11. Assuming there are no longer any transients present, determine the current labeled i_L in the circuit of Fig. 10.47. Express your answer as a single sinusoid.

↳ only steady-state = particular solution

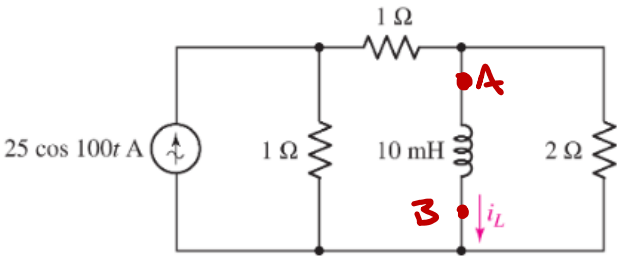
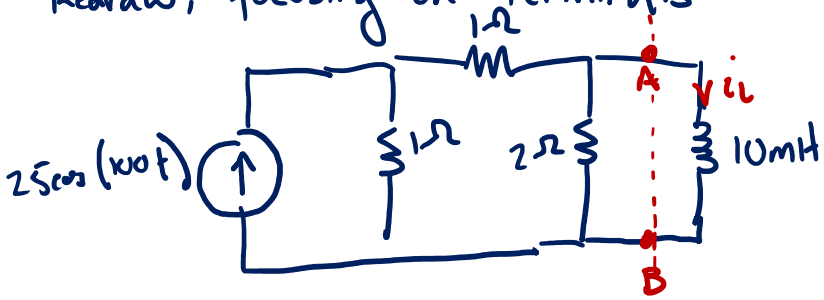
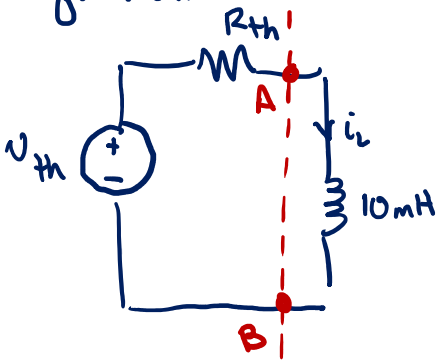


FIGURE 10.47

Redraw, focusing on terminals A & B:



Thevenin equivalent:



$R_{th} = (1\Omega + 1\Omega) \| 2\Omega = 1\Omega$

$V_{th} = \frac{25(1\Omega)}{(1\Omega + 1\Omega)}(1\Omega) = 12.5\text{V}$

$V_{th} = 12.5 \cos 100t$

$V_{th} = i_L R_{th} + L \frac{di_L}{dt}$

Need only the particular solution so "guess"

$i_L(t) = I_L \cos(100t + \varphi)$

$\frac{di_L}{dt} = -100 I_L \sin(100t + \varphi)$

$$v_{th} = i_L R_{th} + L\frac{di_L}{dt}$$

$$12.5\cos(100t) = R_{th} I_L \cos(100t+\varphi) - 100L I_L \sin(100t+\varphi)$$

$$= \sqrt{(R_{th}I_L)^2 + (100LI_L)^2}\cos\left(100t+\varphi - \tan^{-1}\left(\frac{-100LI_L}{R_{th}I_L}\right)\right)$$

$$12.5\cos(100t) = I_L\sqrt{R_{th}^2 + (100L)^2}\cos\left(100t + \varphi - \tan^{-1}\left(\frac{-100L}{R_{th}}\right)\right)$$

Must match amplitude and phase in this equation

$$I_L = \frac{12.5}{\sqrt{1^2 + (100\cdot 10\text{mH})^2}}$$

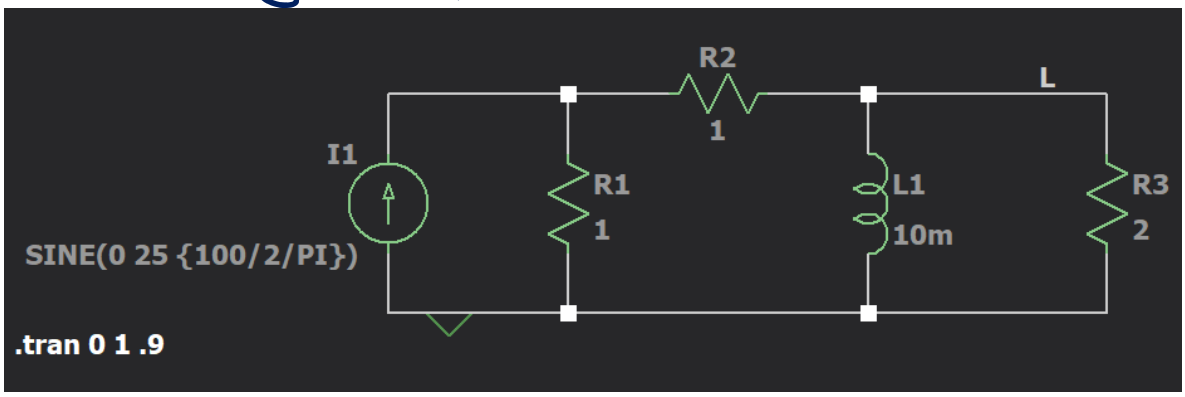
$$I_L = \frac{12.5}{\sqrt{2}} = 8.84$$

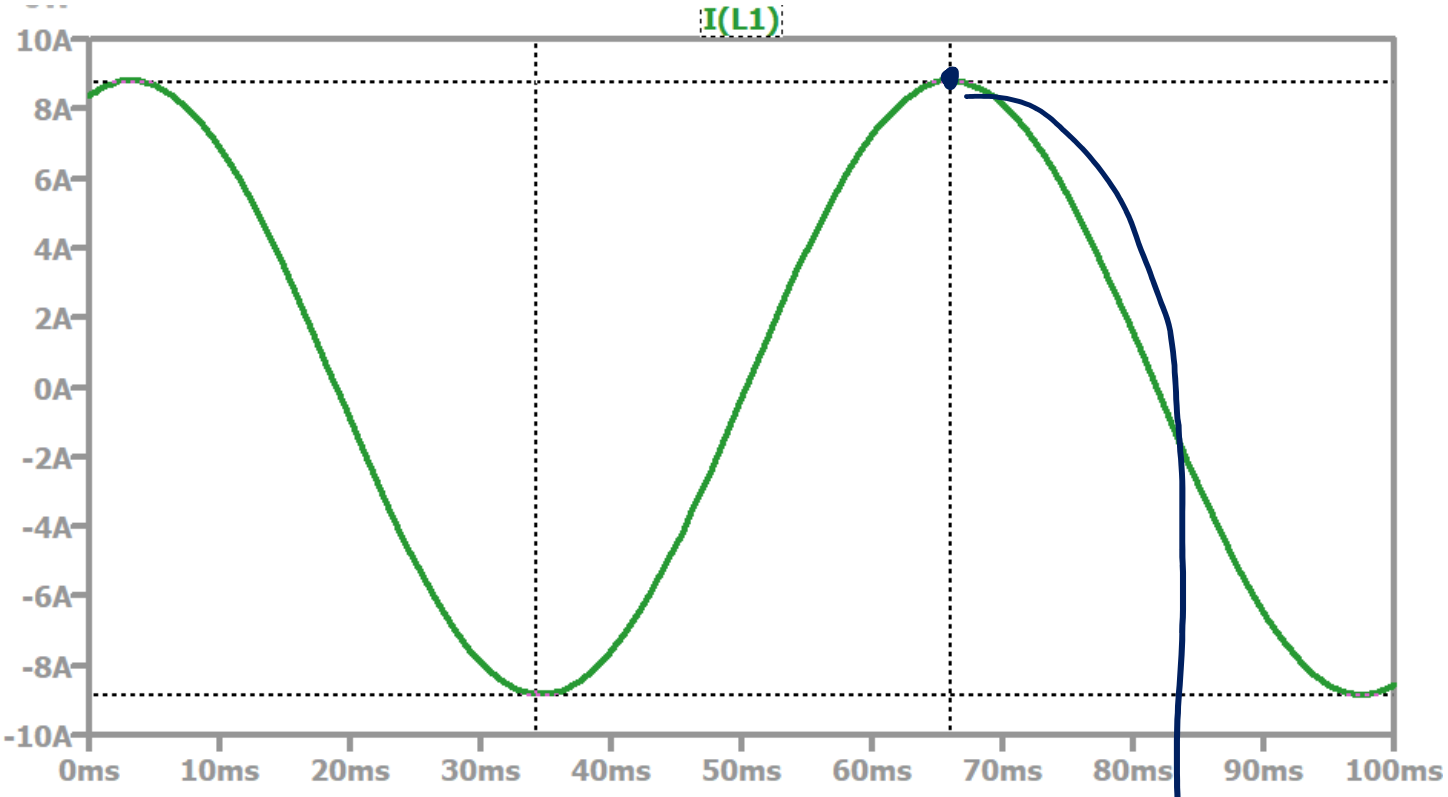
$$\varphi = +\tan^{-1}\left(\frac{-100\cdot 10\text{mH}}{1\,\Omega}\right)$$

$$\varphi = +\tan^{-1}(-1) = -45^\circ = -\frac{\pi}{4}$$

$$\boxed{i_L(t) = 8.84\cos(100t - 45^\circ)}$$

Check using LTspice





Draft1.raw

Cursor 1	I(L1)		
Horz:	65.882353ms	Vert:	8.8292119A
Cursor 2	**I(L1)**		
Horz:	34.117647ms	Vert:	-8.8093347A
Diff (Cursor2 - Cursor1)			
Horz:	-31.764706ms	Vert:	-17.638547A
Freq:	31.481481Hz	Slope:	555.288

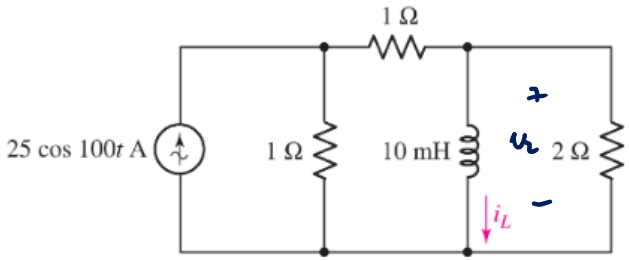


FIGURE 10.47

12. Calculate the power dissipated in the 2 Ω resistor of Fig. 10.47 assuming there are no transients present. Express your answer in terms of a single sinusoidal function.

from previous problem, $i_L(t) = 8.84\cos(100t - 45^\circ)$

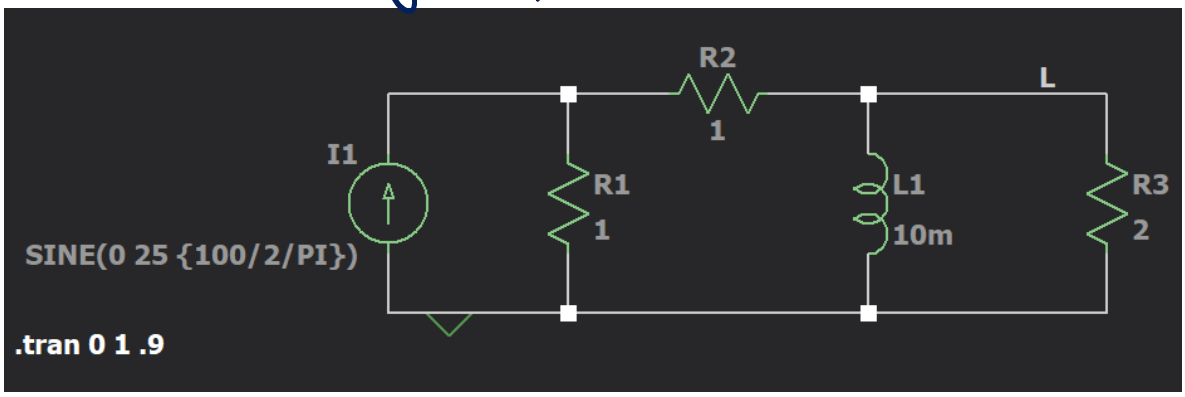
$$v_L = L\frac{di_L}{dt} = -(10\text{mH})(100)\,8.84\sin(100t - 45^\circ)$$

$$= -8.84\sin(100t - 45^\circ)$$

$$p_{2\Omega}(t) = \frac{v_L(t)^2}{2\Omega} = \left(\frac{8.84^2}{2}\right)\sin^2(100t - 45^\circ)$$

$$= 39.1\sin^2(100t - 45^\circ)\ \text{W}$$

Check using LTspice



P = V(l)*I(R3)