EE 474—SATELLITE COMMUNICATIONS SYSTEMS

Fall 2012

Instructor: Dr. Julio Urbina
Office: 315 E^3
Office Hours: M 10:30–11:30 AM, R 10:30–11:30 AM, others by appointment
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Course Website: Available on Penn State's Angel system at http://cms.psu.edu

Catalog Description: "Overview of satellite communications systems, principles, space platforms, orbital mechanics, up/down links and link budgets, modulation techniques."

Prerequisites: EE 330, EE 360

Time: MWF: 12:20–1:10 pm

Classroom: 268 Willard Bldg.

Text: Pratt, T., C. Bostian, and J. Allnutt, *Satellite Communications*, 2nd Ed., Wiley, 2003.
Handouts

Reserve Text: Available at Engineering Library
Roddy, D., *Satellite Communications*, 4th Ed., McGraw–Hill, 2006.
Ippolito, L.J., *Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance*, Wiley, 2008.

Course Objectives: This course is designed to give seniors and graduate students an overview of the principles of satellite communications systems. Building on junior-level courses in electromagnetics and communications, it shows how complex satellite systems operate and provide services that we depend on, such as telephone, television, weather forecasting, and global positioning. Specific topics include: historical background on how satellite systems came to be, present uses of satellite systems, and future trends in satellite systems design, construction, and uses; orbital mechanics and launch systems and vehicles; earth stations; radio propagation and link analysis; signals and satellite access methods. Hands-on experience in the design of satellite communications links is gained through the use of industry-standard satellite system analysis software. In their design, the student must achieve specific goals of satellite accessibility, earth coverage footprint, orbital launch and stability, and communications link budget.

Exams: Two evening midterms

Homework: Assigned every week and must be turned in to the homework slot (in front of 121 EE East) on the indicated due date before 4 pm. The solutions of the homework will normally be posted on Angel within a day or two. The graded

work normally should be returned to you one week after it is collected. Assignments turned in after 4 pm on the due date will be considered late.

Projects: Projects will be discussed in class and provided as separate assignments. Some assignments will require the use of software such as MATLAB Simulink and others will use STK: Satellite Tool Kit. Brief tutorials on this software will be provided.

Late Policy: Each student is allowed to turn in *one* homework or lab assignment (of their choice) late during the semester. However, once the solutions have been posted, an assignment cannot be turned in for a grade. ***The course project may not be turned in late.***

Homework Grading: Problems are all weighted the same and will be graded in the following manner:

- A scale of 0 to 5 will be used for each problem;
- A correct solution will receive 5 points;
- A correct approach but wrong result will receive 4 points;
- A partially correct approach will receive 2 or 3 points depending on how much of it is correct (over half correct will get 3 points, less than half correct will get 2 points);
- An incorrect approach will receive 1 point;
- A problem that is not attempted will receive 0 points.

Course Grading: Your final grade will be based on the following weighting:

25% First midterm exam (Wednesday, 24 Oct., 8:15–10:15 PM, room TBA)
25% Second midterm exam (Wednesday, 5 Dec., 8:15–10:15 PM, room TBA)
20% Projects
10% Homework (roughly 10 assignments)
20% Course project (due 7 Dec.)

Schedule & Content: The course will follow approximately the schedule below. Chapter numbers are from Pratt, Bostian, and Allnutt. Notes will be provided on Angel.

Chapter	Topic	Lectures
1	Introduction	3
2	Orbital Mechanics and Launchers	4
3	Satellites and Spacecraft Subsystems	7
4	Satellite Link Design	5
5	Modulation and Multiplexing Techniques	6
6	Multiple Access	4
7	Error Control	4
8	Propagation Effects on Satellite Links	4
9–12	Satellite Systems and Services	3
	Total lectures	40

Topics to be covered (may change slightly due to time constraints):

1 Introduction

History of satellites and space activity; history or sat comm. systems

2 Orbital Mechanics and Launchers

Kepler's laws; orbits; launch methods

3 Satellites and Spacecraft Subsystems

Spacecraft subsystems; transponders; power amplifiers; antenna subsystems

4 Satellite Link Design

Link budgets; system noise; carrier to noise; uplink/downlink and combined C/N; inter-modulation noise

5 Modulation and Multiplexing Techniques

Analog signals; FM; digital signals; digital systems

6 Multiple Access

Satellite access; FDMA; TMDA; on-board processing; CDMA

7 Error Control

Error detection and correction; error control coding

8 Propagation Effects on Satellite Links

Radio propagation; polarization; Earth segment; interference

9–12 Satellite Systems and Services

Current systems and services