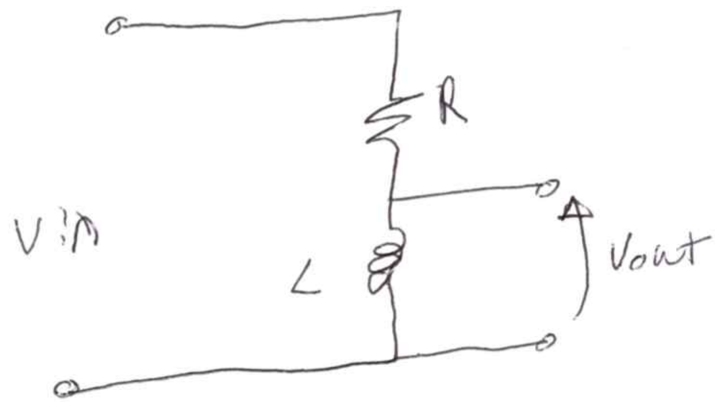
2501 Final 2020 Sols

(1)



~~$v = \frac{1}{2\pi \cdot 6 \times 10^{3}} \ldots$~~

$\tau = \frac{L}{R}$

$$\frac{V_{out}}{V_{in}} = \frac{j\omega L}{R + j\omega L}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{\omega L}{\sqrt{R^2 + \omega^2 L^2}} = \frac{9}{18} = \frac{1}{2}$$

$$\frac{\omega^2 L^2}{R^2 + \omega^2 L^2} = \frac{1}{4}$$

$$4\omega^2 L^2 = R^2 + \omega^2 L^2$$

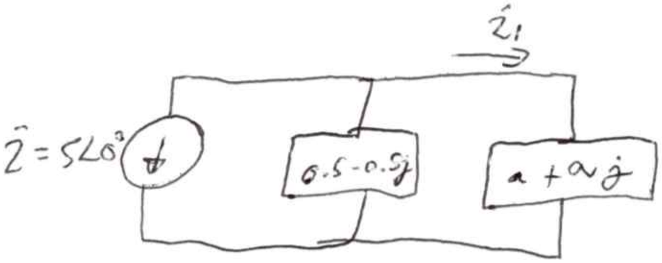
$$3\omega^2 L^2 = R^2$$

$$\tau^2 = \frac{L^2}{R^2} = \frac{1}{3\omega^2}$$

$$\tau = \frac{1}{\sqrt{3}\,\omega}$$

$$\tau = \frac{1}{\sqrt{3}\left(2\pi \cdot 1 \times y \times 10^{3}\right)}$$

② $(1\Omega // -j) = 0.5 - 0.5j$ let $a = y+1$



$$\hat{i}_1 = \hat{I}\left(\frac{0.5-0.5j}{0.5-0.5j+a+aj}\right)$$ (current divider)

$$\text{Power in Resistor} = \frac{|\hat{i}_1|^2}{2}(a)$$

③ let $s = j\omega$

$$G_v(s) = \frac{(10x + s)}{(s+5-5j)(s+5+5j)\left(\frac{s}{1000}+1\right)}$$

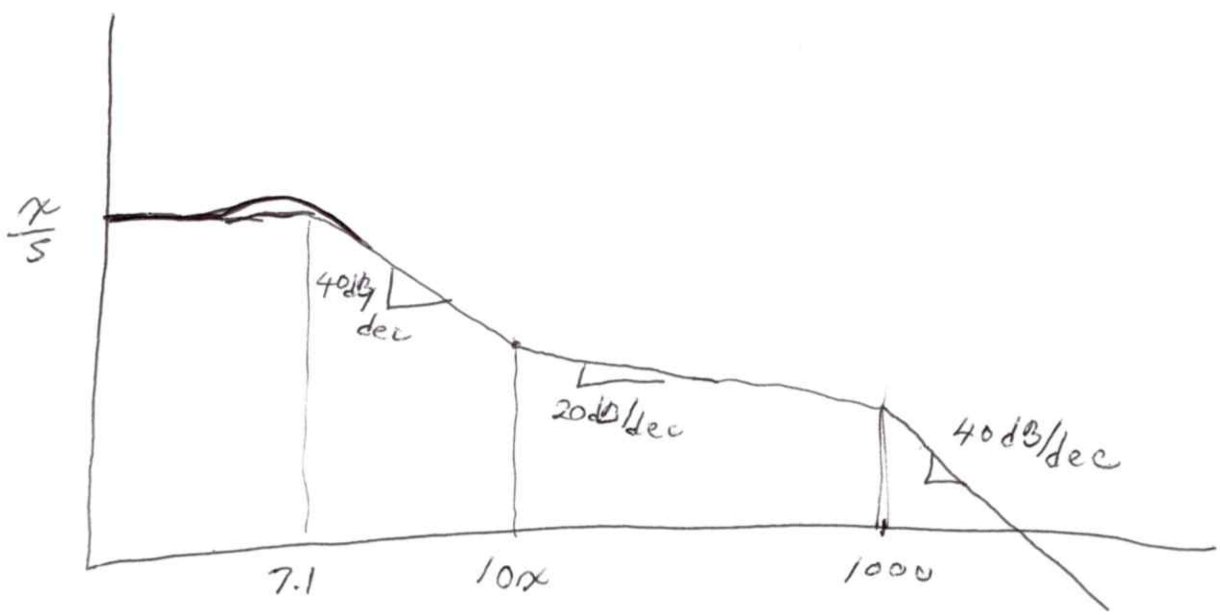
$$(s+5-5j)(s+5+5j)$$

$$= s^2 + 5s + \cancel{5js} + 5s - \cancel{5js} + (5-5j)(5+5j)$$

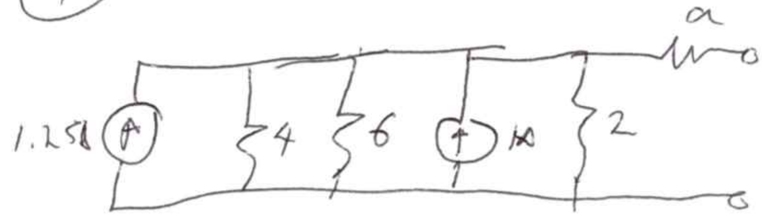
$$= s^2 + 10s + 50$$

$$G(v) = \frac{10x\left(\frac{s}{10x}+1\right)}{(s^2+10s+50)\left(\frac{s}{1000}+1\right)} = \frac{\frac{x}{5}\left(\frac{s}{10x}+1\right)}{\left(\frac{s^2}{50}+\frac{s}{5}+1\right)\left(\frac{s}{1000}+1\right)}$$

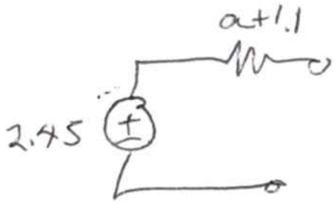
$$\sqrt{50} \simeq 7.1$$



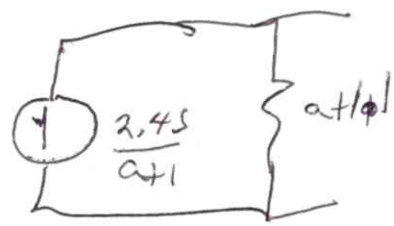
4 Left side let $a = y+1$



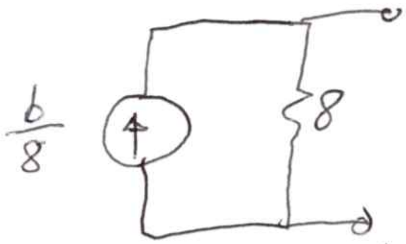
$\Rightarrow$



$\Rightarrow$

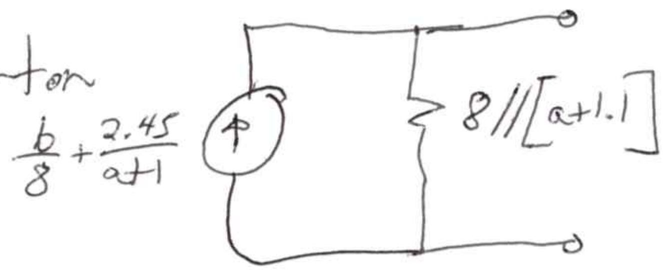


right side let $b = x+1$



(rest doesn't matter)

total Norton



5

$$\omega_{Lo} = \omega_o \left[\frac{-1}{2Q} + \sqrt{\left(\frac{1}{2Q}\right)^2 + 1} \right]$$

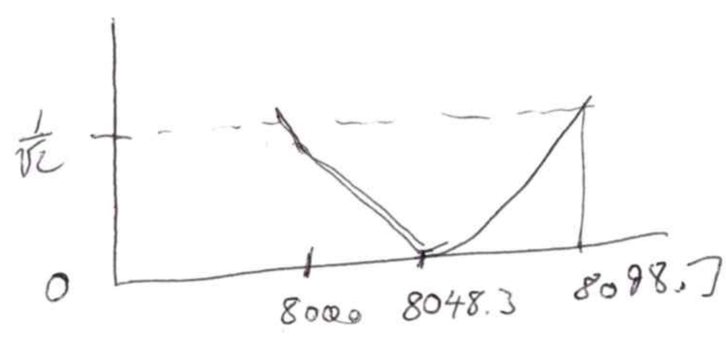
$$\omega_{Lo} = \omega_o \left[-0.00625 + 1 \right]$$

$$\cancel{\omega_{Lo}} \quad \omega_o = \frac{\omega_{Lo}}{0.994} = \frac{8000}{0.994} = 8048.3$$

output will be zero at this freq.

$$\omega_H = \omega_o \left[\frac{1}{2Q} + \sqrt{\left(\frac{1}{2Q}\right)^2 + 1} \right] = 8048.3(1.0063)$$

$$= 8098.7$$



6

13Ω

$R_{th} = \cancel{\text{[illegible]}}$

$V_{th} = 7(2+\cancel{9k})$

$\therefore R_{Load} = 13\,\Omega$

$V_{Load} = \dfrac{V_{th}}{2} \quad \therefore P_{load} = \dfrac{\left(\dfrac{V_{th}}{2}\right)^2}{13}$

(7) initial current from supply

$$I = \frac{(y+1)}{1k + 2k//2k} = \frac{y+1}{2000}$$

$$I_{L\,int} = -\frac{y+1}{4000}$$ (half supply current) (flows right to left)

$$I_{final} = \frac{y+1}{2000}$$ (flows left to right)

resistance seen by L: $R_{eq} = 2k//1k = 667\,\Omega$

$$\tau = \frac{L}{R} = \frac{1}{667} = 1.5\,ms$$

$$i(t) = K_1 + K_2\, e^{-\frac{(t-1ms)}{\tau}}$$

$$i(1ms) = K_1 + K_2 = -\frac{y+1}{4000}$$

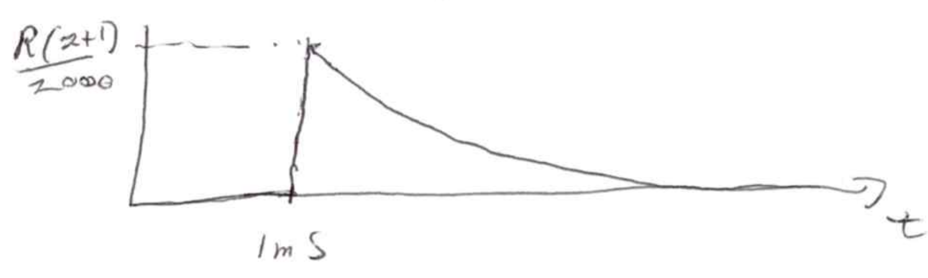
$$i(\infty) = K_1 = \frac{y+1}{2000}$$

$$K_2 = -\frac{y+1}{4000} - \frac{y+1}{2000} = \frac{-3(y+1)}{4000}$$

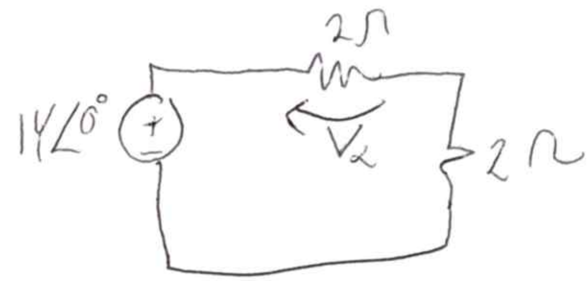
$$i(t) = \frac{(y+1)}{2000} - \frac{3\,y+1}{4000}\, e^{-\frac{(t-1ms)}{\tau}}$$

$$V_x(t) = L\frac{di}{dt} = 3L\left(\frac{y+1}{4000}\right) e^{-\frac{(t-1ms)}{\tau}} \cdot \frac{1}{\tau}$$

$$= 3R\left(\frac{y+1}{4000}\right) e^{-\frac{(t-1ms)}{\tau}}$$



(8) move everything to the primary



$$V_x = \frac{1V}{2}\angle 0^\circ$$