

Curriculum

Space Challenges 2014 consists of nine thematic weeks, which will cover the basics of all Space-related areas including the business side. The weeks are scheduled as follows:

Week(s)	Dates	Theme
1 & 2	1 - 12 October	Aerospace Engineering
3	13 - 19 October	Robotics and A.I.
4	20 - 26 October	Space Exploration
5 & 6	27 Oct - 9 Nov	Space Science
7	10 - 16 November	Space Applications
8	17 - 23 November	Biology and Medicine
9	24 - 30 November	Entrepreneurship and Nanotechnologies

Week 1 and 2: Aerospace Engineering

WS1: Building and organizing space team

WS2: Mission Objectives and Team Requirements

- Introduction to Aerospace Engineering
- What is a spacecraft: System level engineering and architecture
- How does it function: Subsystems, integration and testing
- Mission Design: Concurrent Mission Design, Concurrent Mission Engineering
- Spacecraft technology: State-of-the-art projects – extremely small VS extremely large projects/CubeSat technology, swarm satellites,
- Rocket science: Rocket engines and Space propulsion systems and the next-generation launch systems
- Space stations: Current technology (ISS)
- Space Systems Architecture

Week 3: Robotics and A.I.

WS3: Robotic Engineering and Competition Part 1

WS4: Robotic Engineering and Competition Part 2

- Introduction to A.I., Adaptive Algorithms and Machine learning
- Introduction to Robotics
- Robotic engineering: Subsystems and functionalities
- Computer Vision, Virtual Reality, Augmented Reality
- Human – Robot interaction, Uncanny Valley, Bionics
- Robotics for Earth-based applications: Exoskeleton structures

Week 4: Space Exploration

WS5: Kerbal Space Program Part 1

- Human Spaceflight
- Robotic Space Missions: Lunar exploration, Deep space exploration, Mars exploration, Comet and asteroid exploration
- Robotics in space exploration and extreme environments: Flyers, Divers, Landers and Orbital Probes
- Space stations - future designs and experiments

Week 5 and 6: Space Science: astrophysics and, Space Physics, and orbital mechanics

WS6: STK Orbits Simulation

WS7: Kerbal Space Program Part 2

- Relevant Topics in Modern Astrophysics
 - Exoplanets
 - Search for Extraterrestrial Intelligence (SETI)
 - Astrobiology
 - M Dwarf stars - dominant, active, harboring life?
 - Cosmology
 - Orbits, Orbital Mechanics
- Relevant Topics in Space Physics
 - Solar and Magnetospheric Physics
 - Space Weather
 - Space Radiation

Week 7: Space Applications

WS8: Specific Software Introduction

- Why do we explore space?
- Space and Spaceship Earth: The connection
- Remote Sensing and Earth Observation
- Communication Technologies and applications
- Space Weather and Earth-related studies
- Space-based Positioning, Navigation and Timing (PNT)
- Data Visualization: Earth-based science
- Space and Earth: Space-related business cases
- Space Tourism

Week 8: Biology, biotechnology, neuroscience, space medicine

WS9: Overall Mission Rehearsal

- Space Biomedicine
- Molecular and Synthetic Biology
- Biotechnology
- Neuroscience - biological/computer interaction

- Human physiology in Space
- Closed-loop systems and bioreactors

Week 9: Entrepreneurship in the aerospace and high-tech sectors & Nanotechnology, nanobots, smart materials, material sciences

WS10: Entrepreneurship and Pitch Talk

- Entrepreneurship in the high-tech sector
- Next-Generation high-tech projects
- New Space Initiative
- Economy vs Technology
- Material sciences
- Engineering and Industrial Design and Biomechanics
- Additive Manufacturing (3D Printing)
- Nanotechnology: Atomically Precise Manufacturing

Team Projects

TWS 1-10+: Team Workshops

Goal: Engineering / Development of operational prototype for the Final Mission

FINAL MISSION: 28 - 30 November

Team Project Data Visualization

The project participants will learn about the different ways in which scientific data is visualized. They will learn to use the d3 JavaScript library to create attractive and interactive visualizations for the web. They will team up to develop a website showing the damages caused by the 2014 summer floods in Bulgaria. Ideally, the team members will include JS programmers, database programmers, visual designers, and web site developers.

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Prerequisites:

- Knowledge of at least one programming language is a must, unless you're an amazing designer or a GIS expert
- Knowledge of javascript is preferred
- Knowledge of design/image manipulation software (Illustrator, Photoshop, GIMP, Inkscape) is a plus

Team Project Glider Drone

The project aims at the development of a glider drone which is capable of flying fully autonomously and mapping the observed territory. Additionally, it should be able to collect as much environmental sensory information as possible. Participants will learn how to build an entire robotic system starting from the low level electronics to the abstract AI algorithms running on the glider.

Participants Requirements

- Strong motivation and determination to put the necessary hours of work into the project
- Programming is essential part of the project
- Experience with electronics is an asset.

Team Project Photobioreactor

The project goal is to perform research and to design, develop and build a Membrane Photobioreactor (PBR) prototype capable to operate autonomously at least 72 hours in microgravity environment. The target size should be 2U Cubsat, including control boards (Dimensions 227 x 100 x 100 mm). The system should be entirely closed loop and suitable for stratospheric flight.

Participant Requirements:

- Willingness to work in a specialized laboratory during the team workshops
- Interest in algae and/or closed loop systems is a must
- Background in electronics, programming, biology, mechanics of fluids or structural design is a bonus

Team Project Rover

The project aims at the development of a fully autonomous robotic rover which is capable of safely navigating to a predefined destination and delivering a payload. Participants will learn how to build an entire robotic system starting from the low level electronics to the abstract AI algorithms running on the rover.

Participants Requirements

- Strong motivation and determination to put the necessary hours of work into the project
- Programming is essential part of the project
- Experience with electronics is an asset