of use in modelling aircraft structures and composites will be described. No specific background in any of these three topics is required, but a good knowledge of solid and structural mechanics will be assumed.

AER 1410H Topology Optimization

Topology optimization is a relatively new method for the computational design of structures that enables optimal structural design beyond traditional size and shape optimization. Specifically, topology optimization identifies where to put material and where to put holes within the design domain. This course will examine the background to topology optimization, the theory and algorithms necessary to build a topology optimization code, and the two main approaches to topology optimization. At the conclusion of the course, students will be able to program a basic topology optimization code and use a common commercial software package.

AER 1415H Computational Optimization

This is an introductory graduate-level course on computational optimization and it is assumed that students have had undergraduate level training in multivariable calculus, linear algebra and MATLAB programming. The topics to be covered in this course include: formulation of optimization problems, non-gradient and stochastic search techniques, gradient-based optimization algorithms for unconstrained and constrained problems, numerical methods for sensitivity analysis, surrogate modeling, surrogate-assisted optimization frameworks, applications of optimization algorithms to design, parameter estimation and control.

AER 1513H State Estimation for Aerospace Vehicles

This course introduces the fundamentals of state estimation for aerospace vehicles. Knowing the state (e.g., position, orientation, velocity) of a vehicle is a basic problem faced by both manned and autonomous systems. State estimation is relevant to aircraft, satellites, rockets, landers, and rovers. This course teaches some of the classic techniques used in estimation including least squares and Kalman filtering. It also examines some cutting edge techniques for nonlinear systems including unscented Kalman filtering and particle filtering. Emphasis is placed on the ability to carry out state estimation for vehicles in three-dimensional space, which is complicated by vehicle attitude and often handled incorrectly. Students will have a chance to work with datasets from real sensors in assignments and will apply the principles of the course to a project of their choosing.

AER 1515H Perception for Robotics

This course presents the fundamentals of robotic perception based on a foundation of probability, statistics and information theory. Common sensor types and their probabilistic modeling are surveyed, including computer vision, Lidar, radar, GNSS/INS and odometry. Methods for feature extraction, description & matching, direct photometric and point cloud registration, outlier rejection are presented in the context of a robotic localization and mapping front end. Object detection and tracking, semantic segmentation and prior maps are fused to form a complete perceptual view of dynamic environments for a wide range of robotic applications.

AER 1516H Motion Planning

A rigorous mathematical study of the motion planning problem for aerial, ground, and mobile manipulator robot platforms and for multi-robot systems. Geometric representations and the robot configuration space. Sampling-based motion planning. Feedback motion planning in continuous spaces. Planning under sensor uncertainty and with differential constraints. Course project involving the implementation of modern planning algorithms in simulation and (potentially) on a real mobile manipulator.

AER 1517H Control for Robotics

This course presents optimal, adaptive and learning control principles from the perspective of robotics applications. Working from the Hamilton-Jacobi-Bellman formulation, optimal control methods for aerial and ground robots are developed. Real world challenges such as disturbances, state estimation errors and model errors are addressed and adaptive and reinforcement learning approaches are derived to address these challenges. Course project involves simulated control of an aerial vehicle, with aerodynamic models and wind disturbances.

AER 1604H Air Accident Investigation

This course will provide students with an introduction to the methods, processes and technologies of air accident investigation: what happens after there is an incident or accident involving airplanes in Canada. The course will begin by explaining what happens at the site of an air accident, and will then provide a concrete demonstration by creating a mock air accident using real aircraft wreckage. Students will use their observations of the accident site and other information that they acquire or derive to understand and report on what has occurred. The course will take students through the full investigative process and culminate in the production of an accident report using the techniques and information they have been given during the course. Warning: Air accidents are inherently dangerous events, and students will be exposed to information, images and material associated with injury or death.