EEE509 Final - Review

FINAL - Open Book / Open Notes <u>(you may also print your PDF lecture notes).</u>

Calculators allowed –

You should basically study both from your notes AND from the relevant sections in DSP An interactive approach

Sections to Study:

- All Lecture Notes, MATLAB notes and material from DSP An interactive approach - Chapters 1-5 and 7-8 (up to section 8.4) – (<u>Ch 6 will not be examined</u>). Some more emphasis will be on Chapters after Test 2, namely Chapters 7 and 8 (up to section 8.4)

Material for examination by topic:

-FIR and IIR Discrete-time Linear Systems: difference equations, convolution sum, unit impulse, closed-form expressions for transient and steady-state responses, stability, causality, time invariance, frequency-response function, impulse response, sinusoidal steady-state response
-The Discrete-time Fourier Transform (DTFT): properties and their applications, fundamental transform DTFT pairs (unit impulse, sample sinusoids, digital sinc, exponential sequences), application to system and signal analysis
-Z-transform: Definition, ROC and its properties, right- (causal) and left- (anticausal) sequences, relation to the DTFT, properties of the z-transform, fundamental z-transform pairs (unit impulse, exponential sequences, sinusoids, unit step sequence), transfer function and its relation to the impulse response and the frequency response, poles and zeros, inverse z-transform and its application to the recovery of causal and anticausal sequences from their z-domain functions, residues and their application to the recovery of causal sequences from their z-transform, impulse, transient- and steady-state responses of linear discrete-time systems, simulation diagrams for FIR and IIR filters
-Poles and Zeros and their effect on the magnitude frequency response, design by pole-zero placement, linear phase FIR filters, group delay, symmetries
-The DFT, definitions, properties and their applications, spectral leakage, windows, linear and periodic convolution, relations to the DTFT, response to sinusoids, digital sinc, periodicity, resolution
-The FFT and its relation to the DFT, applications to signal analysis and data compression (e.g., concepts addressed in your project), Decimation In Time FFT, complexity issues, fast convolution
-Design of linear phase filters using the Fourier series and sampled windows. The impulse invariance method. The bilinear transformation and its application to analog filter approximations. Butterworth filter design.
-Random signal processing, stationarity and ergodicity, definitions of first- (mean) and second- (autocorrelation) order statistics, power spectral density, response of linear systems to random signals
- MATLAB related programs and projects covered in the course.

Objectives: You should be able to:

- write difference equations from simulation diagrams and vice versa.
- Find impulse responses for FIR and IIR systems
- Find sinusoidal steady-state responses for FIR and IIR systems
- Identify linearity, time invariance, and causality
- Test for stability
- Evaluate (and sketch) Fourier spectra of continuous and sampled signals
- demonstrate knowledge of sampling theorem
- demonstrate knowledge of properties of the DTFT, and z-transform (those properties covered in class), Application and proofs
- Evaluate inverse z transforms by inspection (left- and right- handed sequences), partial fraction (left- and right- handed sequences), and residue analysis (for right- handed sequences), apply z-transform to system analysis
- Write transfer functions from simulation diagrams and from difference equations and vice versa, Identify poles of the system, write transient- and steady-state responses of the system given the system parameters and the input
- Give pole-zero diagrams, design simple filters by pole-zero placement, realize filters from pole-zero locations, sketch magnitude frequency response from pole zero locations
- identify symmetries for linear phase FIR design, show that symmetries and anti-symmetries produce piecewise linear phase, linear phase filter design

- know how to design FIR linear-phase filters using the Fourier series and sampled windows
- know how to design a simple filters by analog approximation and impulse invariance or bilinear transformation
- write down definitions and properties of the DFT and IDFT, know how to apply the properties of the DFT, Proofs of linearity, time/frequency shift, time convolution, Parsevals' theorem, identify and exploit symmetries in the time- and frequency- domain, determine simple DFT transform pairs using the definition and properties, circular of periodic convolution, convolution using the FFT
- know frequency resolution issues and complexity of FFT algorithms, utility of windows, leakage, etc
- know the concepts associated with the derivation of the DIT/FFT and DIF/FFT algorithms
- know definitions of signal statistics, mean, variance, autocorrelation, spectral density, white noise, colored noise
- given input statistics (mean, variance) and system parameters you should be able to determine output statistics
- know concepts covered in your labs and project
- you should be able to respond to MATLAB related questions.