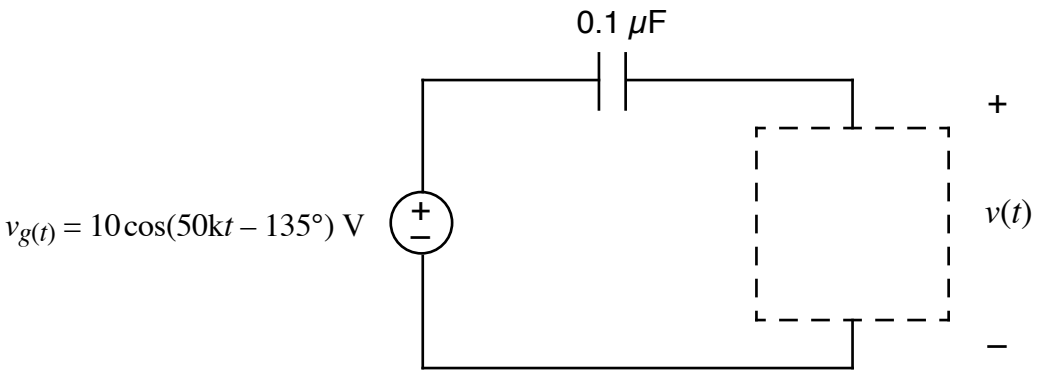
Ex:



a) Choose an R, an L, or a C to be placed in the dashed-line box to make
$v(t) = V_o \sin(50\text{k}t)$
where V_o is a positive real constant (with units of Volts). State the value of the component you choose.

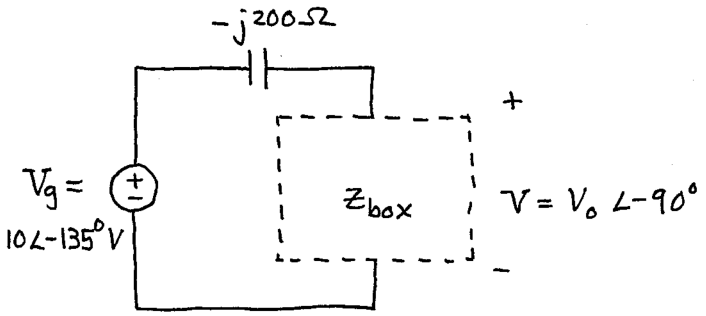
b) With your component from (a) in the circuit, calculate the resulting value of V_o.

Sol'n: a) We first transform the circuit to the frequency domain.

$V_g = 10\angle -135°$ V $V = V_o \angle -90°$ since P[sin ωt] = −j or 1∠−90°

$Z_C = \frac{-j}{\omega C} = \frac{-j}{50\text{K}\cdot 0.1\mu\text{F}} = \frac{-j}{5\text{m}}\ \Omega = -j200\ \Omega$

Note: ω = 50 k r/s from $v_g(t)$ and $v(t)$.



Now we consider phase relationships.

$$V = V_g \cdot \frac{z_{box}}{z_{box} - j200\Omega} \quad \text{from V-divider}$$

$$\angle V = \angle V_g + \angle z_{box} - \angle(z_{box} - j200\Omega)$$

$$\| $$

$$-90^\circ = -135^\circ + \angle z_{box} - \angle(z_{box} - j200\Omega)$$

Thus, $\angle z_{box} - \angle(z_{box} - j200\Omega) = 45^\circ$.

Consider possible contents of z_{box}.

If $z_{box} = j\omega L$ or $\frac{-j}{\omega C}$, then all z values in the circuit are pure imaginary.

Thus, $\angle z_{box} - \angle(z_{box} - j200\Omega)$ would be some multiple of 90°. It follows that z_{box} must be an R value.

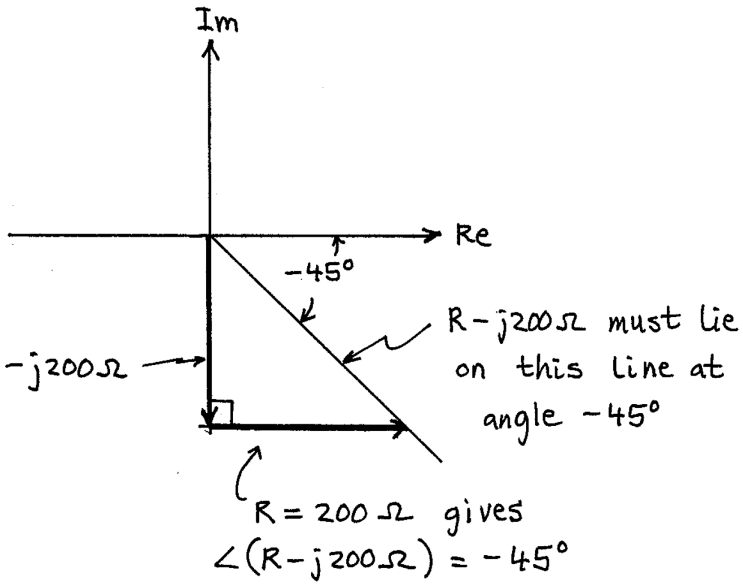
$\therefore$ Let $z_{box} = R$. $\angle R = 0^\circ$

Then $\angle z_{box} - \angle(z_{box} - j200\Omega) = 45^\circ$

$$= 0^\circ - \angle(R - j200\Omega)$$

or $\angle(R - j200\Omega) = -45^\circ$

Now we can find R graphically.



$$Z_{box} = R = 200\,\Omega$$

b) To find V_o, we use magnitude.

$$V_o = |V| = \left| V_g \cdot \frac{Z_{box}}{Z_{box} - j200\,\Omega} \right|$$

$$= \left| V_g \; \frac{R}{R - j200\,\Omega} \right|$$

$$= \left| V_g \; \frac{200\,\Omega}{200\,\Omega - j200\,\Omega} \right|$$

$$= |10V| \; \frac{|200\,\Omega|}{|200\,\Omega - j200\,\Omega|}$$

$$= 10V \cdot \frac{200}{200|1-j|}$$

$$= \frac{10V}{|1-j|}$$

$$= \frac{10\,V}{\sqrt{2}}$$

$$V_o = \frac{10}{\sqrt{2}}\,V$$