EE281 - Phasors & Impedances

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Phasors & Sinusoidal Steady-State Analysis

- **Goal:** Perform only sinusoidal steady-state analysis
  - De wee need to derive the ODE "first"

Time Domain   Phasor Domain

$$v(t) = A\cos\left(\omega t + \phi\right) \;\rightarrow\; V(j\omega) = Ae^{j\phi} = A\angle\phi$$

Phasors & Sinusoidal Steady-State Analysis

- **Goal:** Perform only sinusoidal steady-state analysis
  - No need to find ODE "first"

- **Method:** Phasor notation & the concept of impedance

Time Domain

Phasor Domain

$$v(t) = A\cos(\omega t + \phi) \;\rightarrow\; V(j\omega) = Ae^{j\phi} = A\angle\phi$$

Impedance

Resistance: Time & Phase Domain

$$V(t) = R \cdot I(t)$$

$$V(j\omega) = R \cdot I(j\omega)$$

Impedance

Resistance: Time & Phase Domain

$$V(t) = R \cdot I(t)$$

$$V(j\omega) = R \cdot I(j\omega)$$

Impedance in Phasor Domain

$$V(j\omega) = Z(j\omega) \cdot I(j\omega)$$

Impedance

	Time		Phasor		Impedance
Resistor	$V(t) = R \cdot I(t)$	$\implies$	$V(j\omega) = R \cdot I(j\omega)$	$\implies$	$Z_R(j\omega) = R$
Capacitor					
Inductor					

Impedance

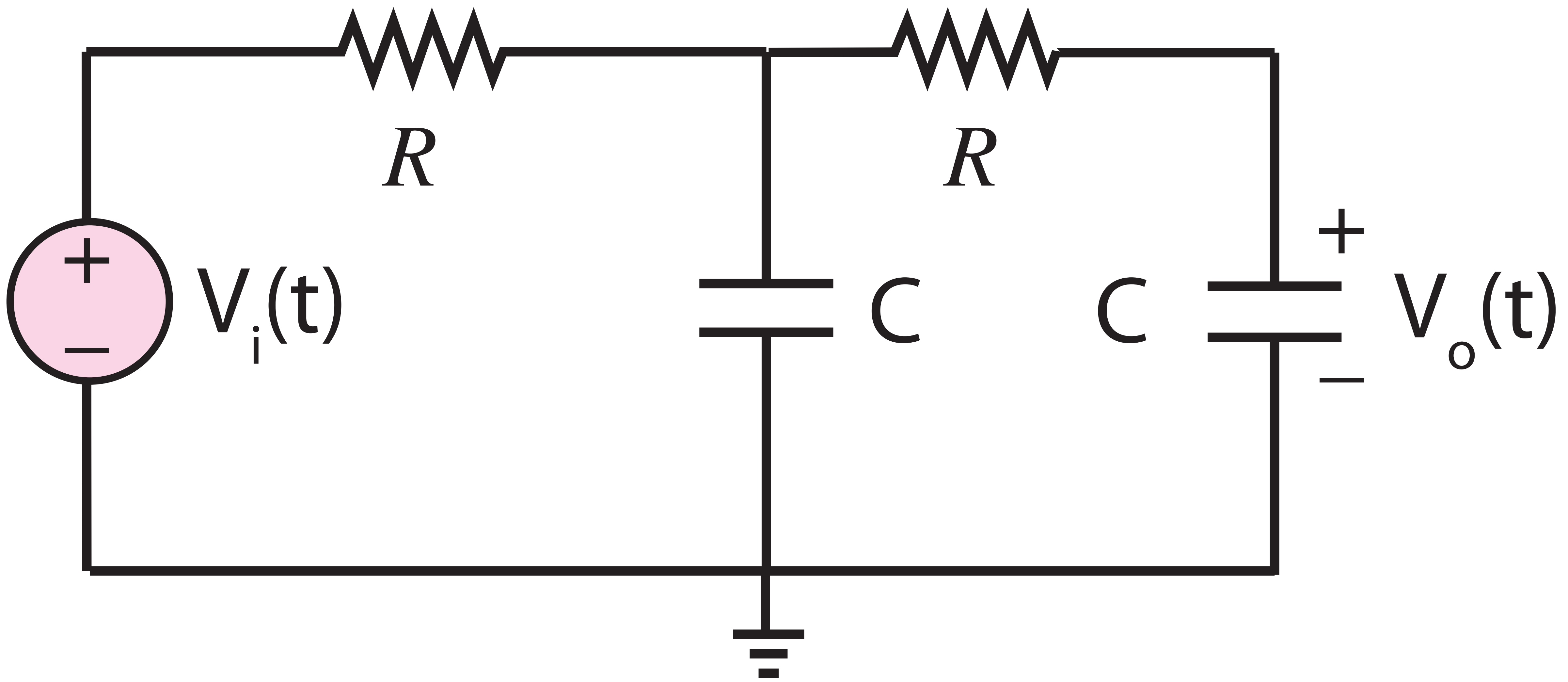
	Time		Phasor		Impedance
Resistor	$V(t) = R \cdot I(t)$	$\Longrightarrow$	$V(j\omega) = R \cdot I(j\omega)$	$\Longrightarrow$	$Z_R(j\omega) = R$
Capacitor	$C\dfrac{dV(t)}{dt} = I(t)$	$\Longrightarrow$	$V(j\omega) = \dfrac{1}{j\omega C} I(j\omega)$	$\Longrightarrow$	$Z_C(j\omega) = \dfrac{1}{j\omega C}$
Inductor					

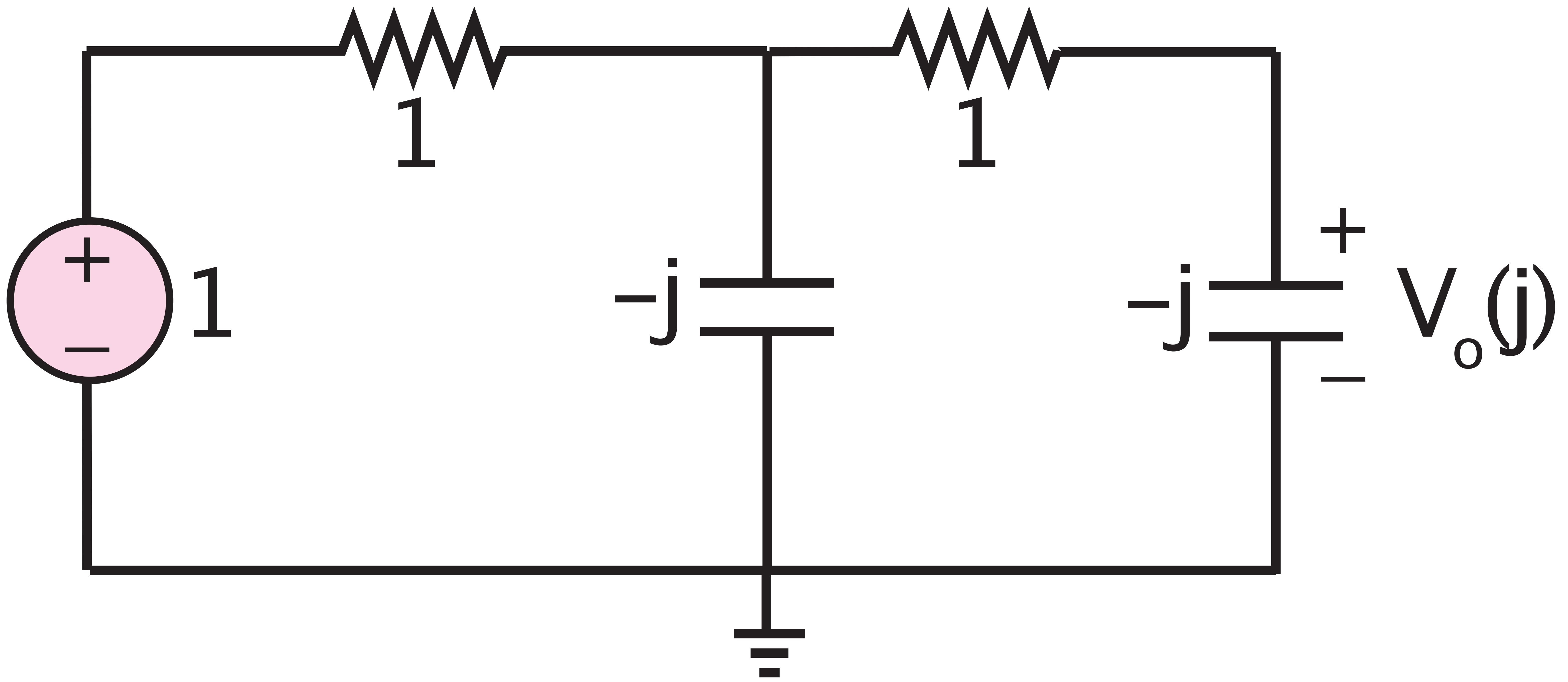
Impedance

	Time		Phasor		Impedance
Resistor	$V(t) = R \cdot I(t)$	$\Longrightarrow$	$V(j\omega) = R \cdot I(j\omega)$	$\Longrightarrow$	$Z_R(j\omega) = R$
Capacitor	$C\frac{dV(t)}{dt} = I(t)$	$\Longrightarrow$	$V(j\omega) = \frac{1}{j\omega C}I(j\omega)$	$\Longrightarrow$	$Z_C(j\omega) = \frac{1}{j\omega C}$
Inductor	$V(t) = L\frac{dI(t)}{dt}$	$\Longrightarrow$	$V(j\omega) = j\omega L \cdot I(j\omega)$	$\Longrightarrow$	$Z_L(j\omega) = j\omega L$

Let R = 1 Ω, C = 1 F

$V_i(t) = \cos(\omega t)$ for $\omega = 1.0$ rad/s




1
1
+
–
1
–j
–j
+
–
Vo(j)

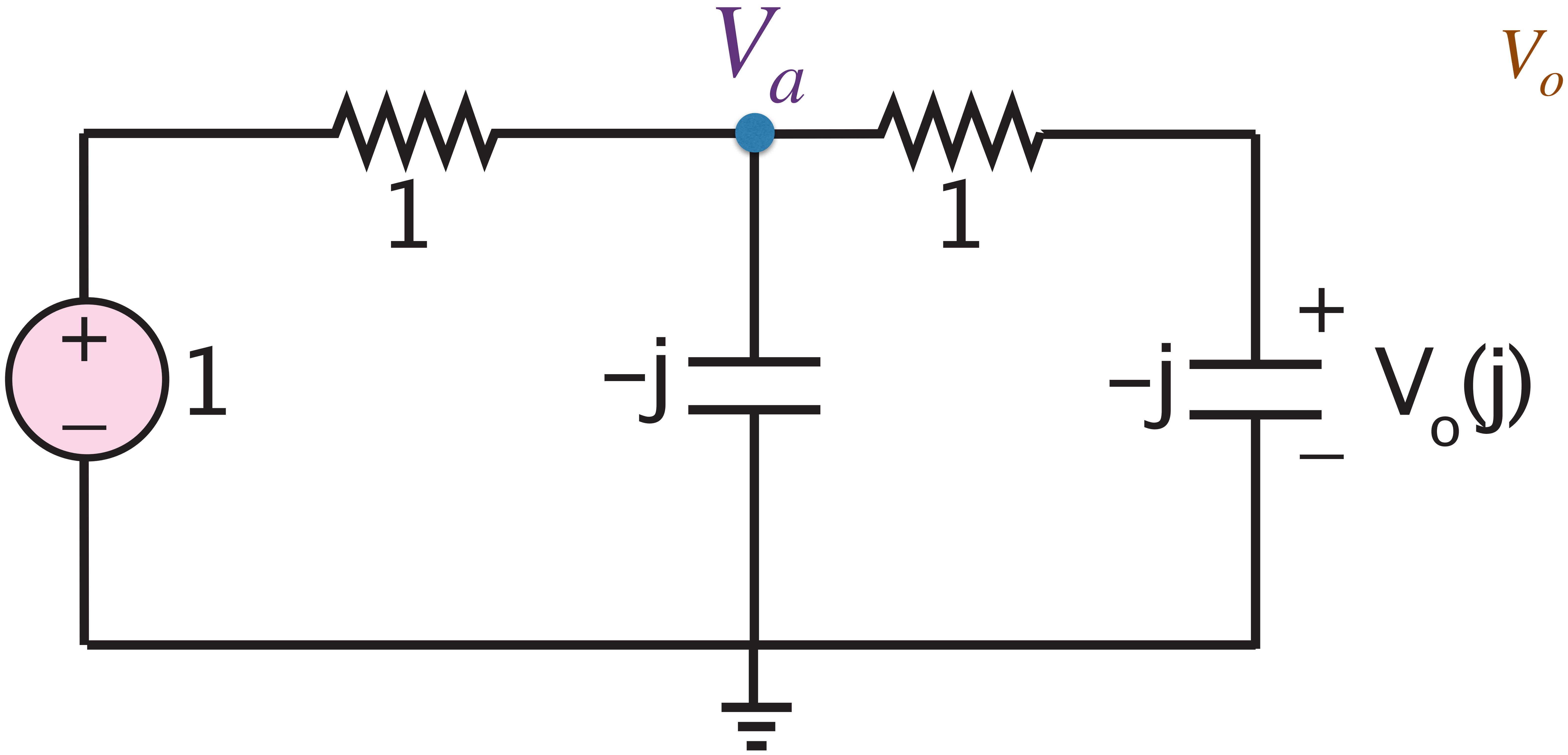
$$(V_a - 1) + \frac{V_a}{-j} + \frac{V_a}{1-j} = 0$$

$$V_a = \frac{2/3}{1+j}$$

$$V_o = \frac{Va}{1-j} \cdot j = \frac{2/3}{1+j}\frac{-j}{1-j}$$

$$V_o = \frac{-j}{3} = \frac{1}{3}\angle\frac{-pi}{2}$$

$$V_o(t) = \frac{1}{3}\cos(t - \pi/2)$$



Let $v_i(t) = \cos(10^3 t)$