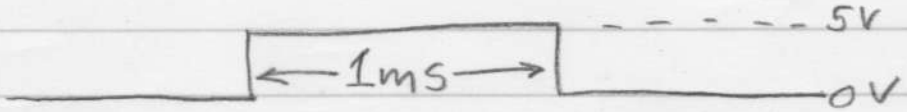
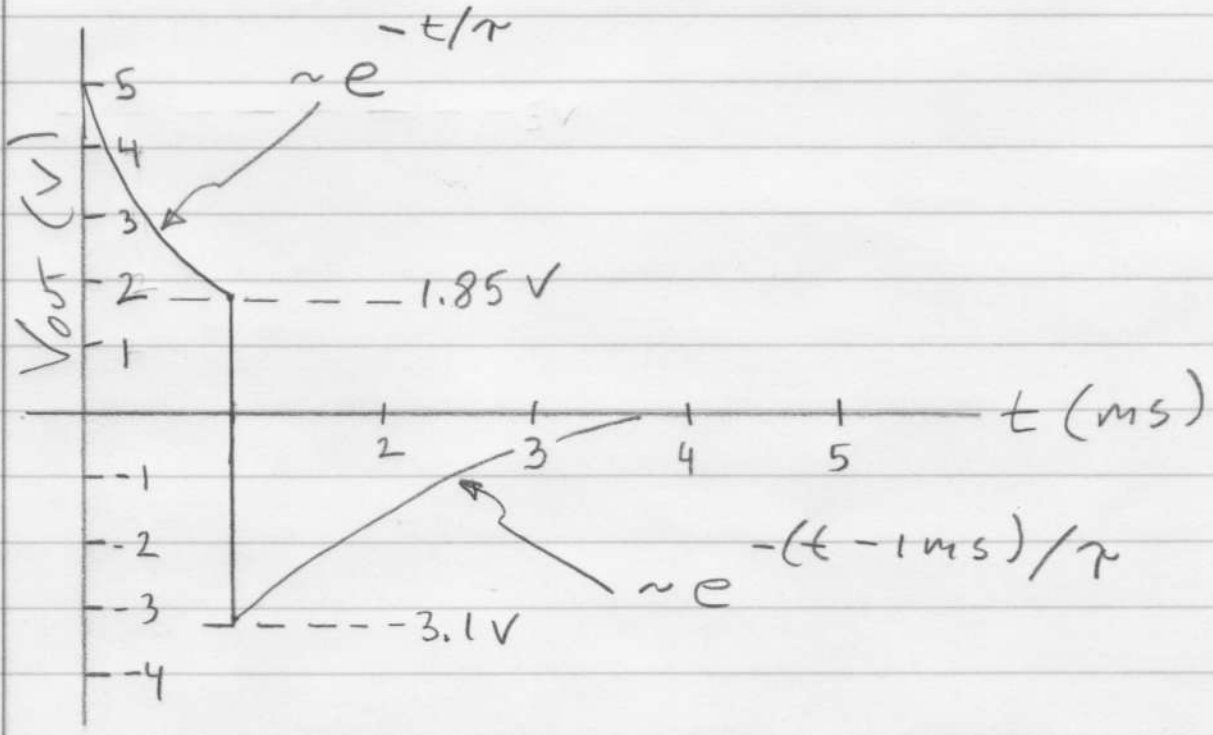
PHYS 334 WINTER QUARTER 2012
HOMEWORK 3 SOLUTIONS V. 1.0

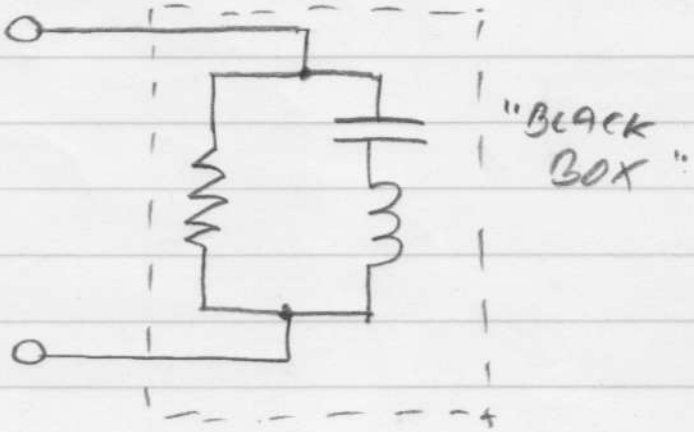
1. V_{IN}



$\tau = RC = 1000\,\Omega \times 1\,\mu F = 1\,ms.$



2. THE ONLY POSSIBLE CONFIGURATION SATISFYING CONSTRAINT 1 & 3 IS



THE IMPEDANCE "LOOKING INTO" THE TWO TERMINALS IS

$$\frac{1}{Z} = \frac{1}{R} + \frac{1}{i\omega L - i/\omega C}$$

$$= \frac{1}{R} + \frac{1}{i\omega L\left(1 - \omega_0^2/\omega^2\right)} \quad i\cdot\omega_0^2 = \frac{1}{LC}$$

$$\frac{1}{L} = \sqrt{\frac{1}{|Z|^2} - \frac{1}{R^2}}\;\omega\left\{1 - \omega_0^2/\omega^2\right\}$$

AT $\omega(60\text{Hz}) \equiv \omega_{60}$, $V_{RMS} = 1\text{ V}$

AND $I_{RMS} = 1/100\text{ A}$

HENCE $|Z| = V_{RMS}/I_{RMS} = 100\,\Omega$ (AT ω_{60})

$= \frac{1}{10}R$ ($R = 1000\,\Omega$ FROM CONSTRAINT 1)

NOTICE $\omega_{60}/\omega_0 = 3/50$

HENCE $L \approx \omega/\omega_0^2\,|Z|$

$$= \frac{60\cdot 2\pi/\text{SEC}}{(1000\cdot 2\pi/\text{SEC})^2} \times 100\,\Omega$$

$\cong 1\text{ mH}$

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$$C = \frac{1}{L\omega_0^2} = \frac{1}{\omega|z|} = \frac{1}{60 \cdot \frac{2\pi}{\text{SEC}} \cdot 100\,\Omega}$$

$$\approx 30\,\mu\text{F}.$$

3. $z = 1000\,\Omega\,(1+i) = 1000\,\Omega\sqrt{2}\,e^{i\pi/4}$

$$V(t) = V_0 e^{i(\omega t + \theta)}$$

θ IS THE ARBITRARY PHASE

$$I(t) = V(t)/z = \frac{V_0 e^{i(\omega t + \theta)}}{1000\,\Omega\sqrt{2}\,e^{i\pi/4}}$$

$$\langle P \rangle = \tfrac{1}{2}\,\text{Re}\,V I^*$$

$$= \tfrac{1}{2}\,\text{Re}\,V_0 e^{i(\omega t+\theta)} \frac{V_0 e^{-i(\omega t+\theta)}}{1000\,\Omega\sqrt{2}\,e^{-i\pi/4}}$$

$$= \frac{1}{2}\frac{|V_0|^2}{1000R\sqrt{2}}\,\text{Re}\,e^{i\pi/4}$$

$$= \frac{1}{2}\frac{|V_0|^2}{1000\,\Omega R\sqrt{2}}\frac{\sqrt{2}}{2}$$

$$= \frac{1}{4}\frac{|10\text{V}|^2}{1000\,\Omega} = 25\,\text{mW}$$