[ELEC3100] [Signal Processing and Communications] [Spring 2024] [Credits: 4]

Course Description

The course provides a comprehensive overview of signal processing and communications using quantitative modeling and analysis. Topics include: 7 layer communications model, discrete Fourier transform and z-transform, IIR and FIR filter design techniques and realizations, complexity and implementation considerations of FFT and FIR/IIR, source coding, digital modulation, PSD and spectrum, effects of noise to communication system designs, detection theory, matched filter, signal space and error analysis, channel models and channel coding. Application examples are provided to illustrate on how practical communication systems are designed using these quantitative tools. Design projects are set up so that the students can apply theory learnt in the class to physical problems. MATLAB CAD tools are being used as an integral part of this course. *Prerequisite(s):* (ELEC 2100 OR ELEC 2100H) AND (ELEC 2600 OR ELEC 2600H)

List of Topics

Lecture Outline

Week 1. Introduction and Discrete-Time Signals
Week 2. Discrete-Time Systems and DTFT for DT Signals and Systems
Week 3. Discrete Fourier Transform
Week 4. Fast Fourier Transform and z-Transform
Week 5. z-Transform
Week 6. FIR Filter Design and Digital Filter and Source Coding
Week 7. Source Coding
Week 8. Channel Coding
Week 9. Baseband Communications and Noise and Optimal Receiver
Week 10. Optimal Receiver and Digital Modulation
Week 11. Digital Modulation and Signal Space
Week 12. Signal Space
Week 13. Channel Models and Multiplexing and Multiple Access

Laboratory Outline

1. CT and DT signals
2. Introduction to DFT
3. Convolution and Filter
4. Information theory
5. BER simulation

Intended Learning Outcomes:

On successful completion of this course, students will be able to:
CO1 - Understand the modeling of communication links as well as understand why we are interested to study communication systems.
CO2 - Be familiar with both mathematical and qualitative concepts regarding analog communication systems as well as digital communication systems.
CO3 - Understand the difference, pros and cons between analog and digital communication systems

CO4 - Understand how practical communication systems (analog and digital) are designed as well as explaining why these systems are designed that way.
CO5 - Understand how to utilize the mathematical tools of random variables and random process to quantify the performance of communication systems under noise.
CO6 - Use software tools (such as Matlab) to design and quantify the performance of communication systems
CO7 - Apply the concept of signal space to qualitatively explain the design of digital communication systems.

Textbooks:

Sanjit K. Mitra, "Digital Signal Processing", McGraw-Hill, 4th Ed., 2011.
John G. Proakis, "Digital Communications", 5th Ed., 2008.

Reference Books/Materials:

R.E. Ziemer and W.H. Tranter, "Principles of Communications: Systems, Modulation, and Noise", Wiley, 6th Ed., 2009.
F.G. Stremler, "Introduction to Communication Systems", Addison-Wesley, 3rd Ed., 1990.
S. Haykin, "Communication Systems", Wiley, 4th Ed., 2001.
S. Haykin "An Introduction to Analog and Digital Communications", Wiley, 1989.
A.B. Carlson, "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", McGraw Hill, 5th Ed., 2010.

Relationship of Course to Program Outcomes:

Please refer to the Report Section 4.3.2 (iii).

Grading Scheme:

Homework	10%
Laboratory	15%
Mid-Term Examination	30%
Final Examination	45%