

# **Semester Team Project**

## **MEEM4810 – Introduction to Aerospace Engineering**

### **Fall 2018**

The goal of this project is to learn more about Aerospace Engineering by doing it. I would like for teams of **5-7 people** to choose a project topic along these lines:

- **Propose your own (aero)space business plan/company (can be for Earth application)**
- **Design a 'Return to the Moon and on to Mars' space exploration mission**
- **Design a space mining mission to mine the Moon, Mars or Asteroids**

During the rest of the semester I expect you to work out a goal for your project, do a mission design with trade-offs and come up with a conceptual design which includes estimated sizes, masses etc. of components. These will be preliminary estimates and should have a buffer in the mass, power, etc. budgets. I expect numeric modeling (model based design) in MS Excel, Amesim or Matlab or another software package to determine the tradeoffs and to show the comparisons as well as graphical representations (NX or other CAD sketches) of the mission and concept of operations.

1. Sept 5: Team formation & project idea due Sept 7
2. Sept 14: Project plan due
3. Oct 12: Interim report due & CATME 1
4. Dec 14: Final Project report and video presentation due on canvas & CATME 2

The projects can be satellites, robotic or manned missions to a destination and with goals you choose but they have to be approved by me using the next page application form before you should start working on them.

There are many business plan competitions, some for aerospace projects specifically. If that is the project you want to do as a team you can find one and propose to participate in that.

Please form your teams and discuss what you want to do. Then fill out the form on the next page and submit it to me so I can read it and approve it or suggest changes.

There are many books and other resources that can help you with this and of course I am here to help you with any questions you may have.

Some examples of book resources:

- Space Mission Analysis and Design
  - The Lunar Base Handbook
  - Space Life Support and Biospherics
- etc.

The final design report containing your mission and trade-studies, conceptual hardware design and overall conclusions will be due on December 14 in class as well as a 30 slide final presentation slidedeck on canvas.

## **MEEM 4810 Project Application Form**

(please type and e-mail to pjvansus@mtu.edu)

Team Name: NILO THICC (Networked Interplanetary Link Optimization – Telemetry Hearing Interplanetary Communication Constellation)

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### **Self sign-up for your team in Canvas**

Student 1 name: Anthony Lackey

Student 2 name: Joe Hurford

Student 3 name: Jacob Hubert

Student 4 name: Zachary Bauman

Student 5 name: Marcello Guadagno

Student 6 name: Andrew Johnson

Student 7 name:

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Type of project : **Space Exploration ???**

Project description 250-500 words describing the goal and scope of your project:

### **Inter-Planetary Link Optimization through Phased-Array (PLOPAr)**

This proposal discusses the possibility of a constellation of small satellites that can act as an interplanetary relay network to allow deep-space satellites to communicate with a ground station regardless of line-of-sight (LOS) conditions between the deep-space probe and the ground station. Additionally, parts of the constellation or the entire constellation, depending on LOS, shall be able to act as a single receiver, emulating a parabolic antenna with the diameter of the entire constellation. Such an array could be utilized as a radio telescope for deep-space exploration, exoplanet discovery, etc...

The current system in place to handle deep-space exploration is NASA's Deep Space Network (DSN), consisting of three ground sites placed strategically around the globe so that there is continuous coverage by at least one ground station of every point in the sky beyond lunar orbit (approx. 240,000 miles from earth). There are twelve active antennas in the DSN, 4 at each of the three locations. These 12 antennas handle communications with every active deep-space satellite or probe, including the Voyager spacecraft, Juno, New Horizons, etc. The number of active deep-space missions and the low-data rates (150 kb/s in the case of Juno) mean that the antennas are almost always in use, and scheduling time on the DSN means a lengthy negotiation process with other missions competing for time on the DSN.

Clearly an alternative system would be a boon to deep-space exploration and allow future deep-space smallsat and cubesat missions to return their data to the ground in a timely fashion without having to compete for ground station use with international flagship missions such as the JWST and the like.

The PLOPAr constellation would consist of 7-10 (TBR) microsatellites fitted with high-sensitivity phased-array antennas placed into high Earth orbit (HEO) and will act as RF repeaters, similar to those used in terrestrial RF communications. By utilizing new swarm technologies pioneered for autonomous drone flight, multiple PLOPAr satellites will be able to act as a single receiving unit, improving gain over a single receiver, providing noise and interference mitigation, and allowing the “beam” to be electronically steered to the desired direction. An added benefit of a space-based constellation of transceivers as opposed to terrestrial ground stations is the reduction of terrestrial RF interference and mitigation of atmospheric propagation loss. These benefits also apply to the use of the constellation as a deep-space radio observatory.