

PTYS 495/595 – Spacecraft Mission Design and Implementation

Live Online – Tuesdays and Thursdays 2:00 – 3:15 pm

Description of Course

This course will provide an overview of NASA and international solar system exploration programs. The focus is on the development and implementation of planetary robotic exploration missions. The instructor is the Principal Investigator for the NASA OSIRIS-REx mission, which successfully collected a sample from asteroid Bennu in October 2020. All aspects of mission development and operations will be covered including science, engineering, management, politics, and resources.

Course Prerequisites or Co-requisites

There are no formal course prerequisites. A background in science or engineering is recommended but not required.

Instructor and Contact Information

Instructor: Professor Dante Lauretta, Lunar and Planetary Laboratory, University of Arizona

Office: Drake Building (1415 N 6th Ave) 104R (currently working from home due to pandemic quarantine)

Email: lauretta@arizona.edu

Office Hours: By appointment (Zoom) – contact Nancy Ramos (nancyramos@email.arizona.edu) to schedule

Web Information: <https://d2l.arizona.edu/d2l/home/1002042>

Course Format and Teaching Methods

The course will be a combination of webinar-style lectures, assigned reading, and group projects. The group projects will focus on the development of science and engineering requirements and design for a planetary exploration mission.

Course Objectives

The course objective is to have students work together as members of a mission design team to develop a mission concept. They will assume specific roles such as Principal Investigator (PI), Project Manager (PM), System Engineer (SE), Instrument Scientist, etc. and work together to define the mission's science objectives, scientific payload, spacecraft architecture, mission profile, resource requirements, system engineering, and project management. The mission target, timeline, and resources must be consistent with the guidelines in NASA's *Announcement of Opportunity for New Frontiers 4*.

Expected Learning Outcomes

The primary expected learning outcome of this course is for students to identify and interrelate the wide variety of elements required for successful planetary mission design and implementation. Students will understand that spacecraft mission development is a multi-faceted challenge that involves political processes, scientific investigation, engineering disciplines, and project management. Students should develop an appreciation for planetary science and its role in government, education, industry, and society. Through the exercise in planetary mission design, students will gain an understanding of how large projects are conceived, planned, designed, and implemented, a perspective that is valuable across a wide range of disciplines.

Makeup Policy for Students Who Register Late

Students who register after the first-class meeting may make up missed reading assignments within one week of joining the class. They will also be able to join any existing activities related to mission team formation and assignment of roles and responsibilities.

Course Communications

The instructor is available via email and by appointment for Zoom meetings. All course material will be posted on D2L. Instructor webinars and student mission-team progress reports will be delivered using Zoom. Students are expected to work in small groups outside of class. The instructor can assist students in setting up these breakout meetings.

Required Texts or Readings

Assigned readings will be available on the course D2L site and will be comprised primarily of NASA documents, reports from the US National Academy of Science, peer-reviewed journal articles, technical reports, white papers, and other planetary science community literature.

Required or Special Materials

None

Required Extracurricular Activities

Students are required to interview a subject matter expert (SME) related to their role on the mission design team. The instructor will assist students in arranging these interviews.

Assignments: Schedule/Due Dates

Each student mission-design team will provide regular reports on their design progress throughout the semester. These reports will include both a written and oral presentation component. The oral component will be presented during the specified class periods. Individual team members will present their section of the report. Each report will contain the following items:

Team Report #1 (1/28/21)

Team members roles and responsibilities
Mission Concept

Team Report #2 (2/16/21)

Level-1 Requirements
Candidate Payload
Instrument Resource Estimates

Team Report #3 (3/11/21)

Revisions to TR#2 products
Science Traceability Matrix

Team Report #4 (3/30/21)

Revisions to TR#3 products
Design Reference Mission
Mission Traceability Matrix
Risk Assessment

Team Report #5 (4/15/21)

Revisions to TR#4 products

Ground Data System

Project Schedule

Project Cost Estimate

Project Work Breakdown Structure

Final Examination or Project

Team Final Reports (5/4/21)

Final presentation of mission concept

Grading Scale and Policies

The grade distribution for the course is as follows:

A:	≥90%	= excellent (regular grade)
B:	≥80% – <90%	= good (regular grade)
C:	≥70% – <80%	= satisfactory (regular grade)
D:	≥60% – <70%	= poor (regular grade)
E:	>60%	= failure (regular grade)

Final grades will be calculated based on classroom attendance (25%), participation in in-class discussions (25%), and the quality of the work demonstrated in the team reports and SME interview report (50%). Each class member will be graded based on their individual presentations during the team reports.

The grading scale above applies to both undergraduate and graduate students. Undergraduate and graduate students will be differentiated by the complexity of the assignments related to the group project. In particular, graduate students are expected to take leadership roles (PI, PM, or SE) on the mission design teams.

Incomplete (I) or Withdrawal (W):

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Scheduled Topics/Activities

1/14/21	Mission Highlight - OSIRIS-REx
1/19/21	NASA Organization, SMD, PSD, Program Offices, Centers and FFRDCs
1/21/21	Science policy, NRC, SSB, AGs, Decadal Survey, Mission programs
1/26/21	Building a Team, Cultures, Conflicts, and Competing interests
1/28/21	Team Mission Status Report #1
2/2/21	Defining a mission: Objectives, Level-1 Requirements, Minimum Success
2/4/21	Science Instruments
2/9/21	Science Instruments Cont'd
2/11/21	Science Traceability, Converting requirements to hardware performance
2/16/21	Team Mission Status Report #2
2/18/21	Mission Highlight - Perseverance and Mars Exploration
2/23/21	Planetary Spacecraft Architecture and Design
2/25/21	READING DAY
3/2/21	Planetary Spacecraft Architecture and Design Cont'd
3/4/21	System Level Integration, Environmental Test Programs/Verification and Validation
3/9/21	READING DAY
3/11/21	Team Mission Status Report #3
3/16/21	Mission Design
3/18/21	Observation Planning, Design Reference Mission, and Science Operations
3/23/21	Launch Vehicles and Launch Site Processing
3/25/21	Project Management, System Engineering, Safety and Mission Assurance
3/30/21	Team Mission Status Report #4
4/1/21	Ground System Architecture, Spacecraft Operations
4/6/21	Deep Space Network
4/8/21	White House, Congress, and the Budget Process
4/13/21	Resources, Cost, Schedule, Contracts, and Reporting
4/15/21	Team Mission Status Report #5
4/20/21	International Space Agencies and Partnerships
4/22/21	Mission Highlight - Hayabusa2
4/27/21	Sample Return, Curation, Sample Analysis
4/29/21	Communication and Public Engagement
5/4/21	Team Mission Final Report

Recording of Webinar Zoom Sessions

The instructor may record class Zoom sessions. These recordings are used at the discretion of the instructor. Students must access this content in D2L only. These recordings are part of the students' educational record and should NOT be shared with anyone outside of the class. Students may not modify any course content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulation. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action. The Instructor will notify students if the Zoom session is being recorded. Students will be able to hide their name and identity during these sessions, if they choose.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>

Campus Health

<http://www.health.arizona.edu/>

Campus Health provides quality medical and mental health care services through virtual & in-person care.

Phone: 520-621-9202

Counseling and Psych Services (CAPS)

<https://health.arizona.edu/counseling-psych-services>

CAPS provides mental health care, including short-term counseling services.

Phone: 520-621-3334

The Dean of Students Office's Student Assistance Program

<http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Student Assistance helps students manage crises, life traumas, and other barriers that impede success.

The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.

Email: DOS-deanofstudents@email.arizona.edu

Phone: 520-621-7057

Survivor Advocacy Program

<https://survivoradvocacy.arizona.edu/>

The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.

Email: survivoradvocacy@email.arizona.edu

Phone: 520-621-5767

Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

University-wide Policies

Links to the following UA policies are here, <https://academicaffairs.arizona.edu/syllabus-policies>:

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement