EELE 250: Circuits, Devices, and Motors

Lecture 12

Assignment Reminder

- Read 5.1 – 5.4 AND 5.5-5.6
- Practice problems:
  - P5.23, P5.24, P5.35, P5.37
  - P5.42, P5.44, P5.47, P5.49, P5.57

- D2L Quiz #6 by 11AM on Monday 10 Oct.

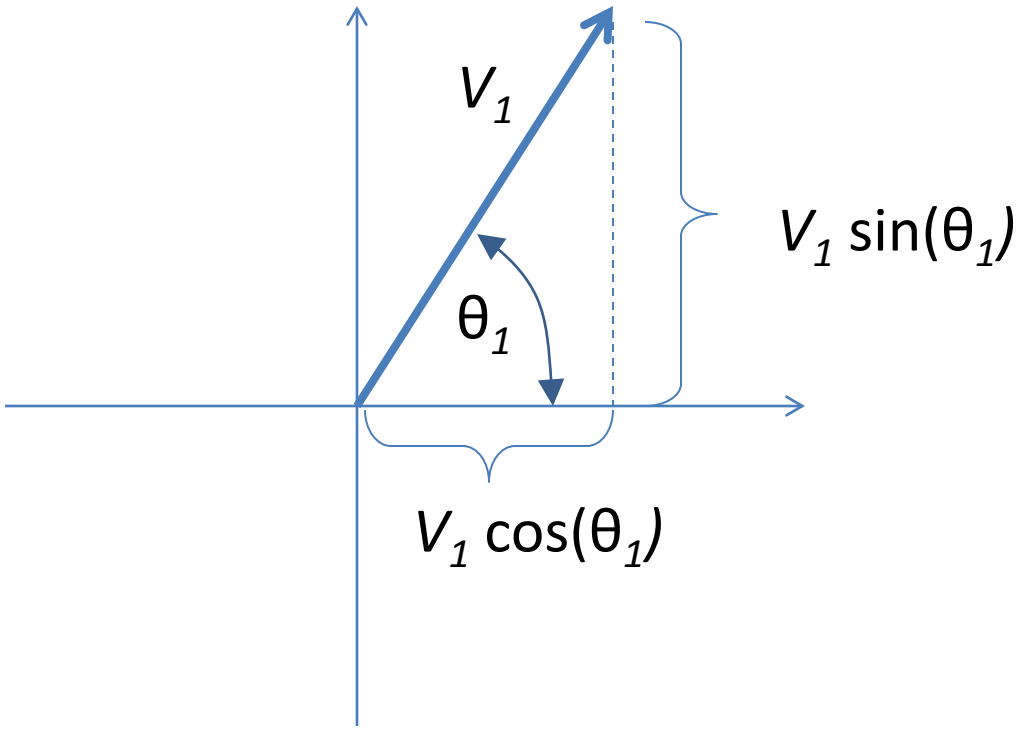
- REMINDER: Lab #3 report is due and Lab #4 will be performed this week—be sure to do the pre-lab assignment calculations!

- Exam #2: in class on Monday 17 Oct.

Sinusoidal Current and Voltage

- Represent sinusoidal currents and voltages as *phasors*. Length is equal to amplitude, angle is equal to phase (cosine reference).
- Ohm's Law: $V = I \cdot R$, can be generalized to $\boldsymbol{V} = \boldsymbol{I} \cdot \boldsymbol{Z}$, where $\boldsymbol{Z}$ is the *impedance*.
  - Impedance of a resistor: $\mathbf{Z} = R$
  - Impedance of an inductor: $\mathbf{Z} = j \omega L$
  - Impedance of a capacitor: $\mathbf{Z} = 1/(j \omega C)$

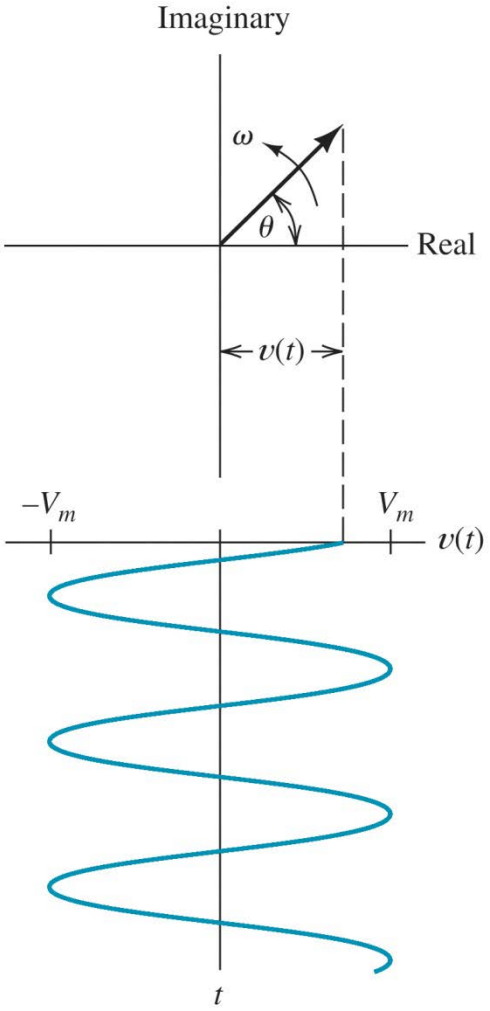
Phasors (cont.)



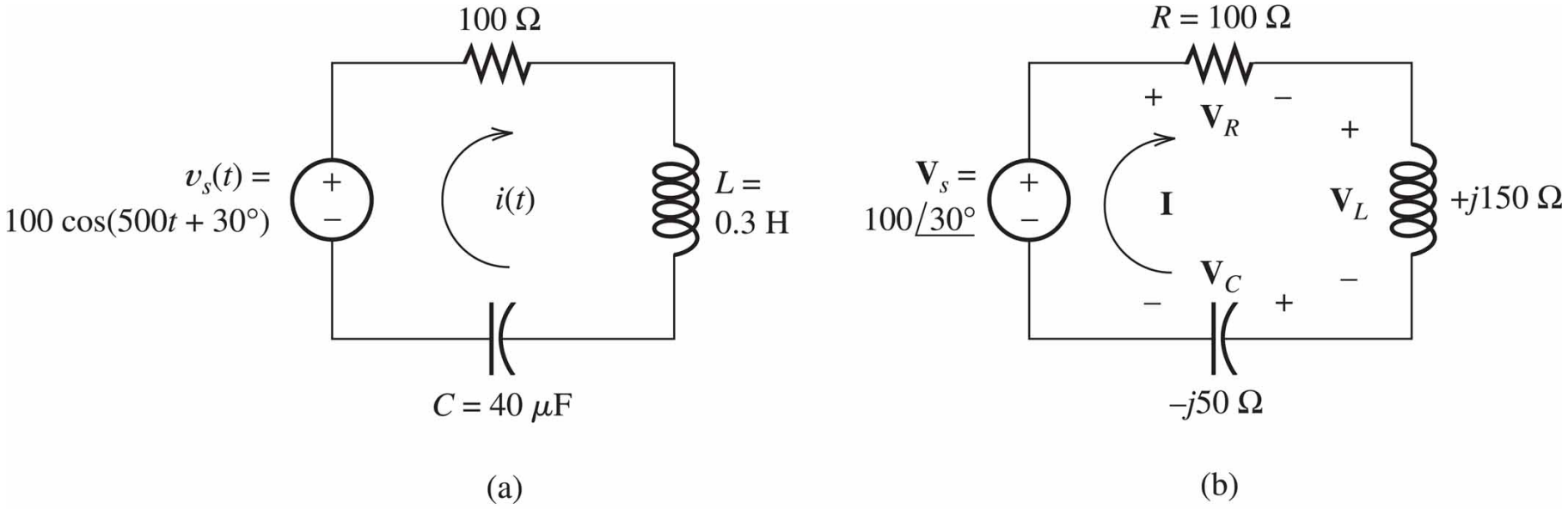
Visualization: Rotating Phasors

- Consider $v(t) = V_m \cdot \cos(\omega t + \theta)$
- Phasor: $V_m \angle \theta$
- We can think of the Phasor as rotating counterclockwise at rate ω radians per second
- Angle at t=0 is θ, angle at other times is $\omega t + \theta$
- Rotating Phasor: $V_m \, e^{j(\omega t + \theta)}$
- $v(t)$ is the real part of the rotating phasor

Rotating Phasors (cont.)



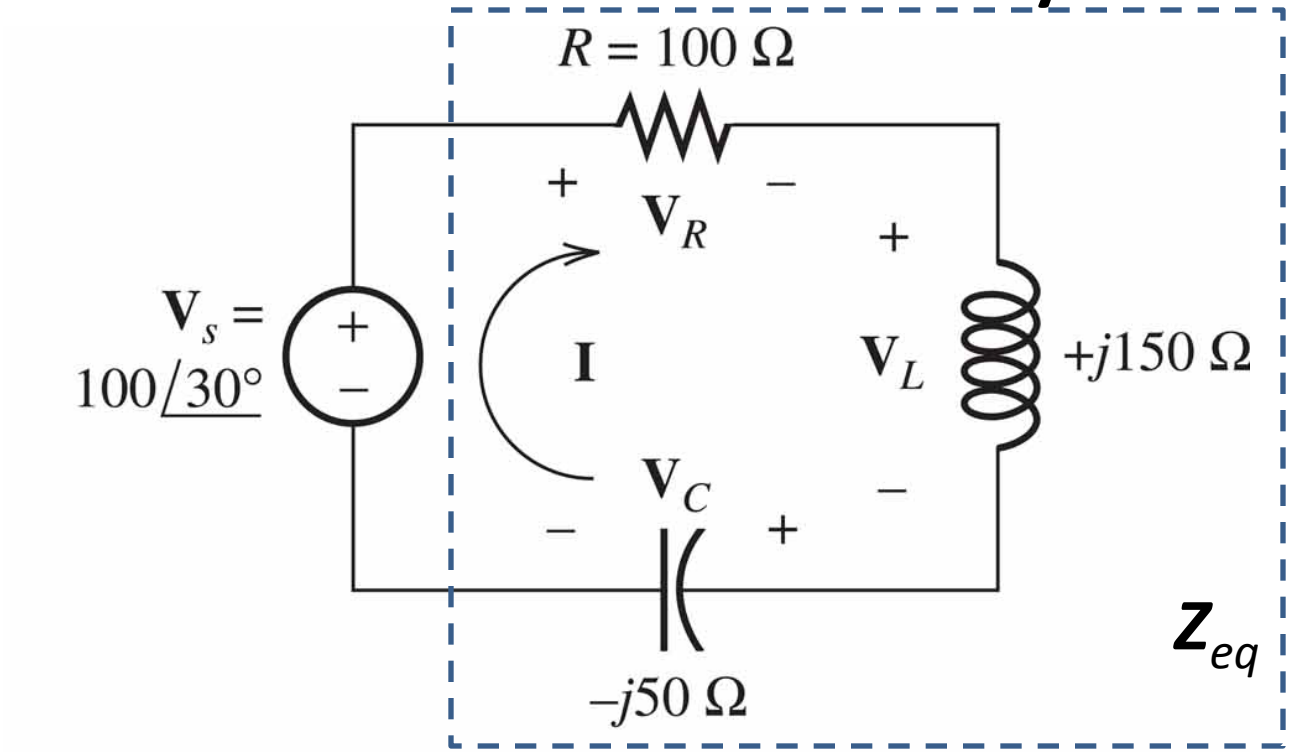
Steady-State AC Analysis



$Z_L = j\,\omega\,L = j\,500 \cdot (0.3) = j\,150\ \Omega$

$Z_C = 1/(j\,\omega\,C) = 1/(j\,500 \cdot (40\mu)) = 50/j = -j\,50\ \Omega$

Phasor Circuit Analysis

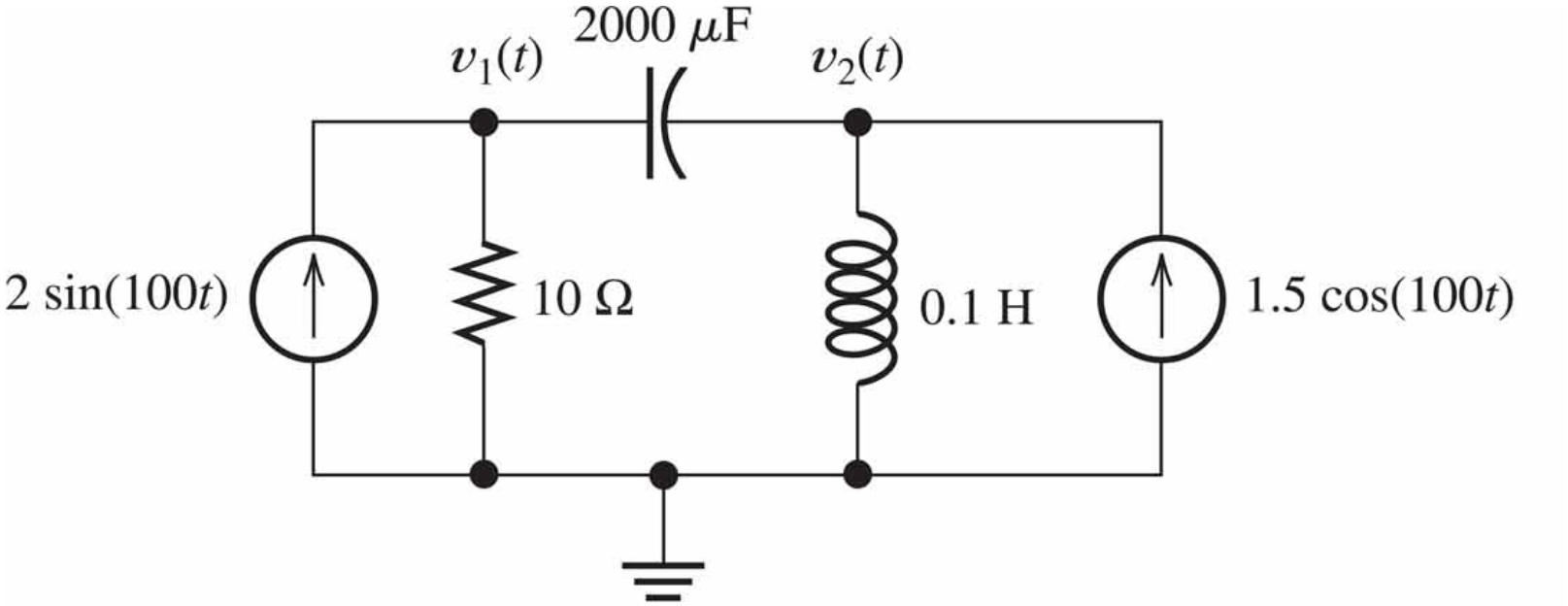


$\mathbf{Z}_{eq} = 100 + j\,150 - j\,50 = 100 + j\,100 = 141.4\ \angle 45°$

$\mathbf{I} = \mathbf{V} / \mathbf{Z}_{eq} = (100\ \angle 30°) / (141.4\ \angle 45°)$

$= 0.707\ \angle -15°$

Phasor Analysis (cont.)



- Convert to impedances
- Write sources and node voltages as phasors
- Write node equations in terms of phasors and impedances
- Solve for phasor voltages, then re-write as time functions

Summary and Review

- Sinusoidal steady-state analysis converts resistors, inductors, and capacitors to impedances, then solve circuit using Ohm's Law, KVL, KCL, Thevenin, etc.
- Impedance of a resistor: $\mathbf{Z} = R$
- Impedance of an inductor: $\mathbf{Z} = j\,\omega\,L$
- Impedance of a capacitor: $\mathbf{Z} = 1/(j\,\omega\,C)$