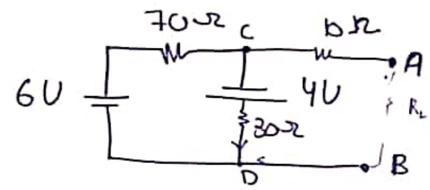
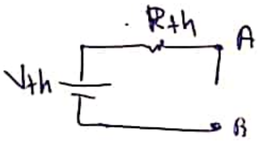
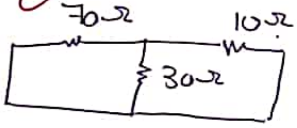
$\boxed{3}$




(a)




(c) to find $R_{th}$ ⇒



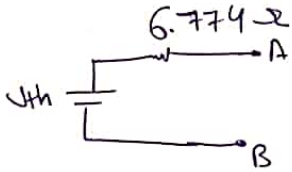

$\cancel{(70 \parallel 30) + 10}$

$\cancel{\frac{(70 \cdot 30)}{(70+30)} + 10} = \cancel{21 + 10 = 31\Omega}$

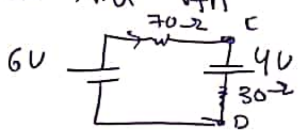
$$\frac{1}{R} = \frac{1}{70} + \frac{1}{30} + \frac{1}{10}$$

$$\frac{1}{R} = 0.1476$$

$$R_{th} = 6.774\Omega$$




(b) to find $V_{th}$ $\qquad V_{th} = V_{AB} = V_{CD} - V_{10\Omega}$

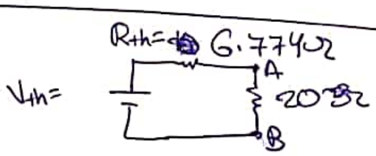



$$I_{short} = 6 + 4 - I_{short}(70+30)$$

$$I_{short} = \frac{10}{100} = 0.1 \text{ Ampere}$$

$$V_{th} = 4V - (30\Omega)\, I_{short}$$
$$= 4 - 30(0.1)$$
$$= 4 - 3$$
$$V_{th} = 1V$$

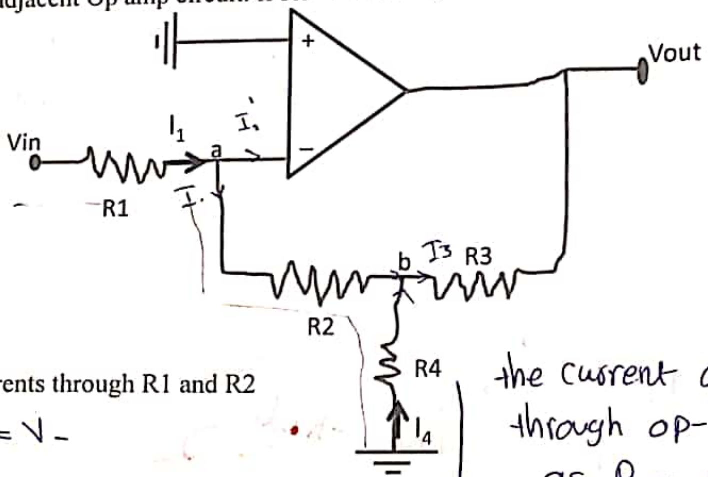
(d)




$$I_{AB} = \frac{V_{th}}{R_{th}+R_L} = \frac{1}{6.774+20} = \frac{1}{26.774} = (0.037\ A)$$

$$V_{R_L} = I_{R_L} * R_L = 0.037 * 20 = 0.74\ V$$

2) In the adjacent Op amp circuit. If R1=R2=R3=R, Find:




a) The currents through R1 and R2

$V_+ = 0 = V_-$

$V_{in} - V_{R_1} = V_- = 0$

$V_{in} = I_1 R_1 = I_1 R \Rightarrow I_1 = \frac{V_{in}}{R}$

the current doesn't pass through op-amp so $I_1' = 0$ as $R$ op-amp $= \infty$

$\Rightarrow$ current pass through R equalls to current throug $I R_1 = \frac{V_{in}}{R}$

b) The voltages at points a and b

$V_a = V_{in} - V_{R_1} = V_- = 0$

$V_b = V_{R_4} - 0 = V_{R_4} + I_4 R_4$

$\cancel{V_a - I_2 R_2}$ $\quad V_b + V_{R_4} = 0 \quad V_b = -V_4 = -I_4 R_4$

c) The current through R4

$V_a - I_1 R_2 + I_4 R_4 = 0$

$V_a = 0 \Rightarrow I_4 R_4 + I_1 R_2$

$I_4 = I_1 \cdot \frac{R_2}{R_4} = \frac{V_{in}}{R} \frac{R}{R_4} = \frac{V_{in}}{R_4}$

d) From a, b, and c, find the gain in the circuit in terms of R and R4

$\cancel{I_1 = I_4 + I_3}$ $\quad I_3 = I_1 + I_4 = \frac{V_{in}}{R} + \frac{V_{in}}{R_4} = V_{in}\left(\frac{1}{R} + \frac{1}{R_4}\right)$

$V_{out} + I_3 R_3 + I_4 R_4 = 0$

$V_{out} = -(I_3 R + I_4 R)$ $\qquad G = \frac{V_{out}}{V_{in}} = -($

$= -\left(V_{in} R\left(\frac{1}{R} + \frac{1}{R_4}\right) + \frac{V_{in}}{R_4} R_4\right)$

$= -V_{in}\left(1 + \frac{R}{R} + \frac{R}{R_4}\right) = -V_{in}\left(2 + \frac{R}{R_4}\right)$

4. If V0=10V, R1 = R2 =10 kΩ. Find the current in R2 when RL.

a) goes to infinity

$R_L \to \infty$

$I' = 0$

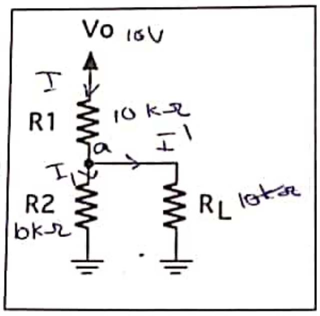
$\Rightarrow V_0 - IR_1 - IR_2 = 0$

$I = \frac{V_0}{R_1 + R_2}$

$= \frac{10}{(10+10) * 10^3}$

$= \frac{10}{20} * 10^{-3} = 0.5 * 10^{-3} A$

$= 0.5 \, mA$




b) goes to zero

$R_L \to 0$ ~~at~~ $\Rightarrow I' = I$

No current will pass through $R_2$

$I_{R_2} = 0$

c) RL=5kΩ

$V_{R_L} = V_{R_2} = V_0 - IR_1$

$I' R_L = I_1 R_2$

$I' (5 * \cancel{10^3}) = I_1 (10 * \cancel{10^3})$

$I' = 2 I_1$

$I' + I_1 = I$

$2I_1 + I_1 = I \qquad I = 3I_1$

$V_0 - IR_1 = V_{R_2}$

$V_0 - 3I_1(10 * 10^3) = I_1(10 * 10^3)$

$\cancel{10} = 4 I_1 (\cancel{10}) * 10^3$

$I_1 = \frac{1}{4} * 10^{-3} A$

$I_1 = 0.25 \, mA$

$\frac{63}{70}$

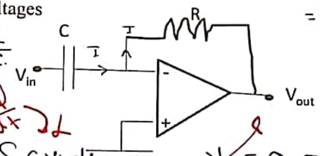
PHY 336 Electronic Instrumentation Name: Haleemah Wesam

First Exam Fall 2015 April 4 2019 1161760

1) The drawing shows an amplifier whose input voltage is connected to the inverting side through a capacitor with capacitance C and a feedback resistance R. If R=10kΩ and C=50μF. Find:

$RC = (10k\Omega)(50\mu F)$
$= 0.5\ F\Omega$

a) The relation between the output and input voltages




$V_{in} - V_C = V_- = 0 \Rightarrow V_{in} = V_C = \frac{q}{C}$

$V_{out} + I_R = V_- = 0$

3 $V_{out} + IR = 0$ $V_{out} = -RC\frac{dQ}{dt}$

$V_{out} = -IR = -R\int q\,dt = -R\int C V_{in} dt$ $V_+ = 0 = V_-$

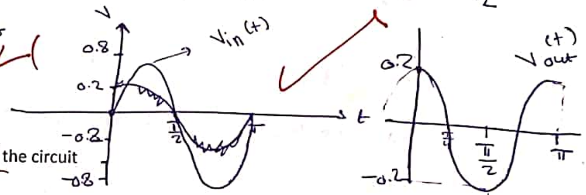
$V_{out} = -RC\int V_{in} dt$ $V_{out} = -0.5\int V_{in} dt$

b) If the amplifier is powered by + and – 10V source and the input voltage is $V_{in}$=0.8sin2t. Draw the input and output voltages as functions of time and show the actual values. Show at least two periods in the drawing. Use back, if needed.

$V_{out} = -0.5\int V_{in} dt = -0.5\int 0.8\sin 2t\, dt = (0.5)\frac{(0.8)}{2}\cos 2t$

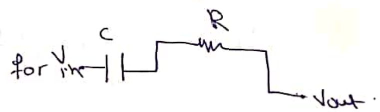
$V_{out} = 0.2\cos 2t$

$2t = 2\pi$
$t = \pi$




C) Find the input impedance of the circuit

$Z_C = \frac{1}{i\omega C}$ $Z_R = R$




~~input~~ impedance $= Z_C + Z_R$

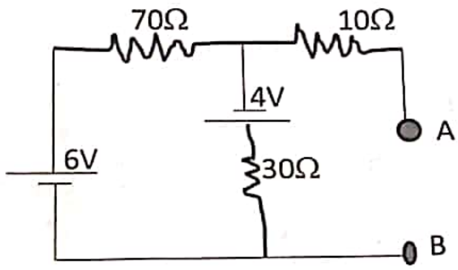
$= \frac{1}{i\omega C} + R$

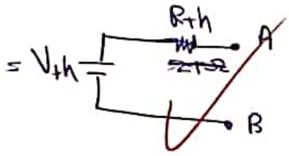
$|$ input impedance $| = \sqrt{\frac{1}{\omega^2 C^2} + R^2}$

the op-amp have $\infty$ input impedance.

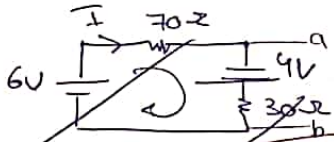
3) In the adjacent circuit.

A) Draw the Thevenin's equivalent circuit between points A and B




B) Find the Thevenin's equivalent voltage



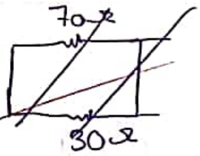

$6V - I(70) + 4 - I(30) = 0$

$I = \frac{10}{70+30} = \frac{10}{100} = 0.1\ A$

$V_{th} = V_{ab} = 4 - I(30) = 4 - (0.1)(30)$

$V_{th} = 4 - 3 = 1V$

C) The Thevenin's equivalent resistance



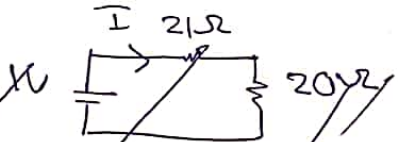

$\frac{1}{R_{th}} = \frac{1}{70} + \frac{1}{30}$

$= \frac{70+30}{70 * 30}$

$= \frac{100}{2100}$

$R_{th} = 21\ \Omega$

D) If a load resistor of 20Ω is connected between A and B. Find the voltage across the resistor and the current through it.




$I = \frac{1V}{21+20}$

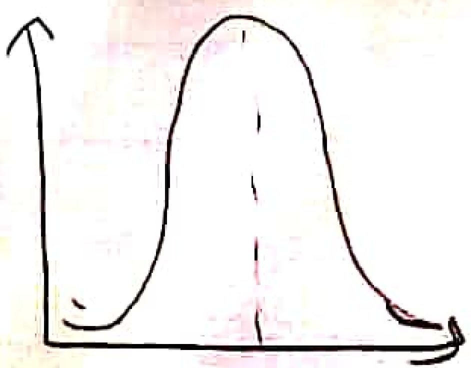
$= \frac{1}{41} = 0.02\ A$

$\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$

(c) and at high $\omega \Rightarrow i \approx 0$

at low $\omega \Rightarrow i \approx 0$

Band pass



$I_{max} = \frac{\varepsilon}{R}$

$$\mathcal{E} = \mathcal{E}_0 \cos(\omega t) = \mathcal{E}_0 e^{i\omega t}$$

$$I = \frac{\mathcal{E}}{Z} = \frac{\mathcal{E}_0 e^{i\omega t}}{Z}$$

$$I_0 = \frac{\mathcal{E}_0}{|Z|} = \frac{\mathcal{E}_0}{\sqrt{Z Z^*}}$$

$$Z = R + i\left(\omega L - \frac{1}{\omega C}\right)$$

$$Z^* = R - i\left(\omega L - \frac{1}{\omega C}\right)$$

$$I_0 = \frac{\mathcal{E}_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$Z_R = R$

$Z_C = \frac{-j}{\omega C}$

$Z_L = j\omega L$

$\frac{j\omega C}{\ } + \frac{1}{j\omega L}$

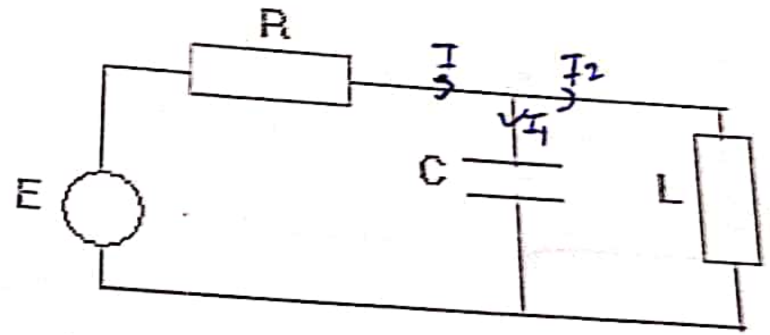
Q2) for the following RLC circuit if:

$E = E_0 \cos(\omega t)$

a) Derive an expression for the current passing through R.

b) Derive and expression for the phase shift between the input voltage and the current passing through R.

c) At what value of $\omega$ would the current be zero.




$$I = \frac{E(t)}{Z_{eq}} = \frac{E_0 \cos(\omega t)}{Z_{eq}} = \frac{E_0 e^{j\omega t}}{Z_{eq}}$$

$$Z_{eq} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}\, e^{i\theta}$$

$\omega L - \frac{1}{\omega C}$