ECE 5230 Spacecraft Systems Engineering
Fall 2016

Description: This class is for Electrical Engineers, Aerospace Engineers, Mechanical Engineers, Physics Majors, and other interested people. This class will introduce students to spacecraft systems by developing tools for the conceptual design of a spacecraft. ECE 5230 will focus on computer aided astrodynamics, orbit design, spacecraft power systems, and spacecraft telemetry systems. Expect plenty of reading and open ended system level design problems. Relax and have fun.

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Office Hours: M (2:30 – 3:30) Th (9:30-10:30) or by appointment

Class Time: M W F 1:30 – 2:20 in ENGR 104

Prerequisites: Math 2250 (differential equations), Familiarity with MS Windows and Excel spreadsheets, is expected.

Objectives

1. Students will understand the time and coordinate systems used in space systems engineering.
2. Students will gain a working knowledge of orbital mechanics through orbital simulation software and will be able to design orbits for various Earth orbiting satellite missions and extract information needed in the design of spacecraft systems.
3. Students will have a conceptual understanding of spacecraft propulsion, launch systems, attitude determination & control systems and thermal control systems.
4. Students will have conceptual understanding and can formulate a conceptual design for a spacecraft solar battery power system.
5. Students will become familiar with the basic concepts and tools of spacecraft thermal management and control.
6. students will have and understanding and can formulate a conceptual design for a spacecraft telemetry system.
7. students will have able to develop reasonable systems engineering trades based on a broad understanding of the various systems that compromise a spacecraft.
8. Students will become proficient in the use of Excel spreadsheets as a tool for conceptual system design.

Required Text: Reading material and reference for homework problems.

Spacecraft Systems Engineering ThirdFourth Edition, Edited by Peter Fortescue, John Stark, Gram Swinerd, TL875.S68 2003, ISBN 0-470-85102-3 or ISBN 0-471-61951-5

Reference Texts: Other source materials for lectures

Fundamentals of Space Systems Second Edition, Vincent L. Piscane ISBN 0-19-516205-6

Space Mission Analysis and Design second edition, wiley J. Larson and James R. Wertz, TL790.S73, ISBN 1-881883-01-9 (pbk.)

Spacecraft Systems Engineering edited by Peter Fortescue and John Stark, ISBN 0-471-93451-8 (pbk.), 1992

Space Vehicle Design Michael D. Griffin and James R. French, TL875.G68, ISBN 0-930403-90-8

Satellite Communications Systems Systems, Techniques, and Technology, second edition, G. Maral and M. Vousquet

Modern Spacecraft Dynamics & Control Marshall H. Kaplan, TL790.K36, ISBN 0-471-45703-5

Spacecraft Attitude Determination and Control James R. Wertz, TL3260.C65, ISBN 90-277-1204-2 (pbk.)

Fundamentals of Astrodynamics Roger R. Bate, Donald D. Mueller, and Jerry E. White

Principles Of Dynamics Donald T. Greenwood

Classical Dynamics of Particles and Systems Jerry B. Marrion

The Upper Atmosphere and Solar-Terrestrial Relations J.K. Hargreaves

Sourcebook on the Space Sciences Samuel Glasstone

The Earth's Ionosphere Plasma Physics and Electrodynamics Michael C. Kelley, QC809.P5k45, ISBN 0-12-404012-8 (hb.), ISBN 0-12-404013-6 (pbk.)

Homework: Homework will be assigned periodically as occasion permits with the goal of having one Homework set that makes use of Excel about every week.

Software: Satellite Tool Kit will be used in either the engineering lab and on your personal computers. MicroSoft Excel will be used extensively.

Systems Design Projects: There will be one large take home systems design project near the end of the semester. This final project will require an extensive writeup describing your design.

Examinations and Quizzes : Short 10 min quizzes will be given weekly

Grading: The scores will be weighted as follows:

Homework	50%
Systems Design Project	30%
Quiz	20 %

Disabilities: If a student has a disability that will likely require some accommodation by the instructor, the student must contact the instructor and document the disability through the Disability Resource Center. In cooperation with the Disability Resource Center, course material may be provided in alternative formats—large print, audio, diskette or Braille upon request.

Course Outline

ECE 5230 Course Outline
Fall Semester 2015 Utah State University

Date	Day	Lecture	Module	Topic	Excel Homework	Homework Description
8/31/15	Mon	1	Intro	Syllabus, spacecraft system engineering		
Sep 02	Wed	2	Excel	Overview, conceptual design tools	Cost Estimating	Lookup databases, Excel Forms, Macro visual basic functions.
Sep 04	Fri	3	Excel	Visual Basic, Concurrent Engineering Models		
Sep 07	Mon			Labor Day No Class		
Sep 09	Wed	4	Environs	The solar cycle, magnetosphere, ionosphere	Space Environment	Solar Cycle Model, Thermosphere Model, Magnetic Model
Sep 11	Fri	5	Environs	Thermosphere models and magnetic models		
Sep 14	Mon	6	Coord	Coordinate system, Basis Vectors, Euler rotations		
Sep 16	Wed	7	Coord	Time systems and celestial motion	Coordinate Systems	Matrix Math, Transformations, Solar Lighting Model
Sep 18	Fri	8	Coord	Transformation Examples		
Sep 21	Mon	9	Orbit	Forces, Energy, Momentum, Newton and Kepler Laws		
Sep 23	Wed	10	Orbit	Math of Keplerian Orbits (Dynamic vs. Geometric)	Celestial Mechanics	Orbit Periods, Orbit Transfer, Perturbations calculations
Sep 25	Fri	11	Orbit	Introduction to orbital mechanics Kepler's equation		
Sep 28	Mon	12	Orbit	Keplers Equation for Time and Orbital Perturbations		
Sep 30	Wed	13	STK	Orbit wizard and useful Earth orbits	STK Exercises	STK Analysis
Oct 02	Fri	14	STK	Mission analysis tools		
Oct 05	Mon	15	STK	Mission design tools		
Oct 07	Wed	16	Prop	Intro, Power, Exhaust Velocity, Thrust Acceleration		
Oct 09	Fri	17	Prop	Overview of propulsion systems (Launch, Spacecraft)	Propulsion Sizing	Propellant mass estimate for ISP and delta V requirements
Oct 12	Mon	18	Prob	System sizing (Chemical, Tank, Electrical)		
Oct 14	Wed	19	Dyn	Dynamics Review		
Oct 16	Fri			Fall Break No Class		
Oct 19	Mon	20	Dyn	Spacecraft Configuration, Center of Mass/Pressure	Spacecraft Configuration	Spacecraft Configuration, Mass Properties, Center of Pressure, Lighting
Oct 21	Wed	21	Dyn	Rotational Motion Overview, Inertia		
Oct 23	Fri	22	Dyn	Rotational Dynamics and Rational Stability		
Oct 26	Mon	23	Attitude	Determining Attitude		
Oct 28	Wed	24	Attitude	Controlling Attitude and Sensors	Attitude Sensors and Actuators	Momentum balance, disturbance torques, magnetic torques
Oct 30	Fri	25	Attitude	Spacecraft Attitude Control		
Nov 02	Mon	26	Power	Spacecraft Lighting, STK and Overview		
Nov 04	Wed	27	Power	Spacecraft Power Systems	Solar and Battery Power	Solar panel design and battery design. Spacecraft Lighting
Nov 06	Fri	28	Power	Spacecraft Power Systems		
Nov 09	Mon	29	Power	Spacecraft Power Systems		
Nov 11	Wed	30	Thermal	Spacecraft Thermal Systems		
Nov 13	Fri	31	Thermal	Spacecraft Thermal Systems	Thermal Design	
Nov 16	Mon	32	Thermal	Spacecraft Thermal Systems		
Nov 18	Wed	33	Com	Communication Systems		
Nov 20	Fri	34	Com	Communication Systems		
Nov 23	Mon	35	Com	Communication Systems	Link Budget	RF Link Budget and antenna design
Nov 25	Wed			Thanksgiving (no class)		
Nov 27	Fri			Thanksgiving (no class)		
Nov 30	Mon	36	Com	Communication Systems		
Dec 02	Wed	37	Data	Data handling, STK and Overview		
Dec 04	Fri	38	Data	Data handling		
Dec 07	Mon	39	Data	Data handling	Telemetry and Data Handling	Buffer size and ground access times, time over ground station
Dec 09	Wed	40	Design	System Design	Final Project	A Spacecraft Conceptual Design Project
Dec 11	Fri	41	Design	System Design		
Dec 14	Mon	42	Design	System Design		
Dec 08	Wed	FINAL				