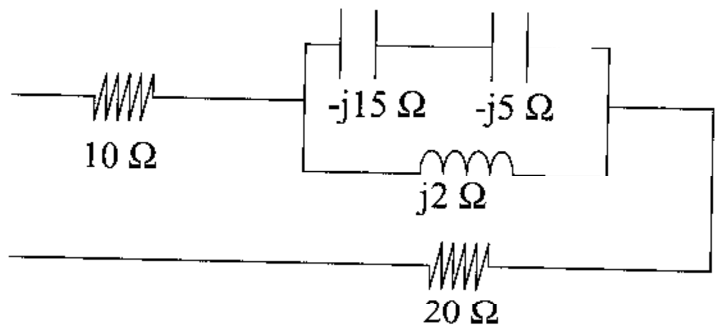
1) Find the equivalent impedance of the following circuit You may use Maple or a calculator to do your calculations, but **show all of your steps** on paper. (25 pts)



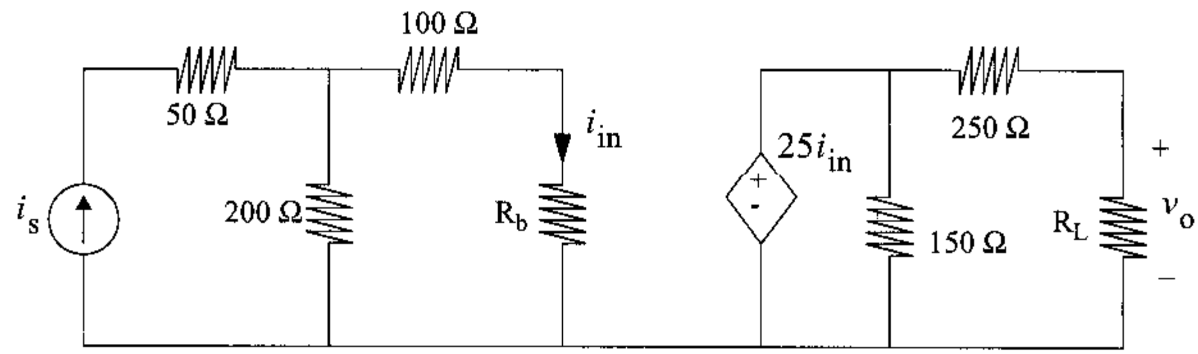
1) $\underline{Z}_{Req} = 10\Omega + 20\Omega + j0 = 30 + j0\,\Omega$

2) $\underline{Z}_{Ceq} = -j15\Omega - j5\Omega = -j20\,\Omega$

3) $\underline{Z}_{LC} = \dfrac{\underline{Z}_{Ceq}\underline{Z}_L}{\underline{Z}_{Ceq} + \underline{Z}_L} = \dfrac{(-j20)(j2)}{(-j20)+(j2)} = \dfrac{-j^2\,40}{-j\,18} = j\dfrac{20}{9}$

4) $\underline{Z}_{eq} = \underline{Z}_{Req} + \underline{Z}_{LC} = \boxed{30 + j\dfrac{20}{9}\,\Omega}$

2) Use the following diagram for the next set of questions. You are limited to using the four tools: Voltage Divider, Current Divider, Source Transformations, and Ohm's Law. You must show all your work to get full credit.: (25 pts)



A) Determine whether R_b should be maximized or minimized to minimize the amplifier loading of the source. Provide an equation to justify your answer. (9 pts)

Make $i_{in} \approx i_s$

$$i_{in} = i_s \frac{200\Omega}{300\Omega + R_b}$$

Make R_b as small as possible

B) Determine whether R_L should be maximized or minimized to minimize the loading of the amplifier. Provide an equation to justify your answer. (9 pts)

Make $v_o \approx 25\Omega\, i_{in}$

$$v_o = 25\Omega\, i_{in} \frac{R_L}{R_L + 250\Omega}$$

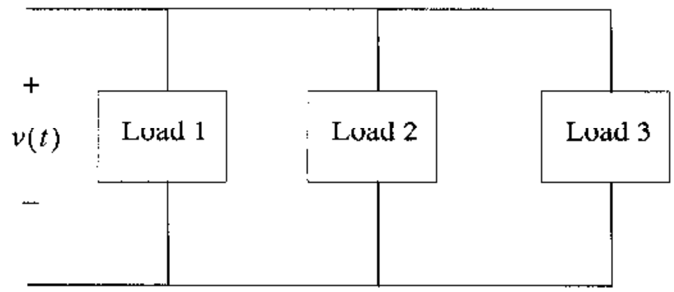
Make R_L as large as possible

C)Assuming that $R_b = 25\Omega$ and $R_L = 75\Omega$, find the gain $A = \frac{v_o}{i_s}$. (7 pts)

$$A = \frac{v_o}{i_s} = 25\Omega\left(\frac{200\Omega}{300\Omega + R_b}\right)\left(\frac{R_L}{R_L + 250\Omega}\right) = 4.19\Omega$$

3) Use the following diagram for the next series of questions (25 pts)

$$v(t) = 10\cos\left(120\pi t + \frac{\pi}{6}\right)$$



A) Load 1 is a capacitive load and absorbs 7.5 kW and 2.5 kVARs. What is the complex power absorbed by this load?(6 pts)

$P = 7.5$ kW

$Q = 2.5$ kVAR

$\underline{S} = P + jQ = 7.5 + j2.5$ kVA

B) Load 2 is 10kVA at a 0.28 pf-leading. What is the complex power absorbed by this load? (6pts)

$|\underline{S}| = 10$ kVA

$0.28 = -\cos(\theta_s)$

$\underline{S} = 10 \angle -73.7$ kVA

$= 2800 - j9600$

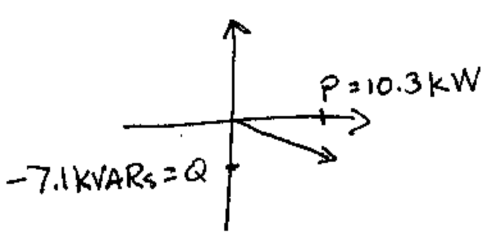
C) The impedance of Load 3 is 12+j5 Ω. What is the complex power absorbed by this load? (6pts)

$\underline{Z}_3 = 12 + j5\ \Omega$ $\quad \underline{V}_3 = \frac{10}{\sqrt{2}} \angle \frac{\pi}{6}$ (RMS)

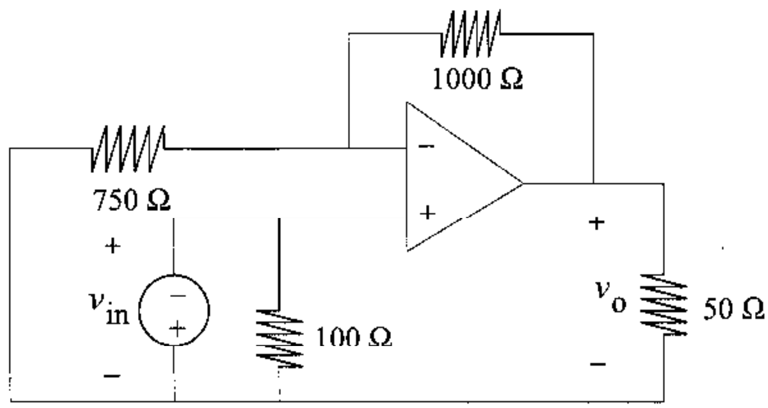
$\underline{S} = \frac{V_3 V_3^*}{\underline{Z}_3^*} = 3.84 \angle 22.62° = 3.55 + j1.48$

D) Draw the power triangle for the combined power absorbed by all three loads. (7 pts)

$\underline{S}_T = \underline{S}_1 + \underline{S}_2 + \underline{S}_3 = 10.3 - j7.1$ kVA $= P_T + jQ_T$



4) Find the gain of the op-amp circuit $A = \frac{v_o}{v_{in}}$ (25 pts)



Non-Inverting Amp

So $A = \frac{v_o}{v_{in}} = \left(1 + \frac{R_{fb}}{R_1}\right) = \left(1 + \frac{1000}{750}\right)$

$= 2.33$

Because v_{in} is negative

$v_o = A_v v_{in}$ will be negative