ECE 592-092
Introduction to Satellites

Instructor(s): Dr. John F. Muth, muth@ncsu.edu

Objective or Description: The number of satellites being launched is growing very rapidly with some estimates that more than 50,000 will be in orbit by 2030. A lot of the growth is driven by the proliferation of low earth orbit satellites (LEO) like Starlink, Kuiper and One Web constellations that are meant to provide low latency high bandwidth wireless communications to rural areas and the developing world, but more ambitious and capable Mid Earth Orbit (MEO) and Geosynchronous Satellites are also coming on-line offering increased bandwidth, imaging, and other services. There is also continued interest in Low cost Cube-Sats and Nano-Sats and increasing interest in High Altitude Platforms (HAPS) that float or fly in the stratosphere. This course is meant to introduce the basic concepts and system design of satellites and connect them to applications with some considerations of the business opportunities and economics connected to the satellite and telecommunications industry.

Prerequisites: Senior Undergraduate or Graduate School Standing.

Textbook: None Required. The course will draw from a variety of sources.

Topics:

1. Types of Satellites and basics of orbital mechanics (2 Weeks)
2. System Design considerations of satellites
    - a) Mechanical considerations and propulsion (1 Weeks)
    - b) Space Weather, Radiation and Electronics (1 Week)
    - b) Powering Satellites and Spacecraft (1 Weeks)
    - d) Antennas and RF subsystems (1 Week)
    - e) Optical systems for Imaging and Communications. (1 Week)

Mid Term – Slide presentation by students on a Satellite

3. Satellite Communications (4 Weeks)
    - a) Basics of RF and optical communications
        Modulation, Link Budgets and Error Correction
    - b) Satellite as part of the Network – uplink and downlink
4. Satellites, 5G, IoT, Rural Broadband and emerging Applications. (1 week)

Final Exam - Student 15 Min Presentation on a satellite application topic to class

Final Paper (3-5 pages + references due at time of scheduled final exam)

Grading: Since the course is open to students from different departments, rather than analytical problem sets, the focus will be reading and discussing papers and when appropriate on using open source tools, to do things like predict when a satellite will be overhead, position a satellite dish, or decode a signal from a satellite. The mid-term is for the student (or student group) to pick a satellite and explain to the class how the subsystems work. The final exam is short presentation to explain the 3-5 page paper on a satellite presentation.

Cross-listing in other departments: Not cross-listed, but MAE and other students are welcome.