ECE 5965/4965
Introduction to Space Communications

Department of Electrical and Computer Engineering
Fall 2021

Instructor: Dr. Omid Semiari, Assistant Professor
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Office hours: Thursdays (by appointment)
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Lecture time and location: Thursdays, 4:45PM-7:20PM, Microsoft Teams

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Description

Space communications has numerous applications such as space exploration, air defense, environmental and climate monitoring, and mobile broadband connectivity for remote areas. The focus of this course is to introduce basic principles of space communications.

Course Learning Outcomes

Upon completion of this course, students will become familiar with important concepts pertaining to space communications, including: digital communication principles (modulation schemes, pulse shaping, noise modeling, etc.); DSP concepts (ADC/DACs, DFT algorithms, etc.); architecture of RF transceivers (LNA, antennas, etc.); and principles of wireless channel modeling, interference modeling, and the link budget for space communications. Students will be also introduced to more advanced topics such as dynamic spectrum management, space electronic warfare, and space situational awareness.

Prerequisite/Co-requisites

ECE 3205 - Circuits and Systems II

Required Textbook

- None. Lecture notes will be provided by the instructor.

Suggested References:

- R. Ziemer and W. Tranter, "Principles of Communications", 7th Edition. Wiley, 2014. ISBN-13: 978-1118078914.
- Alan V. Oppenheim and Ronald W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 3rd Edition, 2009, ISBN-10: 0131988425.

Course Evaluation for ECE 5965

Table 1: Evaluation

Task	Percentage	Comment
Assignments	30%	Literature review, homework, or computer projects
Quiz	15%	–
Project Presentation I (Midterm)	25%	No group work
Project Presentation II (Final)	30%	No group work

Course Evaluation for ECE 4965

Table 2: Evaluation

Task	Percentage	Comment
Assignments	40%	Literature review, homework, or computer projects
Quiz	20%	–
Project Presentation I (Midterm)	20%	Group work is allowed
Project Presentation II (Final)	20%	Group work is allowed

Grading Policy

A (93-100); **A**$^-$(90-92); **B**$^+$(87-89); **B**(83-86); **B**$^-$(80-82); **C**$^+$(77-79); **C**(73-76); **C**$^-$(70-72); **D**$^+$(67-69); **D**(63-66); **D**$^-$(60-62); **F** (below 60).

Course Outline

Table 3: Course outline

Topic	Timeline*
1. Introduction and course overview	1 week
2. Digital communications in space networks	3 weeks
3. Digital signal processing for space communication systems	3 weeks
4. Transceiver architecture and RF Front-End: Antenna, LNA, VCO	1 week
4. RF propagation, interference, and link budget	2 weeks
5. Advanced topics: spectrum sharing, interference mitigation, resource allocation	2 weeks
6. Advanced topics: space electronic and cyber warfare	2 weeks
7. Advanced topics: space situational awareness (SSA)	1 week

* No classes on Nov. 25 (Thanksgiving Break).

Online Component

Canvas: This course will use the Canvas online learning environment for distribution of assignments and supplementary course materials. It will be the responsibility of the student to become familiar with Canvas and to check the 5965/4965 course location regularly for updates. All the course-related announcements and due dates will be sent via Canvas.
Microsoft Teams: All lectures will be delivered online and during the normal class hours using Microsoft Teams.

Course Handouts

Handouts will be uploaded on Canvas prior to the lecture. These notes were prepared by Dr. Omid Semiari; some materials have been adopted from class notes by Prof. Mark Wickert.

Software

ECE 5965/4965 will use either Python or MATLAB for simulations and analysis.

Course Policy

1) *General*:
   - All lectures will be online and interactive during the normal class hours.

- The lectures will be recorded and shared after each class. However, if sharing the recorded lectures results in low level of class participation, the instructor will have the right to stop sharing the recorded lectures in any stage during the semester. In that case, the recorded lectures will be made accessible only to students who have a valid justification for not attending the online sessions.
- To schedule a one-to-one meeting, please send me an email in advance to setup an online appointment. Thursdays are preferred for meetings.
- Before returning to campus, all students must complete the UCCS COVID-19 training available in Skillsoft through your UCCS portal.
- All students must complete the UCCS self-health check at uccs.me/healthcheck before coming to campus.
- Students who are ill should NOT come to campus and should communicate with the instructor to fulfill course expectations.
- Appropriate face coverings (nose and mouth) and six foot social distancing are required in all University buildings. Please bring a face covering with you when you come to campus.

2) *Assignments*:
   - It is important that you work on all the homework assignments. Assignments will be graded.
   - Homework assignments should be submitted electronically in Canvas.
   - Overdue assignments will **NOT** be accepted.
   - All assignments must conform to the following format: A) Include course number, semester and year, and the name of student; B) Detailed description and explanations of the solution, showing all the intermediate steps; C) Graphs, tables, and equations must be properly presented and referenced in the manuscript; D) Citations must be provided for any out-of-class resources that are used in the report; E) Assignments must be written in Latex (you may use Overleaf, see the tutorial link provided at the end of syllabus), or any other appropriate text editor.

3) *Academic Integrity/Honesty*:
   - "As members of the University community, students are obligated to maintain high standards of integrity and are expected to take an active role to encourage other students to respect high standards of integrity" [Campus Policy 200-019]. All students enrolled in credit or non-credit courses at UCCS are bound by the Student Academic Ethics Code. In compliance with this code, your coursework (homework/project/exams) is required to be a bona-fide individual effort. **Copying homework, project, or exam solutions from another student or other source is CHEATING and will not be tolerated**.
   - You may discuss the concepts and ideas underlying graded assignments with other students, but only to the extent that you would discuss them with an instructor. Don't ask another student a question that you would not expect the instructor to answer. Most of us know when we are compromising our integrity. If you are in doubt, ask first.
   - You are encouraged to work together on homework assignments (again, without violating the ethics code), as well as in studying for exams.
   - Undergraduate students can work within a group of up to 3 students for the final project. No group work is allowed for Graduate student and they should work individually on the course project.

4) *Course Project*: Student should work on a relevant project for this course. The topic of the course project should be selected by students and confirmed by the instructor, no later that the first 4 weeks of classes. The topic should be relevant to space communication networks. Only undergraduate students can work within a group (see the note mentioned above).
   The course project will require two presentations. The first presentation will be due by the middle of the semester (Oct 28). The second (final) presentation will be due on Dec. 23 (finals' week). The first presentation will be submitted as a technical paper on Canvas, focusing mostly on the literature review.

The second presentation should include: 1) Final draft of the technical paper (submitted as a .pdf file) addressing a relevant problem in space communications, and 2) a recorded video presentation (up to 10 minutes); both should be submitted on Canvas. For graduate projects, the main emphasis should be on the novelty of the proposed problem and simulations. For undergraduate projects, the main emphasis will on literature review and the overall quality of presentation. All presentations must be based on the IEEE template for conferences and should conform the guidelines mentioned above for the format of assignments. More specific guidelines and rubrics will be provided at the beginning of the semester.

5) *Quizzes*:
   - Course examinations will be based on the material covered in class as well as homework assignments. It is essential that you understand the fundamental concepts demonstrated in the homework problems.
   - Quizzes will be announced beforehand and will be administered on Canvas. Each quiz will take up to 30 minutes and includes 1-2 problems based on the previous topics covered in class. Additional instructions will be provided during the first lecture.
   - Missed quizzes will count as zero without a physician's documentation of an illness, or other appropriate documentation of an emergency beyond your control and requiring your absence. If you arrive late for an exam, you will be permitted to take the exam in the time remaining during the normally scheduled exam period. There will be no time extensions permitted.

6) *Military*: If you are a military student with the potential of being called to military service and/or training during the course of the semester, you are encouraged to contact your UCCS course instructor no later than the first week of class to discuss the class attendence policy.

7) *Disability*: If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to register with Disability Services and provide them with documentation of your disability. They will work with you to determine what accommodations are appropriate for your situation. To avoid any delay, you should contact Disability Services as soon as possible. Please note that accommodations are not retroactive and disability accommodations cannot be provided until a Faculty Accommodation Letter has been given to the course instructor. Please contact Disability Services for more information at Main Hall room 105 (Phone: 719-255-3354, Email: dservice@uccs.edu).

8) *Add/Drop*: This course complies with the UCCS campus rules for add/drop dates.

9) *Copyright*: Solution of homework along with other course materials are for personal use only. Students should not distribute or reproduce the materials. Violation of this copyright will not be tolerated and has serious legal consequences.

Important Dates

Class begins: Aug. 26
First Presentation Due: Oct 28
Thanksgiving Break: Nov. 25
Second (final) Presentation Due: Dec. 23

Useful Resources (click on the links)

1) MATLAB tutorial.
2) Online classes for calculus and linear algebra can be found on MITOpenCourseWare; likewise for probability theory.

3) A good list of freely available mathematics textbooks can be found here.
4) Python tutorial: Tutorial 1, Tutorial 2. To start with Python programming, it is recommended to download and install "Anaconda", using this Link. Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment.
5) Jupyter Notebook tutorial: Click Here. The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more.
6) Overleaf tutorial: Click Here. Overleaf is a collaborative cloud-based LaTeX editor used for writing, editing and publishing scientific documents. It partners with a wide range of scientific publishers to provide official journal LaTeX templates, and direct submission links.