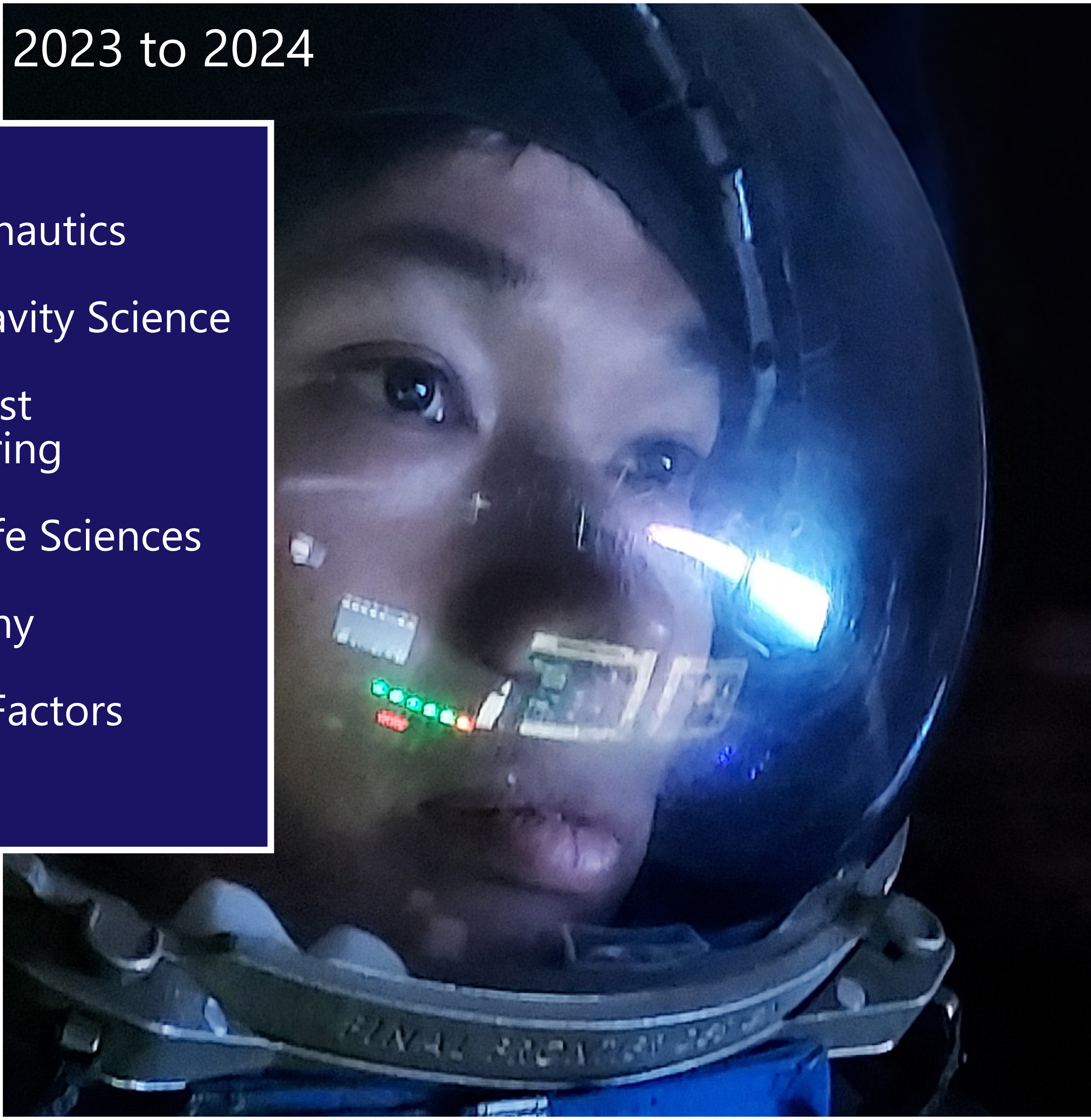
INTERNATIONAL INSTITUTE FOR ASTRONAUTICAL SCIENCES

COURSE CATALOG

Educating the Next Generation of Astronautical Professionals

2023 to 2024



- Bioastronautics
- Microgravity Science
- Flight Test Engineering
- Space Life Sciences
- Aeronomy
- Human Factors

Register at astronauticsinstitute.org

Welcome to IIAS

Astronauts have always provided great returns to the societies that have funded and trained them. Since Yuri Gagarin first flew around the world on Vostok One, astronauts have served to inspire. When Kennedy committed the United States to land a person on the moon, he knew that he was investing in a future generation of science and technology professionals that would lead the world, and the astronauts that would command the best technologies to do the most novel science would be ambassadors to such new fields of science.

These astronauts, many of whom hailed from humble backgrounds, would be the best of the best. They would bring a lifetime of skills and expertise in hopes of being selected for the most daring of missions, and succeeding on the value of their merit. They were people of the highest sense of service. And then when Alexei Leonov and Deke Slayton first shook hands during the Apollo-Soyuz Test Project, astronauts became much more than just a peak of their nation's pride; they became global ambassadors. The International Space Station that would follow became the greatest peacetime collaboration in the history of humankind, serving as a model of how we can work and live in space together to conduct experiments of benefit to all humanity.

The growth of commercial space access provides many new opportunities. The cost of access to space is rapidly decreasing as more countries become involved in our new spacefaring future. Yet the perception of access to space belonging solely for the rich or elite threatens the foundational role of how astronauts have historically served and inspired the societies that have selected and trained them. If young people can no longer see themselves in this bold new future, then we lose everything that astronauts have historically provided to us.

The International Institute for Astronautical Sciences exists to help maintain the bridge that space maintains across political or national divides. It serves to reduce barriers that might exist to people who dream of becoming professionals in this industry by providing access to facilities and expertise formerly privy only to national space agencies and at a cost that is broadly accessible. It serves to provide representation to incubate a broadly inclusive spacefaring future. It serves to produce professionals who have the skills and expertise to demand their place on the frontiers of humanity's first steps towards the stars.

Ad astra,

Jason D. Reimuller, Ph.D.
Executive Director
International Institute for Astronautical Sciences

Contents

Mission Statement

The mission of the International Institute for Astronautical Science is to provide a high-value, immersive education within culturally-diverse operational environments that enable professional citizen-science research promoting multi-national space exploration, science literacy, and the equitable and peaceful uses of outer space.

We embrace three core values:

1. Democratizing Science

IIAS is a citizen-science organization that relies on private participation and funding in addition to traditional public funding sources to conduct and communicate science. IIAS strives to provide economical access to cutting-edge research facilities along with high-value, immersive educational services that enable peer-reviewed publishable science while communicating science to a global audience.

2. International Stewardship

Understanding our shared global environment and laying seeds to be multi-planetary species are global objectives. IIAS embraces its diversity as an international organization and uses space as a means to build bridges across cultural and geopolitical divisions. As of 2023, IIAS serves students originating from 53 different nations.

3. Inclusion

We believe that global issues demand a global response, and IIAS encourages everyone to participate in the process of conducting, publishing, and communicating science. As part of this mandate, IIAS sponsors and manages three outreach programs serving under-represented minorities in science: the PoSSUM 13, Out Astronaut, and Space for all Nations.

The IIAS Professional Certificate in

Astronautical Science

The only program of its type in the world, the IIAS Professional Certificate in Astronautical Science is awarded by the International Institute for Astronautical Sciences to students interested in a career in astronautics and related sciences. It is a 36-credit, thesis-based, immersive professional education program enabling publishable, peer-reviewed scientific research in the fields of aeronomy, bioastronautics, mission design, space flight operations, and flight test engineering.

Students must complete all core classes including six thesis credits, select a concentration of bioastronautics reserach, and select two free electives. Many of the advanced courses involve design elements which may evolve to a thesis project. In the interest of serving a global student body, all IIAS courses are designed to leverage distance learning technolgies while consolidating on-site intensives and reserach campaigns at our satellite campuses or field research locations.

The IIAS Astronautical Science candidate designs experiments and technologies that are tested and validated in a variety of space analog environments, including gravity offset (left and lower right) and parabolic flight (upper right)

The IIAS Professional Certificate in Astronautical Science

	Course	Credits
AST 101	Fundamentals of Astronautics	2 credits
AST 102	Fundamentals of Microgravity Science	3 credits
BIO 101	Spaceflight Physiology	3 credits
EDU 101	Citizen Science Research Methods	3 credits
EVA 101	Life Support Systems	2 credits
AST 199	Thesis	6 credits
	Bioastronautics (with IVA Space Suit Evaluation) Concentration	
BIO 103	Microgravity Space Suit Evaluation	1 credit
BIO 104	Post-Landing Space Suit Evaluation	2 credits
OPS 102	Spacecraft Egress and Rescue Operations	2 credits
	Bioastronautics (with EVA Space Suit Evaluation) Concentration	
EVA 104	Gravity-Offset EVA Space Suit Evaluation	2 credits
	select one of:	
EVA 102	Operational Space Medicine	3 credits
EVA 103	Planetary Field Geology and EVA Tool Development	3 credits
	Free Electives (select two)	
AER 101	Suborbital Space Environment	3 credits
AER 103	Remote Sensing of Noctilucent Clouds	3 credits
BIO 101	Spaceflight Physiology	3 credits
EVA 102	Introduction to Space Medicine	3 credits
EVA 103	Planetary Field Geology and EVA Tool Development	3 credits
EVA 105	Fundamentals of Underwater Analog EVA	3 credits
FTE 101	Fundamentals of Flight Test Engineering	3 credits
OPS 101	Systems Engineering for Human Spaceflight	3 credits

The IIAS Astronautical Science degree is licensed in the State of Connecticut and designed to be completed in 18-24 months of study. Graduates of AST 101 are eligible to be accepted for candidacy and will consult with their faculty advisor in order to select their concentrations of study. Candidates must complete all core classes, one concentration, and two free electives. 2023 Cost Estimates for tuition and lab fees are $23950 and up, plus local lodging for on-sites and flight suit.

Aeronomy

The IIAS Aeronomy Program (a.k.a. Project PoSSUM) provides a practical education for the professional interested in upper-atmospheric research from research aircraft, high-altitude balloons, and suborbital spacecraft. Emphasis is on the study of noctilucent clouds from research aircraft and balloons, the design of space instrumentation, and mission specific training for suborbital noctilucent cloud tomography missions.

Co-developed by the University of Alaska, Columbia University, GATS, Inc., and StarSpec Technologies, the IIAS Professional Credential in Aeronomy is a 14-credit certification designed for the student or professional interested in a career involving upper-atmospheric research. The credential assumes an understanding of mathematics up to differential equations and familiarization with coding and modeling platforms.

Balloon-borne lidar on PMC-Turbo, a NASA balloon carying IIAS technology

IIAS students study noctilucent clouds in Northern Canada from a Mooney M20K aircraft.

The Professional Certificate in Aeronomy

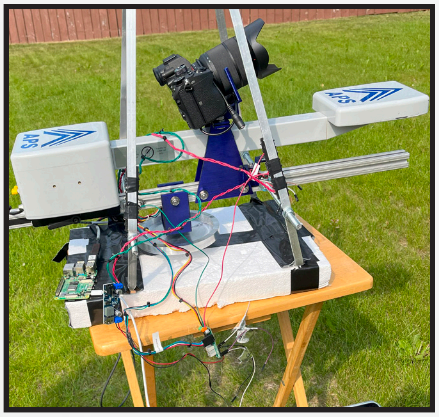
	Course	Credits
AST 101	Fundamentals of Astronautics	2 credits
EDU 101	Citizen-Science Research Methods	3 credits
AER 101	Suborbital Space Environment	3 credits
AER 102	Techniques of Remote Sensing	3 credits
AER 103	Remote Sensing of Noctilucent Clouds	3 credits

At 83 km (50 miles) in altitude, noctilucent clouds are the highest clouds in the Earth's atmosphere and are observed slightly below the mesopause in the polar summertime. These clouds are of special interest, as they are sensitive to both global climate change and to solar/terrestrial influences. Too high to reach by aircraft yet too low to reach by satellite, IIAS explores these clouds using balloons and human-tended payloads on suborbital spacecraft.

IIAS collaborates with the Royal Canadian Air Force for noctilucent cloud studies.

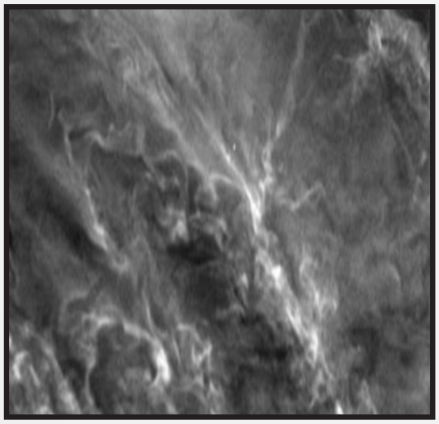
Airborne Remote Sensing of Noctilucent Clouds

IIAS conducts airborne imagery and remote sensing of noctilucent cloud structures using research aircraft. Individual sorties are designed to observe noctilucent cloud structures syncronous with space platforms and terrestrial observation sites to facilitate tomographic reconstruction. These images are used to test the low-latitude thresholds of space-based imagery and qualify instrumentation for high-altitude balloon and suborbital spacecraft missions.



High-Altitude Balloon Imaging of Noctilucent Clouds

IIAS works in partnership with GATS, Columbia University, and the University of Alaska in Fairbanks to develop and test camera systems designed to fly on high-altitude balloons to image noctilucent clouds through long-duration flights around the polar vortex and short-duration, repeatable flights from Pokar Flats Rocket Range in Alaska as part of the IIAS AER 103 'Remote Sensing of Noctilucent Clouds' class.



Noctilucent cloud structures as observed from PMC-Turbo and from which AER 103 balloon campaigns validate data against.

Crewed Suborbital Tomography of Noctilucent Clouds

IIAS's Fundamentals of Astronautics class extends from a NASA-supported flight opportunity and focuses on the PoSSUMCam system, an instrument designed to produce high-resolution imagery of noctilucent cloud micro-features from suborbital spacecraft as they pass through a noctilucent cloud layer. These images may then be combined with in-situ observations to build extremely high-resolution 3D models of the small-scale noctilucent cloud structures that will better inform us of the energy and momentum deposition in the upper atmosphere.

Bioastronautics

The IIAS Professional Certificate in Bioastronautics is a 16-credit program designed to offer a high-value certification for students interested in space life sciences, human performance, and spaceflight operations.

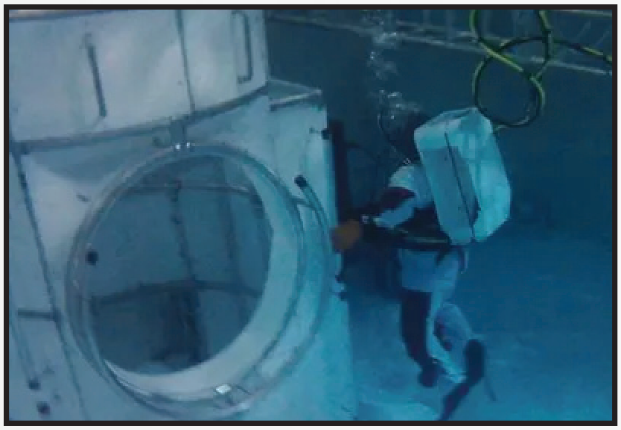
IIAS leads bioastronautic research pertaining to space suit and bio-monitoring technologies in partnership with Integrated Spaceflight Services, the National Research Council of Canada, NAUI, the Southern Aeromedical Institute, and Survival Systems USA. The validation process of these technologies involves analog evaluation in micro-gravity, high-altitude, high-G, and egress and post-landing operational scenarios. The IIAS Bioastronautics Program emphasizes space suit test and evaluation while providing a practical, hands-on, and immersive education geared to the student or professional interested in a career in bioastronautics.

IIAS offers two concentrations of study in bioastronautics: IVA Space Suit Test and Evaluation and EVA Space Suit Test and Evaluation. These concentrations are largely independent of each other and may be taken sequentially or concurrently. Design and evaluation skills are emphasized.

IVA Space Suit Evaluation

The IIAS Bioastronautics Certificate Program emphasizes IVA space suit test and evaluation while providing a practical, hands-on, and immersive education geared to the professional interested in a career in bioastronautics. A foundation of space physiology, life support systems, microgravity sciences, and space systems engeineering is provided.

Microgravity and high-G evaluations in parabolic flight assess CO2 washout, range-of-motion, and fine motor skills in high-fidelity environments. Contingency scenarios, lincluding post-landing egress, are also integral to IVA suit evaluations. IIAS's Neutral Buoyancy Laboratory and Gravity-Offset laboratory are used to simulate reduced gravity for EVA space suit evaluations and crew training.



EVA Space Suit Evaluation

The IIAS Professional Certificate in Bioastronautics with Extravehicular Activity (EVA) concentration provides a practical education for the professional interested in EVA space suit operations. The certification involves all aspects of the testing and evaluation of EVA space suits in analog terrestrial, microgravity, and underwater environments.

The IIAS Bioastronautics Program was developed in partnership with the National Research Council of Canada, NAUI, and Survival Systems USA.

The Professional Certificate in IVA Space Suit Evaluation

	Course	Credits
AST 101	Fundamentals of Astronautics	3
AST 102	Fundamentals of Microgravity Science	3
EDU 101	Citizen-Science Research Methods	3
OPS 102	Spacecraft Egress and Rescue Operations	2
BIO 101	Space Flight Physiology	3
BIO 103	Microgravity Space Suit Evaluation	1
BIO 104	Post-Landing Space Suit Evaluation	2

The Professional Certificate in EVA Space Suit Evaluation

	Course	Credits
AST 101	Fundamentals of Astronautics	3
EDU 101	Citizen-Science Research Methods	3
BIO 101	Spaceflight Physiology	3
EVA 101	Life Support Systems	2
OPS 104	Gravity-Offset EVA Space Suit Evaluation	3
select one of:		
EVA 102	Introduction to Space Medicine	3
EVA 103	Planetary Field Geology and EVA Tool Development	3

Microgravity Research

Microgravity sciences are integral to the IIAS professional certificate in Space Flight Operations.

Microgravity Payload Development and Integration Courses

AST 102 (Fundamentals of Microgravity Science) provides students with a practical foundation about experiments suitable for testing in flight as well as the processes researchers must follow in order to perform their experiments aboard reduced gravity aircraft or spacecraft. The course covers the payload operation, integration, testing and certification process, the Test Equipment Data Package , the Interface Control Documentation, and the Internal Review Board and ethics review that must be done for experiments involving humans.

In June 2021, IIAS enabled a contract to fly IIAS researcher Kellie Gerardi to space on a dedicated research mission with Virgin Galactic. The contract marks the world's first industry-sponsored, human-tended research spaceflight on a commercial vehicle. The IIAS experiments to be flown include the Astroskin Bio-Monitor wearable sensors system as well as a free-floating fluid configuration experiment.

Many payloads involving human test subjects require mission-specific training to ensure flight safety. For space suit evaluation, a trained team of six monitors every aspect of the test subject's state-of-health, as well as critical support

The Professional Certificate in Space Flight Operations

	Course	Credits
AST 101	Fundamentals of Astronautics	2
AST 102	Fundamentals of Microgravity Science	3
EDU 101	Citizen-Science Research Methods	3
OPS 101	System Engineering for Human Space Missions	3
OPS 102	Spacecraft Egress and Rescue Operations	2
OPS 104	Orbital Mechanics and Mission Simulation	3

Microgravity Flight Services

If you just need a flight, we streamline the payload integration and certification process to get your experiment ready for flight on the Falcon 20. Start by completing our online Payload Reference Document (PRD); our experienced PhD-level engineers have microgravity experience and will help you prepare your experiment for its Initial Compliance Check (ICC) prior to the flight qualification, test, and integration process.

IIAS Provides:

• Online Payload Reference Document (PRD) submission

• FAA certification of payloads

• PhD-level assistance in payload certification and integration

• Internal Review Board (IRB) and aerospace medical services (as needed)

• Microgravity flight operations and documentation

Falcon 20 Reduced Gravity Capabilities

• Cabin volume 14.2 m3 (5.0 m x 1.5 m x 1.5 m)

• Flights support up to five researchers

• Each flight supports up to 32 parabolas

• Each parabola has at least 15 seconds of <0.02 g

• G-levels may be customized; experiment may be adjusted on request.

• Aircraft performance data is recorded at 32 Hz

- Aircraft position: altitude, pitch, yaw

- Aircraft movement: airspeed, accelerations

- Cabin environment: temperature, pressure

• 16 channels available to record payload data synchronous with the aircraft data

Many technologies need to demonstrate readiness through analog environments, such as parabolic flight, before they can be committed to space flight. In a typical IIAS campaign, up to twenty experiments may be conducted through the course of one week.

2018 PoSSUM Microgravity Space Suit Evaluation Campaign

Canada
NRC·CNRC

Integrated Spaceflight Services

IIAS contracts Integrated Spaceflight Services LLC for all reserach integration using the Falcon 20 aircraft operated by the National Reserach Council of Canada.

Flight Test Engineering

The IIAS Professional Certificate in Flight Test Engineering is a 13-credit program designed to offer a high-value certification for students interested in the profession of a test pilot or a flight test engineer. Assembled in collaboration with the National Research Council of Canada's Flight Research Laboratory, the IIAS Flight Test Engineering program combines expert instruction with several diverse yet economical aircraft that have been modified to provide the student real-time data of flying qualities including data from an Attitude and Heading Reference System (AHRS), pitot-static information, G-loading, and ambient atmosphere information, engine qualities including RPM, Manifold pressure, and cylinder pressures and temperatures. Aircraft are further configured for demonstrations of control surface deflection, control force, flow visualization leading to and into stall, and spin recovery qualities.

IIAS maintains four aircraft in support of the Flight Test Engineering program: A Turbo Mooney M20K and a Twin-Engine Cessna 310 for performance and stability and control testing, an Extra 300L for stall and spin test demonstrations, and a Marchetti S-211 for demonstrating high-performance procedures in a turbine-engine, swept wing aircraft.

Developed in partnership with the National Reserach Council of Canada.

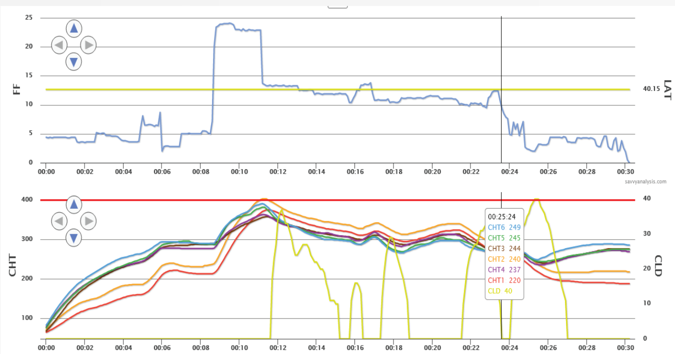
The combination of science, engineering, and operations mixed with the disciplined culture of flight test make this a valuable curriculum for any operational professional.

The Professional Certificate in Flight Test Engineering

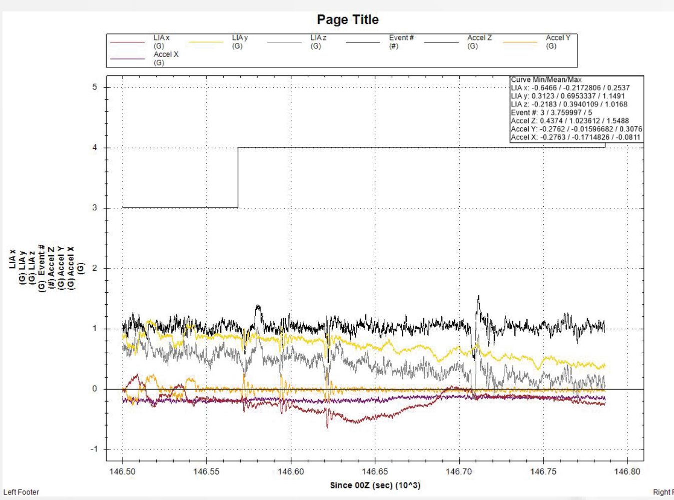
	Course	Credits
FTE 101	Fundamentals of Flight Test Engineering	3
FTE 102	Fixed-Wing Performance Flight Testing	2
FTE 103	Fixed-Wing Stability and Control Flight Testing	2
FTE 104	Aircraft Design	3
AST 102	Fundamentals of Microgravity Science	3

Evaluating Performance in Fixed-Wing Aircraft

IIAS provides comprehensive courses on flight test engineering methods using a variety of aircraft to educate the student on methods and techniques of evaluating the performance characteristics of fixed-wing aircraft. Tests include pitot-static testing, level and turning flight performance, takeoff and landing theory and test methods, climb performance, range and endurance evaluation, and excess power flight testing High performance jet testing is also available using Marchetti S211 jet aircraft.



Real-time engine temperatures and fuel flow data



Attitude and Heading Reference system data through multiple, independent sources.

Evaluating Stability and Control in Fixed-Wing Aircraft

IIAS also provides instruction on methods and techniques of evaluating the stability and control characteristics of fixed-wing aircraft which includes characterization of long-period and short-period oscillations in pitch and roll/yaw along with the characterization of the associated stability. Tests include static and dynamic longitudinal stability, lateral-directional stability and control, lateral control and roll performance, directional control, stall and spin characteristics. Twin-engine aircraft are used to determine the minimum-controllable airspeed in engine-out scenarios.

IIAS FTE 102 and FTE 103 Flight test students evaluate a variety of aircraft in small teams.

AER 101: Suborbital Space Environment

Overview:

AER 101 provides an understanding of the general properties and characteristics of the geospace environment and the underlying physical mechanisms. The student will understand the fundamentals of aeronomy, study of the atomospheric environment of the mesosphere and lower thermosphere (MLT) region of the atmosphere. Special emphasis is given to the to environmental hazards most relevant to the operations of manned spacecraft, including particles and radiation, impact phenomena, spacecraft charging, aerodynamic drag, and oxygen corrosion of surfaces.

The course provides an overview of the atmospheric and space environment experienced by suborbital spacecraft. It builds an understanding of the Earth's atmosphere from the troposphere over the stratosphere and mesosphere to the thermosphere and the near-Earth space environment. The course will introduce the relevant aspects of each environment with a focus on dynamics, chemistry, radiation environment and energetic particle environment. It will outline commonalities as well as differences between these environments and discuss effects on spacecraft where applicable. The course will also introduce measurement techniques for key quantities in the various environments. The course will close with an outlook on space weather and an overview of the atmospheric environment of Mars. While the course is part of the aeronomy concentration in IIAS, concepts introduced in the course will also be applicable to space flight operations and flight test engineering concentrations.

Course Objectives:

The course will provide the student with fundamental knowledge about the Earth's atmosphere from the troposphere to the near-Earth space environment. The student with be able to apply basic concepts that describe these environments. The course will introduce the student to simple models of Earth's atmosphere and allow him or her to apply them to questions concerning the atmospheric environment. It will introduce the student to relevant measurement techniques of atmospheric environments and outline how suborbital measurements contribute to the characterization of these environments. Students will be able to apply this knowledge of environmental effects on spacecraft and measurement design.

Online Instruction: 12 weeks

Instructor: Dr. Armin Kleinboehl

Credits: 3

AER 103: Remote Sensing of Noctilucent Clouds

Overview:

In partnership with the University of Alaska in Fairbanks, AER 103 provides a foundation in the remote sensing of the mesosphere through the imagery and remote sensing of noctilucent cloud structures. Observations are made through airborne and/or balloon-borne observations, synchronized with ground or satellite observations. AER 103 also introduces students to the principles and operations of atmospheric LIDAR and Incoherent Scatter Radar (ISR) techniques for mesospheric observations culminating in hands-on operations of facilities at Poker Flat Observatory near Fairbanks, AK.

Balloon Project: As part of the course, AER 103 students will participate in the design and development of a gyro-stabilized scientific balloon to be launched during the on-site campaign.

Prerequisite: AST 101

Online Preparation and Balloon Development

Week 1: Noctilucent cloud science and monitoring, Introduction to scientific ballooning, Facilitated balloon design project.

Week 2: Principles of astrophotography, Gear for astrophotography.

Week 3: Photogrammetry, camera settings and techniques designed for noctilucent cloud photography, scientific aurora imagery techniques, filming and timelapse photography

Week 4: Principles of LiDAR for atmospheric observation

Week 5: Principles of LiDAR for atmospheric observation (continued)

Week 6: Techniques of LiDAR observation

Week 7: Techniques of LiDAR observation (continued)

Week 8: Introduction to techniques of observation using Incoherent Scatter Radar

Week 9: Scientific Baloon Design: Code development

Week 10 Scientific Baloon Design: Circuit descriptions

Week 11: Scientific Baloon Design: Hardware, gondola design, thermal.

Week 12: Scientific Baloon Design: Critical Design Review, Hang Test, Tracking, Weather, Consumable Handling, Launch and Recovery Operations

ON-SITE 7-day Noctilucent Cloud Campaign at Fairbanks, Alaska. All lodging and local transport provided.

Online Instruction: 12 weeks

In-Person Campaign: 7 days in Fairbanks, Alaska.

Instructors: Adrien Mauduit, Dr. Vishnu Kumar, Ken Ernandes.

Credits: 3

AST 101: Fundamentals of Astronautics

Overview:

AST 101 'Fundamentals of Astronautics' introduces the student to scientific human spaceflight as a systemic problem. Specifically, AST 101 introduces the student to the design and training aspects integral to noctilucent cloud tomography on suborbital commercial space vehicles while providing the principles of aeronomy with a general understanding of the mesosphere, noctilucent cloud dynamics, observational methods and history, noctilucent cloud structures, aerospace physiology, and life support systems relevant to suborbital flight.

AST 101 includes a fully-immersive program that provides the skills required to effectively conduct research on the next generation of commercial space vehicle and serves as a prerequisite to many other courses offered through IIAS.

Course Objectives:

AST 101 covers a wide variety of topics that cntribute to the noctilucent cloud tomography mission, including the Mesosphere and Lower Thermosphere (MLT) Environment, Fundamentals of remote sensing, remote sensing and aerospace cinematography, spaceflight simulation and operations, Crew Resource Management (CRM) techniques, hypoxia awareness and mitigation, space suit operations (including donning, doffing, pressure regulation, and contingency operations), High-G analog and mitigation methods, microgravity and changing-G physiology, Introduction to aerospace physiology and life support systems, celestial navigation, and atmospheric scattering.

Individualized Training Elements:

1. Introduction to suborbital space flight simulation, Crew Resource Management techniques, and mission planning.

2. High-G and microgravity Space Physiology indoctrination flight using an Extra 300L aerobatic aircraft with AGSM and anti-G garment training.

3. High Altitude training in an altitude chamber using simulation for slow-onset hypoxia scenarios.

4. Initial Spacesuit Training (don, doff, regulating pressure, basic mobility, fine motor skills, flight system control, hazardous environments, contingency operations)

5. Airborne scientific imagery training flight using instrumented aircraft (Scientist-Astronaut group only)

6. Individualized instruction on PoSSUMCam and scientific video camera systems

Online Instruction: 3 weeks

In-Person Campaign: 5 days at Florida Tech

Instructors: Dr. Jason Reimuller, Dr. Erik Seedhouse

Credits: 2

AST 102: Fundamentals of Microgravity Science

Overview:

AST 102 provides a foundation in the micro-gravity environment, including micro-gravity research campaign planning and operations.

Course Objectives:

Reduced gravity aircraft provide up to 25 seconds of the near freefall (microgravity) environment. Space agencies and commercial space companies rely on parabolic flight campaigns to perform microgravity experiments and to advance the Technology Readiness Level (TRL) of payloads before launching them into space. IIAS is advancing the TRL of its payloads in flight campaigns provided by the National Research Council of Canada in a modified Falcon-20 aircraft.

In this course, students will learn about Space Physical and Life Sciences experiments suitable for testing in parabolic flights. They will also learn the processes researchers must follow in order to perform their experiments aboard reduced gravity aircraft. A critical element leading up to the flight date is specifying the procedures for the payload operation, integration, testing and certification in a document called the Test Equipment Data Package (TEDP). The course will also describe the Interface Control Documentation that researchers must consult to ensure that their payloads will properly integrate into an aircraft's mechanical and electrical systems. Students will also learn about the Internal Review Board and ethics review that must be done for experiments involving humans and other living organisms.

Outline:

Week 1: microgravity platforms, trade-offs and fine-tuning a parabola, Technology Readiness Levels (TRLs), logistics of planning a flight campaign and the certification process, Test Equipment Data Package (TEDP) requirements document.

Week 2: TEDPs and the payload integration and certification process, Description of the Interface Control Document (ICD), campaign objectives.

Weeks 3-4: TEDP format, Flight plan and flight procedures, Ground support requirements, Cabin requirements, Prior IIAS flight campaigns, Internal Review Board (IRB) / Research Ethics Board (REB) process.

Week 5: Hazard analysis and mitigation, Structural and electrical load analysis, payload transport logistics.

Week 6: Lunar and Martian gravity, G-jitter effects, Description of prior flight campaigns,.

Weeks 7 & 8: Student presentations of their experimental ideas and TEDP including schematics, photos, or videos of their proposed payload.

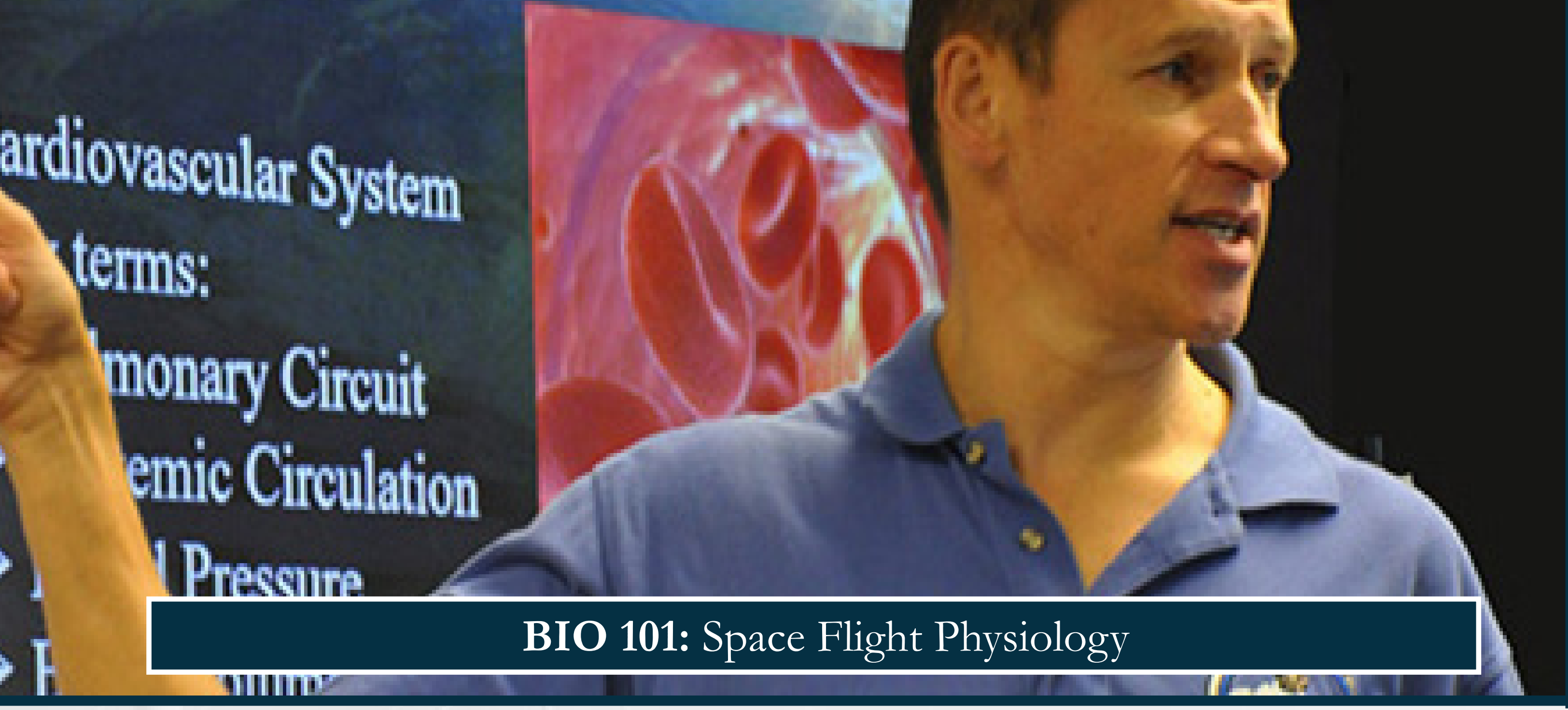
Week 9: Briefings, Logistics Review, Flight Roster, List of experiments and research objectives, Ground and Flight crew roles assigned

Online Instruction: 10 weeks

In-Person Campaign: 4 days in Ottawa, Ontario

Instructors: Dr. Aaron Persad

Credits: 3



BIO 101: Space Flight Physiology

Overview:

BIO 101 covers the unique aspects of health maintenance of individuals exposed to the rigors of spaceflight. An overview of the physiological changes resulting from prolonged exposures to weightlessness and the establishment of countermeasures are presented in this course as with an understanding of the methods currently in use to mitigate these changes.

The course provides an overview of the physiological changes and adaptations that occur during each phase of spaceflight: ascent, early orbit, long-term flight, extra vehicular activities, and reentry. It also describes the counter measures in current use. Data from previous and current U.S. and Russian programs are discussed, in addition to current commercial spaceflight ventures. The physiological/life support requirements for spacecraft design are considered, as well as the techniques and potential impacts of crew selection, training, in-flight medical care, and contingencies. Aspects of human participation during exploration class missions/colonization are reviewed. A medical/life sciences background is not required.

Course Objectives:

Provide each student with the basis of knowledge and complement of skills necessary for awareness and application of human spaceflight physiology to the exploration of space. To further the understanding between space physiology and all the other fields of endeavor within space systems.

Week 1: Course Overview Handout Historical Perspectives from John Paul Stapp to present day.

Week 2: Environmental Control / Life Support System: subsystems Extra Vehicular Activities. Prebreathe and decompression sickness Toxic Hazards. Trace contaminants, VOCs and the SMAC list.

Week 3: Human Capabilities in Space, Human systems adaptation: Cardiovascular and Fluid and Electrolyte Assignment: Describe the mechanisms

Week 4: Human Capabilities in Space, Human systems adaptation: Skeletal

Week 5: Human Capabilities in Space, Human systems adaptation.

Week 6: Human Capabilities in Space, Human systems adaptation: Muscular

Week 7: Human Capabilities in Space, Human systems adaptation: Radiation Assignment: Describe the short and long term effects to high doses of ionizing radiation andexplain how astronauts may be protected by GCRs in deep space.

Week 8: Psychological Considerations, Astronaut select-in and select-out medical criteria.

Week 9: Operational Space Medicine Emergency Rescue Support Space Life Sciences Research.

Week 10: Exploration Class Missions and Human Adaptation. Pantropy. Genetic selection and genetic manipulation.

Online Instruction: 8 weeks

Instructors: Dr. Erik Seedhouse

Credits: 3

BIO 103: Microgravity Space Suit Evaluation

Overview:

BIO 103 provides a foundation in the microgravity environment, microgravity research campaign planning and operations, human factors and spacesuit evaluation research, biomedical monitoring systems, science communication and public outreach. Students will evaluate prototype seat concepts, suit/seat interface, the umbilical interface, and ingress and egress procedures.

Reduced gravity aircraft provide up to 25 seconds of the near freefall (microgravity) environment. Space agencies and commercial space companies rely on parabolic flight campaigns to perform microgravity experiments and to advance the Technology Readiness Level (TRL) of payloads before launching them into space. IIAS is advancing the TRL of its payloads in flight campaigns provided by the National Research Council of Canada in a modified Falcon-20 aircraft.

In this course, students will learn about space suits and related technology experiments suitable for testing in parabolic flights. They will also learn the processes researchers must follow in order to perform their experiments aboard reduced gravity aircraft. Students will also learn about the Internal Review Board and ethics review that must be done for experiments involving humans and other living organisms.

Prerequisites: AST 101, AST 102

Course Objectives:

The course will consist of three one-hour webinars.
Outline:

Week 1
- Description of the Interface Control Document (ICD)
- Discussion of the format of the TEDP (Part A):
- Experiment overview (target audience)
- Identifying campaign objectives
- Experiment description

Week 2
Discussion of the format of the TEDP (Part B):
- Flight plan and flight procedures (Part II)
- Ground support requirements
- Cabin requirements
- Prior IIAS flight campaigns (Part a)
- Space suit evaluations (FFD)
- Biomonitoring (FFD, NRC, CSA)
- Internal Review Board (IRB) / Research Ethics Board (REB) review process

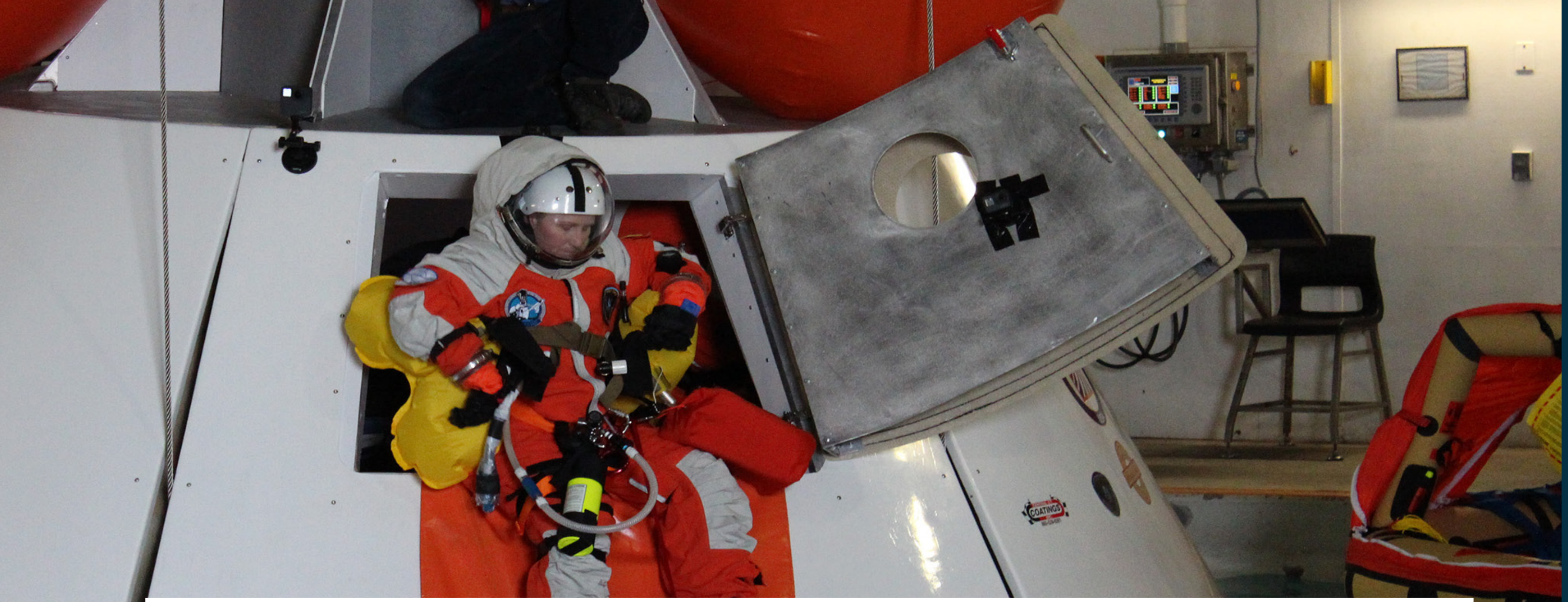
Week 3
Briefing with details related to the NRC Flight Campaign
- Logistics Review
- Flight Roster
- List of experiments and research objectives
- Ground and Flight crew roles assigned

Online Instruction: 3 weeks

In-Person Campaign: 4 days in Ottawa, Ontario

Instructors: Dr. Aaron Persad

Credits: 1



BIO 104: Post-Landing Space Suit Evaluation

Objective:

BIO 104 provides instruction on spacesuit use in nominal and off-nominal post-landing environments. Students demonstrate reliable functionality of parachute release, life preserver unit (LPU), and snorkel functionality in varying sea and lighting conditions. Students also learn the effective use of radios, beacons, signal flares, and other signaling devices in water and egress bottle use for egress operations.

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Prerequisite: AST 101, OPS 102

Learning Objectives:

1. Demonstrate stable flotation for various size test subjects
2. Demonstrate reliable functionality of parachute release in varying sea conditions
3. Demonstrate reliable functionality of snorkel system in varying sea conditions
4. Demonstrate raft ingress in varying sea conditions
5. Qualitative assessments of suit functionality and comfort with LPU
6. Demonstrate effective use of radios, beacons, signal flares, and other signaling devices in water
7. Demonstrate effective use of egress bottle for egress operations

Curriculum:

Classroom instruction: Suit (Pressure suit system description, Analog suit differences), Parachute components, Ejection (sequence, components), Post-ejection, Post-departure through crew/seat separation, Descent (Post seat separation through canopy open and canopy descent, Proper position, CVSPSR, Landing), Survival/signaling, Survival gear descriptions and use, Signaling ops, Water Operations (Psychological, Practical), Rescue Operations, Safety

Capsule Egress Operations: Unsuited Capsule Egress (Side Hatch, Top Hatch, Life raft ops/ingress, Raft ops/signaling), Suited Capsule Egress (Side Hatch, Top Hatch, Life raft ops/ingress, Raft ops/signaling)

Suited Parachute lift and drop: dry (Lift, Position, Canopy check, Visor, Seat kit, Prepare, Release), Suited Parachute lift – wet ((Lift, Position, Canopy check, Visor, Seat kit, Prepare, Drop, Release

Canopy extraction, Hoist ops (Horse collar, Forrest Penetrator, Mail hook)

Online Instruction: none

In-Person Campaign: 4 days in Groton, CT.

Instructors: Ken Trujillo

Credits: 1

EDU 101: Citizen-Science Research Methods

Overview:

EDU 101 provides a foundation on which to participate in or conduct their own research, complimentary to the research and education activities of IIAS.

This course provides an overview of current citizen science research and a foundation for conducting their own research. Current citizen science research gaps in bioastronautics, extra-vehicular activity (EVA), and aeronomy, and possible ways to address these gaps are discussed. Guest instructors, including course alumni, and subject matter experts within the space community, will present their citizen science work as examples.

Course Objectives:

Upon completing this course, graduates will be able to:

1. Describe existing citizen science work supported by space agencies
2. Design and propose citizen science research projects
3. Demonstrate the requirements for human subject research
4. Communicate the current gaps in knowledge within bioastronautics, EVA, spacecraft technologies, and aeronomy research
5. Demonstrate the ability to conduct a literature review of foundational research in support of a chosen project
6. Develop and present their own citizen science research project proposal with literature review, objectives, procedures, budget, potential funding opportunities, and data collection and analysis strategy

Schedule:

Week 1: Introduction to Citizen Science Research

Week 2: Introduction to Literature Reviews & Research Funding

Week 3: Introduction to Human Subjects Research

Week 4: Citizen Science in Bioastronautics

Week 5: Citizen Science in EVA and Analog Missions

Week 6: Citizen Science in Aeronomy: Cloudspotting on Mars

Week 7: Citizen Science at NASA

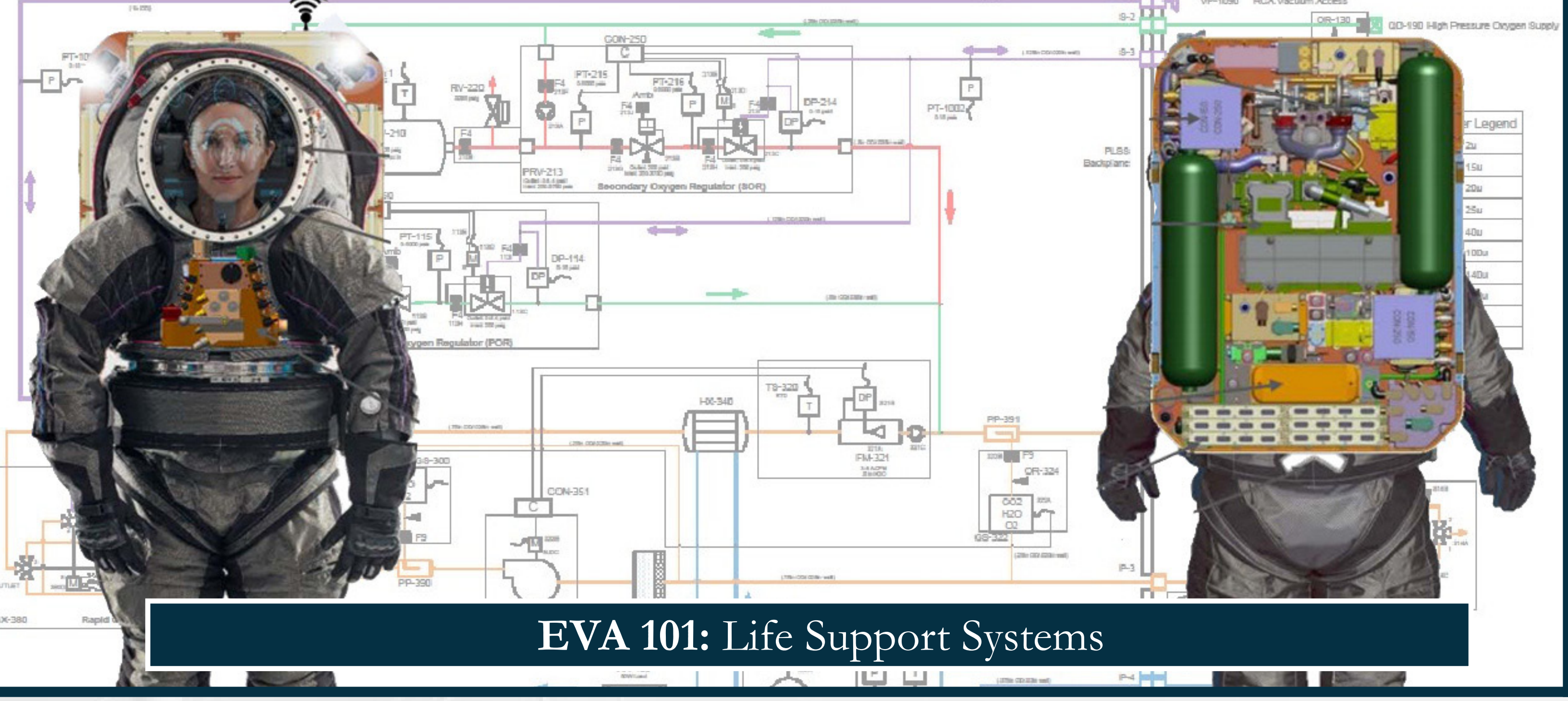
Week 8: Proposal Consultation Time

Week 9: Proposal Presentations

Online Instruction: 9 weeks

Instructors: Scott Ritter, Dr. Narcrisha Norman

Credits: 3



EVA 101: Life Support Systems

Overview:

EVA 101 will familiarize the student with the essential features of life support systems required for various types of space missions and will cover the requirements and design considerations for life support systems in space. Included are an introduction to basic human physiology, a description of the space environment, a survey of historical life support systems, and a presentation of spacecraft limitations and requirements and EVA space suit operations.

Course Objectives:

Upon completion of the course the students will be able to:

1. Describe those attributes of human physiology requiring protection during in space flight with specific reference to the cardiovascular, fluid and skeletal systems.
2. Describe the impact of the psychological effects of long duration space flight.
3. Describe the evolution of life support systems from Mercury to the International Space Station.
4. Identify each of the 6 sub-systems of the ISS life support system and describe what each does with reference to specific sub systems within each sub system.
5. Discuss the role of air and water reuse in long duration space operations with particular reference to the concept of a closed life support system.
6. Describe the space environment, and describe protection techniques for humans against solar flares, galactic cosmic rays and microgravity.
7. Review and list the limitations placed on logistical support and life support requirements on the major NASA space projects (Moon, DSG and Mars missions).
8. Briefly discuss future life support requirements for missions beyond Earth orbit, including extended stays on the lunar surface and manned missions to Mars. Explain the rationale for human phenotyping, genetic manipulation and human hibernation in the context of long duration missions.

Curriculum:

Week 1. Life support introduction.

Week 2. The space environment

Week 3. Life support system basics

Week 4. Physico-chemical life support systems Part I

Week 5. Physico-chemical life support systems Part II

Week 6. Bioregenerative life support systems

Week 7. ISS and spacecraft life support systems

Week 8. Future life support system

Online Instruction: 8 weeks

Instructors: Dr. Erik Seedhouse

Credits: 3

EVA 102: Introduction to Space Medicine

Overview:

EVA 102 participants will learn about space medicine, wilderness medicine, human performance, leadership and psychological resilience. The course will dedicate a special focus to extreme environment & wilderness medicine, and how the spaceflight environments may inform triage and first aid scenarios. The on-site portion of this class will focus on wilderness medicine in extreme environments, culminating with a 4.5 on-site lab portion devoted to triage, scenarios and skills pertaining to wilderness medicine. Basic and Advanced First Aid certifications are prerequisites to EVA 102.

Course Objectives:

It is anticipated that at the end of this course, participants will have gained 1) basic knowledge and understanding of space medicine and physiology, specifically the space environment as it pertains to human health pre-, post- and in-flight, 2) an appreciation of extreme environments and how they inform space exploration, and 3) a basic understanding of, and be able to demonstrate basic competency in skills related to wilderness medicine and outdoor survival.

Course Breakdown & Schedule: Online Seminars (12 hours) = 6 x 2 hours – Each 2 hour webinar will consist of a didactic component, self-study & pre-reading as preparation, discussion and a post-webinar evaluation.

Course Composition: Coursework, self-study, didactic lectures, office hours. Web portal with presentations, videos will host course material that students can access.

Week 1: Introduction to the Spaceflight Environment & Human Health Issues in Spaceflight

Week 2: Principles of Survival & Wilderness Medicine

Week 3: Overview of Classroom Component

Week 4: Introduction to the Space Medicine Challenges and Concepts.

Week 5: Introduction to Space Medicine specifications and developments: Commercial Spaceflight-Class, Exploration-Class, Settlement-Class.

Week 6: Introduction to Operational Space Medecine and Spaceflight Healthcare System.

Campaign Schedule:

Day 1-3: Classroom component – Arrival and check-in, principles of team-building and wilderness medicine trip +/- building shelter based on group experience, round robin events along triage, drills & survival scenarios.

Day 4: Individual & team skills assessments, group and individual debrief, individual evaluations, course evaluations, pack-up

ALL LODGING AND LOCAL TRANSPORTATION (FROM PHOENIX) PROVIDED

Online Instruction: 6 weeks

In-Person Campaign: 4 days near Flagstaff, AZ.

Instructors: Dr. Shawna Pandya

Credits: 3

EVA 103: Planetary Field Geology and EVA Tool Development

Overview:

EVA 103 covers the requirements and design considerations for EVA systems and tools for conducting planetary field geology. Included are an introduction to field science in the context of geology; an overview of the processes that shape the surface environments of Mars and Earth's moon; a survey of historical planetary surface geologic exploration by robots and humans; and a survey of historical EVA systems and tools used for human surface science. Emphasis will be on analyzing the constraints placed by human factors, the EVA environment, science tasks, etc. upon the design and implementation of EVA suits, tools, and procedures for effective and efficient field science operations on planetary surfaces.

Course Objectives:

1. Describe and demonstrate basic field geology skills, including quantitative and qualitative observations of geologic materials and structures.
2. Discuss and demonstrate the importance of maintaining geologic situational awareness and recording geologic context for conducting effective and efficient geologic field work.
3. Discuss and demonstrate the importance of traverse planning and the flexible execution of field plans while conducting geologic field work.
4. Describe the primary geologic processes responsible for shaping planetary surfaces such as that of Mars and the Moon.
5. Discuss some of the fundamental, high-priority open questions about Mars and the Moon that can be addressed using field geology.
6. Describe the physical environments of Mars and the Moon, particularly with regard to constraints, limitations, and opportunities for surface science EVAs.
7. Review past efforts for conducting field geology on Mars and the Moon during missions using robotic and human assets, particularly with regard to EVA suits, tools, and procedures used and how they affected the science return of those missions
8. Review past and current Earth analog field research and training campaigns, particularly with regard to EVA suit, tool, and procedure design for next-generation planetary geologic field work.
9. Analyze and discuss the considerations for the design, fabrication, deployment, and evaluation of a geologic tool to be used during a planetary surface EVA, to include science task requirements; environmental, ergonomic, safety and other limitations; mission constraints such as mass, power, time, etc.
10. Design, fabricate, test and evaluate a geologic tool to be used during a planetary surface EVA.
11. Discuss and demonstrate the practical considerations involved in planning and executing a field campaign at a planetary analog site.

ALL LODGING AND LOCAL TRANSPORTATION (FROM PHOENIX) PROVIDED

Online Instruction: 6 weeks

In-Person Campaign: 4 days near Flagstaff, AZ.

Instructors: Dr. Juse Hurtado, Dr. Ulyana Horodyskyj

Credits: 3

EVA 104: Gravity-Offset EVA Space Suit Evaluation

Overview:

EVA 104 provides an introduction to EVA space suit test and evaluation methods. Students learn fundamentals of EVA space suit operations and then use the tools and procedures developed in the OTTER EVA 102 or EVA 103 courses. IIAS's EVA space suit will be tested and validated in a gravity-offset laboratory environment that can simulate microgravity, lunar, or martian gravity environments.

EVA 104 extends upon the introductory life support system curriculum presented in EVA 101 to include specific EVA space suit systems and test and validation procedures. The course covers a historical analysis of specific US and Russian EVA space suit development programs, EVA space suit systems, laboratory test protocols, terminology and etiquette, EVA space suit test development, and design drivers of future EVA space suit systems.

Prerequisites: EVA 101 and (EVA 102 or EVA 103)

Course Objectives:

Week 1. EVA space suit introduction

Week 2. Historical analysis of Russian EVA Space Suits

Week 3. Historical analysis of US EVA Space Suits

Week 4. EVA Space Suit Systems: LCG system, chest control board, communications, and lighting.

Week 5. EVA Space Suit Systems: diagnostics and repair, biomonitoring systems, suit maintenance

Week 6: MCC Operations, etiquette and terminology, test roles and responsibilities

Week 7: EVA Testing Procedure Development, Airlocks and Airlock Procedures

Week 8: Future of EVA space suit development

Week 9: Briefings of EVA test procedures

In-Person EVA Space Suit Evaluation Campaign:

Day 1: EVA space suit donning, Assisting donning of EVA space suits. Chest control board operations, cooling, communication and lighting system operations. Introduction to gravity offset systems (Lunar, Martian, and microgravity operations).

Day 2-4: Surface EVA Evaluation, lunar and Martian gravity (scooper, drill, hammer, soil sampler, spectrometer, remote rover operations). Microgravity operations (drill and 'Task Board 3' panel removal and maintenance, hatch operations, camera mounting and operation, translation using handrails and carabiners). MCC operations, medical monitoring, and gravity offset system operations. Comparative evaluation of finger, hand, and upper body strength in unsuited, suited and unpressurized, and suited and pressurized environments.

Online Instruction: 10 weeks

In-Person Campaign: 4 days in Melbourne, FL.

Instructors: Ken Trujillo, Dr. Aaron Persad

Credits: 3

EVA 105: Underwater Analog EVA

Overview:

Neutral buoyancy in water is used by space agencies around the word for EVA training, spacesuit evaluation, development of human-robotic partnership protocols and many other simulations. EVA 105 will Introduce students to specificity of developing tools, protocols and experiments for underwater environment.Students will hear many case studies and will be responsible to develop on their own improved equipment and testing protocols based on tools and procedures. EVA 105 continues with the topic of underwater environment, but specializes in development of tools, techniques, equipment and scientific experiments for this extreme space analog. This course orients in engineering and protocol development.

Course Objectives:

Week 1. Introduction to underwater environment

Week 2. Achieving neutral buoyancy (scuba diving physics)

Week 3. Influence of water on materials

Week 4. Design for underwater: X-Deep case study

Week 5. Testing tools (performance, ergonomy)

Week 6. Case study: ESA's Nearby Equipment Support Trolley (NEST)

Week 7. Case study: EVA 105 quest airlock

Week 8. Scientific experiments in underwater environment

Week 9. Case study: Space Mobile Medical Module

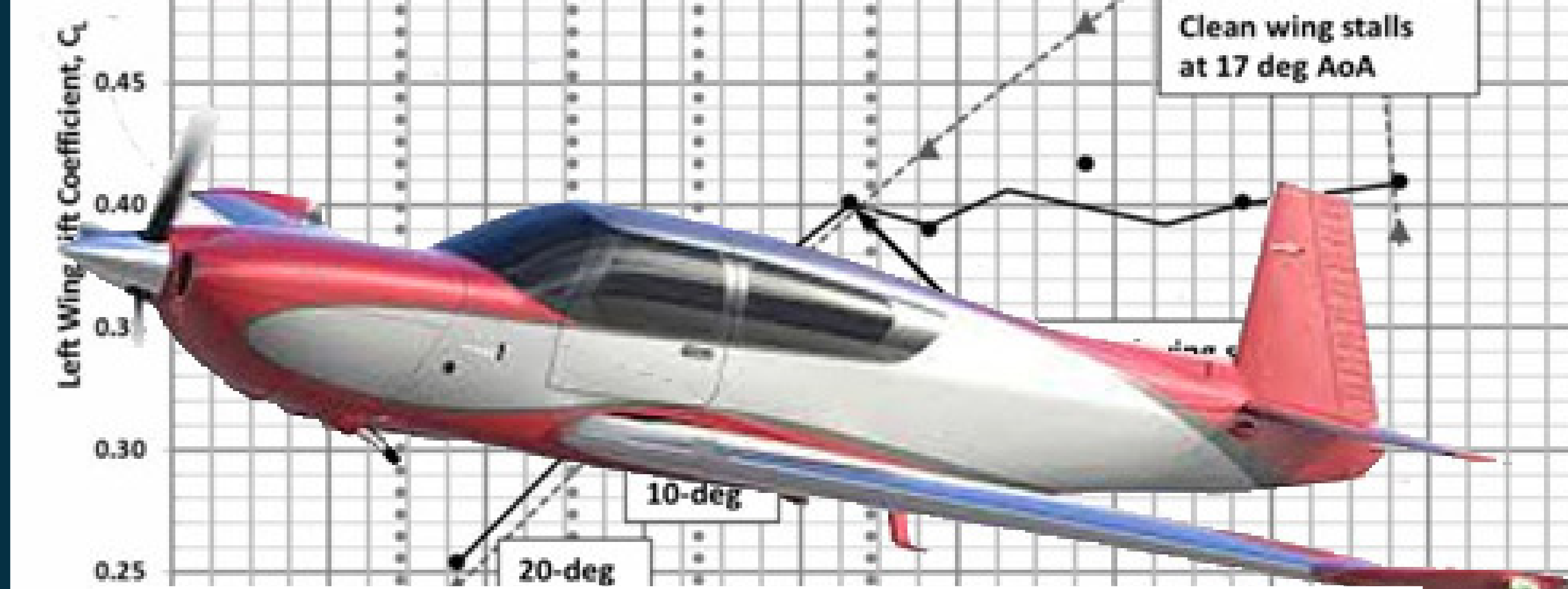
Week 10. Student projects

Online Instruction: 10 weeks

In-Person Campaign: 4 days in Groton, CT.

Instructor: Matt Haracymczuk

Credits: 3



FTE 101: Fundamentals of Flight Test Engineering

Overview:

Fundamentals of Flight Test Engineering is a classroom course which will provide basic introduction to aircraft flight test concepts, methods, and planning. Course focusses on concepts of aerodynamics, airplane performance, and stability and control. Practical exercises in aircraft performance, stability and control utilize single engine, multi-engine, and jet powered aircraft.

Course Objectives:

Flight Test Overview: Flight Test Engineer R&R, Test Team Organization, Safety, Airworthiness Requirements

Atmospherics: Standard Atmosphere, Pitot and Pitot-static Systems, Altimetry & Altitude, aerodynamics, Static Pressure, Temperature, Density, Viscosity, Pressure Altitude, Density Altitude

Aircraft Descriptions and Systems: Flight & Engine Instruments, Flight Controls, Configurations & Characteristics, Aircraft (Wings/Airfoils), Coordinate Systems, Aircraft Systems, Aircraft Weight & Loadings

Aerodynamics – Airspeeds: Errors & Calibration (V speeds), Pitot Statics, Operating Limits, Basic Lift Equation (Lift Coefficient, Dynamic Pressure & Surface Area, Stall), Drag Determination Load factors, V-n Diagram & Aircraft Flight Envelope, Propeller Theory, Two-dimensional Aerodynamics, Three-dimensional Aerodynamics, Determination of Engine Power

Aerodynamics – Flight Test: Aircraft Single-engine Performance (Level Flight Performance, Turning Performance), Takeoff and Landing Theory and Methods, Longitudinal Stability – Static and Dynamic, Lateral-Directional Aerodynamics, Level Flight

Performance – Propeller Driven and Jet Aircraft, Range and Endurance, Climb Performance, Lateral Control – Roll Performance, Directional Control, Flying Qualities, Stall Characteristics, Maneuvering Loads, High α, Control of Airspeed & Altitude & AoA, Aircraft Handling Qualities, Flutter

Flight Test Maneuvers - Airspeed Calibration, Symmetrical Maneuvers, Rolling Maneuvers, Yawing Maneuvers, Stall, High α, Longitudinal Stability/Trim, Roll Performance, Acceleration-Deceleration, Flutter, Level Turn Performance, Spin Recovery, Sawtooth Climb – Climb Performance, Power Required, Max Performance Climb, Man Performance Landing, Control Pulse – Dynamic Response, Doublet, POPU, Wind-up Turn, Steady Heading Sideslips

Test Planning and Operations - Test Plan Development, Test Card Development, Safety & Risk Management, Weather brief and minimums, Instrumentation / Data Processing (Telemetry and data recording, Sensors), Control Room Operations (Radio communications, Control room), Crew Resource Management, Terminology

Online Instruction: 12 weeks

Instructor: Ken Trujillo

Credits: 3

FTE 102: Fixed-Wing Flight Test Engineering - Performance

Overview:

The FTE 102 Fixed-Wing Performance course extends upon the concepts learned in FTE 101 and reviews the concepts and maneuvers for evaluating and determining the performance characteristics of fixed-wing aircraft. These concepts will be used to develop test cards and maneuvers for evaluating the performance of a Mooney M20K aircraft. Post test data analysis and final test report will be submitted by students.

Course Objectives:

Review

1. Takeoff Performance
2. Climb Performance
3. Level Flight Performance
4. Range and Endurance Performance
5. Turning Performance
6. Landing Performance

Test Methods and Maneuvers

1. Instrument Calibration by GPS Method
2. Stall Speed Determination and Visualization
3. Takeoff Performance
4. Climb Performance
5. Level Flight Performance
6. Range and Endurance
7. Turn Performance
8. Landing Performance

Flight Test Planning

1. Test Card Development
2. Instrumentation and Data Methods
3. Safety Review
4. Test Briefing

Performance Evaluation: Mooney M20K, Cessna 310

Online Instruction: none

In-Person Instruction: 6 days (location TBD)

Instructors: Ken Trujillo, Heidi Hammerstein, Dr. Jason Reimuller

Credits: 2

FTE 103: Fixed-Wing Flight Test Engineering - Stability and Control

Overview:

The FTE 103 Fixed Wing Stability and Control course extends upon the concepts learned in FTE 101 and reviews the concepts and maneuvers for evaluating and determining the stability and control characteristics of single- and multi-engine aircraft. These concepts will be used to develop test cards and maneuvers for evaluating the stability and control of a Mooney M20K and a Cessna 310 aircraft. Spin test demonstrations are performed in a Super Decathlon aircraft. Post test data analysis and final test report will be submitted by students.

Course Objectives:

Review
1. Static and Dynamic Longitudinal Stability,
2. Longitudinal Control and Trim
3. Static and Dynamic Lateral-Directional Stability
4. Rolling Performance
5. Directional Control
5. Spin Characteristics

Test Methods and Maneuvers
1. Control Pulses
2. Pushover and Pullup
3. Roll Reversal

Flight Test Planning
1. Test Card Development
2. Instrumentation and Data Methods
3. Safety Review
4. Test Briefing

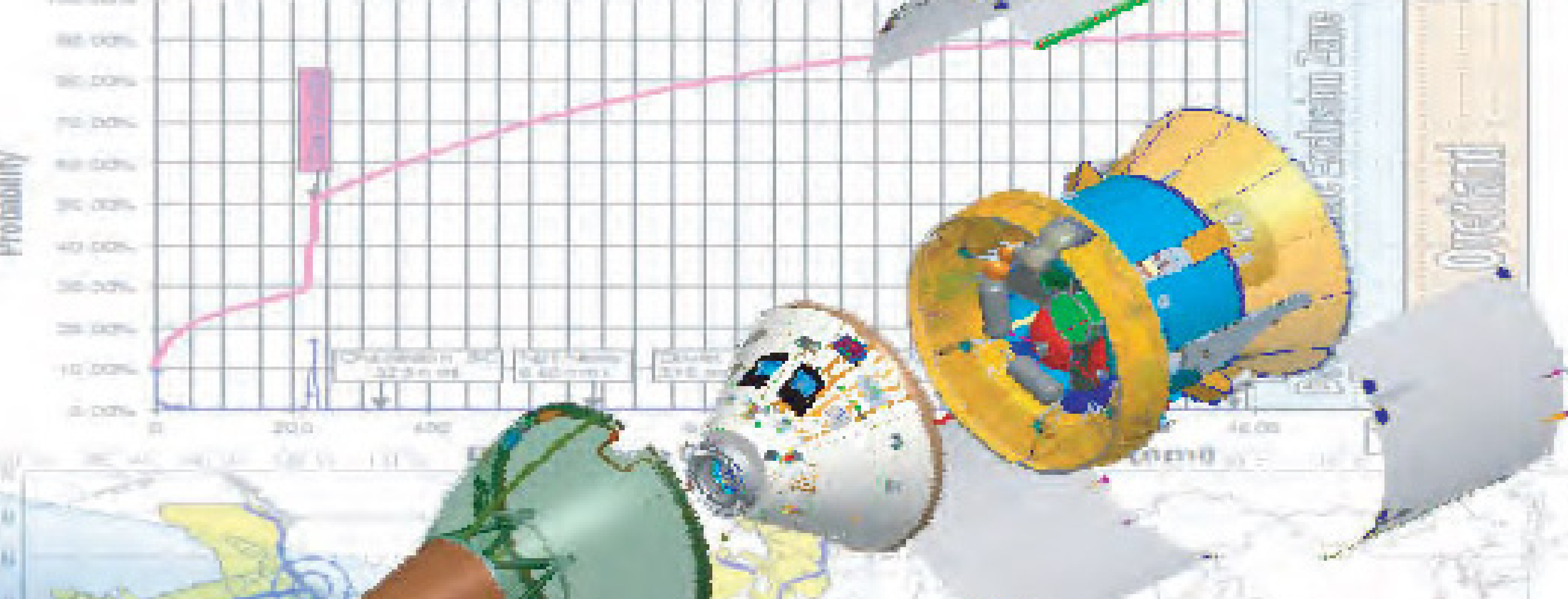
Evaluation of Stability and Control
1. Mooney M20K
2. Cessna 310 (minimum control speed, engine out)
3. Super Decathlon (spin characteristics testing)

Online Instruction: none

In-Person Instruction: 6 days (location TBD)

Instructors: Ken Trujillo, Heidi Hammerstein, Dr. Jason Reimuller

Credits: 2



OPS 101: System Engineering of Human Space Flight

Overview:

OPS 101 covers the roles and responsibilities of the Systems Engineer in supporting the concepts, planning, design, test, verification, operations, and disposal of aerospace systems. The course covers classical Systems Engineering processes with emphasis on spaceflight vehicles and will include assignments to introduce the students to the skills required for successful spacecraft design.

Course Objectives:

OPS 101 exposes the student to the role of the Systems Engineer in the spacecraft development process and to provide an introduction to Systems Engineering as applied to spacecraft and space systems development. Additionally, the course will provide the students an overview of Systems Engineering methods and tools and an understanding of why Systems Engineering is important to program success. Upon completion of this course the students will be able to:

1. Describe the role of the Systems Engineer in spacecraft development
2. Define the project lifecycle and describe the Systems Engineer's role in each phase
3. Understand and demonstrate the importance of good requirements development
4. Understand and demonstrate mission analysis, systems functional analysis, and hazard analysis.
5. Understand and demonstrate test and verification planning
6. Understand and demonstrate Master Planning and Scheduling.
7. Understand and demonstrate Technical and Risk management principles

Curricukum:

Week 1: Role of the Systems Engineer and the Systems Engineering Process

Week 2: Program Lifecycles - Products and Reviews

Week 3: Analyzing stakeholder needs and concept definition

Week 4: Technical Management: Master Schedules

Week 5 Risk Management

Week 6: System Integration: Requirements Development and Flowdown

Week 7: System Analysis and Design

Week 8: Design Downsize and Production

Week 9: Test and Verification

Week 10: Deployment, Operations and Disposal

Week 11: Risk Management

Week 12: Project presentations

Online Instruction: 12 weeks

Instructor: Ken Trujillo

Credits: 3

OPS 102: Spacecraft Egress and Rescue Operations

Overview:

OPS 102 covers the landing and post-landing phase of human spacecraft missions. this course covers nominal and contingency landing scenarios, post-landing planning, rescue and recovery architecture design, egress systems and operational procedures, deconditioning and post-landing survivability, generalized egress skills, and emergency egress bottle use.

Course Objectives:

Each program provides an immersive educational experience covering the following topics:

Spaceflight-Specific Topics of Study: Planning for Nominal and Contingency Landings, Nominal Rescue Operations, Contingency Rescue Operations for Land Landing Spacecraft, International Program-Specific Agreements, Global SAR Response Resources supporting Contingency Landings, Contingency Rescue Operations for Water Landing Spacecraft, Pad Egress Failure Environments, Pad Egress Design and Operations,Early De-orbit scenarios, Post-Landing Contingencies, Egress Systems, Egress Procedures and Operations, Assessing Probabilities and Effects of Injuries and Deconditioning, Assessing the Effects of Deconditioning on Egress Operations, Incapacitation through Entrapment, Egress and Post-Landing, Emergency Post-Landing Survival Kits, Medical Resources

Fundamental Egress and Post-Landing Survivability Skills: Safety and survival equipment utilization and deployment, Coping with physiological and psychological stress, Introduction of rescue devices and simulated rescues, Preparation for emergency landing situations in a spacecraft, Evacuation through an emergency exit from a spacecraft, Physics and physiology for use of compressed air; Preflight inspection, egress considerations, and clearing procedures using an EBD, Conducting an emergency egress on breath hold utilizing the Shallow Water Egress Trainer, Conducting an emergency egress with an EBD utilizing the Shallow Water Egress Trainer, Evacuation and escape training utilizing the Modular Egress Training Simulator (METS™) with and without utilizing an EBD.

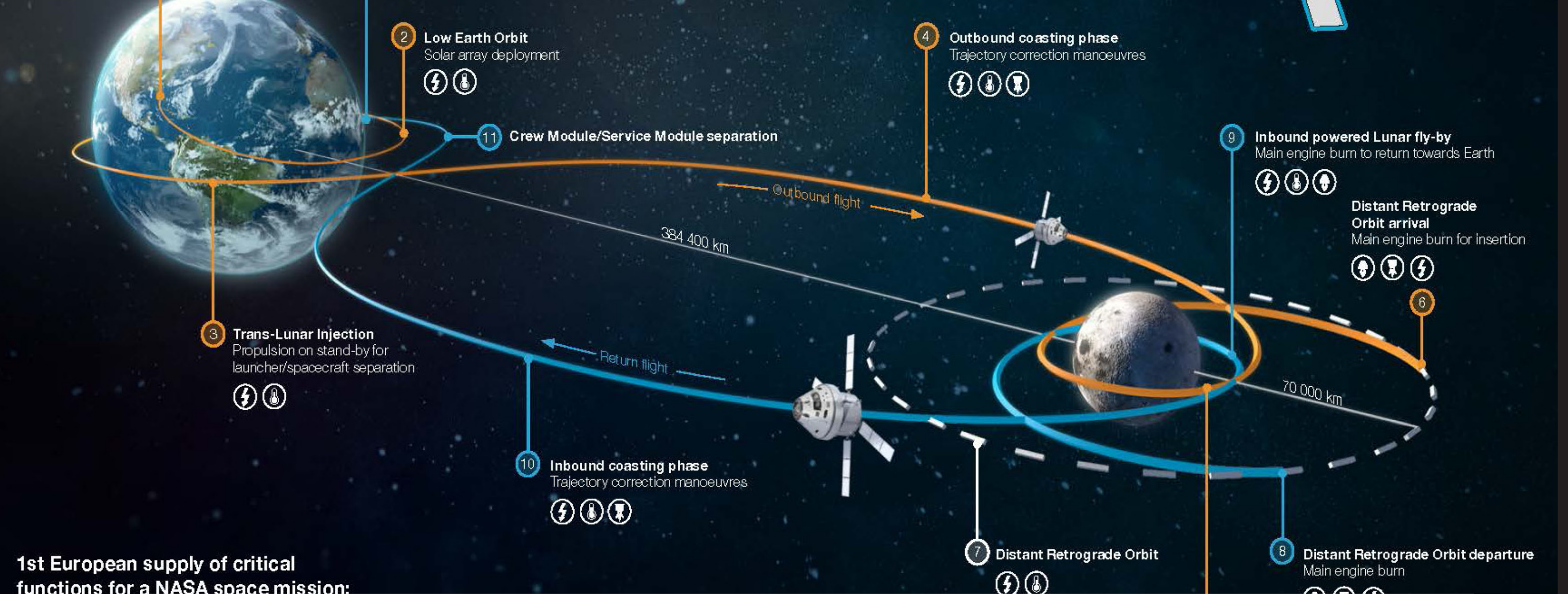
Sea Survival Skills: Safety and survival equipment utilization and deployment, Introduction to hypothermia mitigation and sea survival, Personal rescue techniques and use of life rafts and signaling devices, Characteristics of personal flotation devices and aviation jackets, • Life raft deployment/entry and simulated emergency scenarios, Introduction to individual and group sea surface formations, Introduction to search and rescue resources and equipment.

Online Instruction: 3 weeks

In-Person Instruction: 5 days

Instructor: Dr. Jason Reimuller

Credits: 3



OPS 104: Orbital Mechanics and Mission Simulation

Overview:

OPS 104 provides an overview of orbital and attitudinal dynamics. The intent is to provide a meaningful understanding of spacecraft flight dynamics with minimal mathematical emphasis. Thus, the student will gain sufficient knowledge that, when presented with mission profiles from a flight dynamics specialist, they will have a conceptual understanding of the flight profiles and the sequence of events needed to actualize the profile in a simulation environment.

Course Objectives:

OPS 104 provides a foundation in space flight mechanics, so as to understand why a spacecraft follows suborbital, orbital, and escape trajectories and the methods used to establish and control these trajectories. This knowledge will facilitate flight profile execution in the simulators. Upon completing this course, scientist candidates will be able to:

1. Explain the relationship of gravity and velocity in establishing suborbital, orbital, and escape trajectories.

2. Describe vehicle attitude representations and control methods.

3. Describe an orbit around a celestial body using classical Keplerian Elements.

4. Explain the use of velocity changes to change from an existing to a desired trajectory.

5. Demonstrate the use of simplified linearized approximations and their effective use in rendezvous and proximity operations in preparation for docking.

6. Describe profiles for establishing departure, rendezvous, encounters, entry, and landings between planets or other celestial bodies.

Curriculum:

Part 1 provides-an astrodynamics foundation that provides foundational knowledge of orbital mechanics and attitudinal dynamics to facilitate performance in simulator scenarios.

Part 2 will be a four day Orion spacecraft simulator-based course. Lectures will focus on the practical aspects of flight dynamics, helpful toward executing the simulator scenarios:

1. Launch to ISS orbital intercept/rendezvous using space suits.

2. ISS proximity operations and docking, flight suit environment

3. De-orbit and landing scenarios using space suits

Online Instruction: 12 weeks

Instructor: Ken Ernandes

Credits: 3

Microgravity Payload Development and Integration

Reduced gravity aircraft provide up to 25 seconds of the near freefall (microgravity) environment. Space agencies and commercial space companies rely on parabolic flight campaigns to perform microgravity experiments and to advance the Technology Readiness Level (TRL) of payloads before launching them into space. In this course, students will learn about Space Physical and Life Sciences experiments suitable for testing in parabolic flights. They will also learn the processes researchers must follow in order to perform their experiments aboard reduced gravity aircraft or spacecraft. A critical element leading up to the flight date is specifying the procedures for the payload operation, integration, testing and certification in a document called the Test Equipment Data Package (TEDP). The course will also describe the Interface Control Documentation that researchers must consult to ensure that their payloads will properly integrate into an aircraft's mechanical and electrical systems. Students will also learn about the Internal Review Board and ethics review that must be done for experiments involving humans.

Location: Ottawa, Ontario
Class Duration: 5 days (flexible schedule)
Class Size: 6-12 (minimum 6)
Price: $4500 (per student, flights priced separately)

IVA and EVA Space Suit Operations

This course covers a historical analysis of specific US and Russian EVA space suit development programs, EVA space suit systems, laboratory test protocols, terminology and etiquette, EVA space suit test development, and design drivers of future EVA space suit systems. Students then learn fundamentals of systems and operations of both IVA and EVA space suits in controlled simulated environments. To provide accurate training in an IVA space suit, the IIAS suborbital flight simulator is used. To provide accurate training in an EVA space suit, IIAS uses a custom two-axis gravity-offset system to simulate microgravity, lunar, or Martian gravity environments.

Location: Florida Tech, Melbourne, FL.
Class Duration: 5 days (flexible schedule)
Class Size: 6-12 (minimum 6)
Price: $9500 (per student)

Post-Landing System Engineering for Human Space Missions

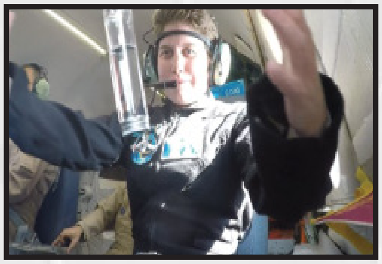
The first professional education course on the landing and post-landing phase of human spacecraft missions, this course covers nominal and contingency landing scenarios, post-landing planning, rescue and recovery architecture design, egress systems and operational procedures, de-conditioning and post-landing survivability, generalized egress skills, and emergency egress bottle use. Each program provides an immersive educational experience covering the following topics: 1) Planning for nominal and contingency landings, 2) Nominal and contingency rescue operations, 3) International program-specific agreements and global SAR response resources, 5) Pad and ascent abort egress environments and design considerations, 6) Early de-orbit scenarios, 7) Post-landing contingencies, 8) Egress procedures and operations, and 9) Probabilities and effects of injuries and deconditioning.

The immersive part of the course places the student in an IVA space suit under various post-landing contingency egress environments involving parachute-drop scenarios. The student will demonstrate 1) stable flotation, 2) reliable functionality of parachute release, 3) raft ingress, 4) suit functionality and comfort with Life Preserver Unit, 5) effective use of radios, beacons, signal flares, and other signaling devices in water, and 5) the effective use of egress bottle for egress operations.

Location: Groton, CT.
Class Duration: 5 days (flexible schedule)
Class Size: 6-12 (minimum 6)
Price: $7500 (per student)

Facilities

Offered through Integrated Spaceflight Services

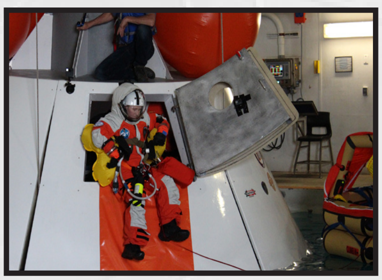


Reduced Gravity Laboratory (Various Locations)

ISS is the integrator of the National Research Council Falcon-20 reduced gravity aircraft. We have experience integrating a wide range of payloads, specializing in human research. Our pilots have 25 years of micro-gravity experience with demonstrated quality within 20 milli-g's with flights dedicated to your experiment.

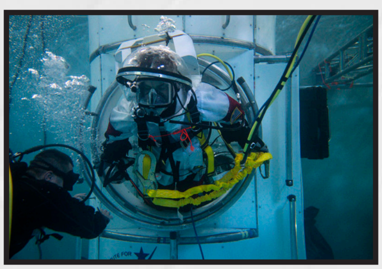
Gravity-Offset Laboratory (Melbourne, FL)

ISS's gravity-offset laboratory is able to produce zero-G to 1-G vertical offload. The two-axis system is actively controlled, combining a hoist with active force control for vertical gravity-offset and an active belt-drive system for horizontal motion. The system is designed to be used to with human test subjects to evaluate human performance and EVA space suit functionality in terrestrial environments of partial gravity (using a regolith bed) or in the simulation of zero gravity environments (using customized mock-ups) in a safe, analog environment. To date, a variety of geological and contingency medical tools have been evaluated in the laboratory, as well as several tools approximating those that would be useful on zero-G maintenance EVAs.



Post-Landing Human Factors Laboratory (Groton, CT)

ISS and Survival Systems USA have jointly developed a Post-Landing Egress Laboratory (PLEL) laboratory that provides analog landing and post-landing environments for the testing and evaluation of crewed space vehicle test 'boilerplates'. The PLEL consists of a 16′ pool, human-rated hoist, and a means to simulate a variety of environmental conditions. NASA Orion spacecraft mock-up shown.



Neutral Buoyancy Laboratory (Groton, CT)

ISS and Survival Systems USA have jointly developed a Neutral Buoyancy Laboratory (NBL) laboratory that provides analog environments for the testing and evaluation of space suit technologies in neutral buoyant environments. Consisting of a 16′ pool with a human-rated hoist, the facility may also be configured as an underwater NBL environment for EVA space suit testing. Quest Airlock mockup shown.

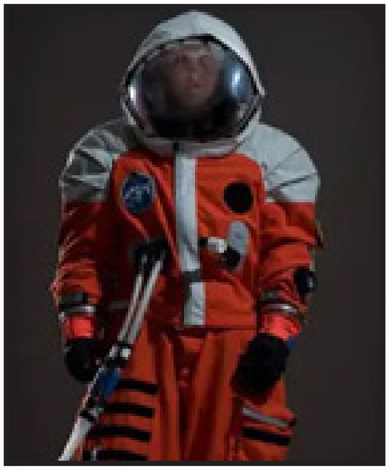
Hypobaric and Hyperbaric Altitude Chamber (Melbourne, FL)

ISS is well-renowned in high-altitude space suit systems testing and is experienced in the low-pressure testing of space suit technologies through human testing in hypobaric hypoxic environments. ISS also has expertise in training and evaluation of human operators of space suit technologies in slow-onset hypoxia environments.

Scientific Ballooning Laboratory (Melbourne, FL)

ISS maintains an instrumentation and remote sensing laboratory for use on scientific baloons. To date, this laboratory has produced the pressure-vessel camera systems recently flown on NASA's PMC-Turbo mission as well as a variety of gyro-stabilized airborne and balloon-borne camera and remote sensing instrumentation for mesospheric observation.

Space Suit Testing Laboratory (Melbourne, FL)



The ISS Space Suit Laboratory consists of motion camera technologies and simulation which may be used for cockpit design trade studies, range-of-motion studies, CO2 washout testing, and kinesthetic assessments. ISS owns:

1 EVA Space Suit Prototype with Liquid Cooling Garment and tethered Personal Life Support System (PLSS)

3 IVA Space Suits (5th Generation) with pressurization and intercooler systems.

2 IVA Space Suits (4th Generation) with post-landing gear (life preserver units, egress bottles, neck dams)

Research and Training Aircraft (Various Locations)

ISS has a variety of aircraft used for research and educational purposes. The following aircraft can be configured for a variety of missions including remote sensing, space suit test and evaluation, training and high-G indoctrination, and flight test engineering:

- Extra 300L: Extra 300L aircraft (N17NL) used for high-G human factors research, High-G indoctrination, and for performance and spin test flight demonstrations. The two-seat aircraft is certified to +/- 10G loads.
- Mooney M20K: Turbocharged Mooney M20K aircraft (N231TF) used for high-altitude remote sensing research, human factors research, and fixed-wing performance flight test demonstrations. The M20K is a 4-place, 165 KIAS, IFR-certified aircraft.
- Cessna 310: Twin-engine aircraft used for the training of airborne imagery techniques and for minimum-control-speed flight test demonstrations. The C-310 is a 4-place, 180 KIAS, IFR-certified aircraft.
- Marchetti S-211: ISS contracts a Marchetti S211 for high-performance flight testing demonstrations and high-G human factors research. The 2-seat aircraft can access speeds of 414 KIAS.

IIAS Orbital Space Flight Simulator (Melbourne, FL)

The ISS Orbital Space Flight Simulator is based on the 2015 design variant of NASA's Orion Spacecraft and supports egress testing and human factors research activities in addition to educational uses. The IIAS Orbital Simulator is used in conjunction with astrodynamics and orbital mechanics courses to better provide an immersive educational experience to our students.

IIAS Suborbital Space Flight Simulator (Melbourne, FL)

The ISS Suborbital Space Flight Simulator is based on Virgin Galactic's Spaceship Two vehicle and is used in conjunction with IIAS aeronomy and fundamentals of astronautics courses in order to better provide an immersive educational experience to our students.

For more information on the use of any of these facilities, please inquire through IIAS at: https://astronauticsinstitute.org/contact

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