EPET 400 ME 400: Space Mission Design

Course Description
Space Mission Design will cover all aspects of spacecraft design, subsystems, science payload, systems engineering, project management, and budgets that are important to producing a fully successful mission. The course is offered in Spring only.

Number of Credits
EPET 400 is a four-credit lecture/laboratory course. It is cross-listed as ME 400.

Relation to Curriculum
EPET 400/ME 400 is an integral part of the EPET certificate program.

Prerequisites:
EPET/ME 301 or ERTH 404

Class contact hours
Under COVID provisions the course is delivered as asynchronous hybrid. General class meetings are synchronous online with two TR 3-hour meetings per semester week. For laboratory and practice class will be split. Small class sections will meet F2F during the first weekly instruction day, while non-lab sections will meet online; to be reversed on the second weekly instruction day. Upon return to regular F2F instruction there will be two TR 3-hour meetings per semester week.

Course Details
The course is structured into learning modules generally aligned with semester weeks. The lecture/laboratory course structure allows about 50% of instruction time for lectures and lecture activities and about 50% for laboratory activities and course project activities. The Model Content and Topics section provides an abbreviated list/description of course modules and course module activities. Lecture and laboratory activities support the learning objectives outlined in lecture topics. EPET 400/ME 400 project activities focus on the conceptualization and design of spacecraft able to complete defined space mission objectives. This EPET 400/ME 400 class project design will be used in the EPET 401/ME 401 Capstone Project - Producing a science satellite.

Course delivery
The main elements of course delivery are mini-lectures, guided Concurrent Design Sessions, and project-based learning activities. Students are engaged in designing a space mission with scientific value and produce a quality final report that can be used as baseline proposal.

The laboratory component of the course is characterized by the integration of theory and practice. In the initial weeks break-out group work and group discussions focus on practice and real problems underpinning lecture topics. Each of the break-out groups reports on the result of the exercise, leading to the advancement of the session topic. Later in the semester, break-out group work will increase in time to about half of the time assigned to the lecture component (on a weekly basis). The difficulty of problems will increase.

Learning objectives are integrated through and culminate in a group-based research project: the design of spacecraft with a scientific instrument for a planetary exploration mission.

The requirement is to deliver a realistic design a mission concept that can be built during the EPET 401/ME 401 Capstone Project: Producing a science satellite.

Textbook
Space Mission Engineering: The New SMAD, J. R. Wertz, D.F. Everett, and J.J. Puschell Microcosm, 2011

Elements of Spacecraft Design, C. Brown 2002 AIAA Education Series

Model Content and topics

Module 1
Lecture, Lecture activities: Setting the stage; Lecture demonstrations, tutorials, problem solving.
Lab activities: Setting the Stage.

Module 2
Lecture, Lecture activities: Space Environment**;** Lecture demonstrations, tutorials, problem solving.
Lab activities: CAD and STK workshop (Computer Aided Design, Software Toolkit AGI).

Module 3
Lecture, Lecture activities: Orbital Mechanics; Lecture demonstrations, tutorials, problem solving
Lab activities: COSMOS workshop (Spaceflight management software)

Module 4
Lecture, Lecture activities: Spacecraft Systems Architecture; Lecture demonstrations, tutorials, problem solving.
Lab activities: Orbital dynamics workshop.

Module 5
Lecture, Lecture activities: Systems Engineering**;** Lecture demonstrations, tutorials, problem solving.
Project activities: Introduction of class research project: preliminary definition.

Module 6
Lecture, Lecture activities: Spacecraft Structures**;** Lecture demonstrations, tutorials, problem solving.
Lab activities: Model Based Systems Engineering workshop.
Project activities: Preliminary project definition.

Module 7
Lecture, Lecture activities: Spacecraft Guidance, Navigation and Control; Lecture demonstrations, tutorials, problem solving
Lab activities: GNC workshop (Guidance, Navigation, and Control).
Project activities: Preliminary project definition.

Module 8
Lecture, Lecture activities: Spacecraft Propulsion; Lecture demonstrations, tutorials, problem solving.
Project activities: First review of class research project: advanced definition.

Module 9
Lecture, Lecture activities: Spacecraft Sensors and Actuators; Lecture demonstrations, tutorials, problem solving.
Lab activities: Payload workshop.
Project activities: Advanced project definition.

Module 10
Lecture, Lecture activities: Electrical Power Systems; Lecture demonstrations, tutorials, problem solving.
Lab activities: EPS workshop (Electrical Power Systems).
Project activities: Advanced project definition.

Module 11
Lecture, Lecture activities: Thermal Control; Lecture demonstrations, tutorials, problem solving.
Project activities: Final design review and implementation of class research project.

Module 12
Lecture, Lecture activities: Telecommunications; Lecture demonstrations, tutorials, problem solving.
Lab activities: COMM workshop (Communication Systems).
Project activities: Project final design.

Module 13
Lecture, Lecture activities: On Board Computing/ Telemetry, Command Data Handling and Processing; Lecture demonstrations, tutorials, problem solving.
Lab activities: OBCS workshop (On Board Computer System).
Project activities: Project final design.

Module 14
Lecture, Lecture activities: Ground Segment; Lecture demonstrations, tutorials, problem solving.
Project activities: Research project work.

Module 15
Lecture, Lecture activities: Spacecraft Mechanisms; Lecture demonstrations, tutorials, problem solving.
Project activities: Research project work

Module 16
Lecture, Lecture activities: Electromagnetic Compatibility; Lecture demonstrations, tutorials, problem solving.
Project activities: Research project work.

Module 17
Lecture, Lecture activities: Spacecraft Delivery and Launch, Product Assurance; Lecture demonstrations, tutorials, problem solving.
Project activities: Course summary; completion of research project**.**

Module 18
Project activities: Completion of research project.