Satellite Communication Systems – ENPM 808Z  
Summer 2016

Instructor: Dr. Tahereh Fazel 
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TU/TH 6:00 pm - 8:40pm

Recommended Books:
- Principle of Communications Satellites by Gary D. Gordon and Walter L. Morgan
  - Publisher: Wiley-Inter science 1 edition (August 5, 1993)
  - Language: English
  - ISBN-10: 047155796X

- Satellite Communications by Dennis Roddy
  - Publisher: McGraw-Hill Education; 4 edition (February 10, 2006)
  - Language: English
  - ISBN-10: 0071462988

Teaching Materials:
- Class Notes – To be posted before each Lecture on CANVAS
- Papers and Journal articles – To be posted before each lecture on CANVAS
- LAB guidelines and procedures – To be posted before each LAB on CANVAS

Course Outline and Syllabus (Last Update: 2/10/2016)

This course will start with a brief introduction to the theory behind any satellite system. The Kepler laws, radio wave propagation, different satellite orbits (GEO, LEO, MEO) will be discussed briefly. After the introduction, different aspect of a satellite system, space segment, earth segment, hardware (antennae, RF section...) will be explored. The transmit/receive powers, amplifiers; antenna, noise, interference and link budget are other important topics of this course. Digital satellite systems will be discussed in at least three sessions and covers different modulation techniques, error correcting codes, source codes for voice/video/data transmission to and from satellite, security and satellite access methods (TDMA, FDMA, …)

This course will have three LABs. We will use SDK software form AIG to explore different scenarios for link budget, access, data transfer, and noise and interference effects on the satellite signal.

Throughout the course, we also take a closer look at the famous satellite system currently working like GPS system, Iridium system and satellite TV.
Course Schedule (Last Update: 2/10/2016)

1st session
1. Introduction to Satellite Systems
2. Introduction to Link Budgets
3. Space Segment
4. Earth Segment
5. Introduction to System Design
6. Introduction to Hardware design (DSP, FPGA, ASIC)

2nd session
1. KEPLER Laws
2. Radio wave propagation
3. Orbits for Communication Satellites
4. Link Budget
5. Frequency reuse – Polarization and Spot Beam

3rd session
1. Antenna
2. Beam Forming
3. Ground based beam forming
4. Power and EIRP
5. Transponders, HPA and Back Off factor
6. Overall Carrier to noise ration

4th session
1. Noise
2. Transmission Losses
3. Interference
4. Complete Link Budget
5. Receiver Transfer Characteristic - RTC
6. Coordination
7. Introduction to Digital Systems
   (Source and Channel Coding)

5th session
Digital Satellite Systems
1. Modulations
2. Digital Systems and A/D – D/A
3. FEC and Codec
4. Multiplexing
5. Introduction to Fixed-point implementation

**LAB 1 – Introduction to STK**

**6th session**

**Digital Satellite Systems**
1. FEC - CRC
2. FEC - Hamming
3. FEC – Convolutional codes
4. Viterbi Decoder
5. Turbo Codes
6. LDPC Codes

**7th session**

**Digital Satellite Systems**
1. Modulation and Coding
2. Demodulator/Time/Freq./phase Detections
3. Probability of False Alarm/Missed Detection

**8th session**

**LAB 2 - Access**
1. Transfer data from Alaska to UMD
2. See-DC and MOLYNA sat.

**9th session**

**Satellite Access**
1. TDMA/FDMA
2. SDMA
3. CDMA and Spread Spectrum
4. ALOHA
5. Throughput

**10th session**

**LAB 3**
1. The international Space Station (ISS)
2. LEO Satellite

**11th session**

**Mid - Term Exam**

**12th session**

1. System Performance Measures
2. Reliability
3. Review of all exercises/old exams
4. Special Topic: VSAT
5. Special Topic: MPEG2
6. Special Topic: DVB- S2
7. Special Topic: OBP
8. Special Topic: VOCODERS
6. Special Topic: Implementation, FPGA, ASIC

13th session
LAB 4
1. Analysis the communication links
2. RF criteria, Noise, TX, RX constrains

14th session
Term Project Due
Presentation, Term Project

15th session
Lab 5

16th session
Final Exam

Grading
Presence and Participation  5%
Homework/Lab Work  25%
Mid-term Exam  20%
Project  25%
Final Exam  25%