EECS 16B CSM Presentation

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Phasors

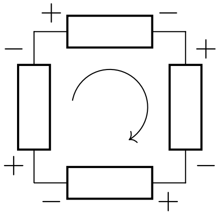
- Encodes information about any sinusoid: voltage, current, etc.
- If frequency is constant, then uniquely identifies

$$A\cos(\omega t + \phi) = \Re\{Ae^{j(\omega t + \phi)}\} = \Re\{\underbrace{Ae^{j\phi}}_{\text{phasor}} e^{j\omega t}\} \tag{1}$$

Properties

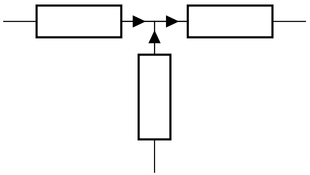
Given $x_1(t) = \Re\{A_1 e^{j\omega t}\}, x_2(t) = \Re\{A_2 e^{j\omega t}\}$ with phasors $A_{1,2}$,

- Uniqueness: $x_1(t) = x_2(t) \implies A_1 = A_2$
- Linearity: $a_1 x_1(t) + a_2 x_2(t) \implies a_1 A_1 + a_2 A_2$ for $a_{1,2} \in \mathbb{R}$
- Differentiation: $x(t) \Leftrightarrow A \implies \frac{d}{dt} x(t) = \frac{d}{dt} \Re\{A e^{j\omega t}\} = \Re\{j\omega A e^{j\omega t}\} \Leftrightarrow j\omega A$



$$\sum_i \overline{V}_i = 0 \tag{2}$$

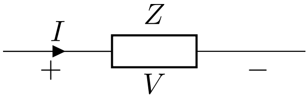
Circuits & Phasors (cont.)
KCL



$$\sum \overline{I}_{out} = \sum \overline{I}_{in} \tag{3}$$

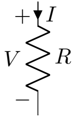
Circuits & Phasors (cont.)

Ohm's Law

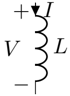


$$\overline{V} = \overline{I} \underbrace{Z}_{\text{impedance}} \tag{4}$$

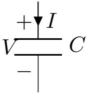
Passive Elements & Phasors



$$\overline{V} = \overline{I}R \tag{5}$$



$$\overline{V} = L\frac{d}{dt}\overline{I} = j\omega L\overline{I} \tag{6}$$



$$\overline{I} = C\frac{d}{dt}\overline{V} = j\omega C\overline{V} \implies \overline{V} = \frac{1}{j\omega C}\overline{I} \tag{7}$$

Demo

`http://tinyurl.com/y5qfnqtk`

Low Pass Filter

$$\overline{V}_{out} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}}\overline{V}_{in} \tag{8}$$

$$\overline{V}_{out} = \frac{1}{1 + j\omega RC}\overline{V}_{in} \tag{9}$$

$$\Rightarrow H(j\omega) = \frac{\overline{V}_{out}}{\overline{V}_{in}} = \frac{1}{1 + j\omega RC} \tag{10}$$