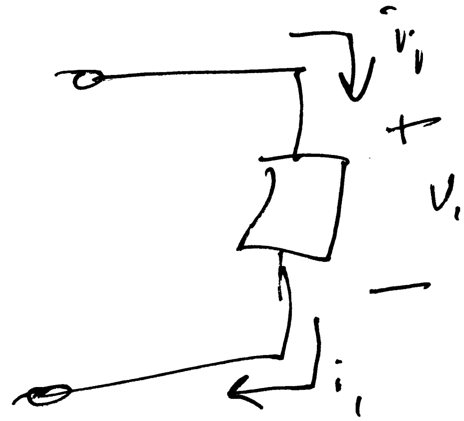
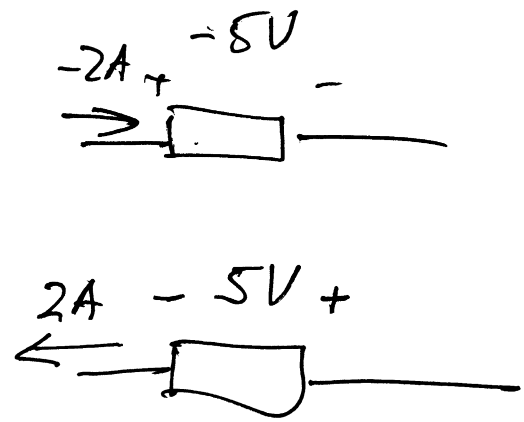
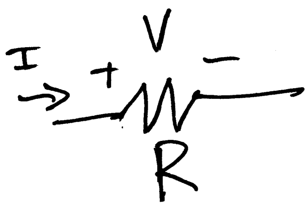




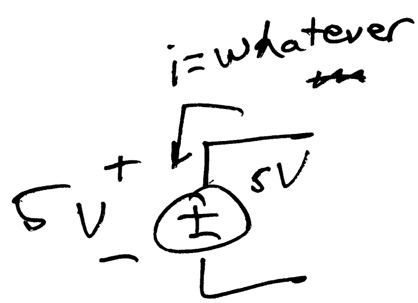
label

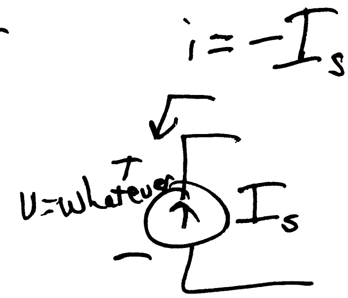
power $P = IV$

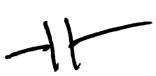
units: Watts

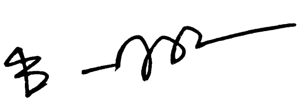


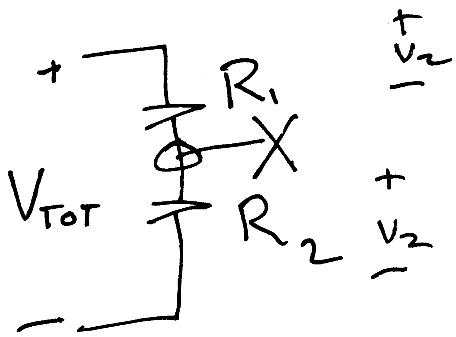
$V = IR$

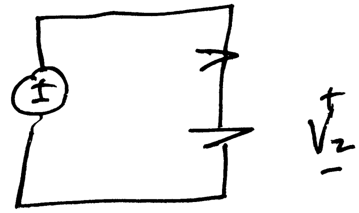


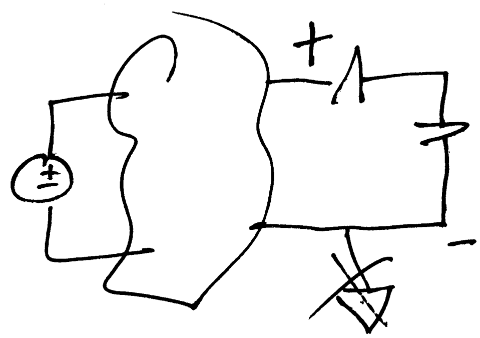






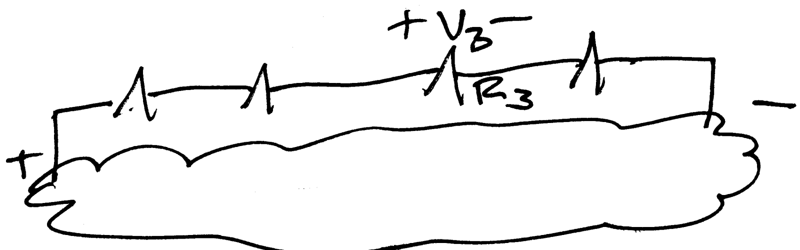




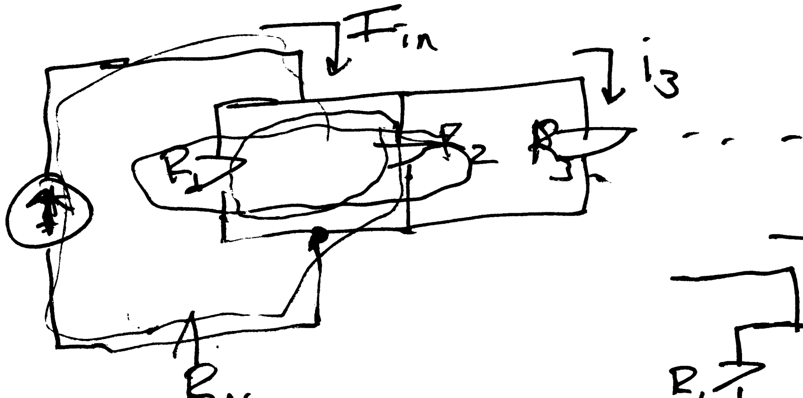


$$V_2 = V_{TOT} \cdot \frac{R_2}{\Sigma R_i}$$

$$R_1 + R_2$$

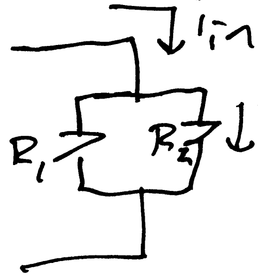


$$v_3 = V_{TOT} \cdot \frac{R_3}{\Sigma R_i}$$

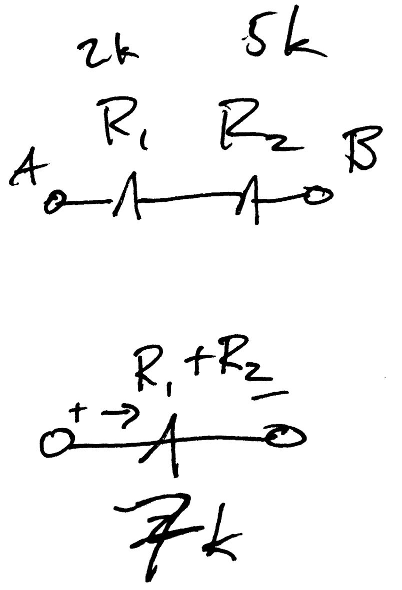


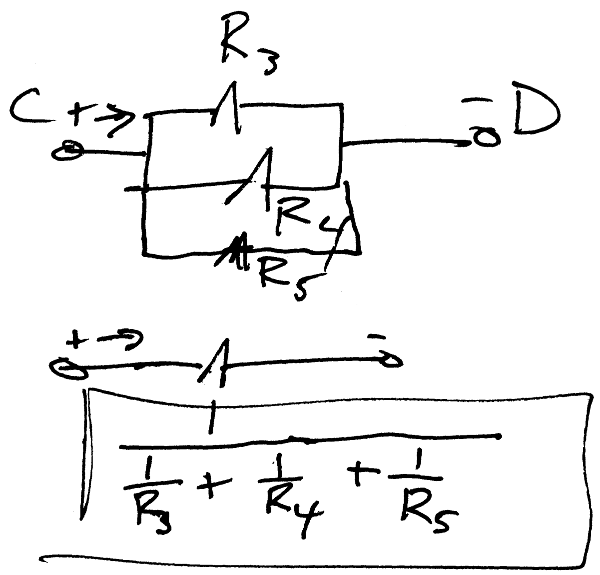
$$\boxed{i_3 = I_{IN} \cdot \frac{1/R_3}{\Sigma G_i}}$$

$$\Sigma \frac{1}{R_i}$$

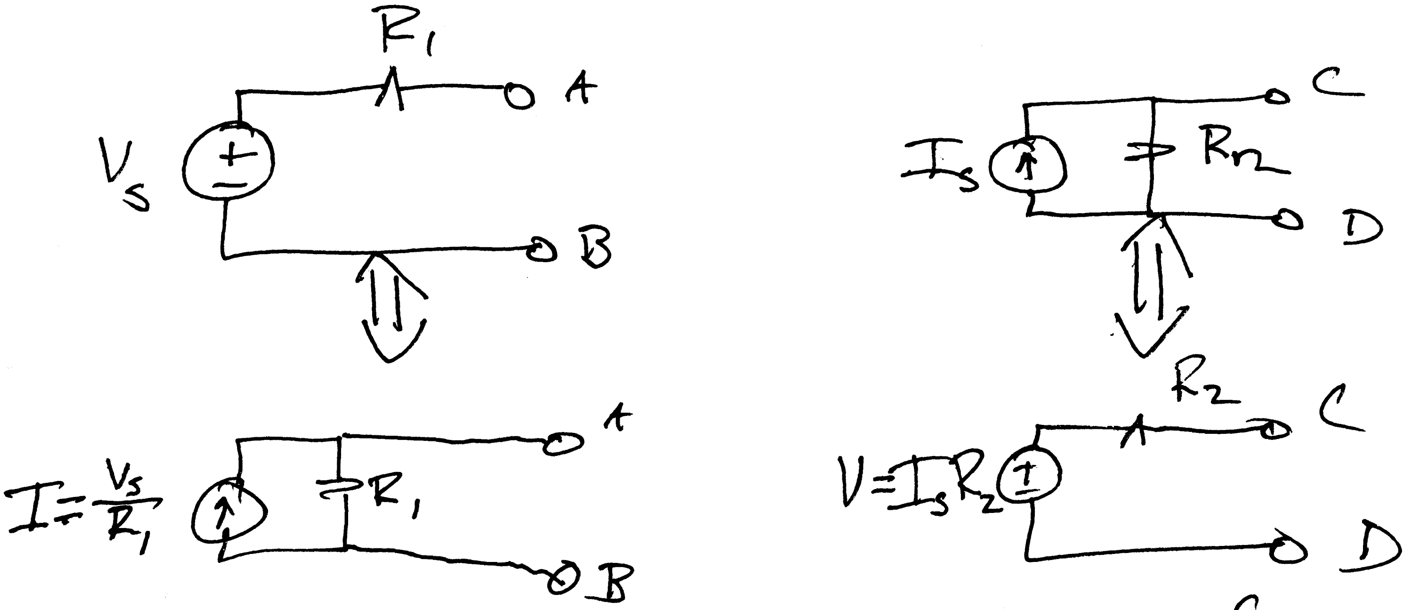


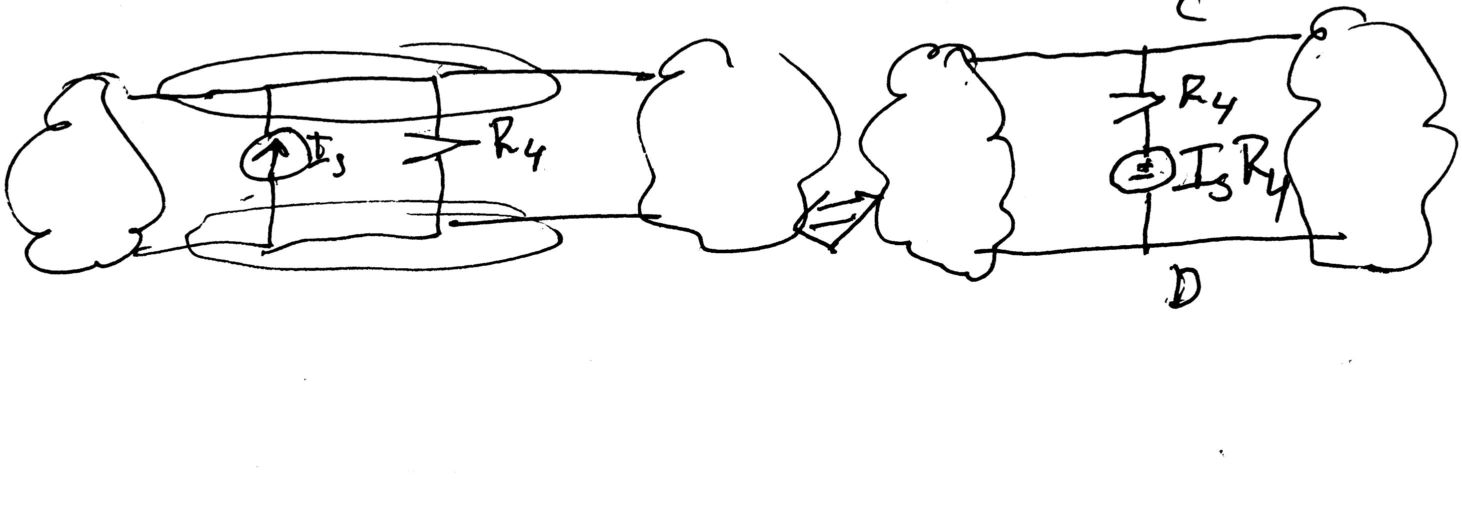
$$i_2 = i_{in} \cdot \frac{R_1}{R_1 + R_2}$$

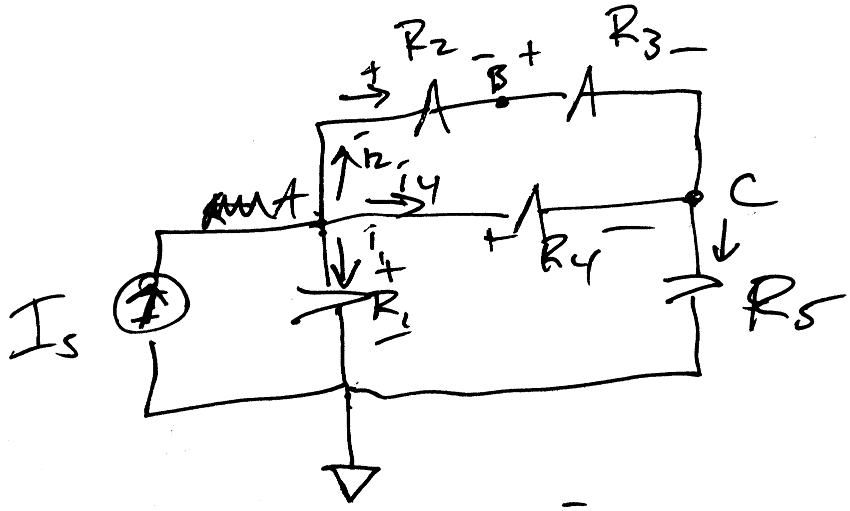

2k 5k
R_1 R_2
A B
R_1+R_2
+ →
7k


R_3
C + →
− D
R_4
R_5
+ →
−
$\boxed{\dfrac{1}{\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_5}}}$


R_3
R_4
$\Rightarrow$
$\dfrac{R_3 R_4}{R_3+R_4}$


R_1
A
V_s
B
$I=\dfrac{V_s}{R_1}$
R_1
A
B
I_s
R_{n2}
C
D
R_2
C
$V=I_sR_2$
D


I_s
R_4
C
R_4
I_sR_4
D



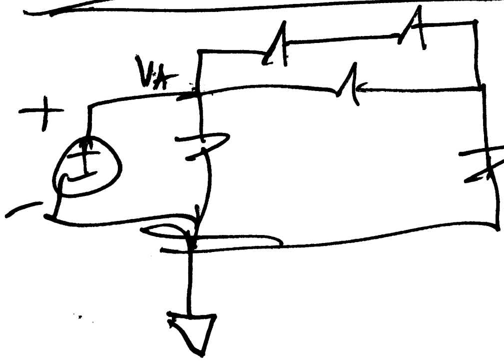
A: $i_1 + i_2 + i_4 = I_S$

$$\frac{V_A - 0}{R_1} + \frac{V_A - V_B}{R_2} + \frac{V_A - V_C}{R_4} = I_S$$

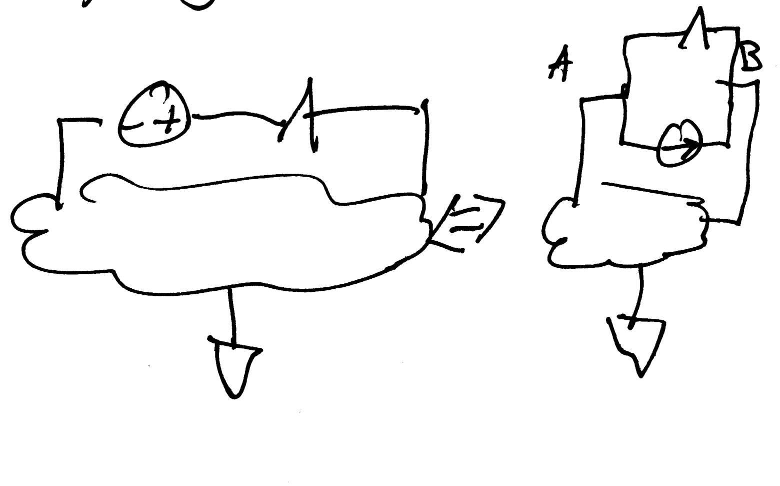
(A) $\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_4}\right)V_A - \frac{1}{R_2} V_B - \frac{1}{R_4} V_C = I_S$

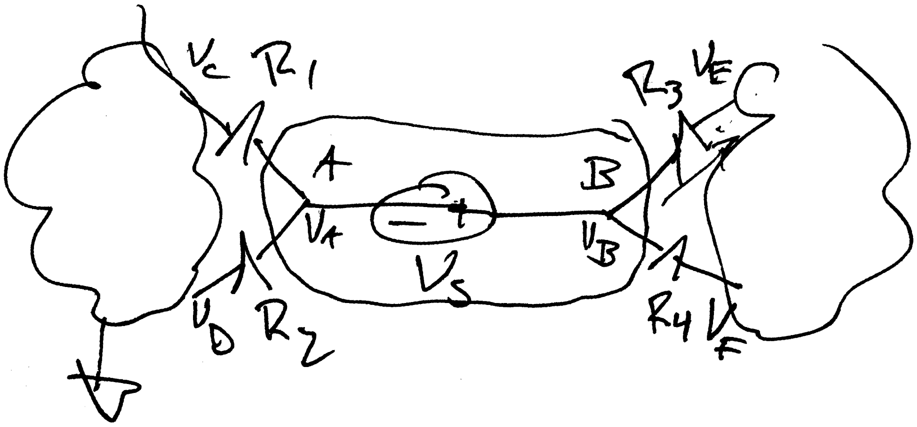
$$\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_4}\right)V_A$$

(C) $-\frac{1}{R_4} \cdot V_A - \frac{1}{R_3} \cdot V_B + \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}\right)V_C = 0$



$(V_A - 0) = V_S$

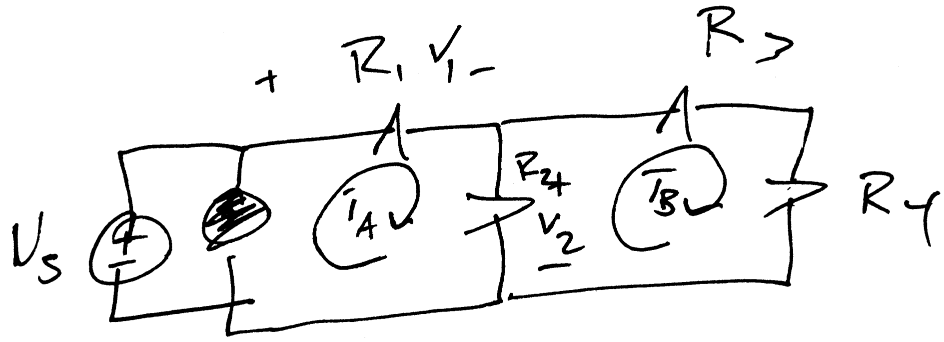




$$SN: \left(\frac{1}{R_1}+\frac{1}{R_2}\right)V_A+\left(\frac{1}{R_3}+\frac{1}{R_4}\right)V_B$$

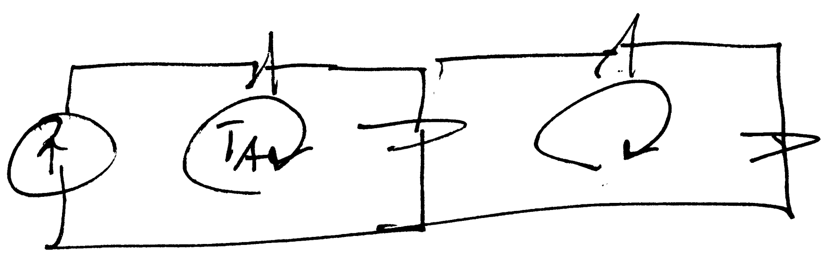
$$-\frac{1}{R_1}V_C-\frac{1}{R_2}V_D-\frac{1}{R_3}\cdot V_E-\frac{1}{R_4}\cdot V_F=0$$

$$V_s = V_B - V_A$$

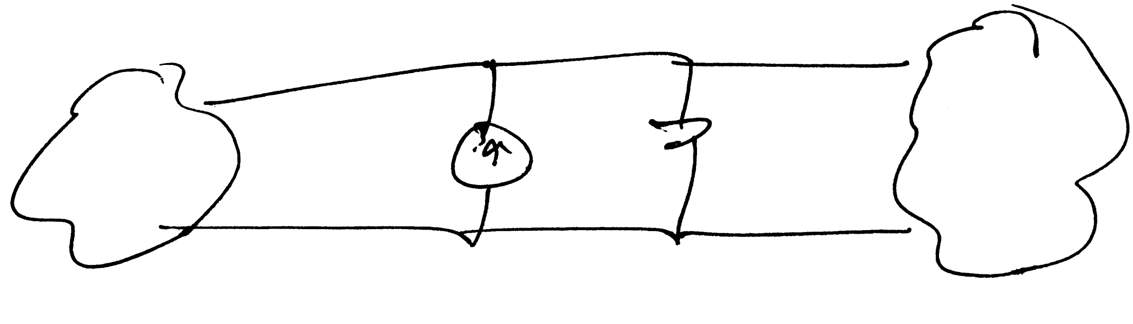


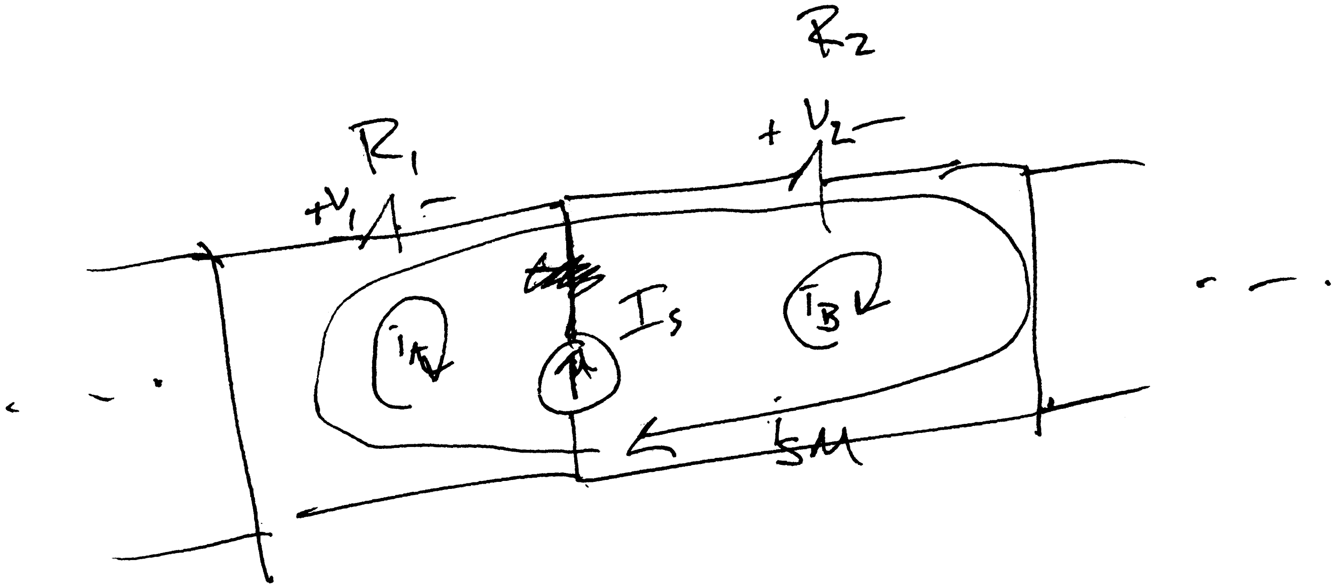
$$-V_S + V_1 + V_2 = 0$$

$$-V_S \cancel{+} i_A R_1 + (i_A - i_B) R_2 = 0$$



$$i_A = I_S$$

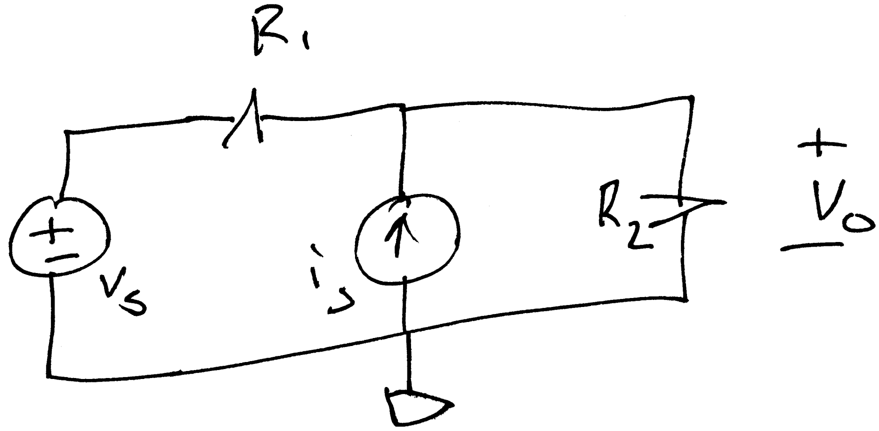


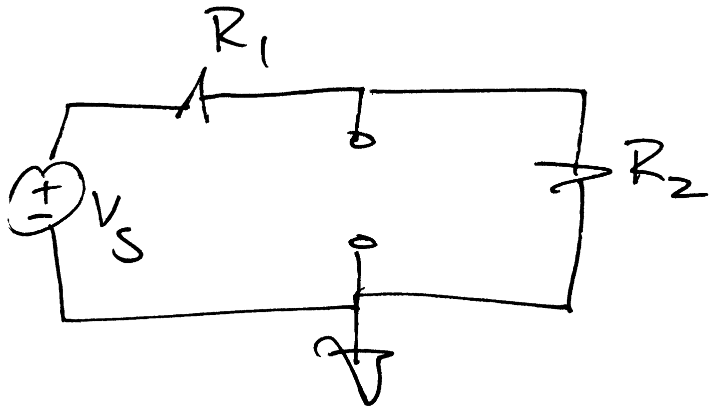


$$V_1 + V_2 = 0$$

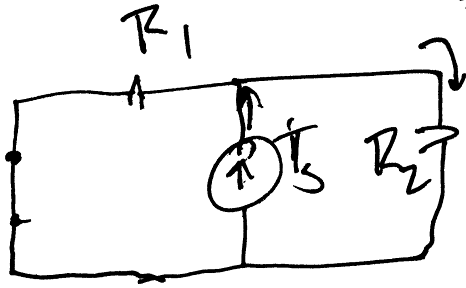
$$\boxed{i_A R_1 + i_B R_2 = 0}$$

$$I_S = i_B - i_A$$





$$V_{o,v} = V_s \cdot \frac{R_2}{R_1 + R_2}$$



$$i_2 = i_s \cdot \frac{R_1}{R_1 + R_2}$$

$$V_{o,I} = I_2 \cdot R_2 = i_s \frac{R_1 R_2}{R_1 + R_2}$$

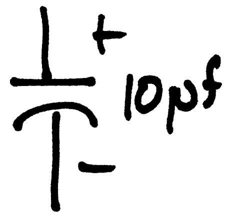
$$V_o = V_s \frac{R_2}{R_1 + R_2} + i_s \frac{R_1 R_2}{R_1 + R_2}$$

inductors/capacitors

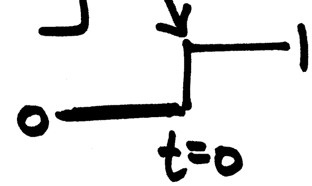
$i_c = C\dfrac{dv_c}{dt}$

$v_L = L\dfrac{di_L}{dt}$

Exercise 6.1



Given $v_c = 25[\sin 2000t]\,u(t)$



$i_c = C\dfrac{dv_c}{dt}$

$= (10\times10^{-6})\,\cancel{2000}^{\,25}\cos 2000t \quad t \geq 0$

$= 0.5 \cos 2000t \quad t \geq 0$

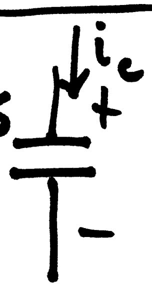
$= 0.5[\cos 2000t]\,u(t)$

$v_c(0) = -5$ volts

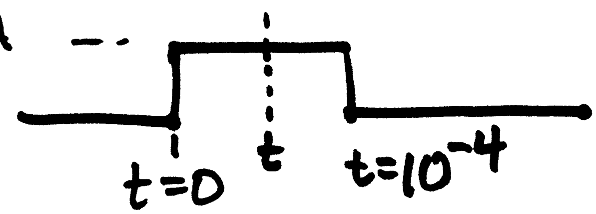
100pf

$\downarrow$

100×10^{-12}



Given $i_c = 10[u(t) -$ [redacted] $u(t-10^{-4})]\,\mu A$



find v_c use $i_c = C\dfrac{dv_c}{dt}$

$$\int_0^t \frac{1}{C}\, i_c\, dt = \int_0^t dv_c \quad \underline{\underline{\text{for } t < 10^{-4}}}$$

$$\frac{1}{C}\int_0^t 10\times10^{-6}\, dt = v_c(t) - \underline{\underline{v_c(0)}}$$

$$\frac{10\times10^{-6}}{100\times10^{-12}}\, t\Big|_0^t = v_c(t) - (-5)$$

$$\frac{10\times10^{-6}}{100\times10^{-12}}\left[t-0\right] = v_c(t)+5$$

$$10000t = v_c(t)+5$$

$$\underline{v_c(t) = 10000t-5} \leftarrow$$

for $t > 10^{-4}$

$$i_c = C\frac{dv_c}{dt}$$

$$\int_{10^{-4}}^{t}\frac{1}{C}\, i_c\, dt = \int_{10^{-4}}^{t} dv_c$$

start at $t=10^{-4}$

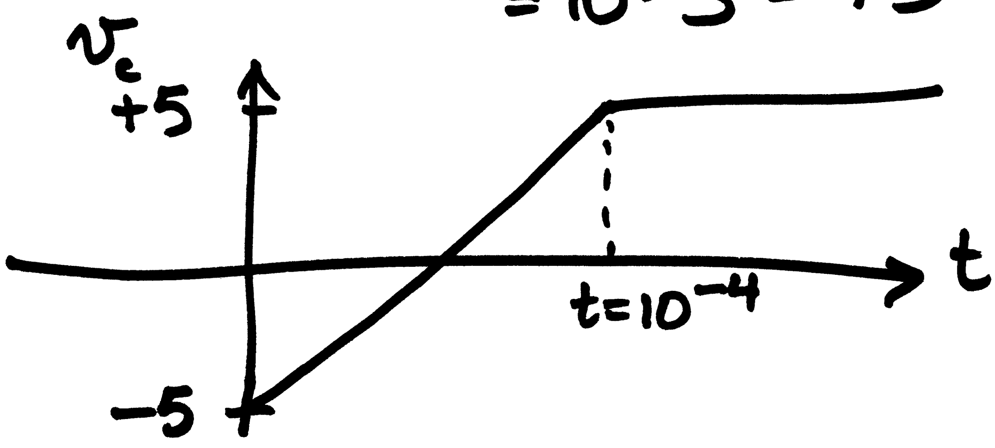
$$\frac{1}{C}\int_{10^{-4}}^{t} 0 \cdot dt = v_c(t) - v_c(10^{-4})$$

$$0 = v_c(t) - v_c(t=10^{-4})$$

$$v_c(t) = v_c(t=10^{-4})$$

what $v_c(t=10^{-4})$ use first formula

$$v_c(t=10^{-4}) = 10000(10^{-4})-5$$
$$= 10-5 = +5 \text{ volts.}$$



Exercise 6-2

$v_c = 5e^{-4000t}$ V. capacitor 200pf

find i_c

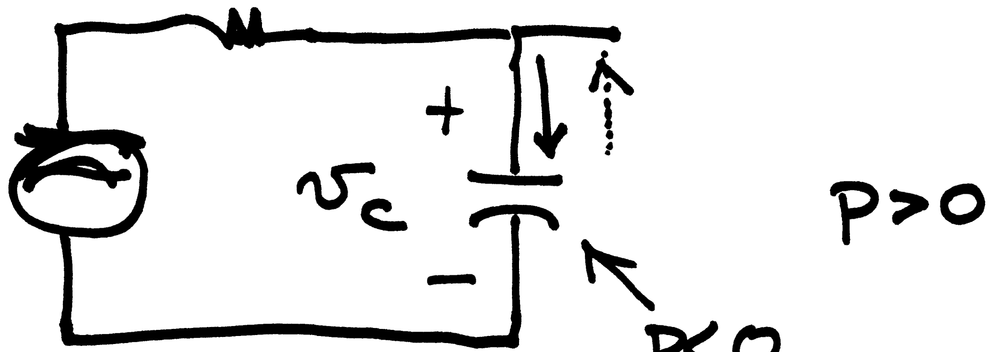
$$i_c = C\frac{dv_c}{dt}$$

$$= (200\times10^{-12})\left[5(-4000)e^{-4000t}\right] P$$

$$i_c = \underbrace{-4}_{4\times10^{-6}}e^{-4000t} \quad \mu A$$

$$P = vi = (5e^{-4000t})(-4e^{-4000t})$$

$$= -20e^{-8000t} < 0$$



$P<0$

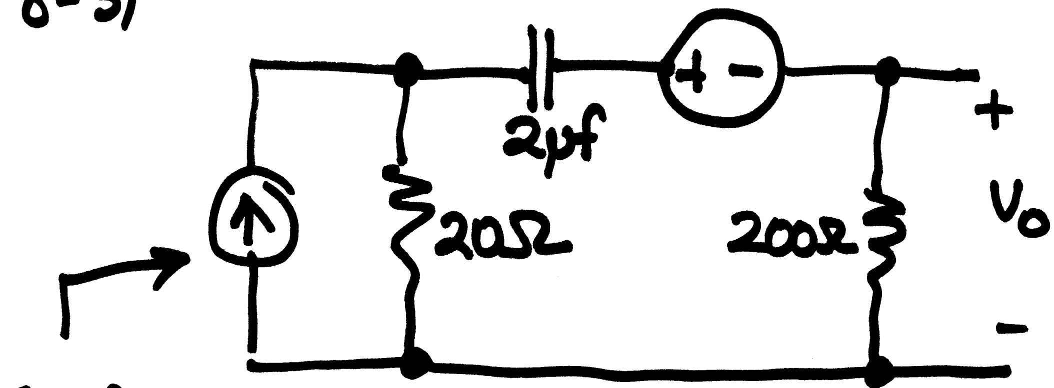
i_c leaving capacitor supplying power to the circuit

Phasors

$\cos \omega t$

8-31)

$10 \cos 4000t$ V.



~~sin 2000~~
$\sin 4000t$ A

① what frequency is this operating at.

$4000 \leftarrow \omega$ radian/sec.

$\omega = 2\pi f \quad \dfrac{\omega}{2\pi} \leftarrow f$ cycles/sec

$\dfrac{4000}{2\pi} = 637$ Hz cycles/sec.

② transform to phasor (sinusoidal steady state)

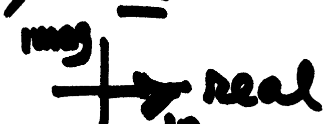
$200\Omega \rightarrow 200\Omega$

$20\Omega \rightarrow 20\Omega$

$\dfrac{1}{j} = -j$

$2\mu f \rightarrow \dfrac{1}{j\omega C} = \dfrac{1}{j(4000)(2\times10^{-6})} = \underline{\underline{-j125}}$

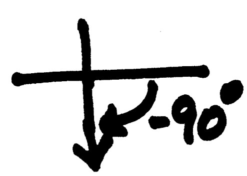
$10 \cos 4000t \rightarrow 10\angle 0^\circ = 10$

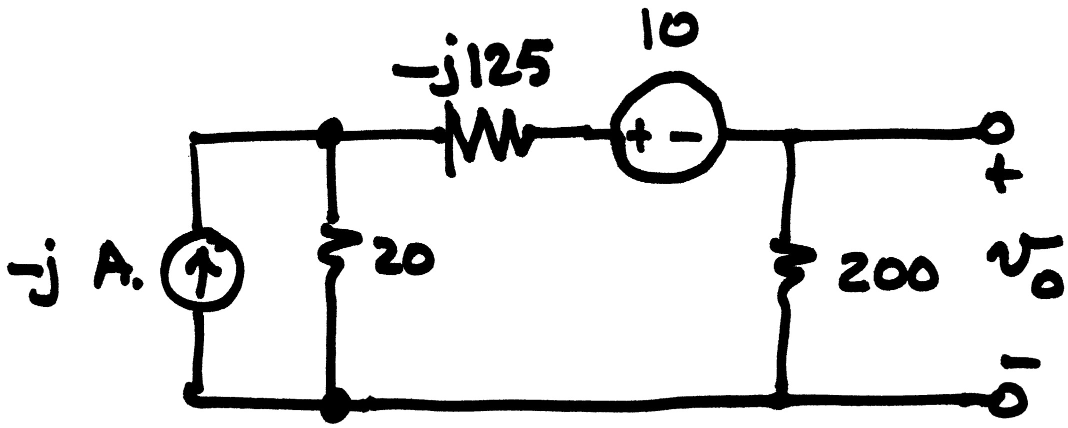


$\sin 4000t \rightarrow 1\angle 0^\circ$

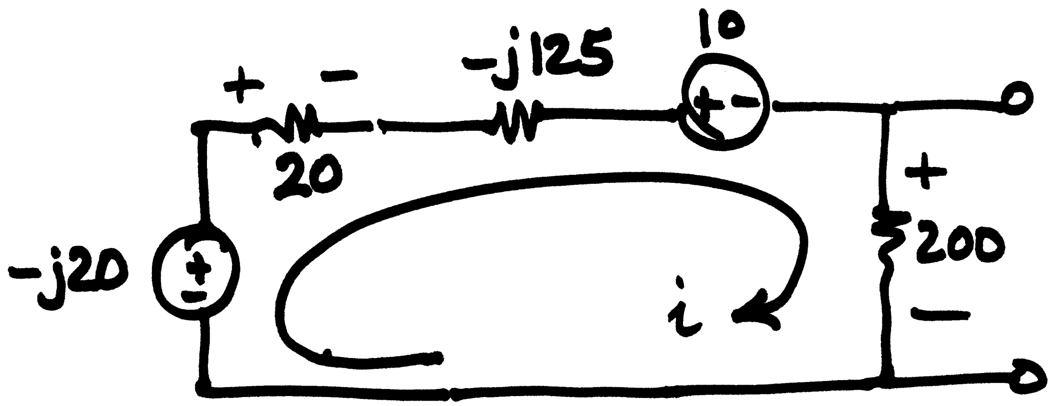
$\Downarrow$

$\cos(4000t - 90^\circ) \rightarrow 1\angle -90^\circ = -j$





source transform:



$V = IZ = (-j)20 = -j20$

using KVL $\quad -(-j20) + 20i + (-j125)i + 10 + 200i = 0$

$$+j20 + 20i - j125i + 10 + 200i = 0$$

$$220i - j125i = -10 - j20$$

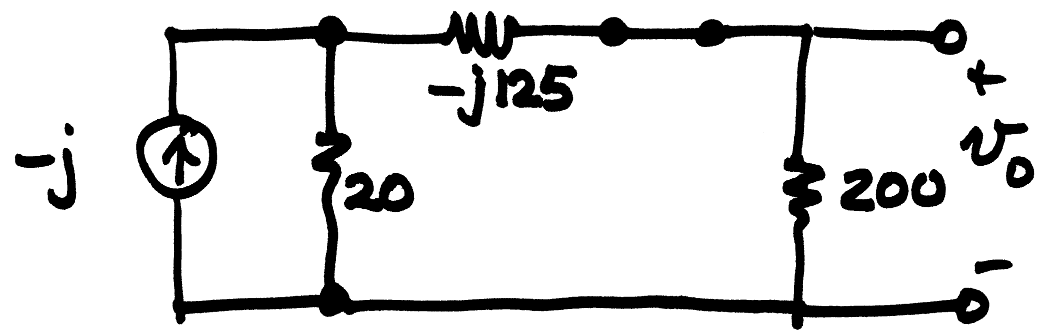
$$i = \frac{-10 - j20}{220 - j125} = .004686 - j.08825$$

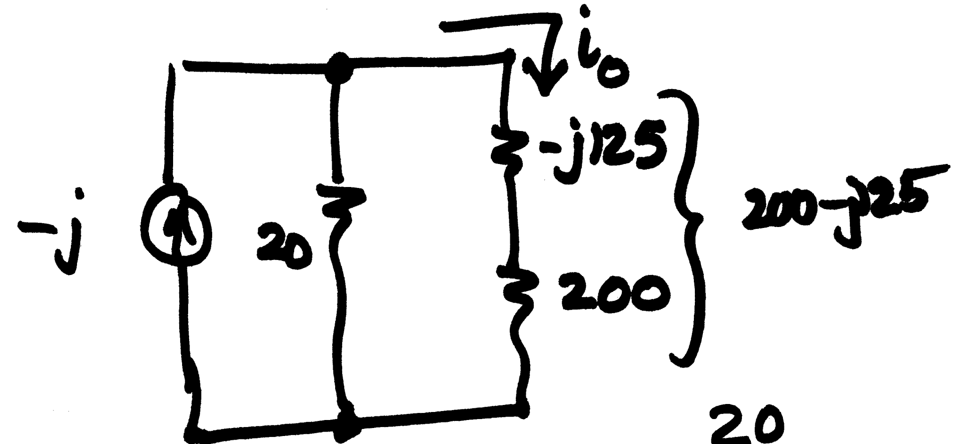
$$v_o = i\,200 = (\quad)(200 + j0) = \underline{0.937 - j17.65}$$

$$v_o = 17.67\angle -87°$$

$$v_o(t) = 17.67\cos(4000t - 87°)$$

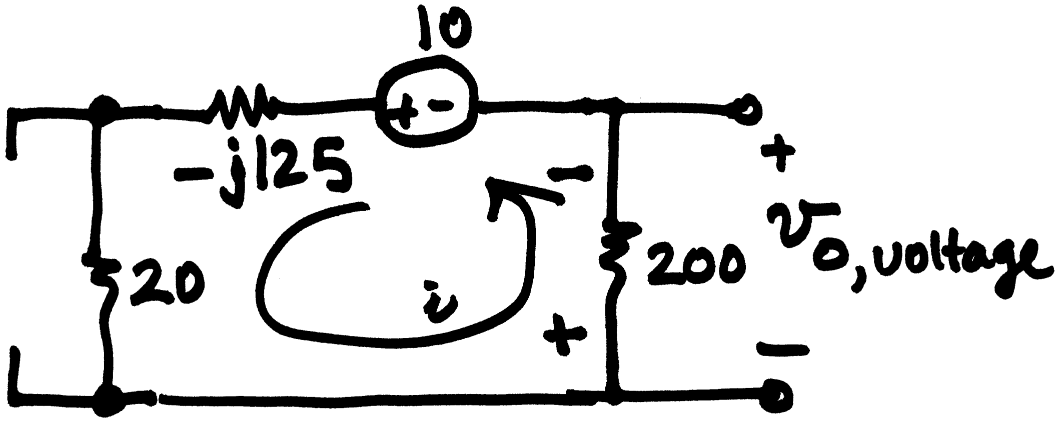
superposition





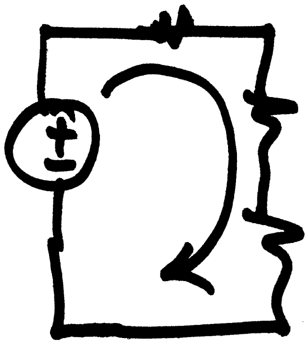
current divider $\quad i_0 = \dfrac{20}{20+200-j125}(-j)$

$$v_{0,\text{current source}} = 200\left[i_0\right] = 200\left[\frac{-j20}{220-j125}\right]$$



voltage divider

$$v_{o,voltage} = -\frac{200}{-j125+20+200}\,10$$

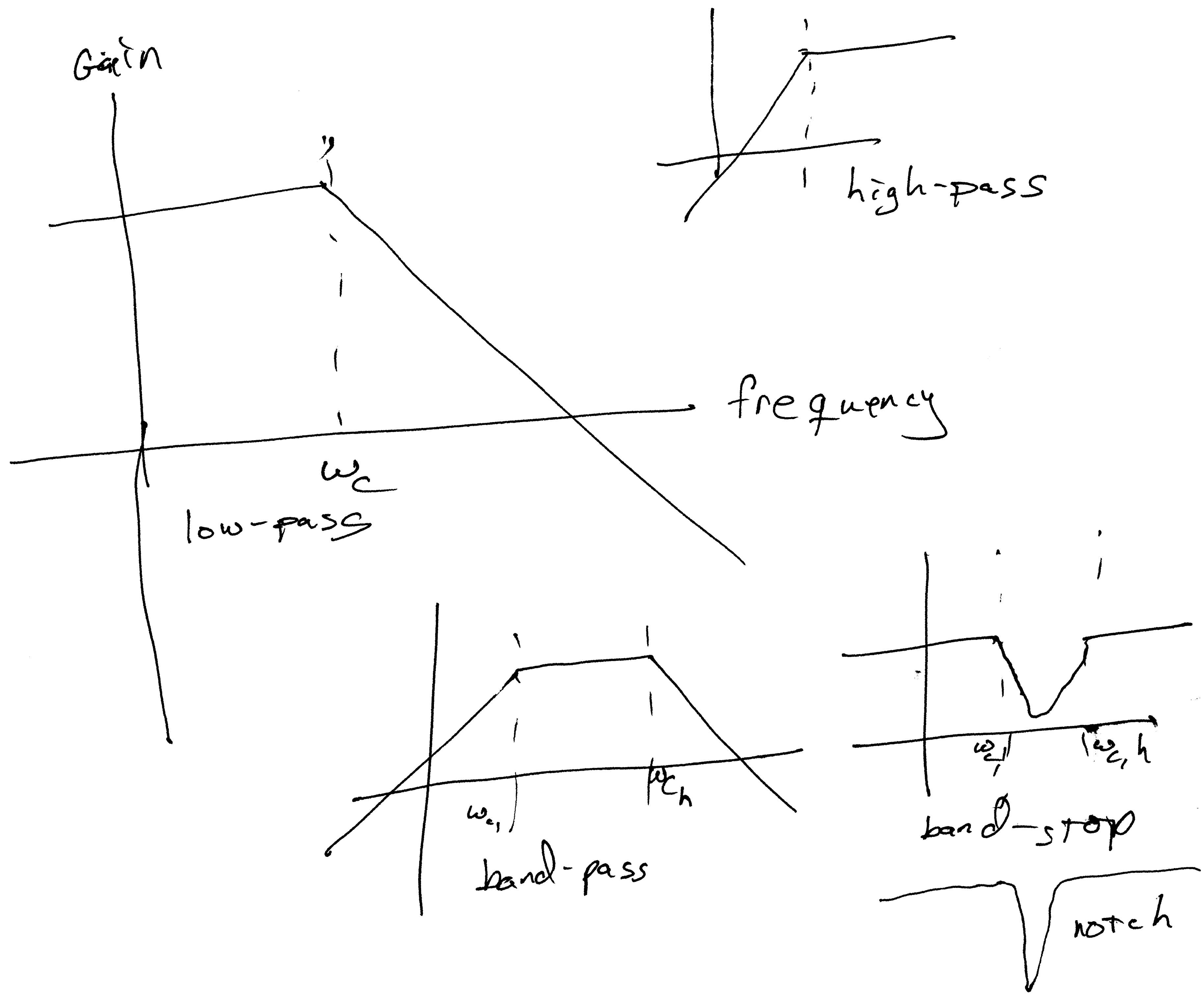


$$= \frac{-2000}{220-j125}$$

$$v_o = v_{o,voltage} + v_{o,current} = \frac{-2000}{\cancel{200}\,220-j125} + \frac{-j4000}{220-j125}$$

$$= \frac{-2000-j4000}{220-j125} = \checkmark$$

Time Domain	Phasor Domain
t	j (i)


Gain
frequency
ω_c
low-pass
high-pass
ω_{c1}
ω_{ch}
band-pass
ω_{c1}
$\omega_{c,h}$
band-stop
notch

$$T_v = \frac{V_o}{V_{in}} = \frac{2000}{10 + j\frac{\omega}{200}} \Big\} \text{denominator}$$

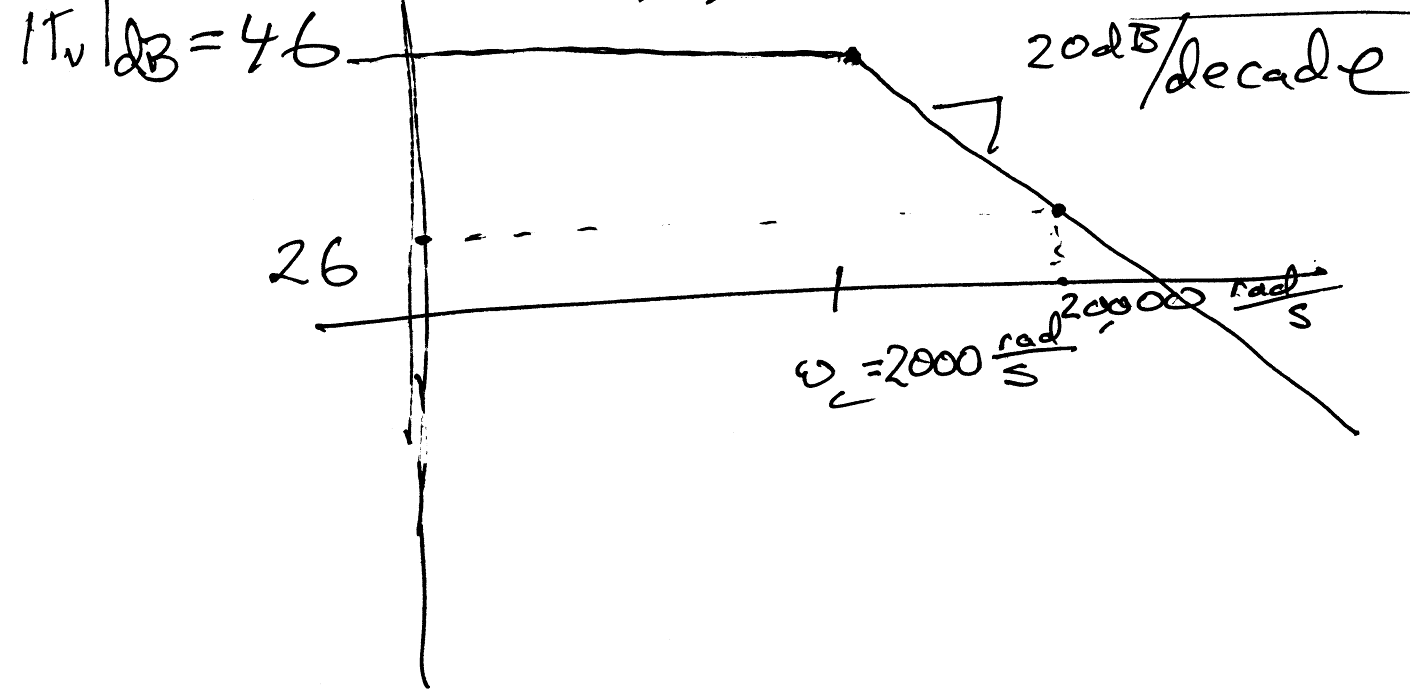
$$1 + j\frac{\omega}{\alpha}$$

$$\boxed{= \frac{200}{1 + j\frac{\omega}{2000}}} \Big\} \text{low pass}$$

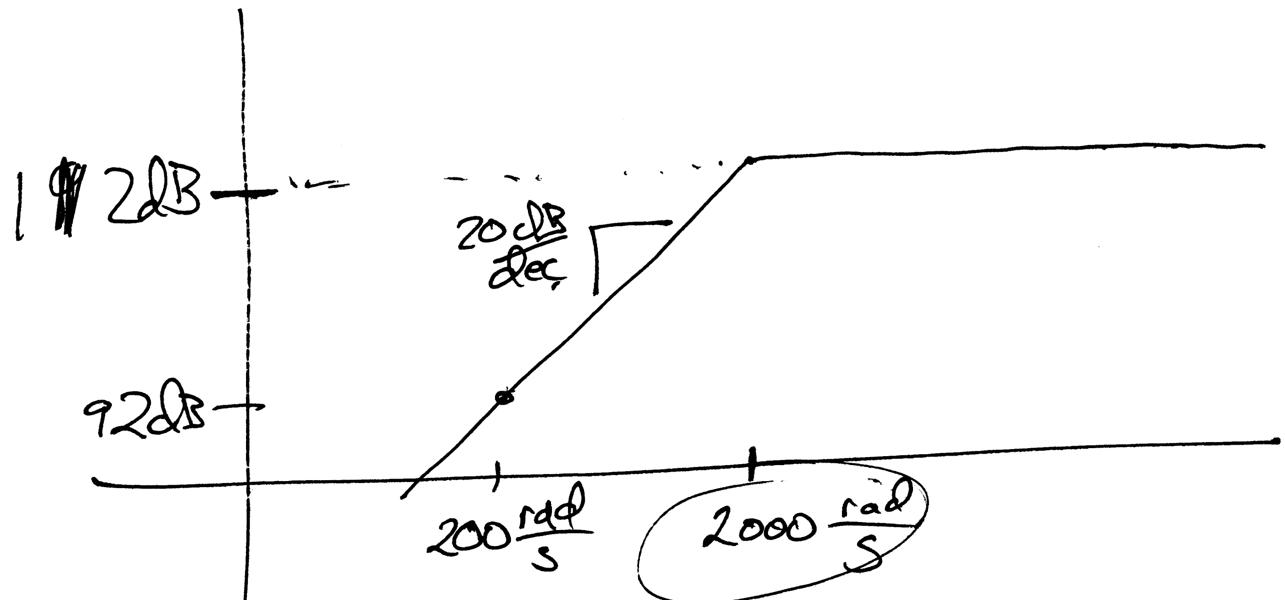
$$\text{in dB} = 20 \log_{10}(T_v)$$

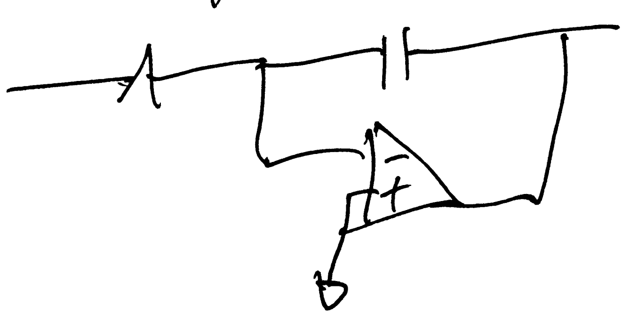
$$T_v(0) = 200$$

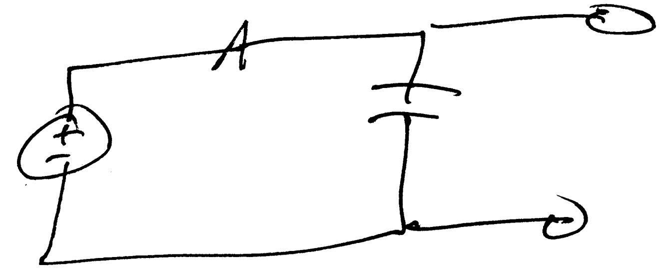
$$= \boxed{\frac{200 j\omega}{1 + j\frac{\omega}{2000}}} \Big\} \text{high pass}$$



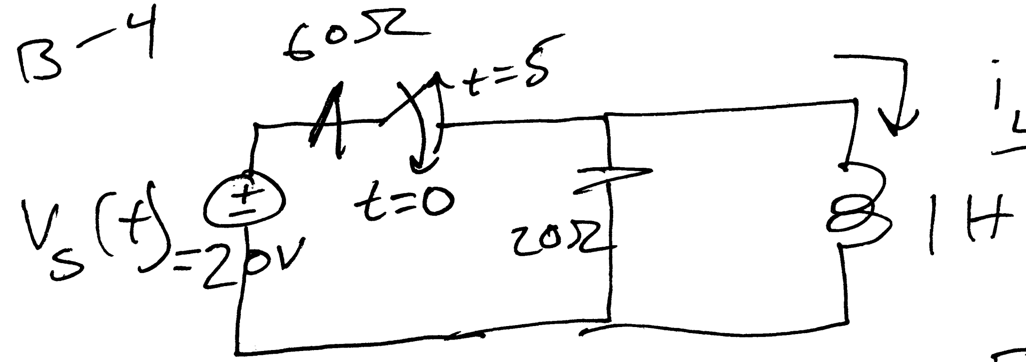
$$\frac{200\,j\omega}{1+j\frac{\omega}{2000}} \qquad \left|H_v(\omega\to\infty)\right| = \frac{200\,\omega}{\frac{\omega}{2000}} = 400{,}000$$







HW B-4



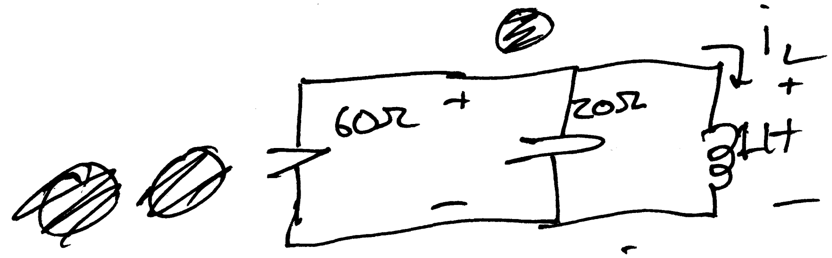
$i_L(t)$

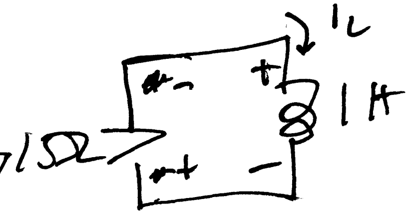
$I_L(0) = 0$

$i_L = \frac{1}{3}A - \frac{1}{3}e^{-\frac{R}{L}t}$

Natural Resp.

$t > 0$





~~$i_{L,\,Natural}$~~ $= kse$

$$\boxed{i_L = Ke^{-\frac{R}{L}t}}$$

$$i_L = Ke^{st}$$

$$\frac{di_L}{dt} = kse^{st}$$

$$V_L + V_R = 0$$

$$L\frac{di_L}{dt} + i_L R = 0$$

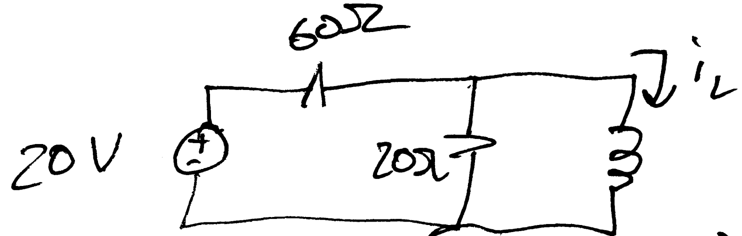
$$Lkse^{st} + RKe^{st} = 0$$

$$\underbrace{Ke^{st}}\underbrace{(Ls + R)} = 0$$

$$Ls + R = 0$$

$$s = -\frac{R}{L}$$

Forced Resp.



$$i_{L,\,forced} = \frac{20V}{60\Omega} = \frac{1}{3}A$$

$$i_L = \frac{1}{3}A + Ke^{-\frac{R}{L}t}$$

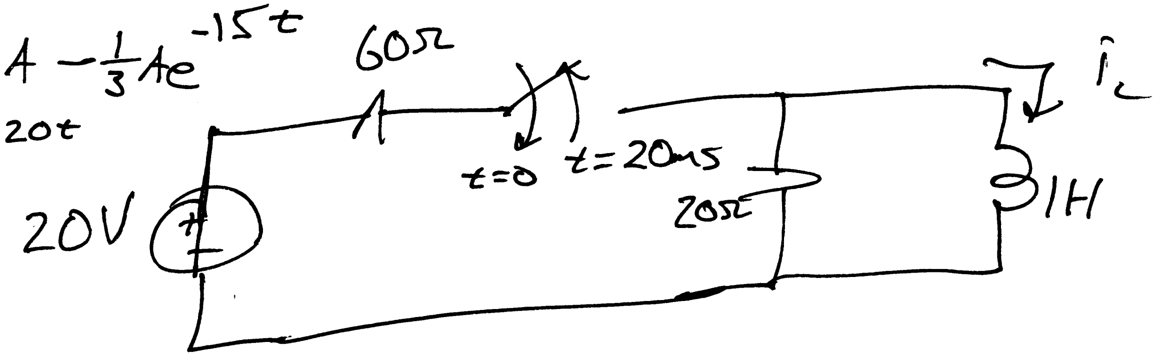
$$0 = \frac{1}{3}A + Ke^{-\frac{R}{4}0}$$

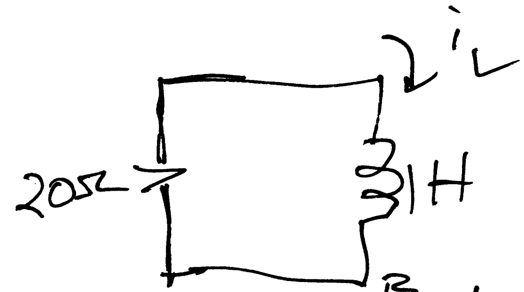
$$= \frac{1}{3}A + K \qquad K = -\frac{1}{3}$$

$t \leq 0 \Rightarrow i_L = 0$

$0 \leq t \leq 20ms \Rightarrow i_L = \frac{1}{3}A - \frac{1}{3}Ae^{-15t}$

$t \geq 20ms \Rightarrow i_L = 0.129e^{-20t}$





$i_L = Ke^{-\frac{R}{L}t}$

$= Ke^{-20t}$

$i_L(20ms) = \cancel{\frac{1}{3}A}\ 0.086 = Ke^{-20 \cdot 0.02}$

$0.086\ \cancel{\frac{1}{3}A} = Ke^{-0.4}$

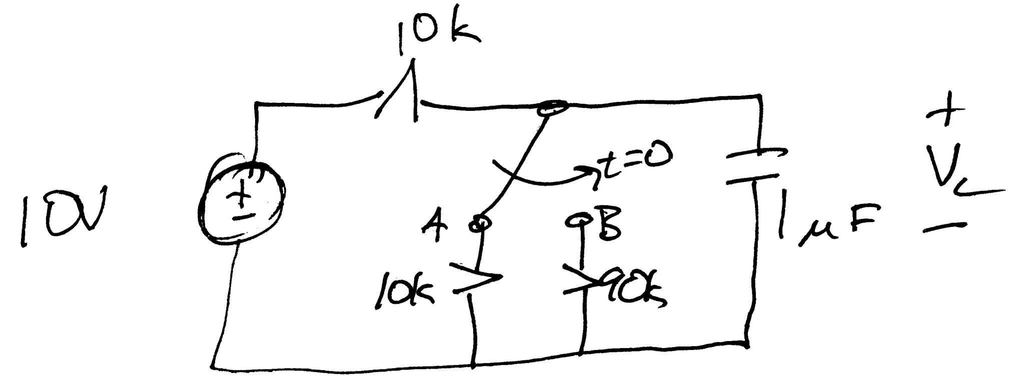
$0.086\ \cancel{\frac{1}{3K}} = \cancel{e^{-0.4}}$

$\frac{0.086}{e^{-0.4}} = K \simeq 0.129$

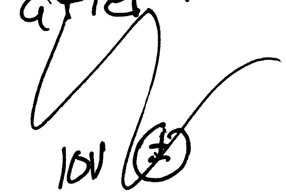
$t \geq 20ms$

$$\boxed{i_L = 0.129e^{-20t}}$$

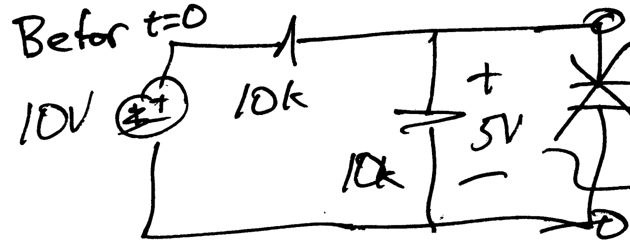
HW 13-5



after t=0

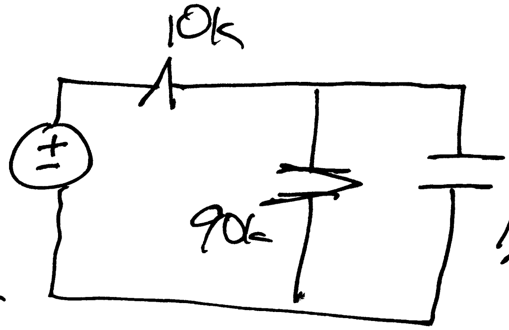


Befor t=0



DC, long time
cap ⇒ open

$\rightarrow V_c(t=0) = 5V$



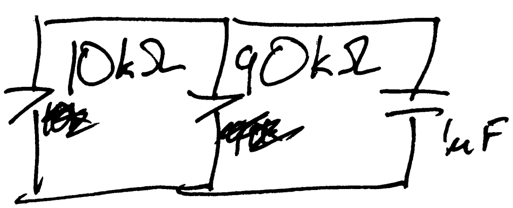
$V_c = 10V \cdot \frac{90k}{10k+90k}$

$\overset{+}{V_c}\underset{-}{} = [IV - FV]e^{-t/T_c} + FV$

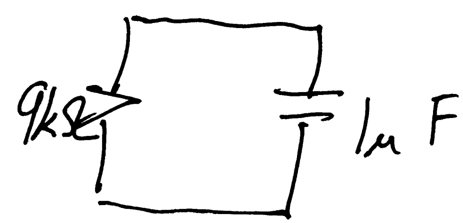
$= [5V - 9V]e^{-t/9ms} + 9V$

$FV = 9V$

τ_c:



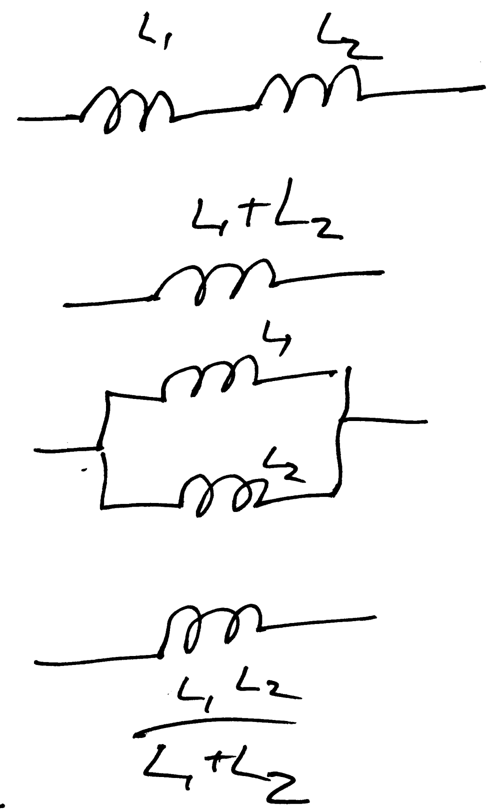
⇒



$T_{c,cap}$: $RC = 9ms$

$T_{c,IND}$: $= L/R$

equiv. ckts.



$t \to \infty$