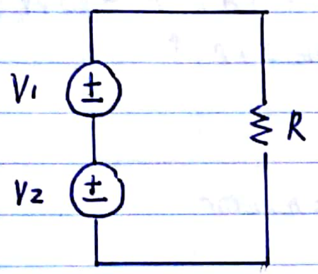
Week 5 Discussion MIDTERM ANS

#1



$V_1(t) = A\sin\omega t$

$V_2(t) = 2A\sin\omega t$

find $\langle p(t)\rangle$ for R (average power consumed by resistor)

$\langle p(t)\rangle = V_{Rms}^2 R$

↑ over the resistor

$$V_{Rms}^2 = \lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{T/2} (V_1(t) + V_2(t))^2\, dt$$

$$= \lim_{T\to\infty} \frac{1}{T}\left[\int_{-T/2}^{T/2} V_1^2(t) + \int_{-T/2}^{T/2} V_2^2(t)\, dt + \int_{-T/2}^{T/2} \cancelto{0}{2V_1(t)V_2(t)\,dt}\right]$$

$$= \frac{A^2}{2} + 2A^2 = \frac{5A^2}{2}$$

$$\langle p(t)\rangle = 5A^2/2R$$

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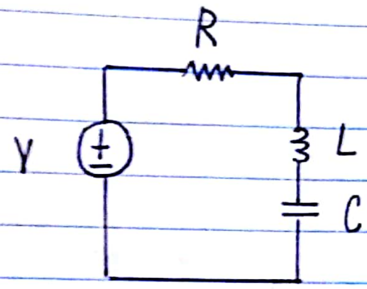
2



sine voltage source. we know $V_{rms} = 5V$

2 conditions:

- when $C = 0.2F$, $I_{rms} = 1A$, $P = 3W$
- when $C = 1/45\ F$, same I & P ↑

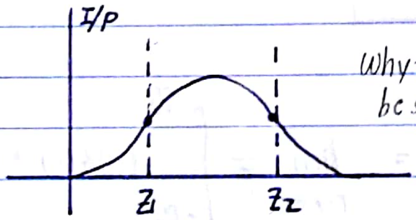
L and C are lossless, only power dissipated should be from the resistor

⇓

$P = I^2R$

$3 = (1)^2 R$

$R = 3\Omega$



Why there can be same I + P

$$I_{rms} = \frac{V_{rms}}{|Z|} = \frac{5}{\sqrt{R^2 + (\omega L - 1/\omega C)^2}}$$

① $3^2 + (\omega L - 5/\omega)^2 = 5^2$

② $\omega L - 5/\omega = -(\omega L - 45/\omega)$

from ② ⇒ $2\omega L = 50/\omega$ ⇒ $\omega^2 L = 25$

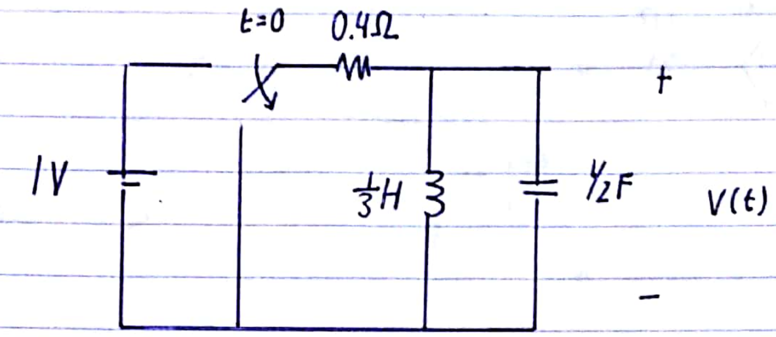
from ① ⇒ $9 + (\omega^2 L - 5)^2/\omega^2 = 25$

$20^2/\omega^2 = 16$

$\omega = 5\ rad/s$

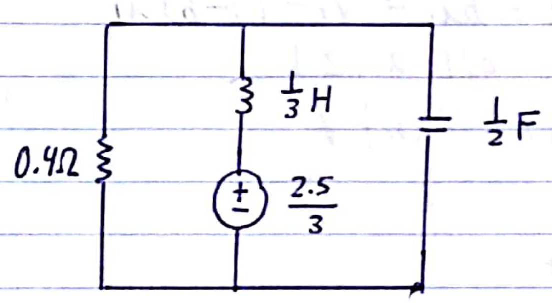
$L = 1H$

#3



$V_c(0^-) = 0V \qquad i_L(0^-) = \frac{1}{0.4} = 2.5A$

initial cond.

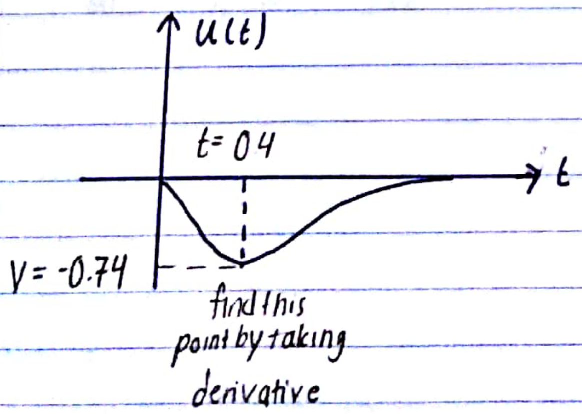


$$V(s) = -\frac{2.5}{3} \cdot \frac{1}{1+sL(G+sC)}$$

$$= -\frac{2.5}{3} \cdot \frac{1}{1+sLG+s^2LC} = -\frac{2.5}{3} \cdot \frac{1}{1+s\,{}^{2.5}/_{3}+s^2/6}$$

$$= -5 \cdot \frac{1}{s^2+5s+6} = -5\left(-\frac{1}{s+3}+\frac{1}{s+2}\right)$$

$$v(t) = \mathcal{L}^{-1}\,V(s) = -5\left(-e^{-3t}+e^{-2t}\right) = 5e^{-3t} - 5e^{-2t}$$



$$\frac{du(t)}{dt} = 0$$

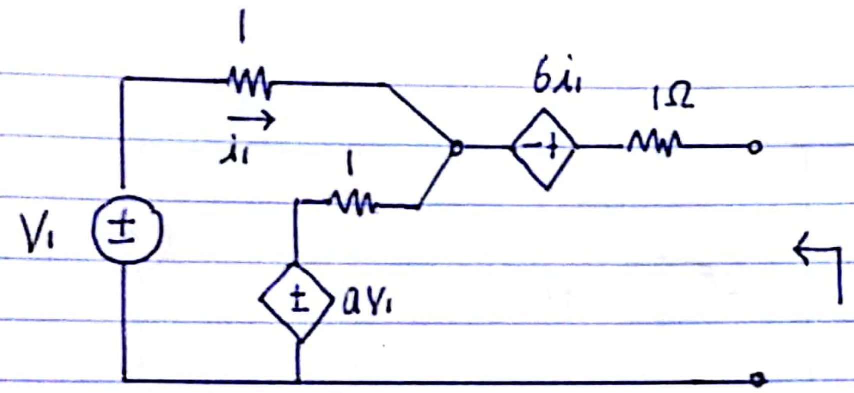
$$-15e^{-3t} + 10e^{-2t} = 0$$

$$2e^{-2t} = 3e^{-3t}$$

$$t = 0.4s$$

$$e^t = 1.5 \Rightarrow v(t) = -0.74V$$

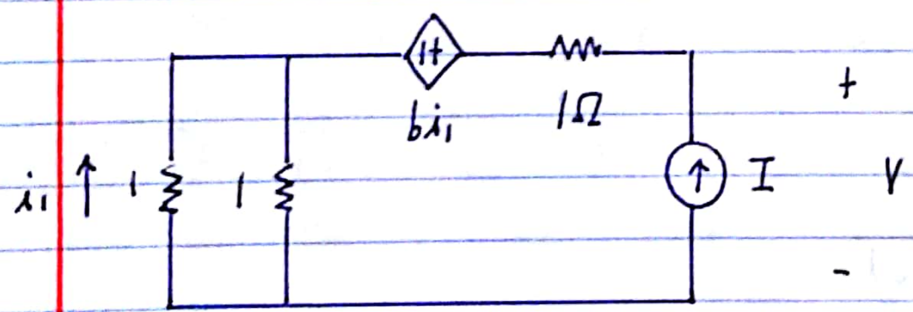
#4



① OC Voltage

$$i_1 = \frac{(V_1 - aV_1)}{2}$$

$$V_T = V_1 - i_1 \cdot 1 + b i_1 = V_1 - (1-b) i_1$$
$$= V_1 [1 - (1-b)(1-a)/2]$$
$$= \frac{V_1}{2}[1 + a + b - ab] \, V$$



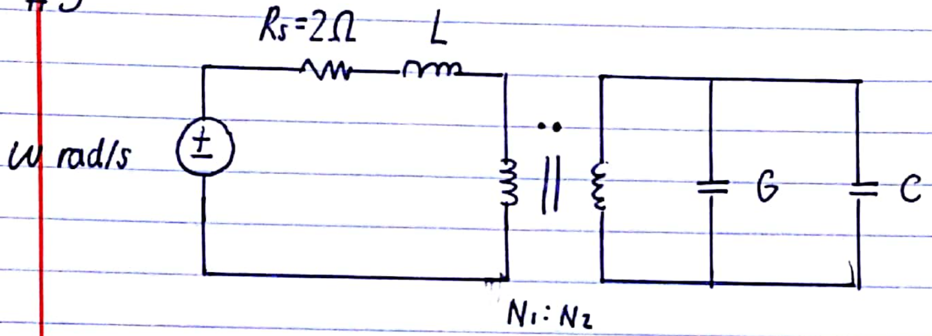
$$i_1 = -\frac{I}{2} \qquad V = -\frac{I}{2} \cdot 1 - \frac{I}{2} \cdot b + I \cdot 1$$

$$\frac{V}{I} = \frac{1}{2}(1-b)\,\Omega$$

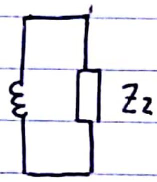
find ωL and N_1/N_2 to deliver max power to G

$G = 2S \quad C = 1S$ — siemens

#5



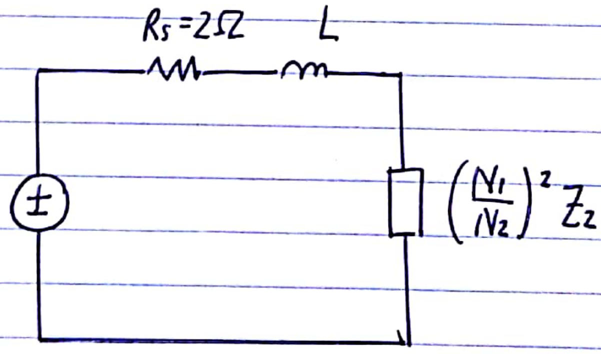
Driving Point Impedance



$$Z_2 = \frac{1}{G + j\omega C} = \frac{1}{G^2 + (\omega C)^2} - j\frac{\omega C}{G^2 + (\omega C)^2}$$

$$= \left(\frac{2}{5} - j\frac{1}{5}\right)\Omega$$

$$\frac{Z_1}{Z_2} = \left(\frac{N_1}{N_2}\right)^2$$



$$Z_1 = Z_2\left(\frac{N_1}{N_2}\right)^2$$

$$R_s = \frac{2}{5}\left(\frac{N_1}{N_2}\right)^2$$

$$\frac{N_1}{N_2} = \sqrt{5}$$

$$\omega L = \frac{1}{5} \cdot 5 = 1\Omega$$