

ECE 423: DSP for Communication

IN

OUT

Signals and Systems

- Can describe key properties of continuous and discrete time LTI systems
 - Transfer functions
 - Impulse response
 - Complex frequency
- For both continuous and discrete time systems, understands connections between:
 - Transfer functions,
 - Poles and zeros,
 - Impulse response,
 - Complex frequency response

Programming

- Able to write simple programs in C or other high-level language
- Some knowledge of development environment, debugger

Block Diagrams

- Can determine behavior of a system built of other interconnected linear systems
- Able to understand operation of a complex digital system such as microprocessor from high-level block diagram

Simulation Analysis

- Can analyze systems in time and frequency domain using MATLAB and Simulink tools

Pre-requisites:

- ECE312, ECE421 recommended

Concepts:

- A/D and D/A Conversion:
 - Sampling theorem
 - Conversion artifacts: aliasing, quantization noise
 - Oversampling ($\Delta\Sigma$) data converters
 - Sampling rate conversion
- Digital signal processing
 - Operators, signal flow diagrams
 - Review of time/frequency domain system characterization for discrete-time systems
 - Filtering, modulation/demodulation
 - Deviations from ideal: quantization noise, finite numerical precision.
- DSP Processor Concepts
 - Processor architecture
 - Fixed, floating point number representations
 - Polling and interrupts for real-time processing
 - Instruction set architecture, special features for DSP
 - DSP algorithms in C and Assembly
- DSP System Design:
 - Design techniques: impulse invariance, Fourier series expansion, pole/zero placement, CAD techniques
 - DSP building blocks: FIR and IIR filters, Differentiators, Hilbert transformers
 - DFT hardware implementations
 - QAM

Applications:

- Audio and video processing
- Control systems
- Voice and data communication
- Instrumentation

Tools:

- Matlab signal processing workbench
- C and Assembly development tools

Sampling and Quantization

- Understands Nyquist sampling rule and the effect of sampling in the frequency domain
- Understands quantization effects, ENOB, and noise mitigation techniques such as oversampling and noise shaping

Discrete-time System Analysis/Design

- Understands sampling and reconstruction.
- Understands discrete-time math characterization in both time and frequency domain of signal processing functions such as filtering, prediction, and spectral analysis.
- Understands basics of digital communication: modulation/demodulation and QAM.

DSP System Design/Characterization

- Understands analog to discrete filter design techniques such as Impulse Invariance and Bilinear Transform
- Understands design of filters as Direct, Transposed, and Cascaded forms
- Understands algorithm and hardware implementation of FFT
- Understands design tradeoffs such as latency and filter coefficient quantization effects.
- Experienced in using MATLAB DSP design tools and design flow from specification to DSP program.

Real-time DSP Hardware and Software

- Able to write simple programs in C and Assembly to implement common DSP functions
- Familiar with DSP processor architecture and techniques for program optimization using hardware knowledge.
- Appreciates hardware limitation such as integer overflow, round-off error, and non-zero processor cycle time