

EECS 361
Test 2 Topics

- 1) Find the Fourier Transform of aperiodic signals
- 2) Find the Fourier Transform of periodic signals
- 3) Find the Fourier Series of a periodic signal using the relationship between Fourier Transform and Fourier Series

$$x_p(t) = \sum_{k=-\infty}^{\infty} x(t - kT_0) = \sum_{n=-\infty}^{\infty} x_n e^{jn\omega_0 t}$$

$$x(t) \leftrightarrow X(\omega)$$

$$x_n = \frac{1}{T_0} X(n\omega_0)$$

- 4) Apply the Fourier Transform theorems and properties to find $X(\omega)$
- 5) Find signal power and energy using Parseval's theorem

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt = \frac{1}{2\pi} \int_{-\infty}^{\infty} |X(\omega)|^2 d\omega.$$

- 6) Determine the Transfer Function of linear time invariant systems - $H(\omega) = |H(\omega)| e^{j\theta(\omega)}$
Finding $H(\omega)$ from block diagram and/or LCCDE
- 7) Determine the output of an LTI system given its input
- 8) Understand the concept of bandwidth and the inverse signal duration/bandwidth relationship
 - First zero definition
 - 3 dB definition
 - Inverse time duration-bandwidth relationship
- 9) Criteria for an ideal linear time invariant system – Ideal Filters & Distortionless Transmission
 - a) Distortionless transmission $y(t) = Kx(t - \tau)$ $H(\omega) = Ke^{-j\omega\tau}$ for all ω , i.e., $|H(\omega)| = K$ and $\theta(\omega) = -\omega\tau$.
 - b) Signal $x(t)$ has bandwidth B_{signal} then distortionless transmission with respect to $x(t)$ if $H(\omega)$ has constant amplitude and linear phase ($H(\omega) = Ke^{-j\omega\tau}$) over the signal bandwidth, B_{signal} .
 - c) ILPF $\rightarrow H(\omega) = Ke^{-j\omega\tau}$ for system bandwidth, B_H .
 - d) IBPF, IBRF, IHPF
 - e) If $B_{\text{System}} \gg B_{\text{signal}}$ then negligible distortion, where B_{System} = system bandwidth and B_{signal} = signal bandwidth
- 16) Basic modulation: DSB-SC, DSB-LC (AM), and FDM: Transmitters and Receivers
- 17) Sampling
 - a) Sampling Theorem
 - b) Sampling rate $f_s > 2B$ (Nyquist sampling rate = $2B$)
 - c) Understanding the periodic nature of the spectrum of a sampled signal
 - d) Aliasing; causes and remedies
 - e) Recovery of $x(t)$ from $x_s(t)$ using an LPF

18) Discrete Time Signals and Systems

- a) Discrete signal notation, e.g., $x[n]=\{a, b, \underline{c}, d, \dots\}$ then $x[0]=c$
- b) Discrete Time Signals $u[n]$, $\delta[n]$, $\cos(\Omega n + \phi)$, $p^n u[n]$
where $\Omega =$ the discrete-time angular frequency
- c) Discrete time LTI systems
 - Difference equations
 - ARMA format for difference equations
 - Block diagrams with delay blocks
 - Properties of Discrete Time Systems
 - o Linearity
 - Scaling
 - Additivity
 - o Time-invariance
 - o Memoryless (static) vs Memory (dynamic)
 - o BIBO stable
 - o Casual
 - o Discrete time impulse response, $h[n]$

19) Discrete Time Convolution

20) z-transform

- a) Finding $X(z)$ given $x[n]$
- b) Finding $x[n]$ given $X(z)$
- c) Finding transfer function $H(z)$ given
 - The impulse response
 - Difference equation
 - Block diagram
- d) Finding locations of poles and zeros of $H(z)$
- e) Finding frequency response $H(e^{j\Omega})$ and understanding its relationship to the unit circle.
- f) Finding the system output given input $= A \cos(\Omega_{in} n + \phi)$