Course Project

ECE 239AS Special Topics in Signals and Systems
Modern Wireless Communications
Fall 2025 · Subject to change.

1 Overview

This course project is meant to serve as an opportunity for students to deeply explore a topic related to wireless communication systems. The research, development, commercialization, and ubiquity of wireless communication systems makes it an incredibly rich topic to study, and as a result, the scope of projects across students is expected to be extremely broad. Projects can be either a **research project**, a **survey project**, or an **implementation project**.

- The final deliverable of a **research project** should be similar in nature to a research paper submitted to a leading conference or journal of the IEEE Communications Society, such as IEEE GLOBECOM or IEEE ICC, or at least a condensed version of such. These projects require students to make some technical contribution or innovation, even if it is small. The hope is that students will actually go on to submit their work to a conference or journal, but this is not required.
- The final deliverable of a **survey project** should be a survey paper (or literature review) of a particular topic. The project should have a detailed survey component and a simulation component (e.g., a MATLAB or Python implementation comparing existing works). While this may seem easier than a research project, I personally believe writing a good survey is quite challenging. Also, it is less likely that this work will directly translate to a conference/journal paper since surveys are less publishable, though it may in outstanding cases.
- The final deliverable of an **implementation project** should be a report of your work deeply investigating and implementing a particular topic. This implementation would presumably be in MATLAB or Python but could also use software-defined radios or other hardware. You must thoroughly mathematically formulate the topic and what is being implemented, along with its broader context in wireless communication systems. Imagine you are teaching me what it is you are implementing. What is it used for? What is the underlying math and technical details behind this technology? Successfully completing an implementation project requires me being able to (hypothetically) reproduce your results from your report alone. Your implementation should, of course, be technically correct.

I recommend students attempt a research project containing some element of innovation, even if it is small or incremental; however, those that prefer a survey or implementation project may choose to do such.

> **Software-defined radios.** This quarter, there is the special opportunity for students to leverage a remote radio platform being developed by my lab for their course project. Interested students will have the opportunity to remotely access software-defined radios to conduct experiments and implement signal processing techniques with real-world hardware. More details will be shared in class.

Each project, regardless of type, has two deliverables:

1. A project **proposal** providing motivation and background on the chosen project topic, along with what you plan to do in this project.
2. A project **report** taking the form similar to an IEEE conference or journal paper detailing the project.

When submitting your deliverables, you must indicate the type of project you are doing in the title. For instance, "Research: My Project Title Here" or "Implementation: My Project Title Here". The MATLAB or Python code associated with your project must be submitted with the report.

When applicable, **I encourage students to work on topics directly related to their research** or use this course project as an opportunity to explore a new area within reach of their ongoing research. However, under no circumstances should projects be reused from prior courses or prior research; you may extend prior work but this should be made explicitly clear to the instructor in all deliverables. For students less interested in doing basic research, this is an opportunity to explore a particular topic of interest in wireless. Due to the wide variety in students taking this course and in their skill levels, I expect a significant amount of variance in the scope and technical rigor of projects across students. With that being said, all students are expected to do a serious and challenging project. Projects will therefore be graded through the combination of objective metrics and subjective evaluation of the quality of the project.

I will very likely be able to tell which projects and which deliverables were completed last-minute. I heavily encourage you to prepare your deliverables well ahead of their due dates. I expect you to have read and revised your deliverable multiple times before submission. Any project deliverable turned in past its due date will receive a grade of zero.

At most two students may work together on a single project, in which case the deliverables only need to be submitted per project (group) not per student. Bear in mind that, in such cases, I will have increased expectations on the quality of the project deliverables and of its technical rigor. An explanation of each student's contributions should be included as a one-page attachment to the final project report.

2 Finding a Project Topic

It is important that you find a project topic that is of interest to you and is fairly modern/relevant. To get some ideas for project topics, I suggest you browse recent (e.g., within the last 5–10 years) literature in:

- magazines such as:
    - *IEEE Communications Magazine*
    - *IEEE Wireless Communications Magazine*
    - *IEEE Signal Processing Magazine*
    - *IEEE BITS Magazine*
- proceedings from conferences and workshops such as:
    - IEEE Global Communications Conference (GLOBECOM)
    - IEEE International Conference on Communications (ICC)

You are also welcome to explore top-tier journals, such as the following, though these may be less useful when searching for a topic; they will certainly be useful to read once you have found a topic.

- *IEEE Transactions on Communications*
- *IEEE Transactions on Wireless Communications*
- *IEEE Transactions on Information Theory*
- *IEEE Transactions on Vehicular Technology*
- *IEEE Journal on Selected Areas in Communications*
- *IEEE Journal on Selected Topics in Signal Processing*
- *IEEE Transactions on Signal Processing*

If you're having trouble finding a good topic, please discuss with your fellow classmates and/or visit me during my office hours. You can also consider the following topics:

- machine learning for wireless communication systems
- OFDM-MIMO communication systems
- digital self-interference cancellation for full-duplex radios, perhaps using machine learning
- fast, robust beam alignment for millimeter-wave communication systems
- joint communication and sensing
- LEO satellite communication systems
- machine learning for channel coding
- orthogonal time frequency space (OTFS) modulation
- massive MIMO
- upper mid-band (FR3) cellular communication systems

3   Project Proposal

A written project proposal will be due mid-quarter at a date announced in class. The project proposal is worth 25% of your total project grade. All proposals should be typeset in LaTeX in a double-column format with either Times New Roman or Computer Modern font of size 11 pt; margins should be 1 inch. I recommend you use IEEE LaTeX formatting. The written proposal should be at most two pages (excluding references) and should consist of the following:

1. A tentative project title with the author(s) listed.
2. A clear description of what topic you intend to investigate.
3. A brief literature review identifying and overviewing key related work on the topic you are investigating.
4. A summary of what you hope to discover, learn, and/or accomplish with the project; in other words, anticipated milestones, deliverables, outcomes, etc.

All citations and references should be in IEEE format; most of the time, the BibTeX entries provided by IEEE Xplore are not exactly in IEEE format and will require a few minor modifications (e.g., adding the month, fixing capitalization, etc.). Your proposal should have no fewer than 7 citations. All math must be typeset in LaTeX. The project proposal is meant to serve as an opportunity for me to provide you early feedback on the direction of your project. It is therefore to your advantage to put in as much thought into your proposal as time allows. If time permits, students will also be asked to present a 5-minute summary of their proposal to the class; details will be provided in class.

4   Project Report

A project report will be due at the end of the quarter at a date announced in class. The project report is worth 75% of your total project grade. All citations and references within the project report should be in proper IEEE format with official abbreviations for all journal/proceedings/venues. Your project report should have no fewer than 15 citations. All math must be typeset in LaTeX. Attention-to-detail is essential; sloppiness will result in points lost. All figures and plots should be high quality. There should be very few, if any, grammatical or spelling mistakes. Start your project report sooner rather than later. I expect you to have gone through multiple iterations of refinement before submitting your final report; any sign that you have not will result in points lost. If time permits, students will also be asked to present a 5-minute summary of their proposal to the class; details will be provided in class.

4.1   Research Project Report

The project report of a research project should be written in double-column format following that of an IEEE conference paper typical in the proceedings of IEEE GLOBECOM, for example. To do this, your report must be typeset using LaTeX with the `IEEEtran` styling class; I recommend you also use this for your proposal. Project reports should be at least 4–6 pages. Do not attempt to inflate the length of your report to meet the required length.

The project report of most research projects should follow the general outline below:

1. Abstract
2. Introduction
3. System Model
4. Contribution
5. Results/Evaluation
6. Conclusion
7. Bibliography

The project report of a research project will be graded as if it is a conference paper submitted to a premier conference sponsored by IEEE Communications Society, such as IEEE GLOBECOM or IEEE ICC.

4.2   Survey Project Report

The project report of a survey project can follow whatever outline suits your project best, but it must be typeset in LaTeX with either Times New Roman or Computer Modern font of size 11 pt; margins should be 1 inch. The project report of a survey project should be similar in nature to surveys submitted to a journal sponsored by IEEE Communications Society (e.g., *IEEE Communications Surveys & Tutorials*).

4.3   Implementation Project Report

The project report of an implementation project can follow whatever outline suits your project best, but it must be typeset in LaTeX with either Times New Roman or Computer Modern font of size 11 pt; margins should be 1 inch.

5 Grading Rubric: Project Proposal

Grading Criterion	Points Received	Points Possible
Motivation, Originality, Timeliness. Is this new work, how current is the topic, how creative is the solution, choice of topic, and/or insights given? This includes properly motivating and explaining what you are doing.		15 pts
Technical Contents. Are the overall contents strong and thorough?		35 pts
Writing, Organization, Figures, Readability. Is the proposal well-written, carefully proofread, well-organized (with sections), proper use of legible and instructive figures? Is it generally a pleasure to read or a painful experience?		25 pts
Referencing Prior Work. All relevant research cited and discussed (or at least a strong attempt made), no frivolous citations, good discussion of previous state-of-the-art with clear demarcation of where it ends and your work begins, and proper IEEE reference style with consistent and correct formatting?		20 pts
Deliverables. Did you submit a hard-copy of your project proposal and a properly named (LastName-FirstName_ProjectTitle.pdf) soft-copy (PDF) to the instructor by e-mail? Did you include the type of project in the title of your proposal?		5 pts
Total Score		**100 pts**

6 Grading Rubric: Project Report

Grading Criterion	Points Received	Points Possible
Motivation, Originality, Timeliness. Is this new work, how current is the topic, how creative is the solution, choice of topic, and/or insights given? This includes properly motivating and explaining what you are doing. For literature reviews, why were these papers chosen, is the most recent notable work included, is context explained?		15 pts
Technical Contents, Execution. Are the overall contents strong and thorough? How well do you deliver on your proposal? How much progress was made since the proposal?		35 pts
Writing, Organization, Figures, Readability. Is the report well-written, carefully proofread, well-organized (with sections), proper use of legible and instructive figures? Is it generally a pleasure to read or a painful experience?		25 pts
Referencing Prior Work. All relevant research cited and discussed (or at least a strong attempt made), no frivolous citations, good discussion of previous state-of-the-art with clear demarcation of where it ends and your work begins, and proper IEEE reference style with consistent and correct formatting?		20 pts
Deliverables. Did you submit a hard-copy of your project report along with an attached hard-copy of the original graded proposal and a properly named (LastName-FirstName_ProjectTitle.pdf) soft-copy (PDF) to the instructor by e-mail? Did you include the type of project in the title of your proposal?		5 pts
Total Score		**100 pts**