ECE 506 PMP (4 cr)
Fundamentals of Wireless Communications (Spring 2024)
February 4, 2024

Professor: James A Ritcey EEB454 jar7@uw.edu
Format In-class with zoom capture
Prof Office Hours: As needed to meet class needs, and can be virtual
TA: Yes, name not currently available
Office hours will be set based on class preferences
Textbooks: *See our Course Homepage.* All books will be available as free pdf downloads. We can use the text by Goldsmith, or the introduction by Gibson

Important Points:

1. PreReqs: An undergrad introduction to engineering signals and systems in discrete and continuous time. The topics most important in 506 include signals, linear systems, Fourier analysis, discrete time processing.
2. Basic knowledge of probability (The UW ECE PMP core sequence is sufficient)
3. We will use Python and GnuRadio Companion. Matlab is also free for UW students through UW IT CONNECT
4. It is *not required* that you had a previous course on digital communications or electromagnetics.
5. I understand that EE PMP come from a variety of backgrounds. You will succeed in the class, if you are able to successfully complete the group assignments.
6. This is a project-based course built around the concepts of digital communications for wireless as implemented using GNU Radio.

Course Topics/Syllabus: Topics

1. A review of Fourier spectral analysis and Digital Signal Processing using GnuRadio.
2. Telecommunications Overview. A overall look at the telecommunications sector from the point of view of market composition, spectrum (FCC regulation), standards (including 5G NR), and recent developments.
3. Radio Overview - block diagrams and functional components, system metrics including bandwidth, power and energy, data rate, signal-to-noise, and error rates. Analog vs Digital Communications.
4. The Structure of Point-to-Point Wireless Communications Systems. The role of bandwidth, power, and data rate. The concept of noise-limited vs interference limited operation. Functions of a radio receiver - detection, estimation, synchronization, and decoding using GNURadio.
5. Classical Modulations: PAM, QAM, MPSK, MFSK., OFDM. We will use GnuRadio simulation platform to explore these modulations.
6. How systems perform in noise. Gaussian noise and channel filtering
7. The concept of Shannon Channel Capacity (maximum bits/sec/Hz at a given Signal-to-Noise) and transmitter-informed adaptive modulation. Modulation Comparisons.
8. The Wireless Channel - Spread spectrum systems, channel fading and Multipath and Diversity.
9. Multi-Antenna Systems for Communications Beamforming and MIMO.
10. Modern Channel Coding Channel Coding and Information Theory. Uncoded vs Coded systems. Classical Forward Error Correction Codes. LDPC and Turbo Codes.

Grading: Homework assignments 30%, Midterm Project 30%, Final Project 30%.

Homework (HW): HW is assigned roughly weekly to the course dropbox. These HW primarily consist of questions that review the course lecture and short projects that implement the concepts in software - often GNU Radio Companion. The simulations will be developed during class time.

Exams: The exams are specially graded HW assignments/projects, mostly based on software simulation implementations. Midterm exam/project is around the middle week of the quarter. The Final Exam is the last HW project.

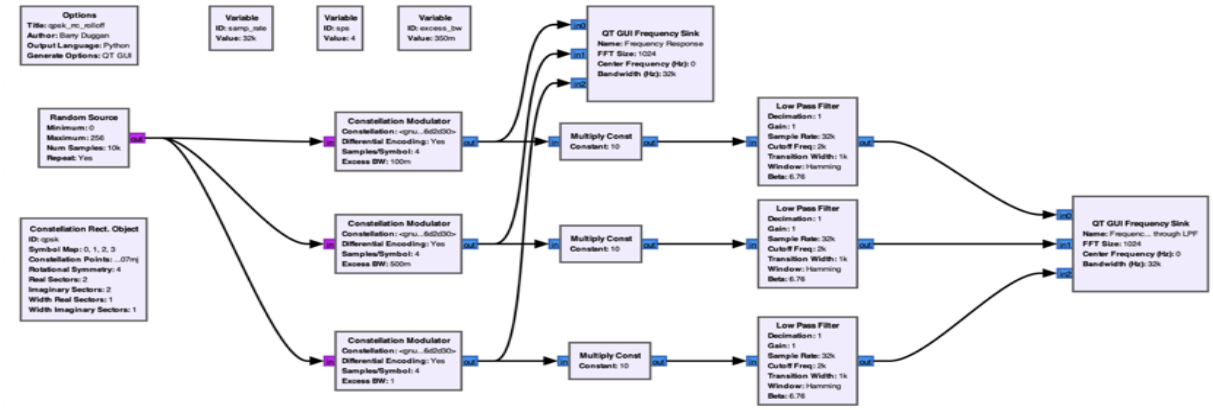
Religious Accommodations: Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy UW Policy Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (UW Policy

Disability Accommodations: The University of Washington is committed to providing access, and reasonable accommodation in its services, programs, activities, education and employment for individuals with disabilities. To request disability accommodation, contact Disability Resources for Students at least 10 days prior to the start of your course. You may also request accommodation in the application process by contacting Disability Services at least 10 days before you submit your application.

Course Policy on Academic Misconduct: Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, shall adhere to the University of Washington's Student Code of Conduct.

Cheating Policy Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student conduct. (See CoE website for more detailed explanation of the academic misconduct adjudication process). Any student found to have committed academic misconduct will receive a 0-grade on impacted academic work (e.g., assignments, project, or exams).

LPF Simulation in GNU Radio Companion



Frequency Response Plots

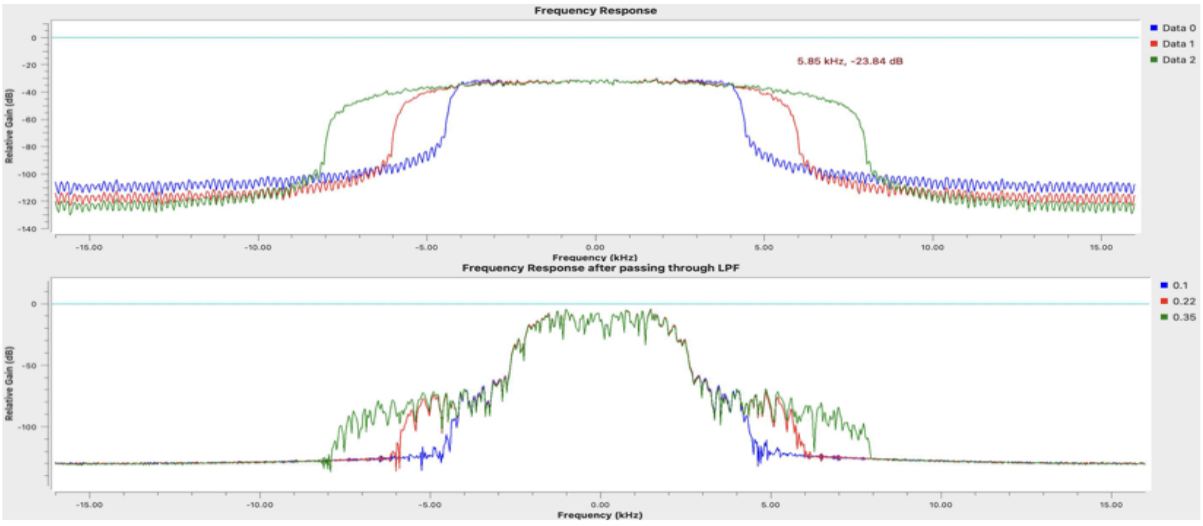


Figure 1: GNU Radio Companion. Simulation Blocks and Output Plots.