

Georgia Institute of Technology
School of Electrical and Computer Engineering

ECE 4606 — Wireless Communications

Syllabus and Course Information

Fall 2026 | 3 Credit Hours

Course Information

Course Number & Title	ECE 4606: Wireless Communications
Credit Hours	3-0-0-3 (3 lecture hours, 0 lab hours, 3 credits)
Term	Fall 2026
CRN / Section	TBD
Meeting Time	TBD
Meeting Location	TBD
Mode of Delivery	In-person lecture, with materials and assignments on Canvas
Final Exam	Per Registrar Final Exam Matrix (see registrar.gatech.edu/info/final-exam-matrices)

Instructor and Teaching Team

Instructor	Sriram Vishwanath
Title	Professor
Email	sriram@ece.gatech.edu
Office	Centergy One, Room 5.120
Office Hours	Fridays Noon-2:45pm ET
Teaching Assistant(s)	TBA
Preferred Contact	A Teams chat will be setup for class. Please use that, please do not use Canvas Inbox.

1. Course Description

From the official ECE 4606 course outline: cellular concept, wireless propagation modeling, types of digital modulation used in wireless systems, diversity combining, performance over fading channels, and multiple access techniques.

In this section we will treat those topics with mathematical rigor, but always with one eye on practice. Every block of theory is anchored by a concrete system, including LTE, 5G NR, Wi-Fi 6/7, or an emerging 6G concept, so that you finish the course able to read a standards document, reason about a real link, and build a simulator from first principles.

3. Course Learning Outcomes

On successful completion of ECE 4606, you will be able to:

1. Perform basic link-budget analysis for a wireless system.
2. Classify types of channel fading (large- vs. small-scale; flat vs. frequency-selective; slow vs. fast).
3. Analyze flat-fading channel effects with spatial diversity combining (selection, EGC, MRC).
4. Explain the benefits and drawbacks of an MSK signal and how it is modulated and demodulated.
5. Calculate the average power of a signal from its power spectral density.
6. Distinguish path loss, multipath fading, and shadowing, both physically and statistically.
7. Estimate the bit error rate of an AWGN link from the signal-space representation and noise PSD.
8. Estimate the loss from knife-edge diffraction.
9. Analyze OFDM signals (waveform, cyclic prefix, channel estimation, PAPR).
10. Analyze the basic MIMO configurations for flat-fading channels (capacity, beamforming, Alamouti).
11. Compute blocking probability, number of channels, or offered traffic for a Blocked-Calls-Cleared trunked system.
12. Classify types of multiple-access technique (TDMA, FDMA, CDMA, OFDMA, NOMA).
13. Explain the major distinctions among the current wireless standards (LTE, 5G NR, Wi-Fi 6/7) and articulate where 6G is heading.
14. Understand the impact of AI on 6G systems.

4. Topics

Topics follow the ECE 4606 course outline (catalog) with modest modernization in the closing weeks:

- Wireless system design challenges; spectrum and regulation
- Path loss (free space, two-ray, log-distance, Okumura/Hata, COST-231)
- Random-variable review; small-scale fading distributions (Rayleigh, Rician, Nakagami)
- Multipath fading; coherence bandwidth; coherence time; Doppler
- Power spectral density basics
- Diversity combining

- Diffraction and shadowing
- Link budget
- Digital transmission with BPSK and noise effects in BPSK receivers
- Geometry of signals; matched filtering
- PSD for linear modulation; Nyquist pulses
- Other linear modulations (QPSK, OQPSK)
- Frequency-shift keying; MSK viewed as OQPSK
- Orthogonal Frequency-Division Multiplexing (OFDM)
- Forward error correction (convolutional, turbo, LDPC, polar)
- Multiple-input multiple-output (MIMO)
- Overview of prevalent standards (LTE, 5G NR, Wi-Fi 6/7)
- Trunking theory; cellular concept
- DSSS and RAKE receivers
- Multiple-access techniques
- Modern context (added by instructor): integrated sensing-and-communication (ISAC), reconfigurable intelligent surfaces (RIS), AI-native air interfaces, O-RAN

5. Required and Recommended Texts

Primary text

- **Andrea Goldsmith**, *Wireless Communications*, Cambridge University Press, 2005. (A free PDF is hosted by the author at wsl.stanford.edu; check current availability.)

Recommended supplements

- T. S. Rappaport, *Wireless Communications: Principles and Practice*, 3rd ed., Pearson, 2024: closer to engineering practice; good for link-budget and propagation chapters.
- D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge, 2005: deeper treatment of MIMO and capacity (free PDF on the authors' site).
- G. L. Stüber, *Principles of Mobile Communication*, 4th ed., Springer, 2017: the comprehensive reference.
- H. Zarrinkoub, *Understanding LTE with MATLAB: From Mathematical Modeling to Simulation and Prototyping*, Wiley, 2011.

Lecture slides, supplementary notes, and selected papers will be posted on Canvas. Standards excerpts (3GPP, IEEE 802.11) will be linked from there.

6. Course Format and Communication

Lectures

Lectures are in person. Slides will be posted on Canvas before each class. You are expected to come prepared, having done the assigned reading, and to participate. Lectures will not be recorded except in unusual circumstances; please come to class.

Canvas

Canvas is the source of truth for course materials, assignment submission, grades, and announcements. Make sure your Canvas notifications are turned on. Course site: canvas.gatech.edu.

Teams

A Teams group chat will be setup for the class, which should be used for any discussions on the course.

Email

Use email for personal matters (e.g., illness, accommodations, grade questions). Please put “ECE 4606” in the subject line. I aim to reply within one business day.

Office hours

Office hours are listed in the table above. Drop in, or schedule a slot if you need a longer conversation. Office hours are the single best use of your time in this course.

7. Grading

Components and weights

Component	Weight	Notes
Homework (6 sets)	20%	Lowest score dropped
MATLAB / Python design project (proposal + demo + report)	20%	Teams of 2–3
Midterm 1	20%	In-class, closed book, 1 hand-written formula sheet allowed
Midterm 2	20%	In-class, closed book, 1 hand-written formula sheet allowed
Final Exam (cumulative)	20%	Per Registrar matrix
Total	100%	

Re-grade requests

All re-grade requests must be submitted in writing (Canvas comment or email) within one week of the graded item being returned. The entire item will be re-graded; the new score may be higher, the same, or lower.

8. Course Schedule

** Dates below follow the Fall 2026 academic calendar as available at the time of writing. Please verify all dates against the official Georgia Tech Registrar calendar (registrar.gatech.edu/current-academic-calendar) and the published Final Exam Matrix. The schedule may be adjusted; any changes will be announced on Canvas.*

Week	Dates*	Topic	Reading (Goldsmith unless noted)	Assessment
1	Aug 17–21	Course intro; the wireless landscape: 1G→5G→6G; system design challenges; spectrum, regulation, the role of standards (3GPP, IEEE, O-RAN)	Ch. 1	—
2	Aug 24–28	Path-loss models: free space, two-ray, log-distance, Okumura-Hata, COST-231; link-budget analysis	Ch. 2.1–2.5	HW 1
3	Aug 31– Sep 4	Random-variable review; large-scale shadowing (log-normal); knife-edge diffraction; outage analysis	Ch. 2.6–2.9	—
4	Sep 7–11	Mon Sep 7 — Labor Day, no class. Small-scale fading: time-varying multipath channel; Rayleigh, Ricean, Nakagami; envelope statistics	Ch. 3.1–3.2	HW 2
5	Sep 14–18	Coherence bandwidth; coherence time; Doppler; flat vs. frequency-selective fading; slow vs. fast fading; the WSSUS model	Ch. 3.3	—
6	Sep 21–25	Digital modulation I: signal-space geometry, BPSK in AWGN, matched filter, BER analysis	Ch. 5.1–5.2	HW 3
7	Sep 28–Oct 2	Digital modulation II: QPSK, OQPSK, MSK as OQPSK, FSK; Nyquist pulses; PSD of linear modulation	Ch. 5.3–5.5	Midterm 1 (Thu Oct 1)

Week	Dates*	Topic	Reading (Goldsmith unless noted)	Assessment
8	Oct 5–9	Performance over fading: BER under Rayleigh and Ricean; outage capacity; Marcum-Q	Ch. 6	—
9	Oct 12–16	[Mon-Tue Fall Recess, no class]. Diversity combining: selection, EGC, MRC; array gain vs. diversity gain	Ch. 7	HW 4
10	Oct 19–23	MIMO I: channel model, capacity (deterministic and ergodic), eigen-beamforming	Ch. 10.1–10.4	—
11	Oct 26–30	MIMO II: spatial multiplexing, V-BLAST, Alamouti space-time coding; intro to massive MIMO	Ch. 10.5–10.7	HW 5
12	Nov 2–6	OFDM: principle, IFFT/FFT implementation, cyclic prefix, channel estimation, PAPR; intro to OFDMA and SC-FDMA	Ch. 12	Project Proposal Due
13	Nov 9–13	Forward error correction: convolutional, turbo, LDPC, polar (5G NR); coded modulation	Ch. 8 + notes	Midterm 2 (Thu Nov 12)
14	Nov 16–20	Multiple access: TDMA / FDMA / CDMA (DSSS, RAKE) / OFDMA; cellular concept, frequency reuse; Erlang-B trunking	Ch. 13–15	HW 6
15	Nov 23–27	[Wed-Fri Thanksgiving, no class]. Survey of standards: LTE / LTE-A; 5G NR (waveform, frame structure, beam management)	Ch. 16 + notes	—
16	Nov 30–Dec 1	Toward 6G: ISAC, AI-native air interfaces, mmWave/THz, RIS, O-RAN; project presentations	Notes	Project Demo
Finals	Dec 4–10*	Comprehensive Final Exam — date and time per Registrar Final Exam Matrix	—	Final Exam

9. Attendance and Late Work

Attendance

Regular attendance is expected. Per Georgia Tech policy (catalog.gatech.edu/rules/4), absences for Institute-approved activities (athletics, official student-organization travel, religious observances, documented illness or family emergencies) are excused. Please notify me as early as possible — and within the first two weeks of the term for known religious observances.

There is no participation grade, but the lectures cover material that is not in any single textbook. Students who skip class consistently do not do well on the exams.

Late homework

Homework is due at 11:59 pm on the listed due date via Canvas. Late homework is accepted up to 48 hours late with a 20% per 24-hour penalty; after 48 hours it receives a zero. The lowest homework score is dropped, which is intended to absorb one missed assignment for any reason.

Missed exams

Exams are taken at the scheduled time. Make-up exams are arranged only for documented Institute-approved absences and require notification before the exam whenever possible. Unexcused missed exams receive a zero.

Project deadlines

Project milestones (proposal, demo, report) are firm. Late project deliverables are penalized 10% per 24 hours.

10. Academic Integrity and the Honor Code

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. You are expected to act according to the highest ethical standards. For information on the Georgia Tech Academic Honor Code, see policylibrary.gatech.edu/student-affairs/academic-honor-code and honor.gatech.edu.

In this course specifically:

- Homework: discussion of approaches with classmates is encouraged. Each student must write up and submit their own solutions. Copying solutions, in whole or in part, from any source — another student, the internet, a solutions manual, a generative-AI tool — is a violation.
- Exams: closed book except for one hand-written single-sided 8.5×11 formula sheet for Midterm 1, two such sheets for Midterm 2, and three for the Final. No electronic devices except an approved scientific calculator.
- Project: collaboration within your team is the point. Across teams, you may discuss high-level ideas but not share code or write-ups. All external code (libraries, examples) must be cited in the report.

Any suspected violation will be reported to the Office of Student Integrity (osi.gatech.edu). I report all suspected violations; OSI determines the outcome.

12. Student–Faculty Expectations Agreement

Georgia Tech believes in mutual respect, acknowledgement, and responsibility between faculty and students. The Institute has articulated baseline expectations on both sides at catalog.gatech.edu/rules/22. Please read it. In short: I will be prepared, on time, and responsive; will grade fairly and transparently; and will treat each of you as a colleague-in-training. I expect the same of you toward me, the TAs, and one another.

13. Accommodations for Students with Disabilities

If you are a student with learning needs that require accommodation, please contact the Office of Disability Services (ODS) at (404) 894-2563 or disabilityservices.gatech.edu as early in the term as possible. Once you have an accommodations letter from ODS, please share it with me confidentially so we can make arrangements. Accommodations cannot be applied retroactively, so please don't wait until the day before an exam.

14. Mental Health and Well-Being

Engineering school is hard, and Georgia Tech is harder than most. If you are struggling, academically or otherwise, please reach out. I am happy to talk, and the following resources are available 24/7:

- Center for Mental Health Care & Resources: 404-894-2575, mentalhealth.gatech.edu
- Counseling Center: 404-894-2575, counseling.gatech.edu
- Dean of Students Care Network: studentlife.gatech.edu/students-of-concern
- Stamps Health Services: 404-894-1420
- In an emergency, call GT Police at 404-894-2500 or 911.

15. Title IX, Non-Discrimination, and a Welcoming Classroom

Georgia Tech does not tolerate discrimination, harassment, or sexual misconduct of any kind. Faculty are mandatory reporters under Title IX; if you disclose an incident to me, I am required to report it to the Title IX office (titleix.gatech.edu, 404-385-4464). Confidential resources are available at the Counseling Center and at the VOICE program (healthinitiatives.gatech.edu/well-being/voice).

In this classroom, all students are welcome regardless of race, ethnicity, religion, national origin, gender, gender identity, sexual orientation, age, ability, or socioeconomic background. Wireless engineering is built by a diverse global community and we will draw on that diversity in this course.

16. Course Improvement and Student Feedback

Near the end of the term, please complete the Course-Instructor Opinion Survey (CIOS). Your feedback genuinely shapes how this course evolves. I also welcome anonymous feedback at any point in the term — there will be a Canvas survey for this purpose.

17. Disclaimer

This syllabus is a contract between us, but it is not immutable. If circumstances require a change (a campus closure, a calendar adjustment, an opportunity to bring in a guest speaker), I will announce the change on Canvas and update this document. The version of record at any time is the version posted on Canvas and at syllabus.gatech.edu.

Appendix A: Suggested Project Themes

Projects are open-ended; the following are suggestions inspired by ongoing work at the Center for Wireless Intelligence. Teams may propose alternatives.

- Build an OFDM link simulator (Tx → fading channel → Rx) and characterize BER vs. SNR for QPSK, 16-QAM, and 64-QAM under flat and frequency-selective fading.
- Implement and benchmark Alamouti space-time coding against a SISO baseline; quantify diversity gain.
- Replicate a simplified 5G NR downlink frame and decode it from a synthetic capture.
- Joint communication-and-sensing (ISAC): use an OFDM waveform to simultaneously communicate and detect a target; characterize the rate-vs.-detection trade-off.
- Open-source RAN: stand up a srsRAN or OAI link in the loop and demonstrate a measurement (link budget, throughput, latency).
- AI-native receiver: train a small neural network to demodulate a noisy QPSK or OFDM signal; compare to a matched filter.