

ABET Course Syllabus**ENAE 441 Space Navigation & Guidance**

**Credits & Contact Hours:** 3 credits (3 hours of lecture)

**Course Status:** Required

**Schedule:** Offered every Fall semester

**Course Description:** Principles of navigation. Celestial, radio, and inertial navigation schemes. Navigational and guidance requirements for orbital, planetary, and atmospheric entry missions. Fundamentals of communications and information theory. Link budgets, antennas and telemetry systems.

**Pre-Requisites:** ENAE 404, ENAE 432

**Co-Requisites:** None

**Textbooks:** (1) H. Curtis. Orbital Mechanics: Engineering for Students. Butterworth-Heinemann, 2005.  
(2) O. Montenbruck and E. Gill. Satellite Orbits: Models, Methods and Applications. Springer, 2005 (recommended).

**Other Required Material:** Course lecture notes and handouts

**Course Oversight:** Dynamics and Control Committee

**Syllabus Prepared By/Date:** Dr. Liam Healy on June 2011

**Course Objectives/Student Learning Outcomes:**

1. Understand observation techniques and limitations, and how navigation data is collected and assimilated
2. Compute initial orbits based on observation data
3. Improve orbit estimates using least squares estimation
4. Understand basics of advanced techniques such as Kalman filters
5. Understand sources of errors, how errors are treated, and their effect on navigation solutions
6. Compute GPS position solutions

**Topics Covered:**

1. Introduction to guidance and navigation
2. Sensors and observations
3. Algorithms
  - a. Initial orbit determination
  - b. Advanced orbital maneuvering
  - c. Interplanetary maneuvers
  - d. Linear orbit estimation
  - e. Nonlinear orbit estimation
  - f. Kalman filters
  - g. Atmospheric entry
4. Navigation networks and applications

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- a. Space Surveillance Network, Deep Space Network
- b. Global positioning system
- c. Debris and the built space environment
- d. TDRSS
- e. Geostationary satellite stationkeeping
- f. Proximity navigation and docking

**Relationship of Course Objectives to Program Outcomes**

This course addresses program outcomes: 1, 3, 4, 5, 7, 9, 12, 14