+ Finally, I had 28 pages.

+ And I also submitted our course evaluation.

Nhat Ho

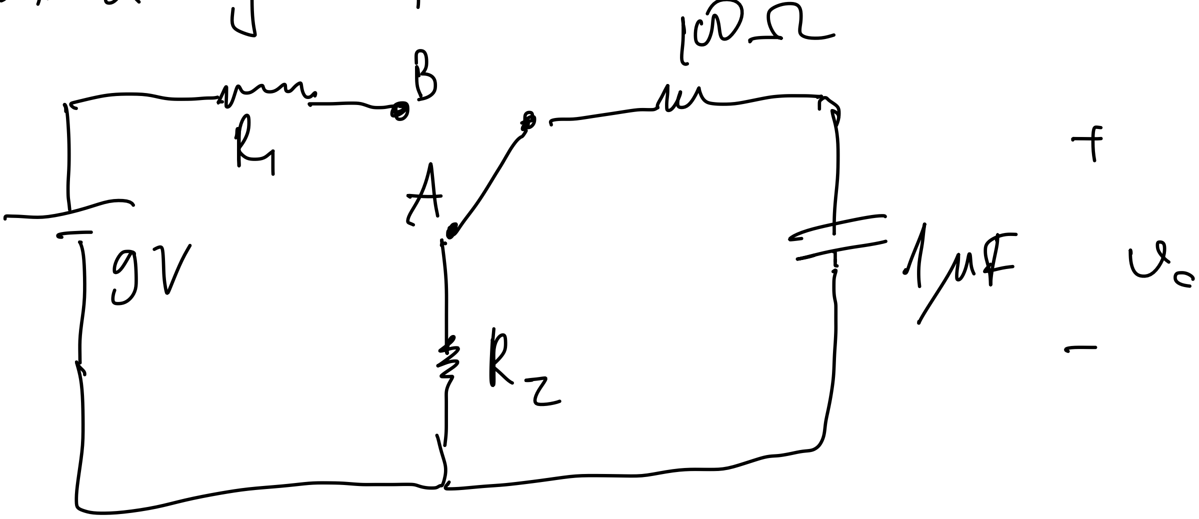
#1

105355311

I do problem 3 first.

Problem 3:

For a long time, we have



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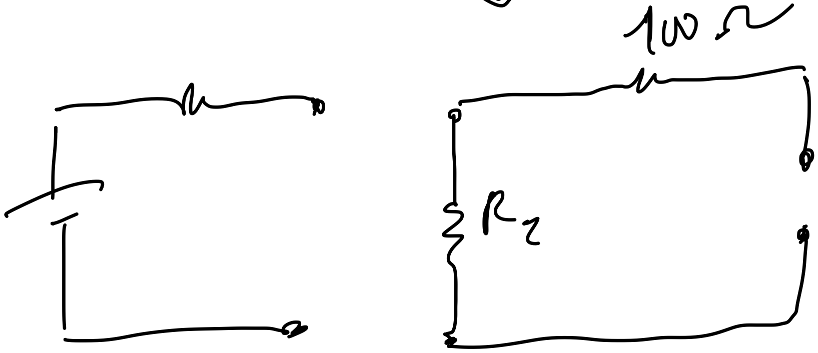
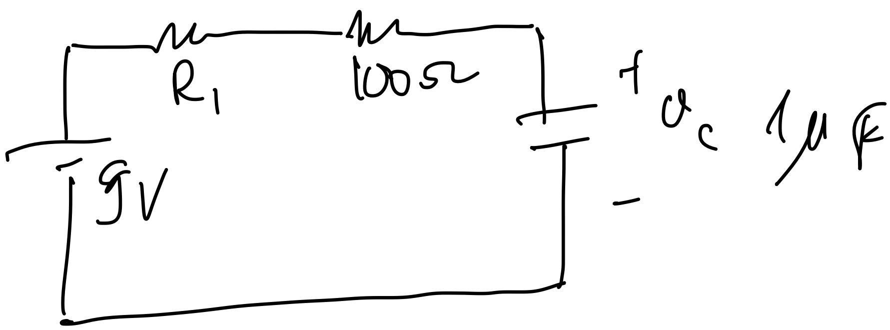


$\Rightarrow$ at $t = 0^- \Rightarrow v_c(0^-) = 0\,(V)$

#2

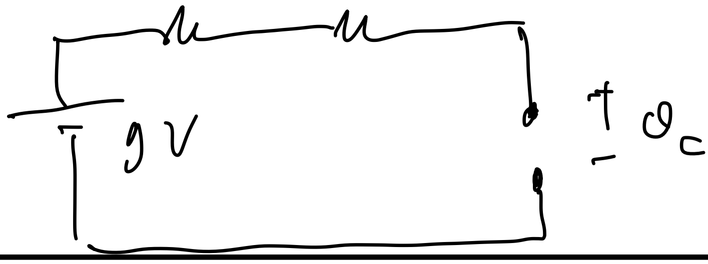
at $t = 0$, switch move to B, we have:



Since capacitor cannot change the voltage instanteously

$\Rightarrow v_c(0^+) = v_c(0^-) = 0\,(V)$

with $t \to \infty$, we have:



$\Rightarrow v_c(\infty) = 9V$.

Because this circuit contain the resistance and capacitor, then this circuit is a first order circuit, we have:

$$v_c(t) = v_c[\infty] - \left(v_c[\infty] - v_c(0^+)\right] e^{-t/RC}$$

We have: $RC = (R_1 + 100) \times 1 \times 10^{-6}$ (s)

$$\Rightarrow v_c(t) = 9 - (9 - 0)\, e^{-t/RC}$$

$$v_c(t) = 9 - 9e^{-t/RC}$$

$\Rightarrow$ from $0 \le t \le 1\,ms$, we have

#3

$$v_c(t) = 9 - 9e^{-t/RC}$$

$$\Rightarrow \text{at } t = 1^{-}ms \Rightarrow v_c(1^-) = 9 - 9e^{-10^{-3}/RC} = 8V$$

$$\Rightarrow 9e^{-10^{-3}/RC} = 1 \Rightarrow e^{-10^{-3}/RC} = \frac{1}{9}$$

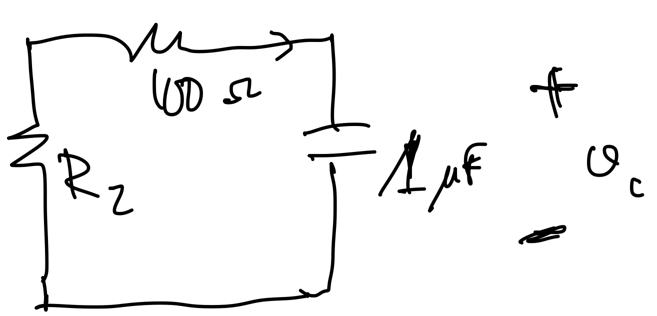
$$\Rightarrow \frac{-0.001}{(R_1+100)\times 10^{-6}} = \ln\frac{1}{9}$$

$$\Rightarrow (R_1 + 100) = 455.12$$

$$\Rightarrow \boxed{R_1 = 355.12\,(\Omega)}$$

at $t = 1\,ms$, switch to position A, we have:

$$v_c(1^+) = v_c(1^-) = 8(V).$$



at $t = 2\,ms$,

$$v_c(2ms) = 1V$$

at $t = \infty \Rightarrow v_c = 0V$

$\Rightarrow$ continue discharged for capacitor.

$$\Rightarrow v_C(t) = 0 - (0 - 8)e^{-t/RC}$$

$$v_C(t) = 8e^{-t/RC}$$ with $t = t_{new} = 1ms$

$$\Rightarrow 8e^{-10^{-3}/RC} = 1V$$

$$\Rightarrow e^{-0.001/RC} = \frac{1}{8}$$

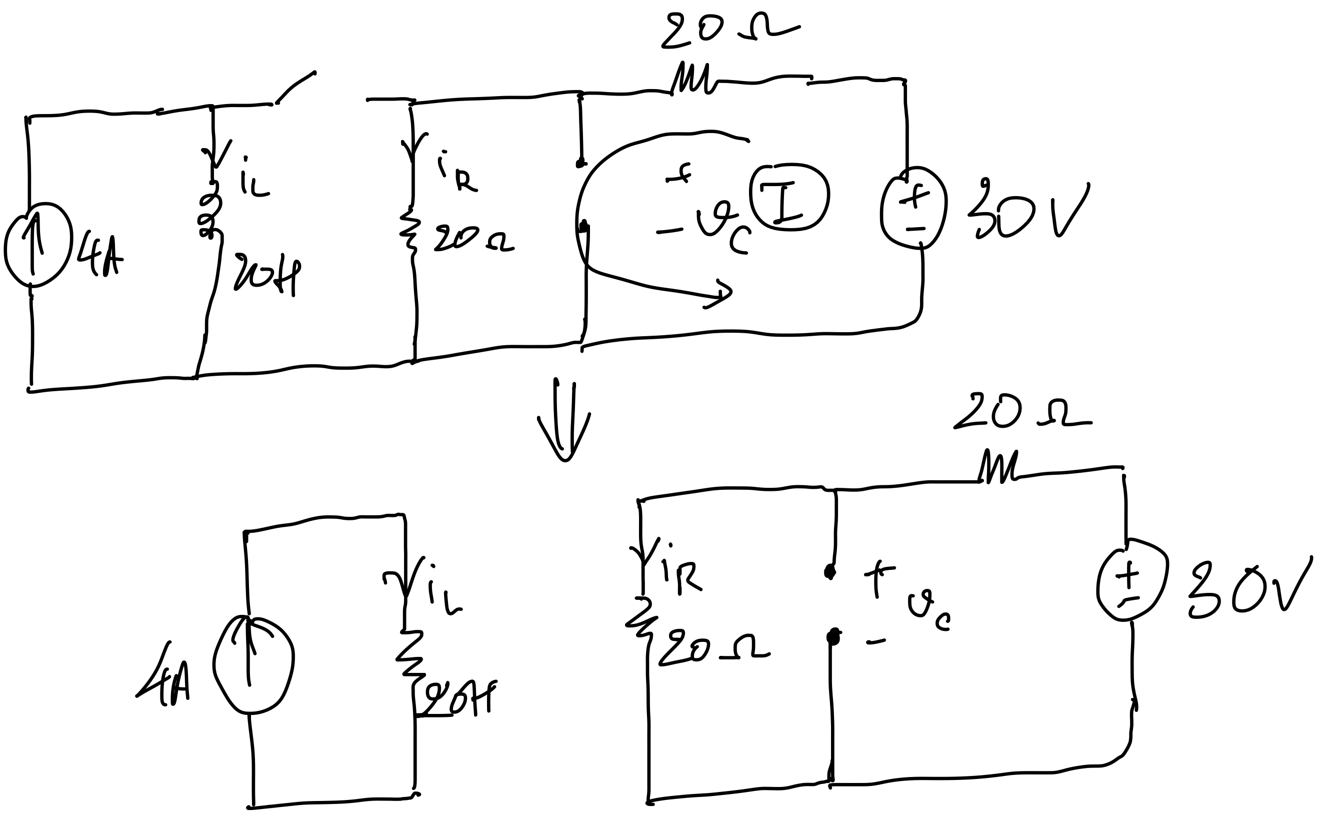
$$\Rightarrow \frac{-0.001}{(R_2 + 100) \times 10^{-6}} = \ln \frac{1}{8}$$

$$\Rightarrow R_2 + 100 = 480.9$$

$$\boxed{\Rightarrow R_2 = 380.9\ \Omega}$$

There is only one capacitor storing the power
$\Rightarrow$ this is a first order circuit.

Problem 4: at $t=0^-$, we have:



$\Rightarrow i_L(0^-) = 4A$

also, Apply KVL for loop I, we have:

$+30 = (20+20)\, i_R \Rightarrow i_R = \frac{30}{40} = 0.75(A)$

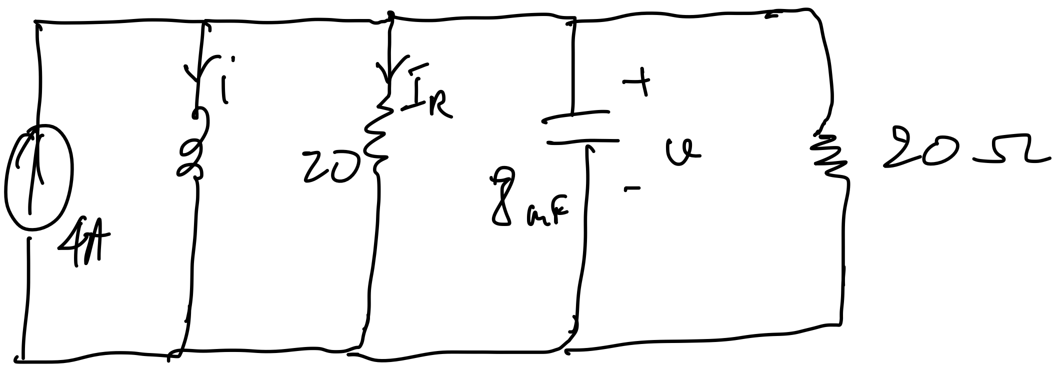
$\Rightarrow v_C(0^-) = i_R \times 20 = 20 \times 0.75 = (15V)$

At $t=0^+$, we have:

$i_L(0^+) = 4A$ & $v_C(0^+) = 15(V)$.

#5

We have the circuit:

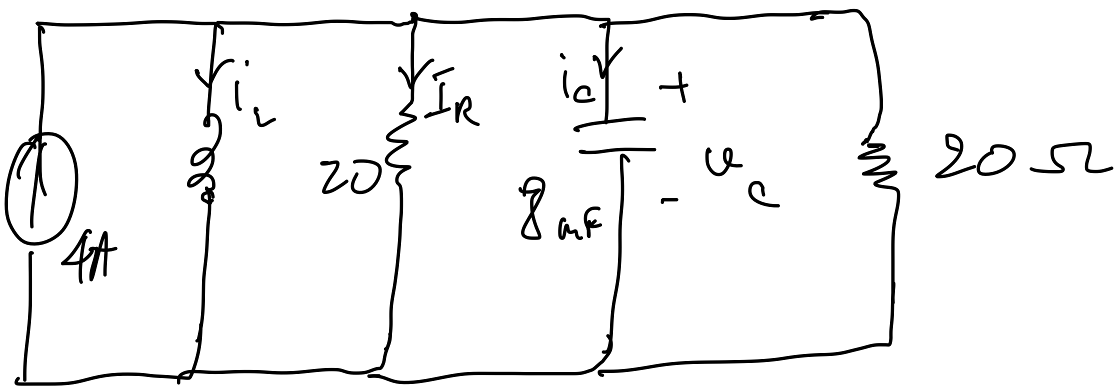


a) The characterizes 2nd order circuit is conductor (L) & capacitor (C). & Resistance(R)
This circuit contain both L & C & R, then this is a second order circuit

b) Draw the equivalent circuit for $t<0$ & $t\geq 0$ as above.

c) We have:

#6



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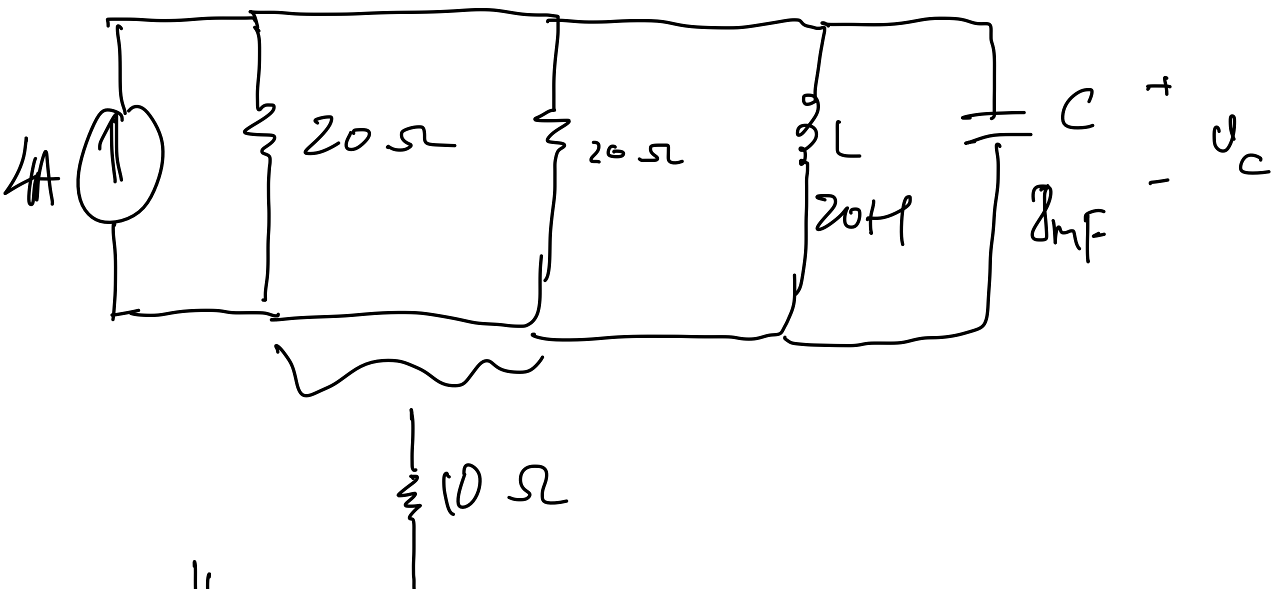

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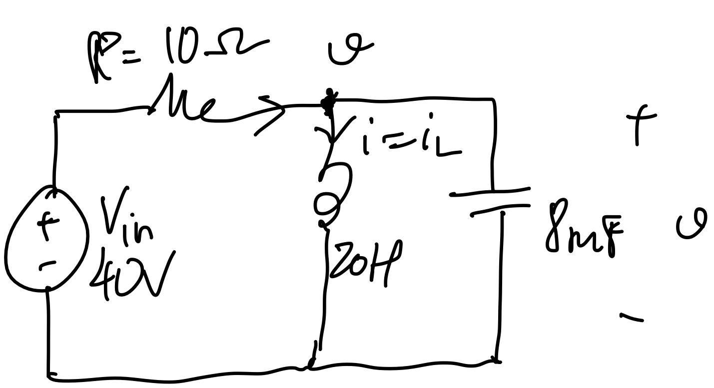


We have : $v = v_L = v_c$

$$\frac{V_{in} - v}{R} = i_L + i_c$$

$$\Rightarrow \frac{v_{in}}{R} = \frac{v}{R} + i_L + i_C \ ; \ \frac{v}{R} = \frac{v_L}{R} = \frac{L}{R}\frac{di_L}{dt}$$

8

$$i_C = C\frac{dv_C}{dt} = C\frac{dv_L}{dt}, \quad v_L = L\frac{di_L}{dt}$$

$$\Rightarrow i_C = CL\frac{d^2 i_L}{dt^2}$$

$$\Rightarrow \frac{v_{in}}{R} = \frac{L}{R}\frac{di_L}{dt} + i_L + CL\frac{d^2 i_L}{dt^2}$$

$$\Rightarrow CL\frac{d^2 i_L}{dt^2} + \frac{L}{R}\frac{di_L}{dt} + i_L = \frac{v_{in}}{R} = \frac{40}{10} = 4$$

$$\Rightarrow \frac{d^2 i_L}{dt^2} + \frac{1}{RC}\frac{di_L}{dt} + \frac{1}{CL} i_L = 4$$

$$\Rightarrow \boxed{S^2 + 2 w_0 \xi S + \omega_0^2 = 4}$$

d) As we did above, we have:

$$\boxed{i(t = 0^+) = i_L(0^+) = 4\,A}$$

$$\boxed{v(t=0^+) = v_C(0^+) = 15\,(V)}$$

#9

e) Check $s^2 + 2\omega_0 \xi s + \omega_0^2 = 0$

$$2\omega_0 \xi = \frac{1}{RC} = \frac{1}{10\,\Omega \times 8 \times 10^{-3}} = 12.5$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20 \times 8 \times 10^{-3}}} = \boxed{2.5\,(rad/s)}$$

$$\Rightarrow \xi = \frac{12.5}{2 \times \omega_0} = \frac{12.5}{2 \times 2.5} = \boxed{2.5}$$

f) $\boxed{\text{Since } \xi = 2.5 > 1 \Rightarrow \text{overdamped}}$

g) We have:

$$i_L(t) = K_1 e^{s_1 t} + K_2 e^{s_2 t}$$

#10

$$S_{1,2} = \left(-\xi \pm \sqrt{\xi^2 - 1}\right)\omega_0 .$$

$$= \left(-2.5 \pm \sqrt{2.5^2 - 1}\right) \times 2.5$$

$$= \left(-2.5 \pm 2.3\right) \times 2.5$$

$$\boxed{\Rightarrow \begin{cases} S_1 = -0.2 \times 2.5 = -0.5 \\ S_2 = -4.8 \times 2.5 = -12 \end{cases}}$$

b)

$$\Rightarrow i_L(t) = K_1 e^{-0.5t} + K_2 e^{-12t} .$$

We have $i_L(0^+) = 4$

$$\Rightarrow K_1 + K_2 = 4 \quad (1)$$

$$v_L(t) = L\frac{di_L}{dt} = 20\left[-0.5K_1 e^{-0.5t}\right.$$

$$\left.-12K_2 e^{-12t}\right]$$

#11

$v_L(t=0^+) = 15V$

$\Rightarrow 15 = 20\left[-0.5K_1 - 12K_2\right]$

$\Rightarrow 0.5K_1 + 12K_2 = -0.75$ (2)

From (1) & (2)

$\Rightarrow \begin{cases} K_1 = 4.24 \\ K_2 = -0.24 \end{cases}$

$\Rightarrow i_L(t) = 4.24e^{-0.5t} - 0.24e^{-12t} + i_{Lp}(t)$

Also $i_{Lp}(t) = i_{Lp}(t\to\infty) = 4(A)$

$\Rightarrow \boxed{i_L(t) = 4.24e^{-0.5t} - 0.24e^{-12t} + 4}$

i) $v_L(t) = L\frac{di}{dt}$

#12

$$= 20\left[-0.5 \times 4.24 e^{-0.5t} + 12 \times 0.24 e^{-12t}\right]$$

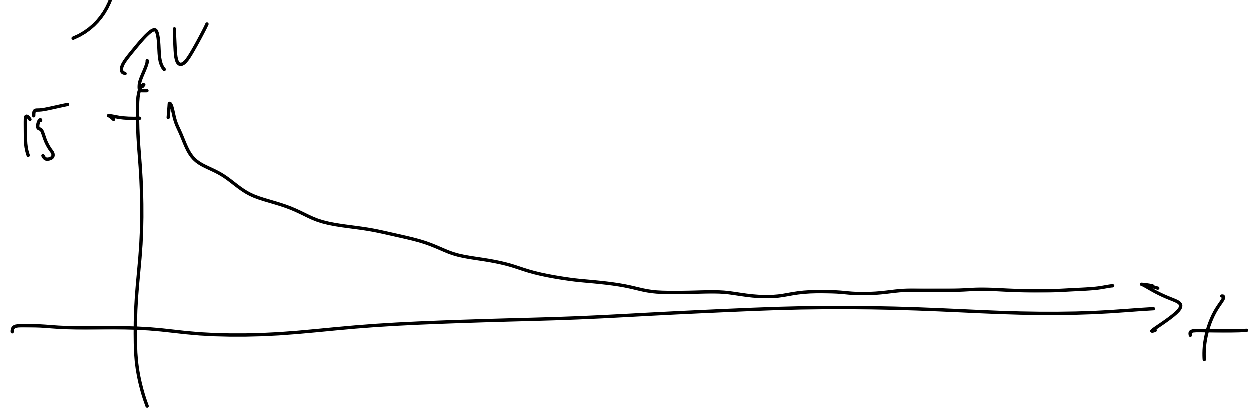
$$= -4.24 e^{-0.5t} + 57.6 e^{-12t} \quad (V)$$

Also $v_R(t) = v_L(t)$

$$\Rightarrow i_R = \frac{v_L(t)}{20} = \frac{-4.24 e^{-0.5t} + 57.6 e^{-12t}}{20}$$

$$= \boxed{-0.212 e^{-0.5t} + 2.88 e^{-12t} \quad (A)}$$

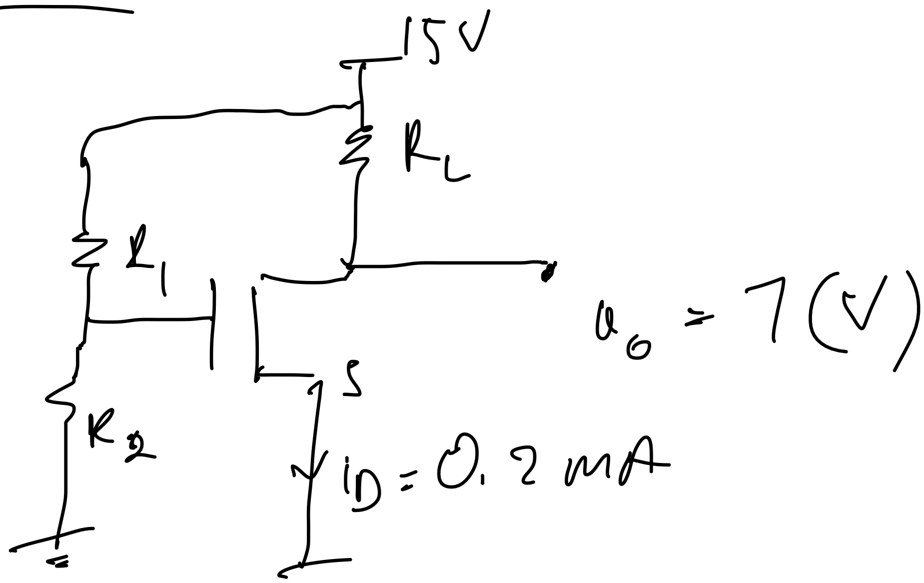
j) $v_C(t) = v_L(t)$



Problem 5 :

a) For DC analysis, capacitor is opened

We have :



apply KVL, we have :

$$15 - I_D R_L - V_o = 0$$

$$\Rightarrow R_L = \frac{15 - V_o}{I_D} = \frac{15 - 7}{0.2\ mA} = 40000$$

$$\Rightarrow \boxed{R_L = 40(K\Omega)}$$

Also $I_D = K(v_{gs} - v_{to})^2 = 0.2 \frac{mA}{V^2} (v_{gs} - 2)^2$

#14

$\Rightarrow 0.2\,mA = 0.2\,\frac{mA}{V^2}(v_{gs} - 2)^2$

$\Rightarrow (v_{gs}-2)^2 = 1 \Rightarrow v_{gs} - 2 = \pm 1$

$\Rightarrow \left[\begin{array}{l} v_{gs} = 3(V) \text{ (received)} \\ v_{gs} = 1(V) \text{ (rejected since } v_{gs} < V_T = 2V) \end{array}\right.$

$\Rightarrow \boxed{V_{gs} = 3\,V}$

b) We have: $I_D = K(V_{gs} - V_T)^2$

$\Rightarrow g_m = \frac{\partial i_D}{\partial V_{gs}} = 2K(V_{gs} - V_T)$

$= 2 \times 0.2 \times (3 - 2)$

$= \boxed{0.4\,(mA/V)}$

c) $R_1 + R_2 = 500\,K\Omega$

We have $v_{gs} = 3V = v_g - v_s$ #15

$= v_g$

$\Rightarrow v_g = 3(V)$

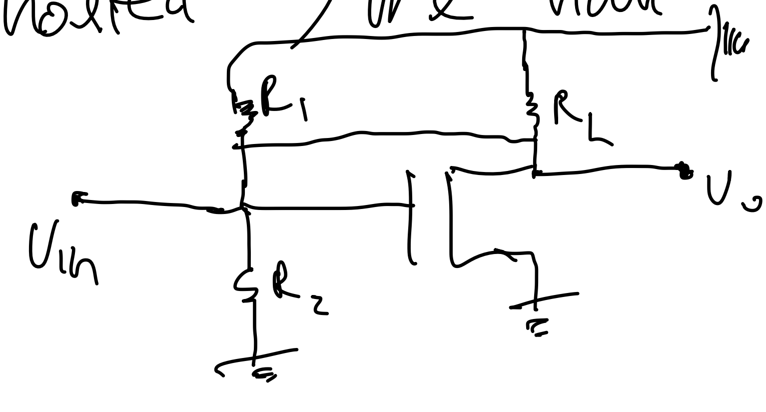
Apply the voltage divider:

$$V_g = \frac{15 \times R_2}{R_1 + R_2} = \frac{15 \times R_2}{500K\Omega} = 3V$$

$$\Rightarrow \boxed{R_2 = 100K\Omega}$$

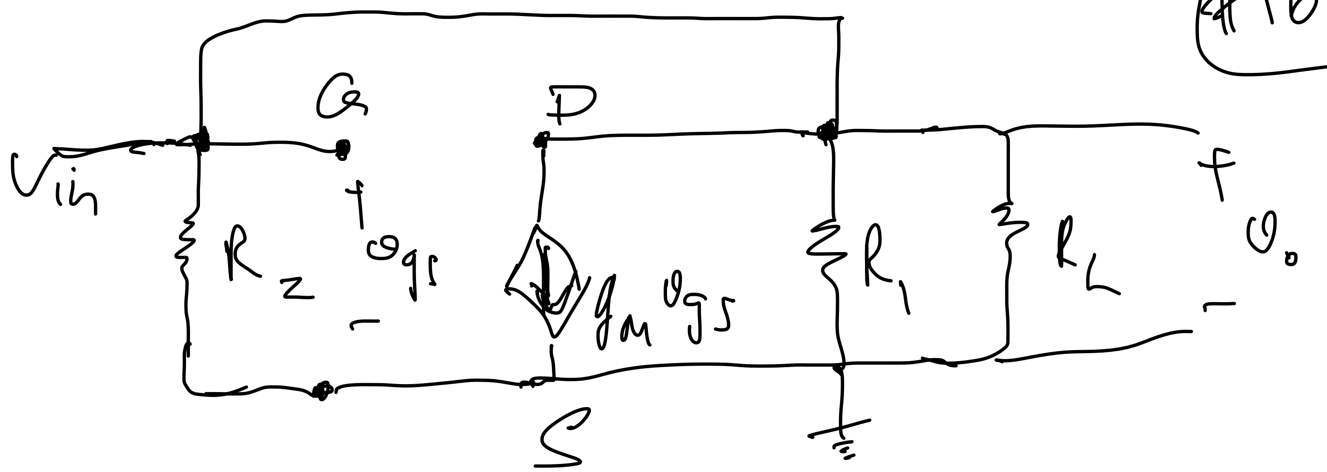
$$\Rightarrow \boxed{R_1 = 400K\Omega}$$

d) Small signal, all DC voltages source connected to ground & capacitor will be shorted $\Rightarrow$ We have:

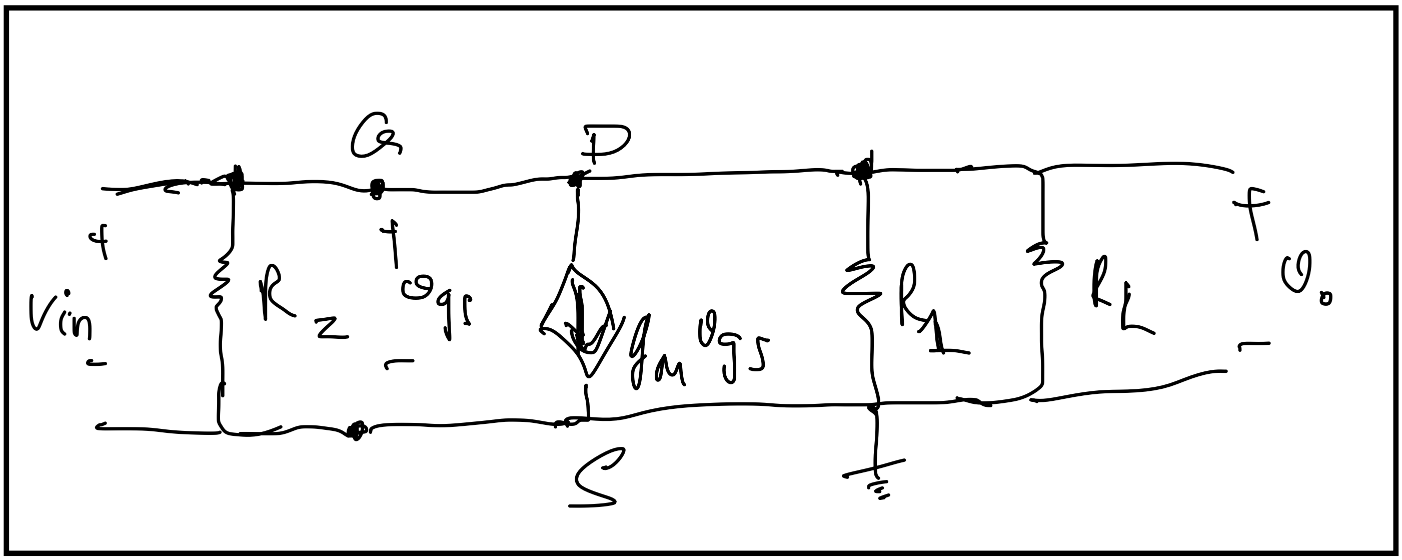


#16

$\Leftrightarrow$

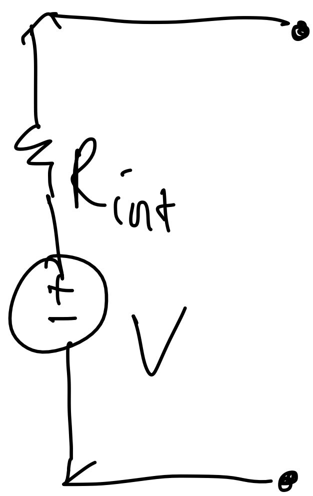


$\Downarrow$

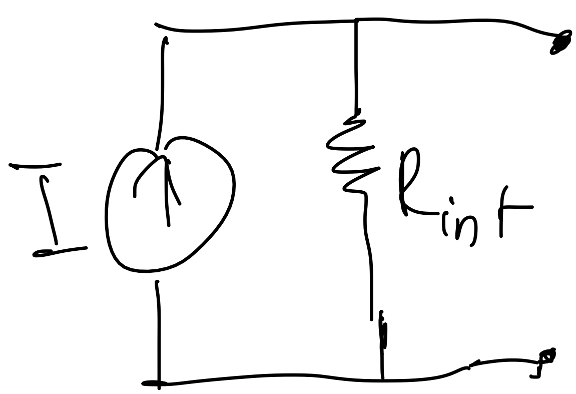


Problem 2: Circuit:

a)

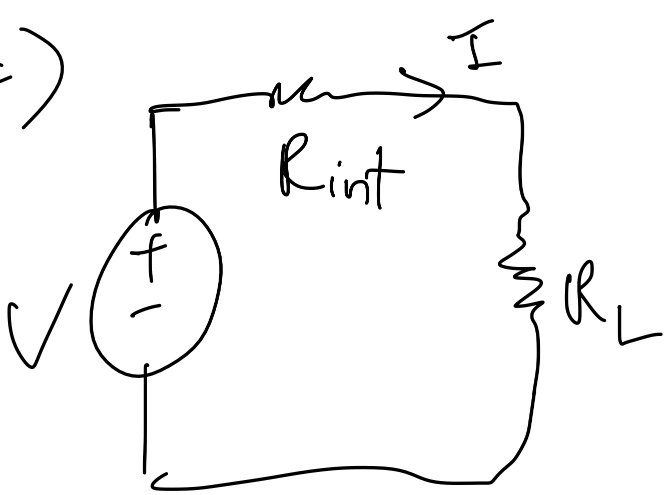


b) We have: the circuit:



$$I = \frac{V}{R_{int}}$$

c)



We have:

$$I = \frac{V}{R_{in} + R_L}$$

$\Rightarrow$ <u>Power</u>: $P = I^2 R_L = \boxed{\left(\frac{V}{R_{in}+R_L}\right)^2 \times R_L}$ #8

d) called $R_L = x$, $R_{in} = a$ (const), $x > 0$

$$\Rightarrow P = \left(\frac{V}{a+x}\right)^2 \cdot x = \frac{V^2 x}{(a+x)^2}$$

$$P'_{(x)} = V^2 \left[\frac{1(a+x)^2 - 2x(a+x)}{(a+x)^4} \right]$$

$$P' = 0 \Leftrightarrow (a+x)(a+x-2x) = 0$$

$$\Rightarrow \left[\begin{array}{l} a - x = 0 \Leftrightarrow x = a \\ a+x = 0 \text{ (reject since } x > 0) \end{array}\right.$$

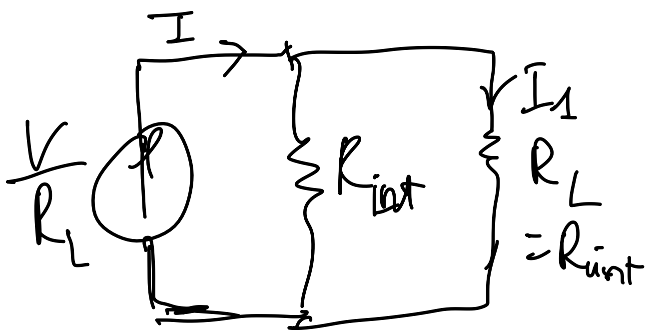
$\Rightarrow R_L$ has the power max when $x = a$

$\Leftrightarrow \boxed{R_L = R_{int}}$

$\Rightarrow P_{max} = \left(\frac{V}{2R_L}\right)^2 \times R_L = \frac{V^2}{4R_L^2} \times R_L$

$$\Rightarrow \boxed{P_{max} = \frac{V^2}{4R_L}}$$

e) Equivalent current source:



Since $R_L = R_{int}$

$\Rightarrow I_1 = \frac{I}{2}$

$= \frac{V}{2R_L}$

$\Rightarrow I_1 = \frac{V}{2R_L}$

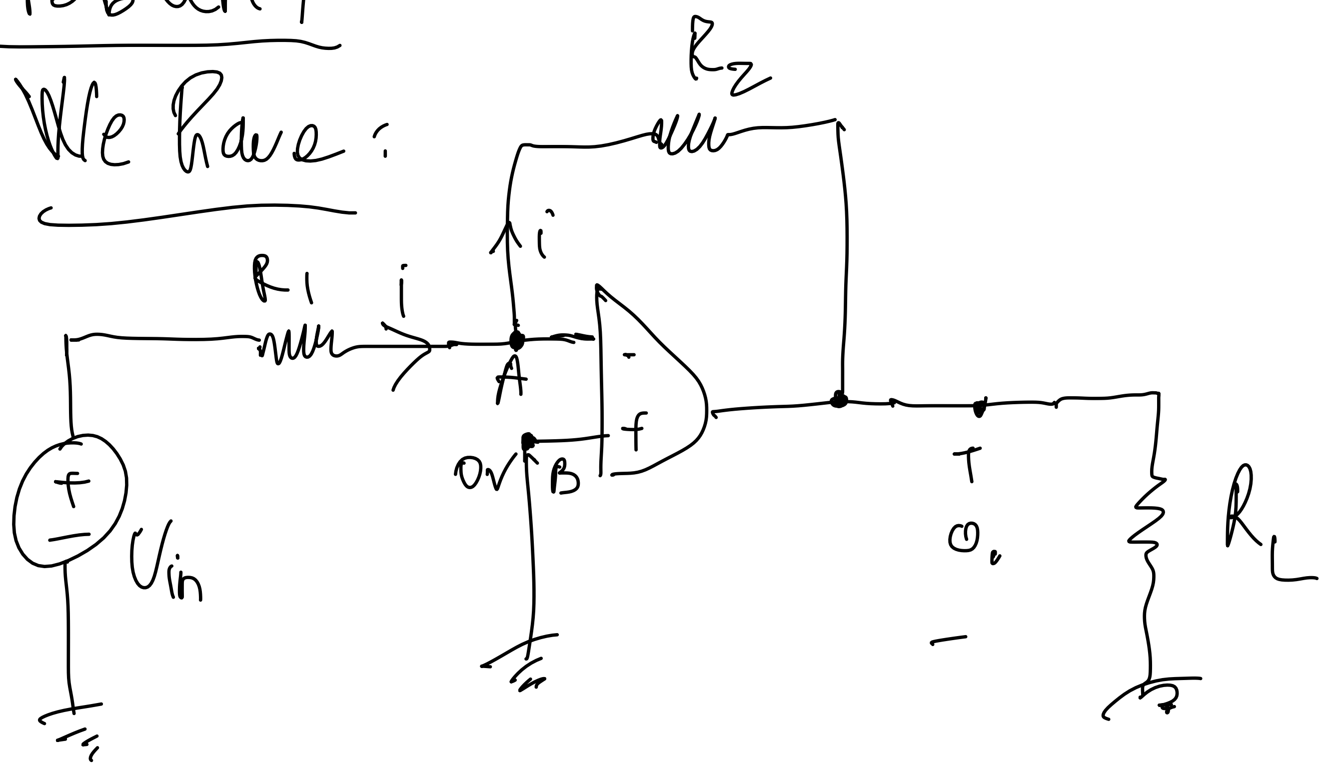
$\Rightarrow P_L = (I_1)^2 \times R_L = \frac{V^2}{4R_L^2} \times R_L = \frac{V^2}{4R_L}$

$\Rightarrow P_L$ is still equal $\frac{V^2}{4R_L} = P_{max}$

$\Rightarrow$ $\boxed{\text{this is still true}}$

Problem 7:

We have:



a) At point A, $V_A = V_B = 0V$.

$$\Rightarrow \frac{V_{in} - 0}{R_1} = \frac{0 - v_0}{R_2}$$

$$\Rightarrow \frac{V_{in}}{R_1} = \frac{-v_0}{R_2} \Rightarrow \frac{v_0}{v_{in}} = -\frac{R_2}{R_1}$$

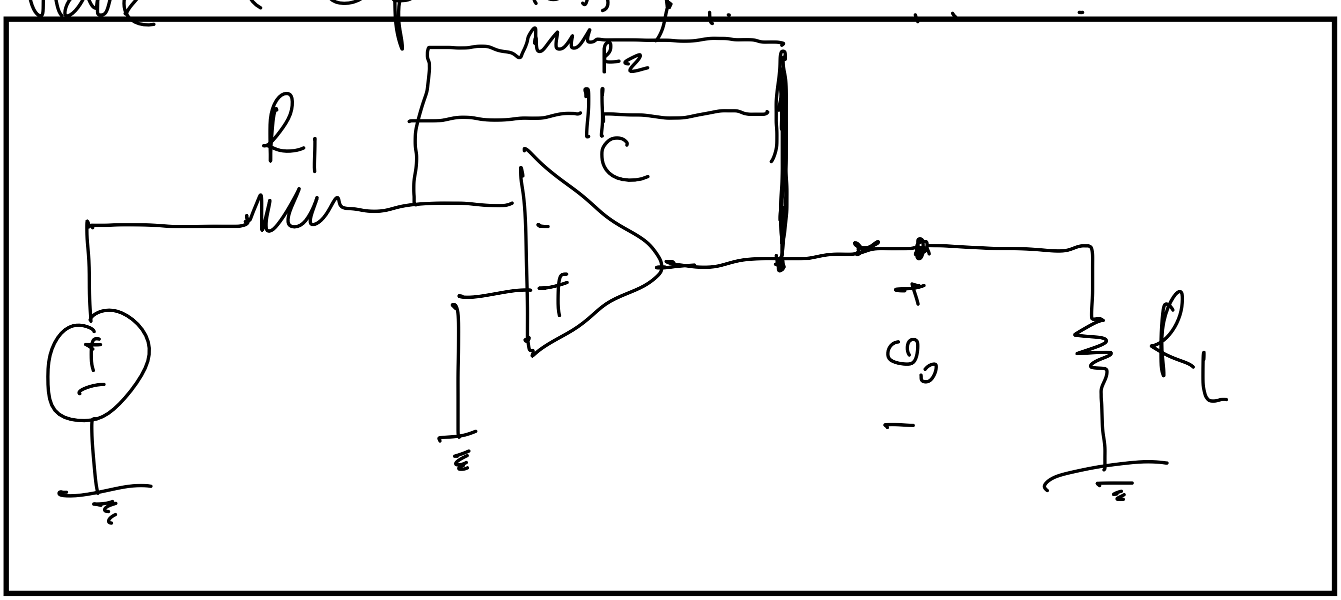
$$\Rightarrow \boxed{A_v = \frac{v_0}{v_{in}} = -\frac{R_2}{R_1}}$$

With $A_v = -5 \Rightarrow -\frac{R_2}{R_1} = -5$

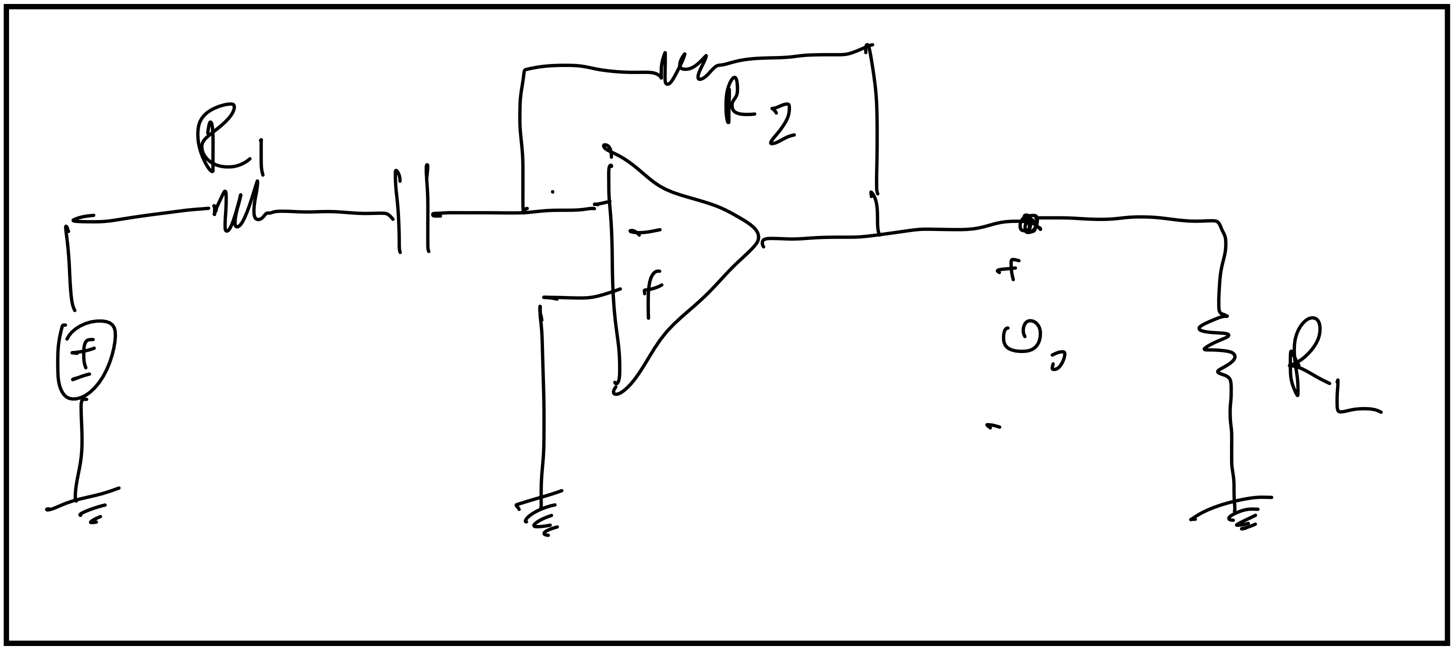
$\Rightarrow R_2 = 5R_1$

Since the gain A does not depend on R_L $\Rightarrow$ to get $A_v = -5$, we need focus on R_2 & R_1 with $R_2 = 5R_1$ and doesnot matter R_L

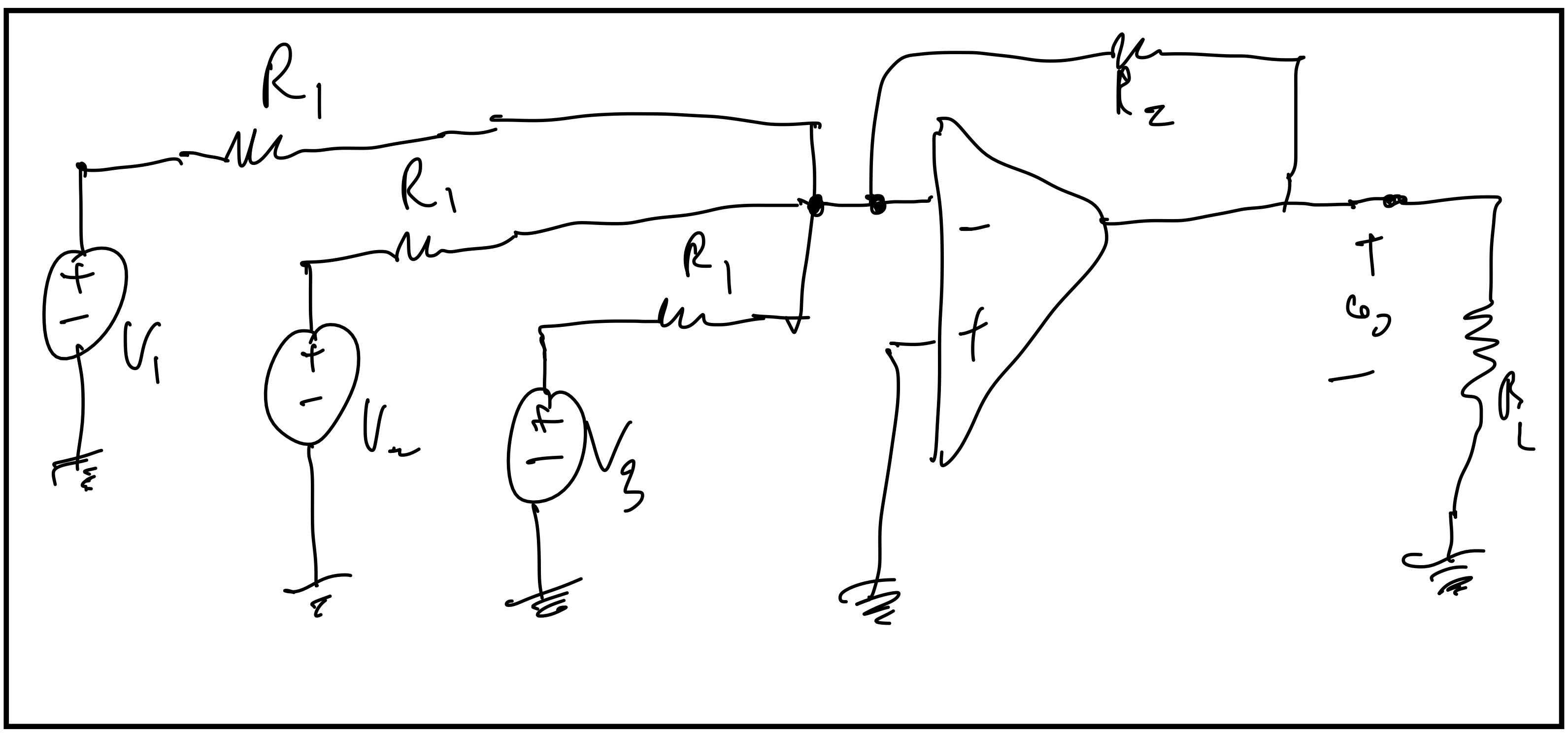
b) To have an integrator, we need to have a capacitor parallel with R_2 like this one



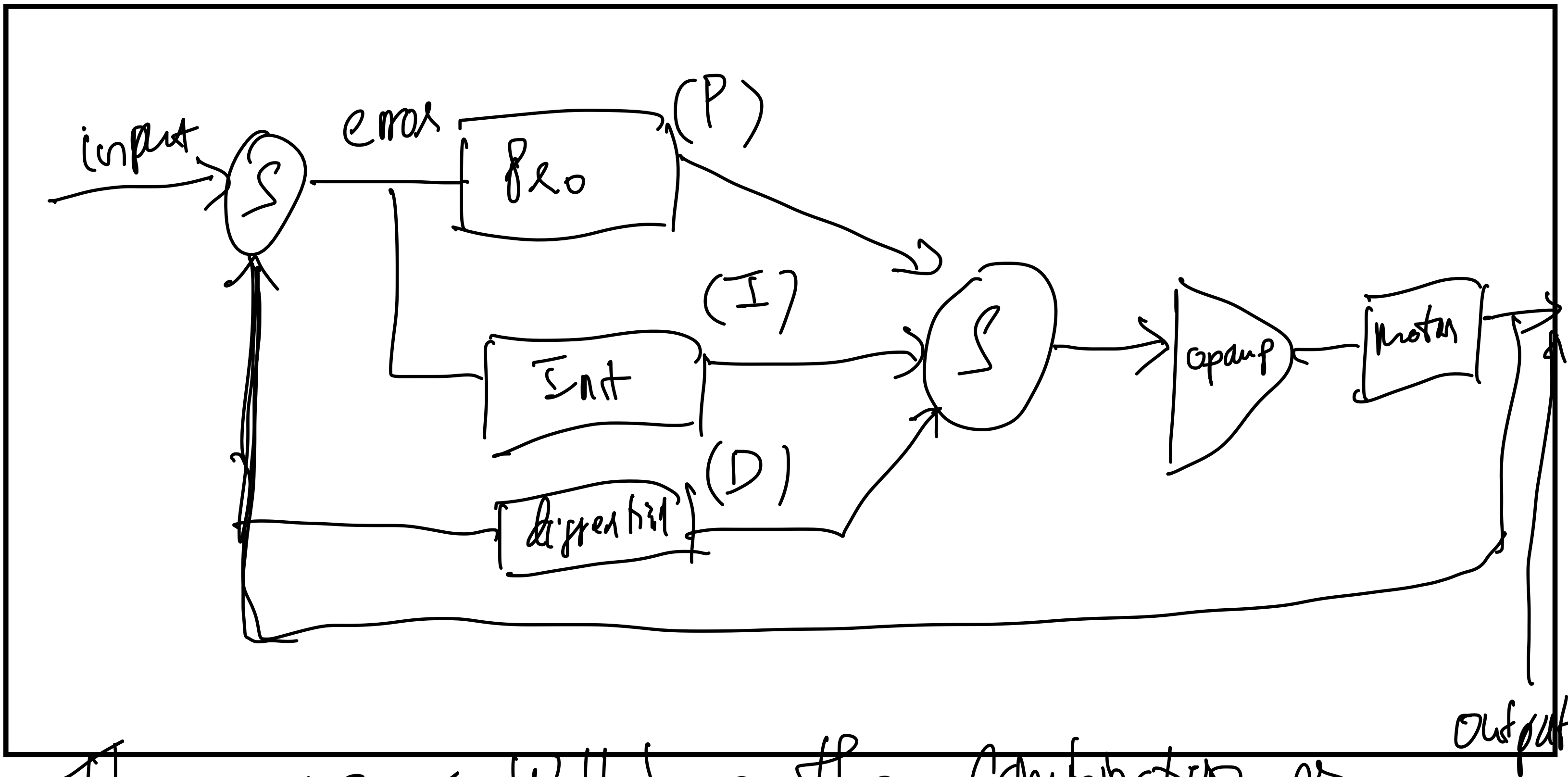
c) To have a differentiator, we need a capacitor at the input like this one.



d) To have a summation of 3 input:



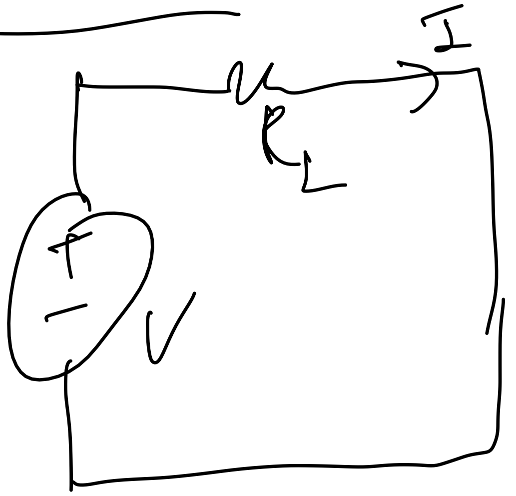
e) Firstly, we have the block diagram : [23]



The opamp will have the combination of 3 input as P, I, & D, and then control the motor, then it also get the output to find the error to make a better result in the next controlling.

Problem 1:

a)



$$\Rightarrow P_{R_L} = I^2 R_L$$

$$I = \frac{V}{R_L} \Rightarrow I^2 = \frac{V^2}{R_L^2}$$

$$\Rightarrow P_R = \frac{V^2}{R_L^2} R_L = \boxed{\frac{V^2}{R_L}}$$

b) length: L

mass: kg

time: s

$\Rightarrow$ $\boxed{\text{(iii) Amperes}}$

c) $Z = R + jX$ with R is a real part, jX is a imaginary part.

then Ohm Law: $\boxed{I = \frac{V}{Z} = \frac{V}{R + jX}}$

d) a phasor is a complex number representing a sinusoidal function whose amplitude A, angular frequency ω and initial phase θ..

#25

Voltage phasor V: $\Rightarrow$ $I = \dfrac{V}{Z}$

$$V = V_0 \cos(\omega t + 0) = V_0 \cos(\omega t)$$

$$R + jX = \sqrt{R^2 + X^2} \angle \arctan(X/R)$$

$$\Rightarrow I = \frac{V_0}{Z} = \frac{V_0 \angle 0^\circ}{\sqrt{R^2+X^2} \angle \arctan(X/R)}$$

$$\Rightarrow \boxed{I = \frac{V_0}{\sqrt{R^2+X^2}} \angle \arctan(X/R)}$$

$$\Rightarrow \boxed{P_{source} = V I = \frac{V_0^2}{\sqrt{R^2+X^2}} \angle \arctan(X/R)}$$

#26

The meaning of the imaginary component of power show us ~~know~~ that in addition to the resistance, the power also be stored by the capacitor or inductor.

e)

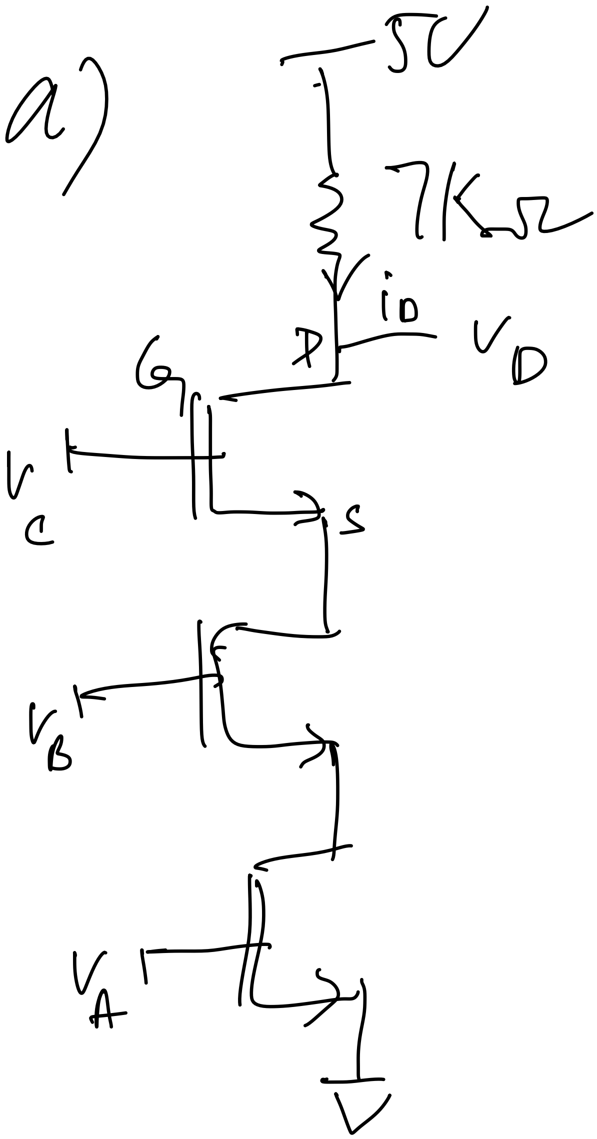
f)

#27

Problem 6:

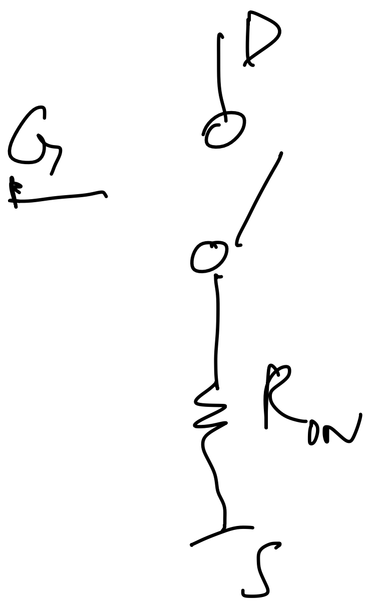
#28

a)



$V > 4 \Rightarrow$ one

$V < 1 \Rightarrow 0$



$V_{in} < V_{th}$

A	Y
0	1
1	0

$$5 - V_D = iR = 7i$$

$$\Rightarrow \quad V_D = 5 - 7i$$