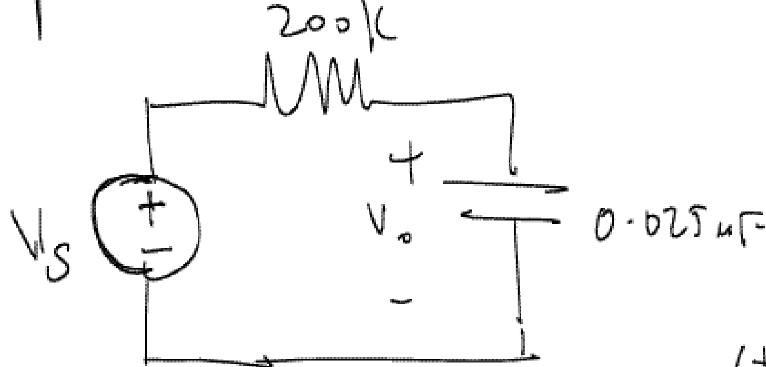
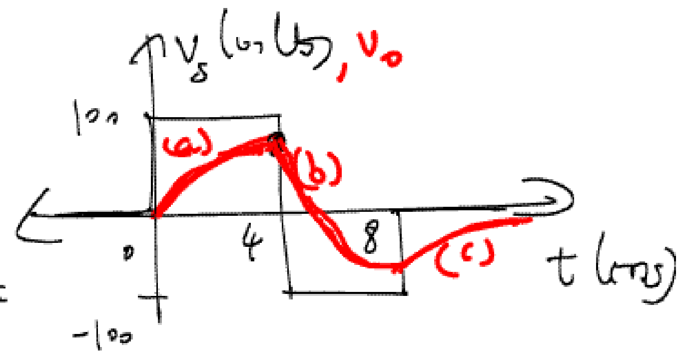
Final, Final Office Hours

Question - p 7.82





$$v_o(t) = V_{of} + (V_{oi} - V_{of})\, e^{-\frac{(t-t_x)}{\tau}}$$

$$\tau = RC = 200k \cdot \frac{25}{1000}\,\mu F = 5\text{ ms}$$

Region (a): $V_{oi} = 0$

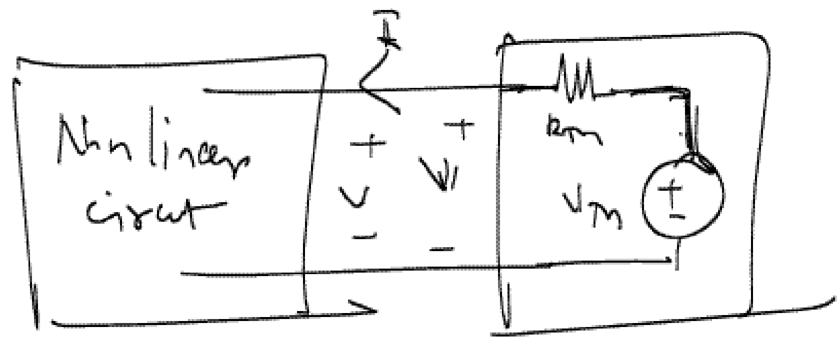
$$V_{of} \triangleq \lim_{t\to\infty} V_o(t) = 100\text{ V}$$

$$V_o(t_{switching} = 4\text{ ms}) = ?$$

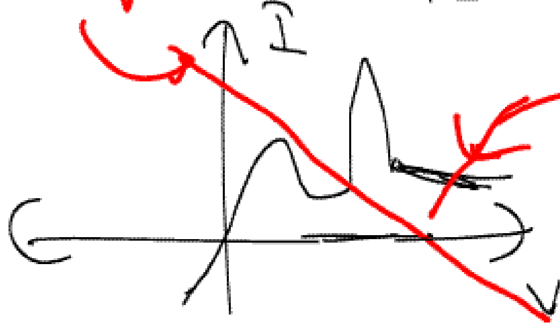
$$\Rightarrow V_o(t_{switch} = 4ms) = 100 + (0 - 100)\, e^{-\frac{(4ms - 0)}{5ms}}$$

$$\boxed{V_o(t_{switch}) = 56\ V}$$

Load lines:

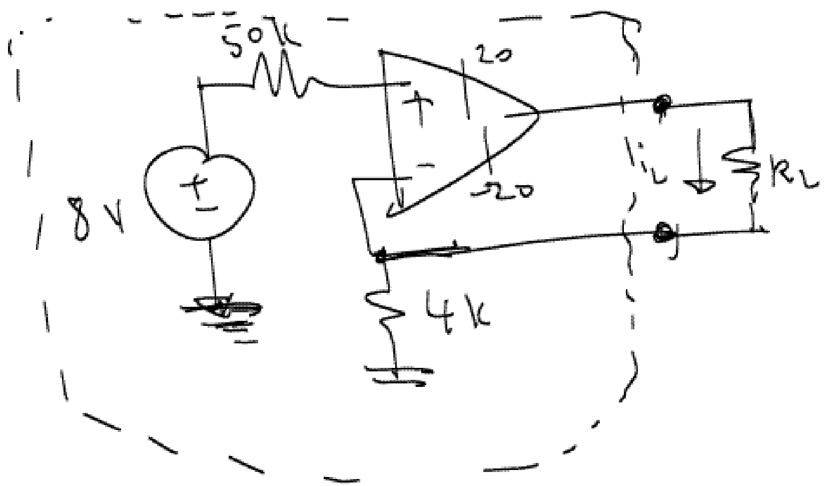


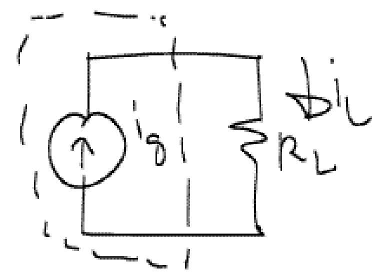
"Load line equation"



$$\boxed{I = \frac{V_{Th} - V}{R_{Th}}}$$

p(5.13)

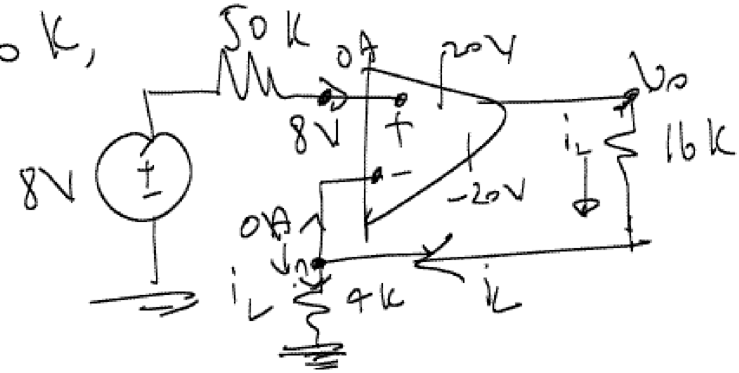




point of the problem: ideally, i_g can be any value you want, but in reality, the op-amp saturates.

part (c): if $R_L = 16K$, $i_L = ?$

Assume: $v_p = v_n$



$\therefore\ V_n = 8V \Rightarrow\ i_L = \frac{8}{4k} = 2\ mA$

But, $v_o = V_n + (i_L)(16k) \longleftarrow \left(i_L = \frac{V_o - v_n}{16k} \right)$

$= 40V > 20V$

$\Rightarrow$ op-amp saturates $\Rightarrow\ V_n \neq 8V \Rightarrow\ i_L \neq 2mA$

$\therefore$ op-amp is not acting as a constant current source, because $V_n = 4V$, i_L is only $1mA$.

<u>Note</u>: Find

V_n: $\frac{20 - V_n}{16k} = \frac{V_n}{4k}$

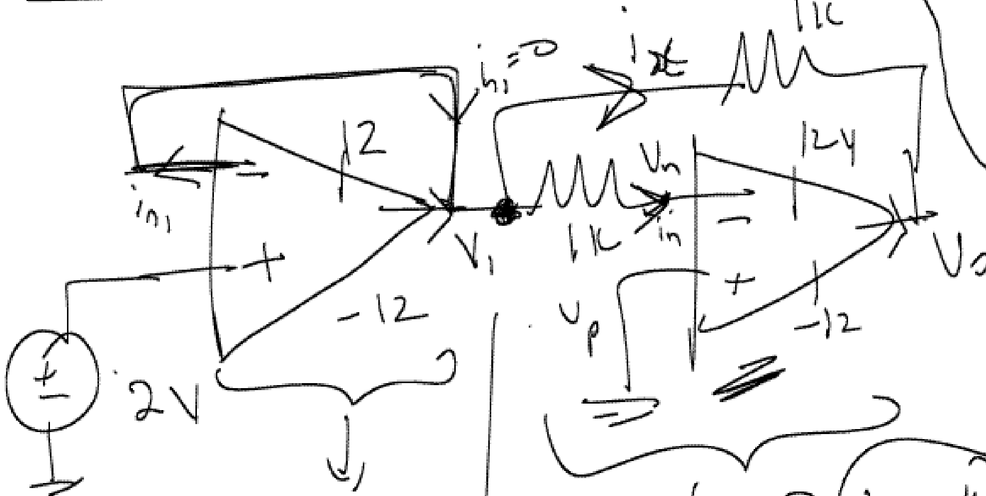
$\Rightarrow 4V_n = 20 - v_n$

$\Rightarrow \boxed{V_n = 4V}$

Notice $V_o = A(v_p - v_n) = 10^6(8-4) \to 4\times10^6 > 20$

$\Rightarrow v_o = 20$

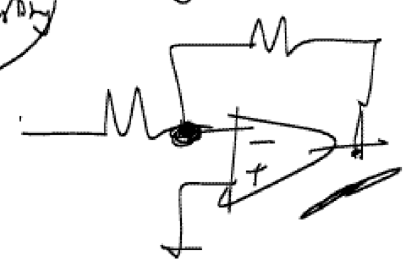
Evil Final problem: ← Final is NOT LIKE THIS, it is conceptual, NOT tricky



voltage follower

NOT inverting amplifier

$V_o = ?$

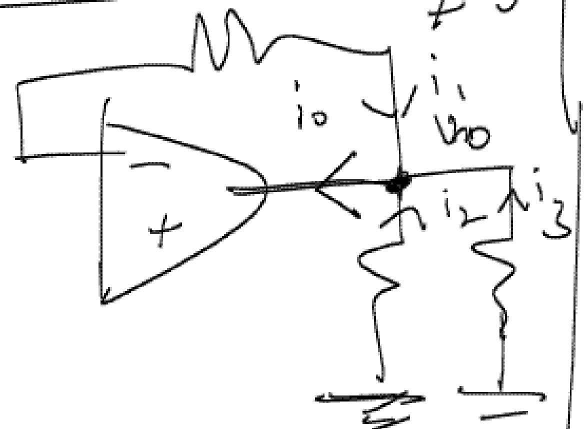


$V_1 = 2V$,

Assume $V_n = V_p$

$\Rightarrow V_n = 0 \Rightarrow i_n \neq 0$, $i_n = \dfrac{V_1 - V_n}{1k} = \dfrac{2-0}{1k} = 2mA$

<u>Note:</u> i_o usually $\neq 0$



Only way to find i_o: KCL @ V_o,

$i_o = i_1 + i_2 + i_3$

But, $i_n = i_p = 0$ ← ALWAYS TRUE!

$\therefore$ if $i_n = 0 \Rightarrow v_n = V_1 = 2V$

Ok, what's $V_o = ?$

You can't use, $i_{a} = \dfrac{V_n - V_o}{1k}$

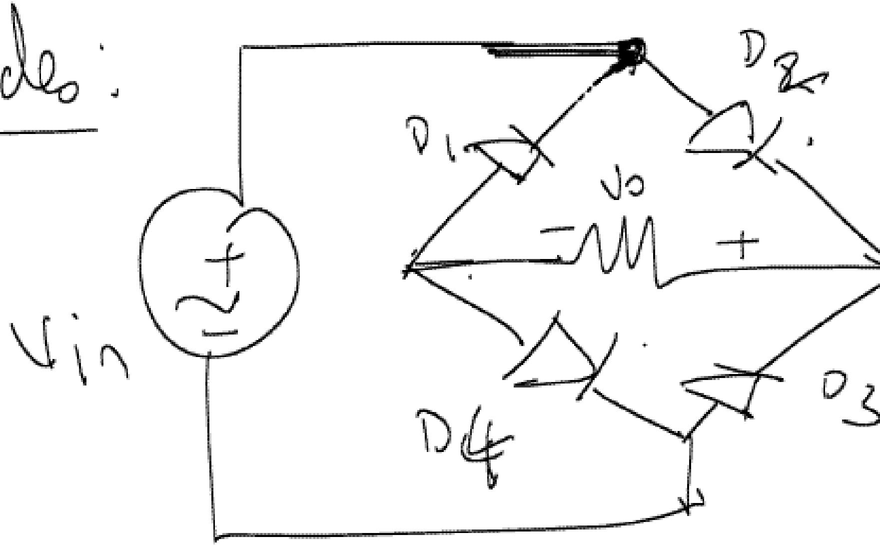
Since you don't know i_{a}.

Therefore, $V_o = A(v_p - v_n)$

$= 10^6(0-2) < 0$

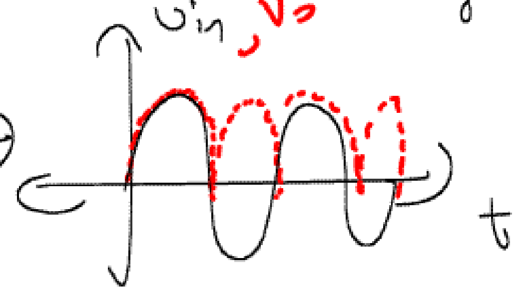
$\Rightarrow \boxed{V_o = -12}$

Diodes:

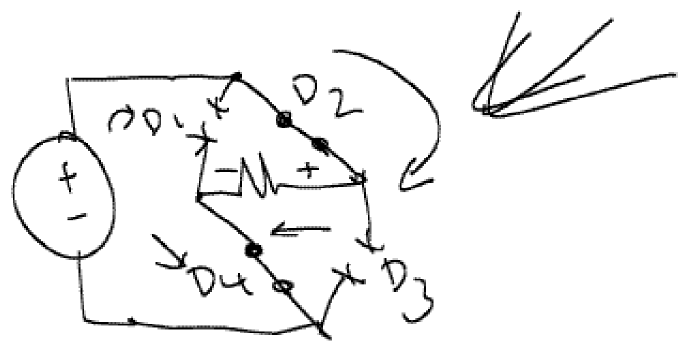


Bridge rectifier [refer to Justin notes, eg 5]

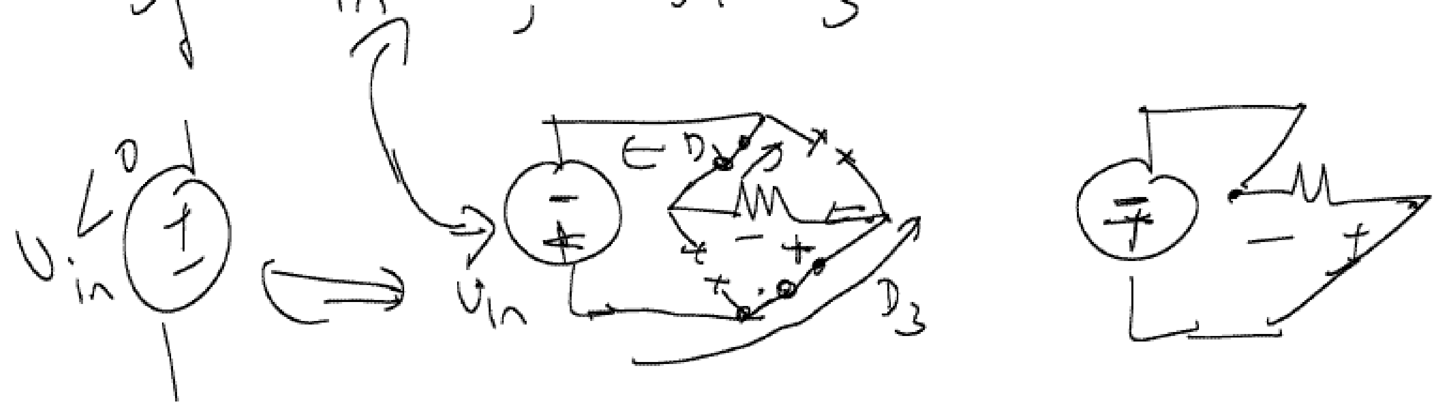
$V_{in}(t) = \sin(\omega t)$



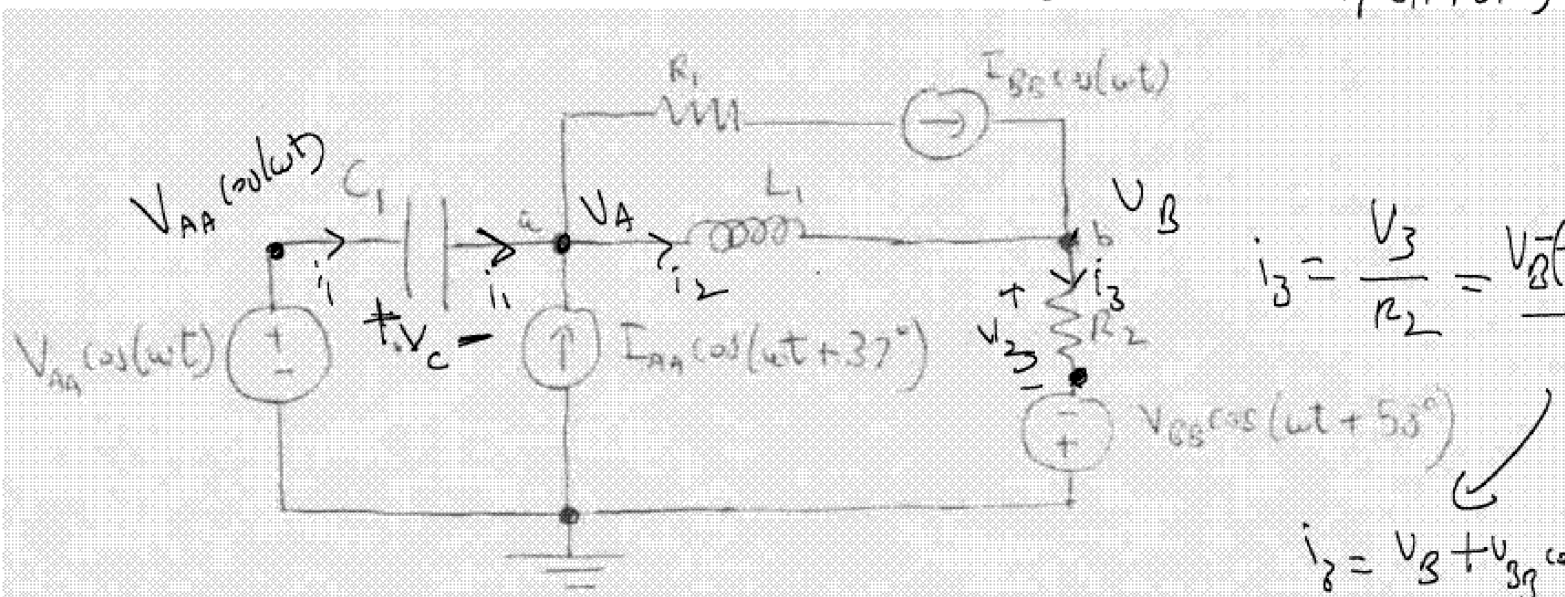
If $V_{in} > 0$, D_2 & D_4 are on!



If $V_{in} < 0$, D_1 & D_3 are on



Nodal analysis: From Summer 04 final (p. 3). Setup nodal equations to solve V_A & V_B. DO NOT SOLVE/SIMPLIFY.



$$i_3 = \frac{V_3}{R_2} = \frac{V_B - (-V_{BB}\ldots)}{R_2}$$

$$i_3 = \frac{V_B + V_{BB}\cos(\omega t + 18)}{R_2}$$

(1) We have two unknown node voltages V_A & V_B:

(2) Write KCL at each unknown node.

@ $\underline{v_A}$: $i_1 + I_{AA}\cos(\omega t + 37°) = I_{BB}\cos(\omega t) + i_2$

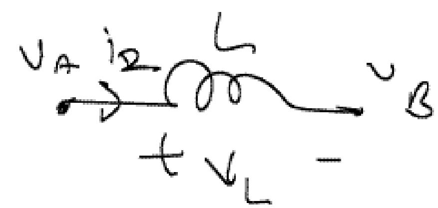
@ $\underline{v_B}$: $I_{BB}\cos(\omega t) + i_2 = i_3$

(3) Write unknown currents in terms of unknown node voltages:

$$i_1 = C\frac{dv_C}{dt} = C\frac{d}{dt}\left(V_{AA}\cos(\omega t) - V_A\right)$$

$$i_2 = \frac{1}{L}\int(v_A - v_B)$$

$$\boxed{\underline{v_A}:\ C\frac{d}{dt}\left(V_{AA}\cos(\omega t) - V_A\right) + I_{AA}\cos(\omega t + 37°) = I_{BB}\cos(\omega t) + \frac{1}{L}\int(v_A - v_B)}$$



$$v_L = L\frac{di_2}{dt}$$

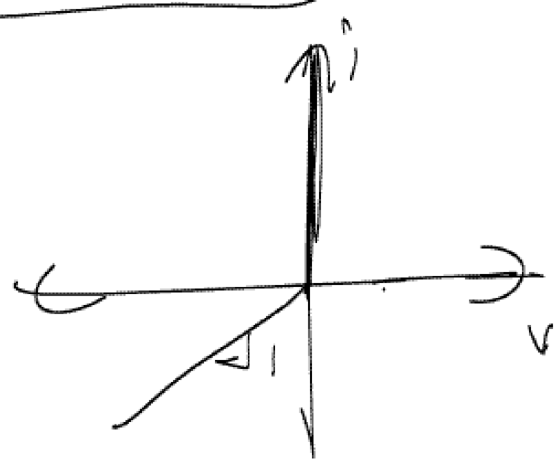
not necessary

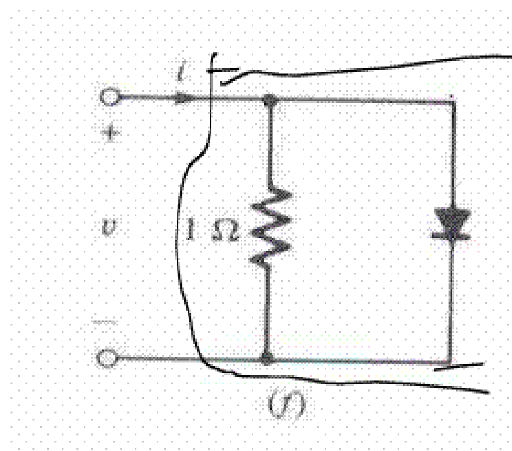
$$\Rightarrow\ i_2(t) = \frac{1}{L}\int v_L + \cancel{v_L(0)}$$

limits unnecessary

$\underline{V_B}$: $I_{B3}\cos(\omega t) + \frac{1}{L}\int(V_A - V_B) = \frac{V_3 + V_{3B}\cos(\omega t + 58)}{R_2}$

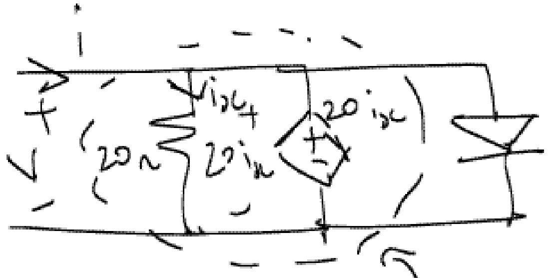
Review problem 14:





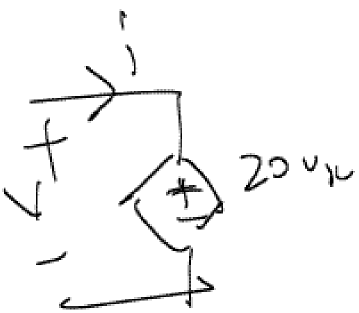
e^{v/v_t}

Q:) What if you have a dependent source?



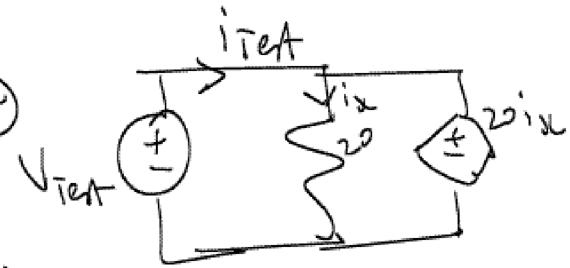
Thevenin:

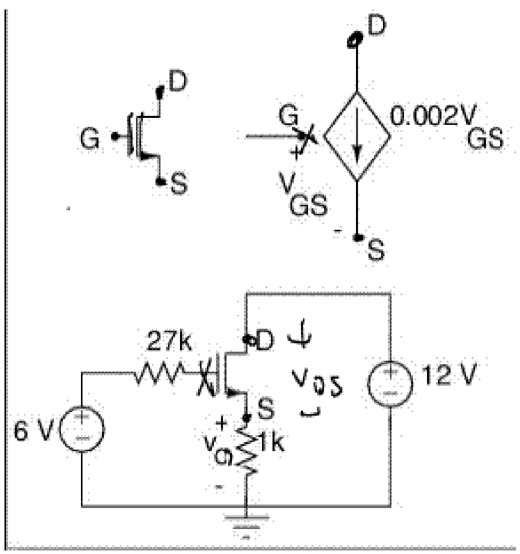
$$i_x = \frac{20 i_x}{20} \Rightarrow i_x = i_x$$



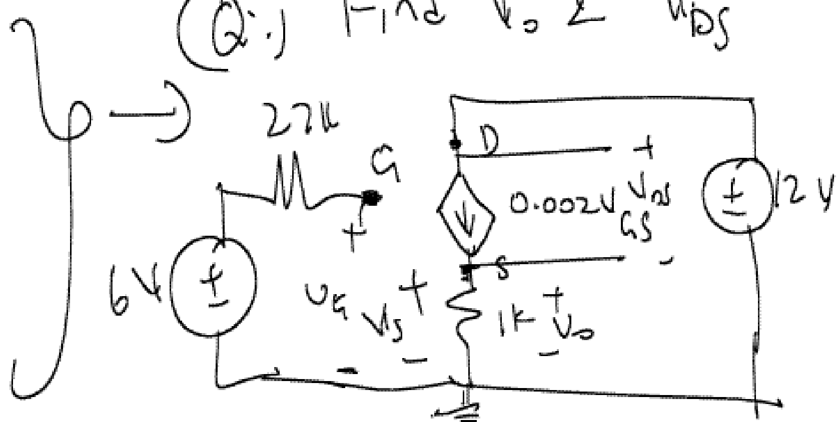
$v = 20 v_x$] begs the question! How do u get an i-v graph for a dependent source?

i. Find R_{th} →





(Q:) Find V_o & V_{DS}



$V_S = (0.002 V_{GS})(1k)$

$$V_S = \left[0.002\,(V_G - V_S)\right](1k)$$

$$\Rightarrow \quad V_S = \left[0.002\,(6 - V_S)\right](1k)$$

$\Rightarrow \quad V_S = ?,\ V_{DS} \Rightarrow$ use $_{KVL}$ $(V_S = V_D)$