Some Review

Lesson 17
Review of Where Stand

• Signals
  – Continuous vs Discrete Time
    \[ x(t) = e^{st}, \quad x(n) = z^n \]
  – Periodic vs Aperiodic
    \[ x(t+T) = x(t) \quad \text{for all } t \]
  – Bounded vs Unbounded
  – Symmetries
    Even vs Odd
  – Complex functions

• Unit Impulse And Unit Step Functions
  – Unit Impulse Function
    \[
    \delta(t) = \begin{cases} 
      0 & \text{for } t \neq 0 \\
      \text{undefined} & \text{for } t = 0
    \end{cases}
    \]
    \[ \int_{-\infty}^{\infty} f(t)\delta(t-\tau)\,dt = f(\tau) \]
    \[ \int_{-\infty}^{\infty} \delta(t)\,dt = 1 \]
Review Continues

- Unit Step Function

\[ u(t) = 1 \text{ for } t \geq 0; \]
\[ = 0 \text{ for } t < 0 \]
\[ u(t) = \int_{-\infty}^{t} \delta(\tau) d\tau \]

- Linear Time Invariant Systems
  - Linearity and superposition
    \[ \sum_k a_k x_k(t) \rightarrow \sum_k a_k y_k(t) \]
  - Causality
  - Time Invariant
    \[ x_k(t-t_0) \rightarrow y_k(t-t_0) \]
**Review #3**

- **Differential and Difference Equations**
  - 1\textsuperscript{st} and 2\textsuperscript{nd} Order Linear Ordinary Differential Equations
  - Response Components of the Solution to ODEs
  - Source Free Response
    - Characteristic and Homogenous Equation
    - Eigenfunctions with its Eigenvalues are solutions to these equations
    - Examples of the solution to the 2\textsuperscript{nd} Order ODE (overdamped, underdamped & critically damped)
  - Source Response
    - Network response function
      \[
      y(t) = \frac{B(p)}{A(p)} x(t) = H(p)x(t)
      \]
    - Poles and Zeroes
Review #4

- **Sinusoidal Steady State Response**
  - Replacing $p$ with $j\omega$ in the Network Response Function yielded the $H(j\omega)$ in phasor form
  - Bode Plots

- **Difference Equations**

- **Convolution**
  - System Response of a system due to a Unit Impulse Function, $h(t)$
  - Response of a system due to other sources
    \[ y(t) = \int x(\tau)h(t - \tau)\,d\tau \]
Review #5

• Stability of Systems
  – The poles of $H(p)$ must lie in the left hand complex plane for continuous systems
  – The poles of $h(n)$ must lie in the unit circle for discrete systems

• Signal Analysis
  – Fourier Series
    – Using Orthogonal Functions
    – Periodic Functions
Review #6

- Continuous & Periodic in the Time Domain
- Infinite & Discrete in the Frequency Domain

\[ a_k = \frac{1}{T} \int_{-\frac{T}{2}}^{\frac{T}{2}} f(t) e^{-\frac{j2\pi kt}{T}} \, dt \]

\[ f(t) = A_0 + \sum_{k=1}^{\infty} \left[ a_k e^{\frac{j2\pi kt}{T}} + a_k^* e^{-\frac{j2\pi kt}{T}} \right] + \sum_{k=1}^{\infty} 2|a_k| \cos\left(\frac{j2\pi kt}{T} + \psi_k\right) \]

- Quadratic Content
- Sampling Function
Review #7

• Fourier Transform
  – Infinite Period
  – Continuous in the Frequency Domain
  – Spectral Density

\[ \mathcal{F}[f(t)] = F(j\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t} \, dt \]

\[ \mathcal{F}^{-1}[F(j\omega)] = f(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(j\omega)e^{j\omega t} \, d\omega \]

  – Properties and Dualities of the FT
  – FTs for discrete functions
Review #8

• Filters
  – Types of Filters
  – Idealized Filters
• Modulation
  – Amplitude and Angle
  – Frequency Spectrum
  – PAM
• Sampling Theorem
  – Nyquist Sampling Rate
  – TDM
• Pulse Code Modulation
  – Quantization Error
  – Amplitude and Angle Modulation