**AE 4532 – Spacecraft Flight Dynamics**

**Hours:** 3-0-3

**Catalog Description (25 words or fewer):**

Cover fundamental material in orbit and attitude dynamics. Investigate orbits, rendezvous / intercept maneuvers, interplanetary transfers, attitude coordinates, attitude stability, attitude control, and attitude estimation.

**Prerequisites:**

AE 3530

AE 3330

**TEXTBOOKS:**

Wiesel, *Spaceflight Dynamics*, McGraw-Hill

**Course Objectives:**

Formulation and Numerical Solution of Flight Dynamics Equations of Motion

Understanding of Static and Dynamic Stability of Aerospace Systems

Familiarity with Space Mission Design (Intercept, Rendezvous, Interplanetary & Lunar Transfers, Gravity Assist, Formation / Constellation Design)

Formulation of relative motion dynamics

Introduced to GNSS systems

Introduced to Atmospheric Entry

Understanding of Kinematics and Dynamics of a 3D Rigid Body

Introduced to attitude determination and control instruments & techniques

**Learning Outcomes:**

1. Generate kinematics and dynamics solutions to problems
2. Mission/trajectory design
3. Spacecraft attitude system design
4. Applied programming in MATLAB
5. Constructing simulations in SIMULINK

|  |  |
| --- | --- |
| **Topical outline:** | **Hrs.** |
| Introduction | **1** |
| Vectors, reference frames, and kinematics | **1** |
| Review of Newton’s law of gravitation, N-body problem, two-body problem | **1** |
| Kepler’s Equation and Time-of-Flight | **2** |
| Gauss’ Problem: Intercept & Rendezvous Mission Design (p-iteration) | **5** |
| Interplanetary and Lunar Transfers (Patched Conics, Gravity assist, Free-return) | **5** |
| Relative Motion | **2** |
| GNSS Overview | **2** |
| Spacecraft Constellation and Formation Overview | **2** |
| Subtotal: 21 |  |
| Attitude parameterizations | **2** |
| Attitude Kinematics | **1** |
| Attitude Dynamics | **3** |
| Attitude Stability (spin, dual-spin, 3-axis, gravity gradient) | **4** |
| Attitude control mechanisms | **4** |
| Attitude control of spinning and non-spinning spacecraft, yo-yo | **2** |
| Spacecraft attitude control design | **2** |
| Attitude sensors (rate gyros, sun sensors, star trackers, magnetometers) | **3** |
| Subtotal: 21 |  |
| Midterm Exam and Quizzes (3 / +0) Subtotal: 3 | **3** |