ELEC 241: CA Session 4 Notes (Quiz I Review)

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September 19, 2012

Complex Exponentials

$$e^{j\theta} = \cos\theta + j\sin\theta$$
$$\cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$$
$$\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$$
$$\cos\theta = \mathrm{Re}[e^{j\theta}] = \mathrm{Im}[je^{j\theta}]$$
$$\sin\theta = \mathrm{Im}[e^{j\theta}] = \mathrm{Re}[-je^{j\theta}]$$

Trigonometry

$$\sin(x+y) = \sin x\cos y + \cos x\sin y$$
$$\cos(x+y) = \cos x\cos y - \sin x\sin y$$
$$\sin(2x) = 2\sin x\cos x$$
$$\cos(2x) = \cos^2 x - \sin^2 x$$
$$\sin^2 x + \cos^2 x = 1$$
$$1 + \cot^2 x = \csc^2 x$$
$$\tan^2 x + 1 = \sec^2 x$$

Impedances

$$Z_R = R$$
$$Z_C = \frac{1}{j2\pi fC}$$
$$Z_L = j2\pi L$$
Series: $Z_{eq} = Z_1 + Z_2$

Parallel: $Z_{eq} = Z_1||Z_2 = \frac{Z_1 Z_2}{Z_1 + Z_2}$

Conductance: $G = \frac{1}{Z}$

Circuits

Ohm's Law: $v = iZ$

Voltage divider: $V_1 = \frac{Z_1}{Z_1 + Z_2} V_{in}$

Current divider: $i_1 = \frac{Z_2}{Z_1 + Z_2} i_{in}$

Power: $P = iv = i^2 Z = \frac{v^2}{Z}$

KVL: $\sum_{loop} v_k = 0$

KCL: $i_{in} - i_{out} = 0$

LTI Systems

$$\sum(\text{scaled, time-shifted inputs})$$
$$\xrightarrow{S} \sum(\text{scaled, time-shifted outputs})$$
$$S\left[\sum_{k=1}^{\infty} c_k x(t-\tau_k)\right] = \sum_{k=1}^{\infty} c_k y(t-\tau_k)$$

Transfer Functions

$$H(f) = \frac{V_{out}}{V_{in}} \text{ OR } \frac{I_{out}}{V_{in}} \text{ OR } \frac{V_{out}}{I_{in}} \text{ OR } \frac{I_{out}}{I_{in}}$$

Low-pass filter: $\lim_{f\to\infty} H(f) = 0, G = |H(0)|$

High-pass filter: $\lim_{f\to 0} H(f) = 0, G = |H(\infty)|$

Cutoff Frequency: $|H(f_c)| = \frac{1}{\sqrt{2}} G$