Master Syllabus
EPET 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. This course has a Contemporary Ethical Issues (E) Focus designation.

Contemporary ethical issues are fully integrated into the main course material and will constitute at least 30% of the content. At least 8 hours of class time will be spent discussing ethical issues. Through the use of lectures, discussions and assignments, students will develop basic competency in recognizing and analyzing ethical issues; responsibly deliberating on ethical issues; and making ethically determined judgments.

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
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 subject matter and ethics lectures and lecture activities E1, E4 and about 50% for laboratory and course project activities, including the discussion of project relevant ethics issues E2, E3. The Master 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 may be used in the EPET 401/ME 401 Capstone Project - Producing a science satellite.

Course delivery
The main elements of course delivery are lectures, guided Concurrent Design Sessions, and project-based learning activities. Students are engaged in designing a space mission with scientific value and produce quality interim and final reports in line with the project review schedule.

The laboratory component of the course is characterized by the integration of theory and practice. Break-out group work and group discussions focus on practice and real problems underpinning lecture topics.

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 design research work includes project relevant discussion and integration of professional and space related ethics issues. 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**

*Spacecraft Mission Design*, F. Zhu et al., 2020

**Reference Books**


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

**Course Evaluation**


For each project design review, student design/research groups are required to produce a paper and a PowerPoint presentation. Both papers and presentations are evaluated with respect to content as well as the appropriate inclusion/disscusion of ethics principles. Students have the opportunity, in an iterative an interactive process, to improve their papers to approach a high-quality outcome. Content and ethics aspects are graded separately for each product, with content at 85% and ethics aspects at 15% of the total product grade. Grading of ethics aspects will follow a Contemporary Ethics Issue Rubric provided. There will be ten homework assignments. Three of the homework assignments will be essays on space ethics issues graded following the rubric.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>% of grade technical</th>
<th>% of grade ethics</th>
<th>Overall % contribution to grade</th>
<th>Overall % of grade technical</th>
<th>Overall % of grade ethics</th>
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<td>20</td>
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<td>SSR paper and presentation</td>
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<td>PDR paper and presentation</td>
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<td>CDR paper and presentation</td>
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<td>15</td>
<td>20</td>
<td>17</td>
<td>3</td>
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Model Content and topics

Module 1
Lecture, Lecture activities: Setting the stage; Lecture demonstrations, tutorials, problem solving.
Lab activities: Setting the Stage.
Project activities: Project definition; Team formations and roles assignments.
Ethics activities: Ethics lecture and discussion topic 1: Space Debris E1, E4

Module 2
Lecture, Lecture activities: Space Environment; Lecture demonstrations, tutorials, problem solving.
Lab activities: CAD and STK workshop (Computer Aided Design, Software Toolkit AGI).
Project activities: Concurrent Design Session (1).
Ethics activities: Ethics lecture and discussion topic 2: Protecting Ecosystems E1, E4

Module 3
Lecture, Lecture activities: Orbital Mechanics; Lecture demonstrations, tutorials, problem solving.
Lab activities: COSMOS workshop (Spaceflight management software)
Project activities, Ethics activities: Concurrent Design Session (2). E2, E3

Module 4
Lecture, Lecture activities: Spacecraft Systems Architecture; Lecture demonstrations, tutorials, problem solving.
Project activities: System Requirements Review (SRR).
Ethics activities: Inclusion of ethics considerations in SSR presentation and documents

Module 5
Lecture, Lecture activities: Systems Engineering; Lecture demonstrations, tutorials, problem solving.
Lab activities: Orbital dynamics workshop.
Project activities, Ethics activities: Concurrent Design Session (3). E2, E3

Module 6
Lecture, Lecture activities: Spacecraft Structures; Lecture demonstrations, tutorials, problem solving.
Lab activities: Model Based Systems Engineering workshop.
Project activities: Preliminary Design Review (PDR).
Ethics activities: Inclusion of ethics considerations in PDR presentation and documents

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, Ethics activities: Concurrent Design Session (4). E2, E3
Ethics activities: Ethics lecture and discussion topic 3: Human exploration of space – Low Earth Orbit E1, E4; essay homework

Module 8
Lecture, Lecture activities: Spacecraft Propulsion; Lecture demonstrations, tutorials, problem solving.
Project activities: First review of class research project: advanced definition.
Project activities, Ethics activities: Concurrent Design Session (5). E2, E3

Module 9
Lecture, Lecture activities: Spacecraft Sensors and Actuators; Lecture demonstrations, tutorials, problem solving.
Lab activities: Payload workshop.
Project activities: Advanced project definition.
Project activities: Critical Design Review (CDR).
Ethics activities: Inclusion of ethics considerations in CDR presentation and documents

Module 10
Lab activities: EPS workshop (Electrical Power Systems).
Project activities, Ethics activities: Concurrent Design Session (6). E2, E3
Ethics activities: Ethics lecture and discussion topic 4: Human exploration of Space – The Moon and beyond E1, E4; essay homework

Module 11
Lecture, Lecture activities: Thermal Control; Lecture demonstrations, tutorials, problem solving.
Project activities, Ethics activities: Concurrent Design Session (7). E2, E3

Module 12
Lecture, Lecture activities: Telecommunications; Lecture demonstrations, tutorials, problem solving.
Lab activities: COMM workshop (Communication Systems).
Project activities Ethics activities: Concurrent Design Session (8). E2, E3

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: Concurrent Design Session (9). E2, E3
Ethics activities: Ethics lecture and discussion topic 5: Human exploitation of space – Who can mine the Moon? Why or why not? E1, E4; essay homework

Module 14
Lecture, Lecture activities: Ground Segment; Lecture demonstrations, tutorials, problem solving.
Project activities, Ethics activities: Concurrent Design Session (10). E2, E3
Module 15
Lecture, Lecture activities: Spacecraft Mechanisms; Lecture demonstrations, tutorials, problem solving.
Project activities; Ethics activities: Concurrent Design Session (11). E2, E3

Module 16
Lecture, Lecture activities: Electromagnetic Compatibility; Lecture demonstrations, tutorials, problem solving.
Project activities: Flight Readiness Review (FRR).
Ethics activities: Inclusion of ethics considerations in FRR presentation and documents

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