EE 521 : DSP Lab
Assignment 1

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> Sinusoidal Signal

$$x(t) = A \sin(\omega_0 t + \phi)$$

• Power of the signal:

$$P = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$$

$$\Rightarrow P = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |A \sin(\omega_0 t + \phi)|^2 dt$$

$$\Rightarrow P = \lim_{T\to\infty} \frac{A^2}{T} \int_{-T/2}^{T/2} \left| \frac{1 - \cos(2\omega_0 t + 2\phi)}{2} \right| dt$$

$$\Rightarrow P = \lim_{T\to\infty} \frac{A^2}{2T} \int_{-T/2}^{T/2} dt - \frac{A^2}{2T} \int_{-T/2}^{T/2} \cos(2\omega_0 t + 2\phi) dt$$

$$\Rightarrow P = \lim_{T\to\infty} \frac{A^2}{2T} \int_{-T/2}^{T/2} dt - 0$$

$$\Rightarrow P = \lim_{T\to\infty} \frac{A^2}{2T} \left[\frac{T}{2} + \frac{T}{2} \right] = \frac{A^2}{2}$$

$$\boxed{P = \frac{A^2}{2}}$$

• Energy of the signal:

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{\infty} |A \sin(\omega_0 t + \phi)|^2 dt$$

$$\Rightarrow E = A^2 \int_{-\infty}^{\infty} \left[\frac{1 - \cos(2\omega_0 t + 2\phi)}{2} \right] dt$$

$$\Rightarrow E = \frac{A^2}{2} \int_{-\infty}^{\infty} dt - \frac{A^2}{2} \int_{-\infty}^{\infty} \cos(2\omega_0 t + 2\phi) dt$$

$$\Rightarrow E = \frac{A^2}{2} [t]_{-\infty}^{\infty} - 0 = \infty$$

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→ Exponential Signals

$$x(t) = A e^{-Bt} u(t)$$

• Energy of the signal:

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt$$

$$= \int_{-\infty}^{\infty} |Ae^{-Bt} u(t)|^2 dt$$

$$= \int_{0}^{\infty} |Ae^{-Bt}|^2 dt = \int_{0}^{\infty} A^2 e^{-2Bt} dt$$

$$= \frac{-A^2}{2B} \left[e^{-2Bt}\right]_0^{\infty} = \frac{-A^2}{2B} [0 - 1]$$

$$\boxed{E = \frac{A^2}{2B}}$$

• Power of the signal:

Since the signal has finite energy so Power of the signal will be zero.

$$\boxed{P = 0}$$

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Complex Exponential Signal

$$x(t) = \alpha e^{j(\omega t + \phi)}$$

- **Energy of the signal:**

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt$$

$$E = \int_{-\infty}^{\infty} |\alpha e^{j(\omega t+\phi)}|^2 dt = \int_{-\infty}^{\infty} \alpha^2 dt$$

$$\Rightarrow E = \alpha^2 [t]_{-\infty}^{\infty}$$

$$\Rightarrow \boxed{E = \infty}$$

- **Power of the signal:**

$$P = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$$

$$= \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |\alpha e^{j(\omega t+\phi)}|^2 dt$$

$$= \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \alpha^2 dt$$

$$= \lim_{T\to\infty} \frac{\alpha^2}{T} [t]_{-T/2}^{T/2} = \lim_{T\to\infty} \frac{\alpha^2}{T} \cdot T$$

$$\Rightarrow P = \lim_{T\to\infty} \alpha^2$$

$$\Rightarrow \boxed{P = \alpha^2}$$