EE 438 DIGITAL SIGNAL PROCESSING WITH APPLICATIONS

Sem. 1 and 2. Class 3, Lab. 3, cr. 4

***Prerequisite*:** EE 301 and 302.

Engineering Science: 1.5 credits

Engineering Design: 2.5 credits

Course Description:

The course is composed of three topical units designed to support laboratory experiments and a design project. The first lecture unit, Foundations, is followed by two units chosen from a set of three possible topics. The choice and order of these second two units varies depending on the design project. For example, if the design project topic is on speech recognition, then the Speech Processing unit is covered first so that the maximum amount of time is available for projects. A brief description of each unit follows.

Foundations: review of continuous-time and discrete-time signals, and spectral analysis; probabilistic methods in digital signal processing, design of finite impulse response and infinite impulse response digital filters. *Image processing:* two-dimensional signals, systems, and spectral analysis; image enhancement; image coding; and image reconstruction. *Speech processing:* vocal tract models and characteristics of the speech waveform; short-time spectral analysis and synthesis; linear predictive coding. *Array processing:* basic radar principles; representation of propagating waves; delay-and-sum beamformer; array pattern.

Throughout the course, the integration of digital signal processing concepts in a design environment is emphasized. As part of the laboratory, students work in teams of four on a semester-long design project, which requires trade-offs between performance and cost.

Objectives:

This course will treat a broad range of Digital Signal Processing (DSP) topics. It will strengthen the student's understanding of the foundations of DSP, introduce the students to two of three major application areas: speech processing, image processing, and array signal processing, and provide extensive hands-on design experience.

Required Texts:

Digital Signal Processing, 3rd edition, John G. Proakis and Dimitris G. Manolakis, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, ISBN 0-13-373762-4, 1996.

EE 438 Supplementary Reference, edited by J. P. Allebach, C. A. Bouman, and M. D. Zoltowski, Custom Academic Publishers Company (CAPCO), Oklahoma City, Oklahoma, ISBN 0-604-11783-3, 1996 (available at Follett's Bookstore, Purdue West Shopping Center).

Course Outline:

1.0 Foundations 6 weeks
- 1.1 Continuous-time and discrete-time signals and spectral analysis (CTFT and DTFT)
- 1.2 Continuous-time and discrete-time systems
- 1.3 Sampling
- 1.4 Decimation and interpolation
- 1.5 Z Transform
- 1.6 Discrete Fourier Transform (DFT)

1.7 Probabilistic methods in digital signal processing
1.8 Quantization

Two units from topics 2.0, 3.0 and 4.0

2.0 Image Processing 3 weeks
- 2.1 2-D signals and systems
- 2.2 Image processing and enhancement
- 2.3 Image coding
- 2.4 Computed tomography

3.0 Speech and Audio Processing 3 weeks
- 3.1 Speech models and characteristics
- 3.2 Short-time Fourier analysis and synthesis
- 3.3 Differential Pulse Code Modulation (DPCM)
- 3.4 Linear predictive coding

4.0 Array Signal Processing 3 weeks
- 4.1 Basic radar principles
- 4.2 Representation of propagating waves
- 4.3 Beam forming

5.0 Project Preparation 2 weeks

6.0 Examinations 1 week

List of Experiments:

0) *Laboratory Initialization and Rules.*

1) *Discrete and Continuous-Time Signals.*

2) *Discrete-Time Systems.*

3) *Frequency Analysis.*

4) *Sampling and Reconstruction.*

5) *Digital Filter Design.*

6) DFT and FFT.

7) Discrete Random Processes and Spectrum Estimation

8) Number Representation and Waveform Quantization

Other labs will be added as the semester progresses.