Announcements

• No Phasor analysis expected in HW2

• HW1 graded
  – 9.56 & 9.57 – review solutions
  – 13.5: \( L_1 = 0.5L_2 = 1 \text{ mH} \)
    \[
    \begin{align*}
    L_1 &= 1 \text{ mH} \\
    L_2 &= 2 \text{ mH}
    \end{align*}
    \]

• Quiz on Wednesday 2/16
  – Covers Chapter 13, HW 1&2, Mutual inductance and transformers
**Phasor Notation**

\[ V(t) = A e^{j\omega t + \phi} = \text{Re} \{ A e^{j\omega t} e^{j\phi} \} \]

\[ i(t) = B \sin(\omega t + \theta) = B e^{j(\omega t + \theta - \frac{\pi}{2})} \]

\[ V = A e^{j\phi} \quad \leftrightarrow \quad A \angle \phi \quad \text{(short hand notation)} \]

**Comments:**
- Phasor transform works for volt/current sources & signals
- Everything in the circuit must be at a **single frequency** \( \omega \)
- Complex numbers:
  - No imaginary number in \( v(t) \) or \( i(t) \) (in time domain)
  - No time in the phasor domain \( \rightarrow \) no \( 't' \) in \( V \) or \( I \)
# Phasor Circuit Elements

## Time Domain

<table>
<thead>
<tr>
<th>Component</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i(t)$</td>
<td>$v(t) = i(t)R$</td>
</tr>
<tr>
<td>$v(t)$</td>
<td>$v(t) = L \frac{di}{dt}$</td>
</tr>
<tr>
<td>$C$</td>
<td>$i(t) = C \frac{dv}{dt}$</td>
</tr>
</tbody>
</table>

## Phasor Domain

<table>
<thead>
<tr>
<th>Component</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I$</td>
<td>$V = IR$</td>
</tr>
<tr>
<td>$V$</td>
<td>$v(t) = L A \omega \cos(\omega t + \phi + 90^\circ)$</td>
</tr>
<tr>
<td>$i(t)$</td>
<td>$i(t) = C \frac{dv}{dt}$</td>
</tr>
</tbody>
</table>

## Phasor Transform

<table>
<thead>
<tr>
<th>Component</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V$</td>
<td>$V = Ae^{j\phi}$</td>
</tr>
<tr>
<td>$I$</td>
<td>$I = \frac{A}{2} e^{j\phi}$</td>
</tr>
<tr>
<td>$\frac{-j}{\omega C} I$</td>
<td>$V = \frac{1}{\frac{-j}{\omega C}} I$</td>
</tr>
</tbody>
</table>

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**Notes:**
- $\omega$ is the angular frequency.
- $\phi$ is the phase angle.
- $A$ is the amplitude.
- $R$, $L$, and $C$ are the resistance, inductance, and capacitance, respectively.
- $v(t)$ and $i(t)$ represent the voltage and current in the time domain, respectively.
- $V$ and $I$ represent the phasor voltage and current, respectively.
- The phasor transform converts time-domain signals into phasor domain for easier analysis.
\[ v_1(t) = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt} \]
\[ v_2(t) = M \frac{di_1}{dt} + L_2 \frac{di_2}{dt} \]

**Phasor Domain**

\[ V_1 = j\omega L_1 I_1 + j\omega M I_2 \]
\[ V_2 = j\omega L_2 I_2 \]

\[ \frac{v_1}{N_1} = \frac{v_2}{N_2} \]
\[ N_1 I_1 + N_2 I_2 = 0 \]
Impedance

Phasor equivalent of ohm's law
\[ V = I \angle Z \]
\[ Z = \text{"Impedance"} = R + jX \]
\[ \text{Re}\{Z\} = R \]
\[ \text{Im}\{Z\} = X \]

\[ Z_R = R, \text{ Resistor} \]
\[ Z_L = j\omega L, \text{ Inductor} \]
\[ Z_C = \frac{1}{j\omega C}, \text{ Capacitor} \]

All have units of ohms (Ω, R, X)

\[ Y = \text{\'Admittance\'} = \frac{1}{Z} = G + jB \]
\[ \text{Conductance} \]
\[ \text{Susceptance} \]

\[ Y = \frac{1}{Z} = \frac{1}{R + jX} \neq \frac{1}{R} + j\frac{1}{X} \text{ No.} \]

\[ \text{Yes!} \quad \frac{1}{R + jX} \frac{(R - jX)}{(R - jX)} = \frac{R - jX}{R^2 + X^2} = \frac{R}{R^2 + X^2} - j\frac{X}{R^2 + X^2} \]