ENGR 210 HW 10 Solutions Spring '05

#1

$v(t) = 100 - 200\cos(\pi t) - 75\sin(40000\pi t) + 35\cos(80000\pi t)$ $\underline{\underline{mV}}$ ← watch units

a) $T_0 = ?$ $T_0 = \frac{1}{f_0} = \frac{1}{\omega/2\pi} = \frac{1}{\pi/2\pi} = 2$ $\boxed{T_0 = 2s}$ You can assume seconds, because $Hz = \frac{1}{s}$

↑ fundamental

b) Avg Value = ?

$\boxed{V_{Avg} = \text{DC Value} = 100mV}$

c) Amp of fund?

$\boxed{V = 200mV}$

d) highest freq. ?

$\omega = 80000\pi = 2\pi f$

$\boxed{f = 40kHz}$

#2

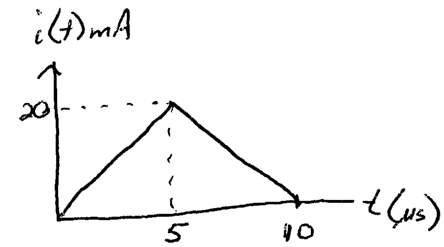
$L = 25mH$

$V_L = L\frac{di_L}{dt}$

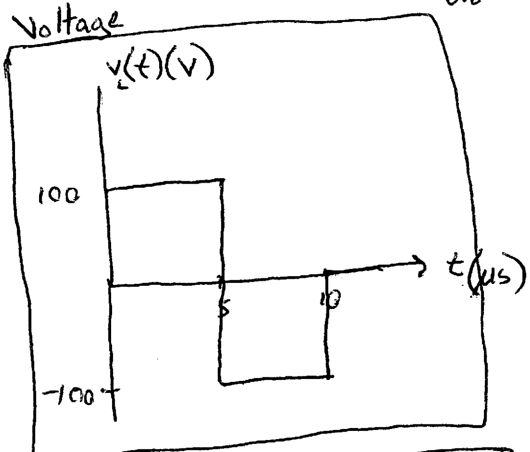
derivative is slope.

$\frac{rise}{run} = \frac{20mA}{5\mu s} = 4000$

$V_L(t) = (25m)(4K) = 100V$



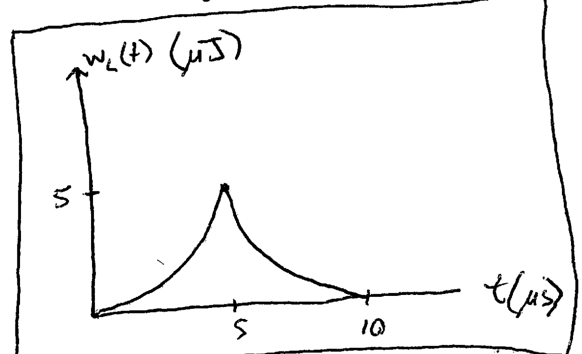
Voltage



Energy

$w_L(t) = \frac{1}{2}Li^2(t)$

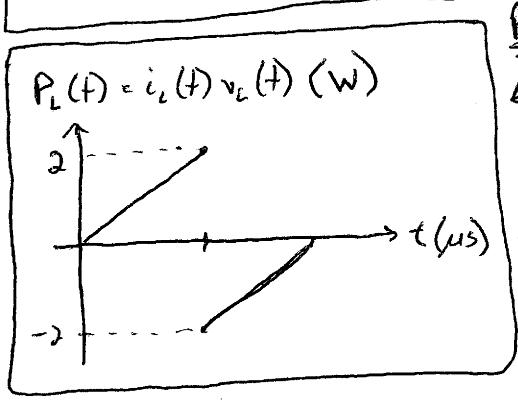
$\frac{1}{2}(25m)(20m)(20m) = 5\mu J$



Parabolic

Power

← Multiply the v(t) graph with the i(t) graph.



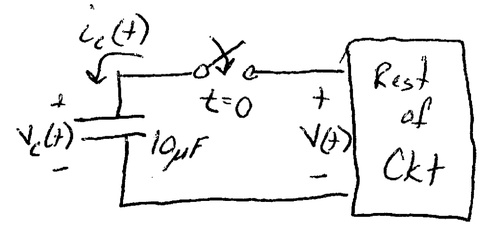
#3

$V_c(0)=25V$

$V_c(t)=50-25e^{-5000t}$

$i_c=?$

$P_c=?$



$$i_c(t)=C\frac{dv_c(t)}{dt}$$

$$=10\mu F\,\frac{d}{dt}\left(50-25e^{-5000t}\right)$$

$$=10\mu F\left[125000\,e^{-5000t}\right]$$

$$\boxed{i_c(t)=1.25\,e^{-5000t}\ A}$$

$$p_c(t)=i_c(t)v_c(t)=\left[50-25e^{-5000t}\right]\left[1.25e^{-5000t}\right]$$

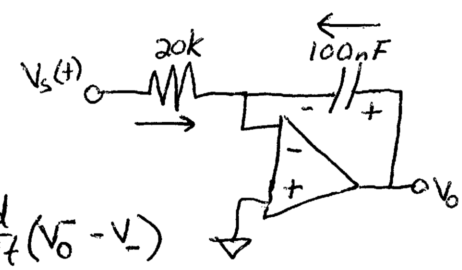
$$\boxed{P_c(t)=62.5\,e^{-5000t}-31.25\,e^{-10000t}}$$

$\underline{p_c(t)>0}$ for $t>0$ $\Rightarrow$ $\boxed{\text{Absorbing power}}$

#4

$V_c(0)=0$

$V_s(t)=5\,[\sin\omega t]\,u(t)$



KCL at V^-

$$\frac{V_s(t)-V_-}{20k}=-i_c(t)=-C\frac{dv_c(t)}{dt}=-C\frac{d}{dt}(V_o-V_-)$$

$$V_-=0$$

$$\frac{V_s(t)}{20k}=-C\frac{dV_o}{dt}$$

$$V_o=\frac{-1}{20k(100nF)}\int_0^t v_s(x)\,dx=\frac{-5}{20k(100nF)}\int_0^t \sin\omega t\,dt+\cancel{V_c(0)}^{\,0}$$

$$V_o(t)=\frac{-5}{20k(100nF)}\left[\frac{-1}{\omega}\cos\omega t\right]_0^t=\frac{-5}{20k(100nF)}\,\frac{1}{\omega}\left[-\cos\omega t+1\right]$$

$$\boxed{V_o(t)=\frac{-2500}{\omega}\left[1-\cos(\omega t)\right]}$$

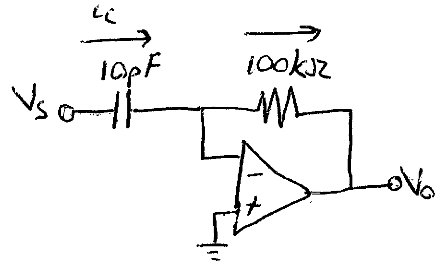
cos is max of ±1

OpAmp Saturates at ±15V

$$-15=\frac{-2500}{\omega}\left[1--1\right]$$

$$\boxed{\omega=\frac{5000}{15}=333\ \frac{rad}{s}}$$ when opamp enters saturation.

#5



$V_s(t) = 5\left[e^{-\alpha t}\right]u(t)$ KCL at V^-

$V^- = 0V$

$$10pF \frac{dV_s(t)}{dt} = \frac{-V_o}{100k}$$

$$V_o = -100k(10pF)\frac{dV_s(t)}{dt} = -1\times10^{-6}\left[-5\alpha e^{-\alpha t}\right]u(t)$$

$$\boxed{V_o = 5\times10^{-6}\alpha e^{-\alpha t}u(t)}$$

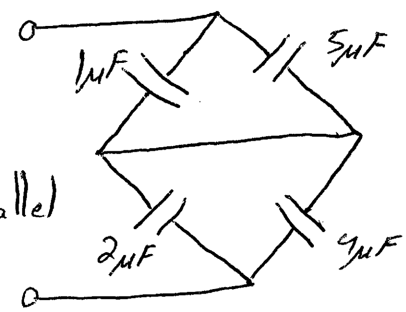
OpAmp saturates at $\pm 15V$

$15 = 5\times10^{-6}\alpha$ @ $t=0$ exponential is a maximum (1)

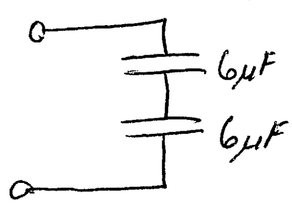
$$\alpha = \frac{15}{5\times10^{-6}}$$

$\boxed{\alpha = 3\times10^{6}}$ when opamp enters saturation

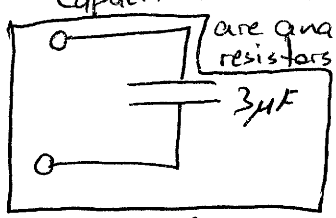
#6



Capacitors in parallel add.

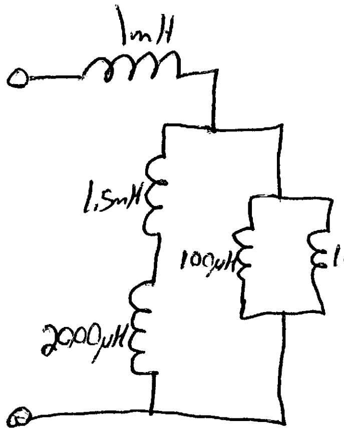


Capacitors in Series are analogous to resistors in parallel

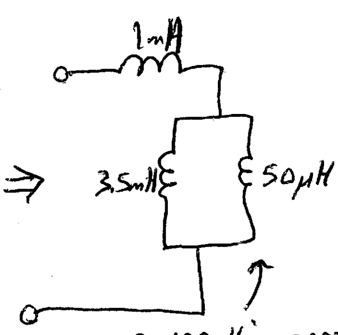


$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \Rightarrow C_{eq} = \frac{(6\mu F)(6\mu F)}{6\mu F + 6\mu F} = \boxed{3\mu F}$$

Inductors are reduced the same as resistors. Series Add; Parallel → use formula

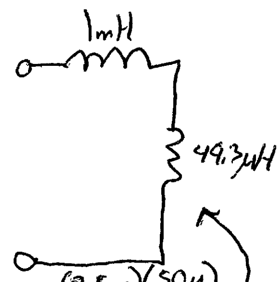


⇒



2 100µH in parallel

⇒



$$\frac{(3.5m)(50\mu)}{(3.5m)+50\mu}$$