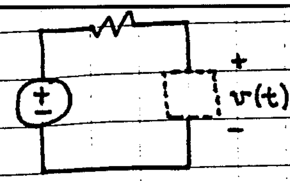
2.

$v_g(t) = 200 \sin(1000t - 30°)$ V

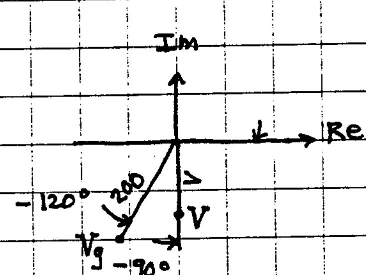


Choose R, L, or C in dashed box to make $v(t) = V_n \sin(1000t)$ V where V_n is real constant.
State component value and resulting value of V_n.

sol'n: $\mathbb{V}_g = 200 \angle -90° - 30°$ V $= 200 \angle -120°$ V (phasor)
↑ from sin()

$\mathbb{V} = \mathcal{P}[v(t)] = V_n \angle -90°$ V (phasor)

Phasor diagram:



$\mathbb{V} = \mathbb{V}_g \cdot \dfrac{z}{1k + z}$ where z is impedance of dashed box

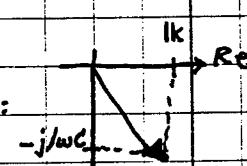
From phasor diagram, we need a phase shift of +30° to get from −120° for $\mathbb{V}_g$ to −90° for $\mathbb{V}$.

$\therefore \dfrac{z}{1k + z}$ must give $\angle +30°$

Consider $z = R$ $\dfrac{z}{1k + R} = \dfrac{\text{real \#}}{\text{real \#} + \text{real \#}} = \text{real \#}$ $\therefore \angle = 0°$
So R won't work

Consider $z = \dfrac{-j}{\omega C}$ $\angle \dfrac{-j/\omega C}{1k - j/\omega C} = \angle -j/\omega C - \angle(1k - j/\omega C)$

but $\angle -j/\omega C = -90°$ since ωC is real
$\angle 1k - j/\omega C$ will be in range $-90°$ to $0°$:



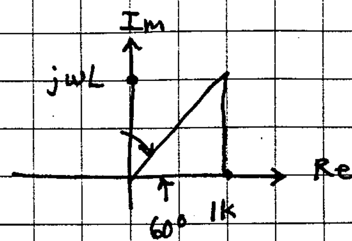
$\therefore \angle \dfrac{z}{1k + z} = -90° - \underbrace{(-90° \text{ to } 0°)}_{\text{range of possible } \angle} = \angle \underbrace{-90° \text{ to } 0°}_{\text{range pass.}} \neq 30°$

2. (cont) $\therefore$ C won't work

Consider $z = j\omega L$ $\qquad \angle \dfrac{j\omega L}{1k + j\omega L} = \angle j\omega L - \angle(1k + j\omega L)$

$\angle j\omega L = 90^\circ$

$\therefore$ we need $\angle 1k + j\omega L = 60^\circ$ to get
$\angle j\omega L - \angle 1k + j\omega L = 30^\circ$, as desired.



On phasor diagram, $1k\Omega$ is real part, and $j\omega L$ is imaginary part

$\angle 1k + j\omega L = \tan^{-1} \dfrac{\omega L}{1k} = 60^\circ$ desired

$\therefore \dfrac{\omega L}{1k} = \tan 60^\circ = \sqrt{3}$

$\omega L = \sqrt{3} \cdot 1k$

$\omega = 1k$ so $L = \sqrt{3}\,H.$