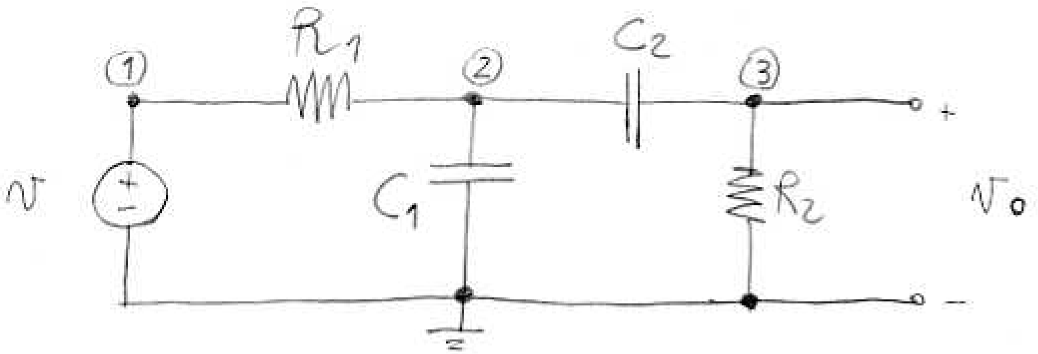
EE 40 SUMMER '04 HW 2

A) 2^{nd} order circuits

Consider the circuit:



Follow the steps that I tell you to find the answer:

A.1) Pick a reference point like in figure an consider the three nodes ①,②,③. Pick reference directions an polarities for all branches.

Write KCL for each node.

A.2) You have to find now the equation for v_3 and v_2

I) Take derivative of equation at node ②.

II) From equation at node ③, write $\frac{dv_2}{dt}$ as function of v_3 and $\frac{dv_3}{dt}$ (call this equation ④)

III) take derivative of equation ④ to find an expression for d^2v_2/dt^2

IV) Substitute $\frac{dV_2}{dt}$ an $\frac{d^2V_2}{dt^2}$ found in II and III in equation obtained in I. Call this new equation (2')

A.3) We want to study the steady state response when $v(t) = \sin(w_0 t)$ where $w_0 = 2\pi f_0$.

As usual, assume $v_3(t) = A\sin(w_0t) + B\cos(w_0t)$.

I) Substitute $v_3(t) = A\sin(w_0t) + B\cos(w_0t)$ in (2')

II) Compute A and B

We know that $A\sin x + B\cos x = \sqrt{A^2+B^2}\,\sin\left(x + tg^{-1}\left(\frac{A}{B}\right)\right)$

We are interested in $\sqrt{A^2+B^2}$

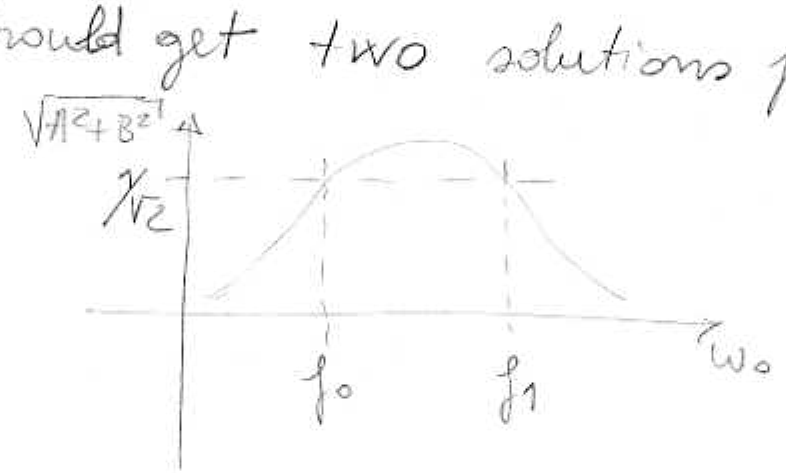
III) Compute A^2+B^2

A.4) We want to know the cutoff frequencies.

I) Solve the equation:

$$\sqrt{A^2+B^2} = \frac{1}{\sqrt{2}}$$

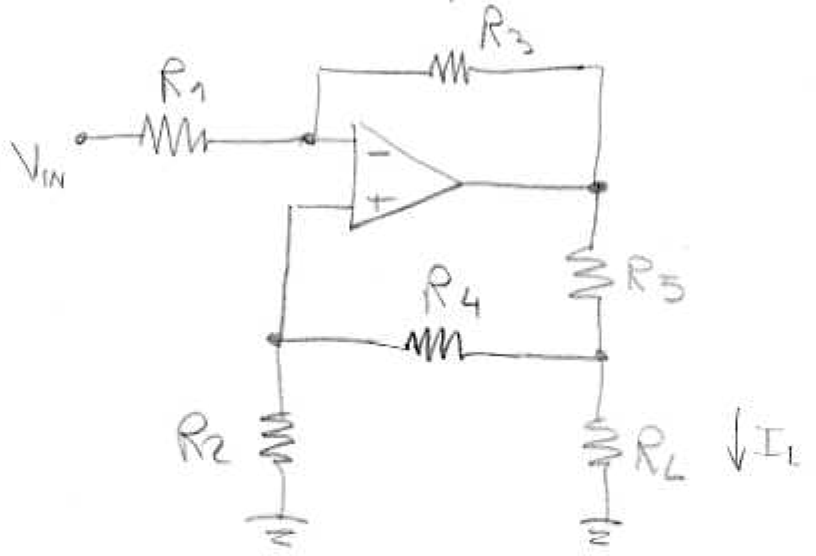
You should get two solutions for w_0 meaning



it is a bandpass filter!! (cool, isn't it?)

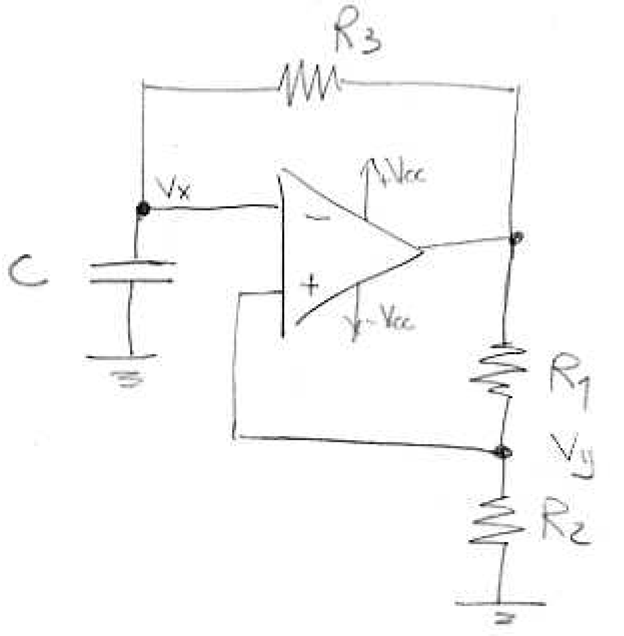
B) Op-Amps : current source

Given the following circuit



B.1) Compute I_L as a function of V_{IN} in the case where $\begin{cases} R_3 = R_4 + R_5 \\ R_1 = R_2 \end{cases}$

C) Op-Amps: non linear circuit



C.1) Consider $V_x = V_{cc} \frac{R_2}{R_1+R_2}$ and the output to be $-V_{cc}$.
What is going to happen?
Describe how the circuit works

C.2) Compute the frequency of the output oscillation