Instructor: Zak M. Kassas

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Course Webpage: Available through Canvas
Office Hours: Mon., 6:30 – 8:00 pm

Lectures: Mon. & Wed., 5:00 – 6:20 pm, Anteater Learning Pavilion (ALP) 2300

Text: P. Misra and P. Enge, *Global Positioning System: Signals, Measurements, and Performance*, Ganga-Jamuna Press, Second Edition, 2011

Suggested References:

- J. Morton, F. van Diggelen, J. Spilker, Jr., and B. Parkinson, *Position, Navigation, and Timing Technologies in the 21st Century: Integrated Satellite Navigation, Sensor Systems, and Civil Applications*, Wiley-Blackwell, 2020
- E. Kaplan and C. Hegarty, *Understanding GPS/GNSS: Principles and Applications*, Second Edition, Artech House, 2017
- P. Groves, *Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems*, Artech House, Second Edition, 2013
- T. Pany, *Navigation Signal Processing for GNSS Software Receivers*, Artech House, 2010
- J. Farrell, *Aided Navigation: GPS with High Rate Sensors*, McGraw-Hill Professional, 2008
- B. Parkinson and J. Spilker, Jr., *Global Positioning System: Theory and Applications – Volume I & II*, AIAA, 1996

Prerequisites: Knowledge in Signals and Systems or Consent of Instructor

Course Objective: This course develops a comprehensive understanding of GNSS signal structure, GNSS communication channel, received power, RF front-end receiver design, sampling, correlation, acquisition techniques, tracking loop theory, noise and bandwidth concepts, generation of GNSS observables, and software-defined radio (SDR) implementation.

Exams: There will be one midterm exam and a final. Missed exams may **not** be made up (unless it is the result of an officially excused absence).

Project: There will be a final project to design and implement a GPS SDR via high-level programming tools (e.g., MATLAB and LabVIEW). The project will integrate many of the topics introduced in the course.

Attendance and Course Policy: Attendance is expected. You are responsible for material covered in class and in the reading assignments.

Grading:

Project	20%
Midterm Exam	40%
Final Exam	40%

Tentative Topical Coverage:

Week	Topics
1	**GNSS Fundamentals:** Introduction; methods of radionavigation; GNSS system architecture; Doppler, pseudorange, and carrier phase measurement models
2	**Noise in Communication Systems:** Received signal-to-noise levels, carrier-to-noise ratio, noise in cascaded systems
3	**Spread Spectrum Signaling:** Power spectrum of binary data sequences, direct sequence spread spectrum, multiple access
4	**GPS Signal Structure:** Model, linear feedback shift registers, Gold sequences
5	**GNSS Radiowave Propagation Effects:** Ionospheric effects, code-carrier divergence, phase and group delay, calibration for ionospheric effects, scintillation effects, neutral atmospheric effects
6	**Signal Conditioning:** RF front-ends, frequency conversion, analog-to-digital conversion, bandpass sampling, practical sampling, uniform sampling and down-conversion, quantization
7	**Signal Acquisition:** Statistics of signal acquisition, hypothesis testing, Neyman-Pearson Lemma, FFT-based acquisition
8	**Coherent and Non-Coherent Integration:** Coherence time, signal models for long coherent integration, high-sensitivity receivers
9	**Tracking Loops:** Steady-state tracking error and loop type, phase tracking loops, code tracking loops, loop filters, code generation
10	**Software-Defined GNSS Receiver Design:** Combined code and carrier tracking, GNSS receiver block diagram, GNSS observables and navigation solutions