EE419 Reference for Final Exam

- **Discrete Signal**: \( x(n) = x_a(t = nT) = x_a(t = n/F_s) \)
- **Sampling Theorem**: \( F_s >= 2B \) for no aliasing (theoretically)
  \( w_0 = 2\pi F_0 / F_s \)
- **Difference Equation**: \( y(n) = \sum_{k=0}^{M-1} b_k x(n-k) - \sum_{k=1}^{N-1} a_k y(n-k) \)
- **DTFT**: \( x(n) \xleftarrow{\text{DTFT}} X(w) \), \( X(w) = \sum_{n=-\infty}^{\infty} x(n)e^{-jwn}, -\pi <= w <= \pi \)
- **I-DTFT**: \( x(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} X(\omega)e^{j\omega n} d\omega \)
- **Frequency-Shift Property of DTFT**: Given \( h(n) \xleftarrow{\text{DTFT}} H(w) \), Then \( e^{j\omega_0 n} h(n) \xleftarrow{\text{DTFT}} H(w - \omega_0) \)
- **DFT**: \( x(n) \xleftarrow{\text{DFT} (N)} X(k) \), \( X(k) = \sum_{n=0}^{N-1} x(n)e^{-j2\pi kn/N} \) with \( k = 0, N-1 \)
  
  Associated analog frequencies = \( F_k = k\Delta F = k F_s/N \)
- **I-DFT**: \( x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k)e^{j2\pi kn/N}, n = 0, N-1 \)
- **Z Transform**: \( x(n) \xleftarrow{\text{Z}} X(Z) \), \( X(Z) = \sum_{n=0}^{\infty} x(n)z^{-n} \)
- **Spectral Spacing**: \( \Delta F = F_s / N \)
- **Spectral Resolution**: \( \Delta F = F_s / L \)
- **Spectral Leakage**: None observed, if \( (F_0 N) / F_s \) = integer
- **Eular’s Law**: \( e^{j\theta} + e^{-j\theta} = 2\cos\theta \), \( e^{j\theta} - e^{-j\theta} = j2\sin\theta \)
- **Geometric Series**: \( \sum_{n=0}^{N-1} a^n = \frac{1-a^N}{1-a}, a \neq 1 \)
- **Group Delay**: \( g = \frac{-d < H(w)}{dw} \) (samples)
- **Impulse response of an ideal, shifted low pass filter, odd length M**: \( h(n) = \sin[ w_c (n - (M-1)/2 ) ] / [ \pi (n - (M-1)/2 ) ] \), for n != (M-1)/2
  \( h(n) = w_c / \pi \), for n = (M-1)/2
- **Hamming window**: \( w(n) = 0.54 - 0.46 \cos[ 2\pi n / (M-1) ] \)
- **Frequency sampling method**: \( w_k = k \cdot 2\pi / M \), \( <H_d(w_k) = -g w_k \), \( g = (M-1)/2 \)
- **Impulse response for system with 2\textsuperscript{nd} order poles at** \( r e^{j\omega_0} \)
  \( h(n) = r^n [ A \cos \omega_0 n + B \sin \omega_0 n ] u(n) \), and for 1\textsuperscript{st} order: \( h(n) = a^n u(n) \)
- **Bilinear Transform**: \( s = \frac{2 (1-z^{-1})}{T (1+z^{-1})} \)
Areas suggested for review, in addition to items on the reference sheet:

- Model of sampling process
- Aliasing
- Zero padding
- Relationships between: F (Hz) <-> w (rads/sample) <-> k (sample index)
- Frequency response and impulse response, h(n) <-> DTFT -> H(w)
- Relationship between H(w) and H(z)
- Graphical method of finding |H(w)|
- Identify if a system is FIR or IIR
- H(z) and associated poles and zeros, and p/z plots
- Relationship between H(z) and the difference equation
- General form of H(z) for 1\textsuperscript{st} and 2\textsuperscript{nd} order systems with complex p/z
- General form of h(n) for 1\textsuperscript{st} and 2\textsuperscript{nd} order systems with complex poles
- Comparing DFT and FFT
- Reading FFT Butterfly diagram
- Transforming a filter structure into an equivalent difference equation
- Filter design by pole/zero placement, yielding a causal filter.
- Filter design by windowing method
- Filter design by frequency sampling
- Filter design by bilinear transform
- Transforming digital filters from low pass to high pass
- Group delay
- Fundamental question on DaDISP, MatLab, CCS, or lab procedures.
- Review Homework, Labs, Reading
- Exam Cumulative!