TEACHING SCIENCE AND TECHNOLOGY, INC.

Integrated CubeSat Engineering Workshop (I-CEW)

Course Description

This 4 or 5 day tailorable course examines the application of Systems Engineering tools and techniques that will provide participants with the necessary skills, industry standards, information, and tools necessary to plan and implement a credible CubeSat Development Program. Emphasis is on practice over theory using a fully-functional (hardware and software) desktop (non-flight) CubeSat as the system of interest. Using the 3U EssentialSAT (ESat) desktop satellite, the course follows the progression of a hypothetical CubeSat mission – NanoMet-2 – designed to deliver large scale meteorological imagery from LEO. NanoMet-2 serves as an end-to- end systems engineering and project management training platform to examine issues that develop during each phase of a project lifecycle.

The course is organized along the the lines of a real space mission, starting with Pre-Phase A concept development and then progressing from Phase A to D, introducing systems engineering artifacts that would be developed at each major milestone and providing hands-on examples using the NanoMet mission. NanoMet, based on the ESat platform, is designed to conform to the 3U CubeSat standard in terms of form and fit and includes all standard spacecraft bus functions (power, data handling, communication, and attitude determination and control). All hardware was designed to be for use around the world and is "ITAR-free," (it is not space qualified or even qualifiable). Participants are provided with key lectures and resources including design tools and model-based systems engineering (MBSE). Through a variety of in-class exercises and hands-on activities they will learn by doing.

Who Should Attend

Systems engineers, project managers, integrated product team members involved with any aspect of system engineering and analysis, especially design and development, test and evaluation of CubeSats.

Course Objectives

At the end of this course you'll be able to...

- ✦ Define mission needs, goals, objectives and ConOps for a CubeSat mission to satisfy a Pre-Phase A requirements
- ✦ Develop and organize detailed mission and system requirements as required by a Phase A System Requirements Review (SRR)
- ✦ Describe the tools and techniques needed to develop the complete preliminary design for a CubeSat and conduct a Phase B preliminary design review (PDR)
- ✦ Evaluate the typical products produced for a critical design review (CDR) at the end of Phase D including system specifications and test plans
- ✦ Implement a typical assembly, integration and test plan for a representative CubeSat system to apply the flow down from requirements to verification activities
- ✦ Conduct simulated operations using a representative CubeSat system to develop and apply operational planning and procedures implementation
- ✦ Apply Model-based Systems Engineering (MBSE) to each phase of a project lifecycle
- ✦ Enter any phase of the space mission lifecycle and apply course principles to achieve practical results

Course Materials

- A complete set of course notes
- An e-copy of the *Applied Space Systems Engineering* textbook.

Course Topics

- ✦ **NanoMET-2 Case Study**
- ✦ **Conceptual CubeSat Mission Design Fundamentals**
  - CubeSat Mission Essentials
  - Applied Space Systems Engineering
  - Planning for Launch/Space Environments
  - Launch System Services
- ✦ **Introduction to Model-based Systems Engineering**
  - *NanoMET-2 MCR**
- ✦ **CubeSat Mission Preliminary Design**
  - System, Orbit Design
  - *NanoMET-2 SRR and other Exercises*
- ✦ **CubeSat Mission Critical Design**
  - Spacecraft Architecture Development
  - Subsystem Design
  - Fundamentals of Flight Software Engineering
  - Introduction to Electronic and Mechanical Design
  - *NanoMET-2 PDR/CDR and other Exercises*
- ✦ **CubeSat AIT, Launch and Checkout**
  - Space System Verification and Validation
  - *NanoMET-2 SIR*
  - *NanoMET Assembly, Integration and Verification Exercise*
- ✦ **CubeSat Mission Operations**

*Guided Hands-on Exercises

Testimonials

"All Systems Engineers should take this." –Boeing Engineer

"The course exceeded my expectations. I did not think that the course could cover so many fundamentals of space missions!" – ESA Engineer

" Theory tied to practical applications well. Great presenters with thorough knowledge of the material." – NASA Engineer

"Testing a CubeSat was definitely the most interesting part in this course" - JAXA Engineer