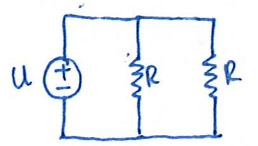
1)

a) C - Two speakers of 4Ω, 50W in parallel



$R = 4\Omega$ $\quad P_u = 100W @ 4\Omega$

$R_{eq} = R // R = 2\Omega$

$P_u = 100W = \frac{u^2}{4\Omega} \Rightarrow u = 20V$

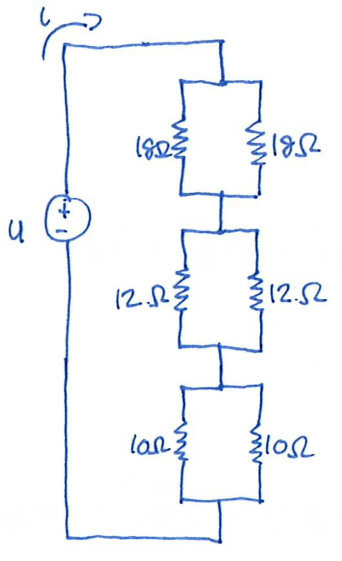
$P_R = \frac{u^2}{R} = \frac{20^2}{4} = 100W$ ($> 50W$ load maximum!)

b) D - Two Non-Inverting Amplifiers followed by a Differential Amplifier

Non-inverting amplifiers on each differential input remove the need for impedance matching by making the input impedance nearly infinite.

c) There are many solutions. Example:

$P_u = 2W @ 20\Omega \Rightarrow 2W = \frac{u^2}{20\Omega} \Rightarrow u = 2\sqrt{10}\,V$



$R_{eq} = (18 // 18) + (12 // 12) + (10 // 10) = 9 + 6 + 5 = \underline{20\Omega}$

$i = \frac{2\sqrt{10}}{20} = \frac{1}{\sqrt{10}} A$

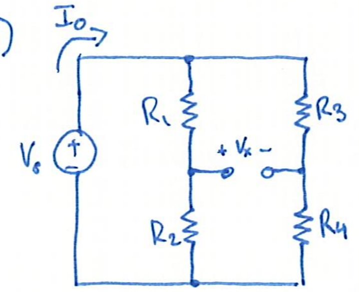
$I_{18\Omega} = I_{12\Omega} = I_{10\Omega} = \frac{1}{2\sqrt{10}} A = \frac{i}{2}$

$P_{18\Omega} = I_{18\Omega}^2 \cdot 18\Omega = \frac{18}{40} = \underline{0.45W < 0.5W}$

$P_{12\Omega} = I_{12\Omega}^2 \cdot 12\Omega = \frac{12}{40} = \underline{0.30W < 0.5W}$

$P_{10\Omega} = I_{10\Omega}^2 \cdot 10\Omega = \frac{10}{40} = \underline{0.25W < 0.5W}$

2)



$V_o = 30V$
$R_1 = 5.0k\Omega$
$R_2 = 1.0k\Omega$
$R_3 = 60k\Omega$
$R_4 = 15k\Omega$

a) $V_x+ : V_o \cdot \frac{R_2}{R_1+R_2} = 30 \cdot \frac{1k\Omega}{1k\Omega + 5k\Omega} = 5V$

$V_x- : V_o \cdot \frac{R_4}{R_3+R_4} = 30 \cdot \frac{15k\Omega}{60k\Omega + 15k\Omega} = 6V$

$V_x = (V_x+) - (V_x-) = 5V - 6V = \boxed{-1V}$

b) $R_{eq} = (R_1 + R_2) \,//\, (R_3 + R_4)$

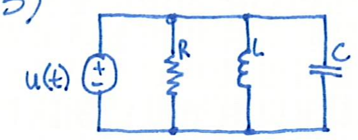
$= 6k\Omega \,//\, 75k\Omega = \frac{6k\Omega \cdot 75k\Omega}{6k\Omega + 75k\Omega}$

$R_{eq} \approx 5.6k\Omega$

$I_o = \frac{V_o}{R_{eq}} = 30/5.6k = 5.4 \cdot 10^{-3} A = \boxed{5.4mA}$

---

3)



$R = 50\Omega$
$L = 0.50H$
$C = 10\mu F$
$u(t) = 500\sqrt{2} \cdot \cos(\omega t) V$
$\omega = 377 \text{ rad/s}$

a) Average Power: $P_{avg} = S_R = \frac{1}{2} U I_R^* = \frac{1}{2} \frac{UU^*}{R^*} = \frac{1}{2} \frac{|U|^2}{R^*} = \frac{V_{rms}}{R}$

$V_{rms} = \frac{500\sqrt{2}}{\sqrt{2}} = 500V$

$P_{avg} = \frac{500V^2}{50} = 5000W = \boxed{5kW}$

b) Reactive Power: $P_{rea} = S_L + S_C = \frac{1}{2} U I_L^* + \frac{1}{2} U I_C^* = \frac{1}{2} \frac{|U|^2}{Z_L^*} + \frac{1}{2} \frac{|U|^2}{Z_C^*}$

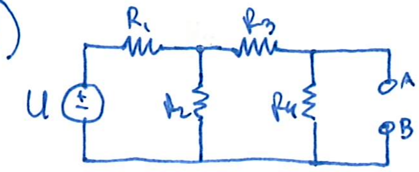
$Z_L^* = -j\omega L = -j377 \cdot 0.5$

$Z_C^* = j\frac{1}{\omega C} = \frac{j}{377 \cdot 10 \cdot 10^{-6}}$

$S_L + S_C = \frac{(500\sqrt{2})^2}{2} \left(\frac{1}{-j377 \cdot 0.5} - j377 \cdot 10 \cdot 10^{-6} \right) \approx j384 = jQ \Rightarrow \boxed{P_{rea} = 384VAR}$

Effective Power: $S = \sqrt{P_R^2 + Q^2} = \sqrt{5000^2 + 384^2} = \underline{5014 VA}$

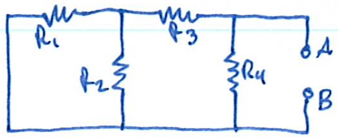
4)



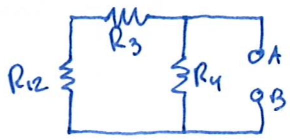
$R_1 = 200\Omega$
$R_2 = 300\Omega$
$R_3 = 60\Omega$
$R_4 = 220\Omega$
$U = 120V$

a) Thevenin Equivalent:

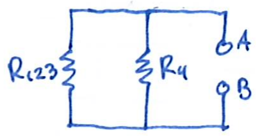
$R_{TH} = R_{eq}$ if sources $= \varnothing$



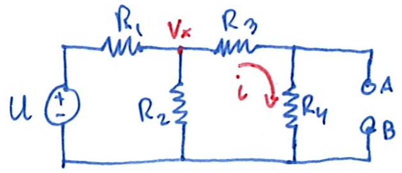
$R_{12} = R_1 // R_2 = 120\Omega$



$R_{123} = R_{12} + R_3 = 180\Omega$



$R_{1234} = R_{TH} = R_{123} // R_4 = \underline{99\Omega}$



$V_{oc} = V_{AB} = i \cdot R_4$

$V_x: \frac{U - V_x}{R_1} - \frac{V_x}{R_2} - \frac{V_x}{R_3 + R_4} = 0$

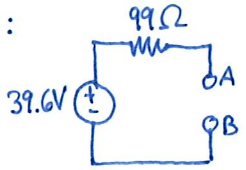
$\frac{30}{200} - \frac{V_x}{200} - \frac{V_x}{300} - \frac{V_x}{280} = 0$

$V_x = 50.4V$

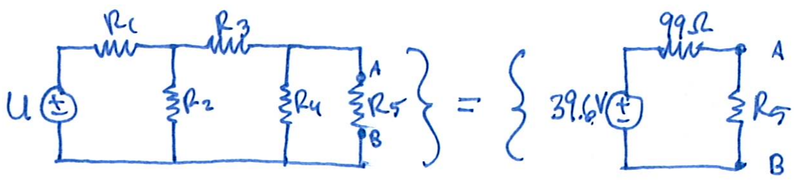
$i = \frac{V_x}{R_3 + R_4} = \frac{50.4}{60 + 220} = 0.18A$

$V_{TH} = 0.18 \cdot 220 = \boxed{39.6V}$

Answer:



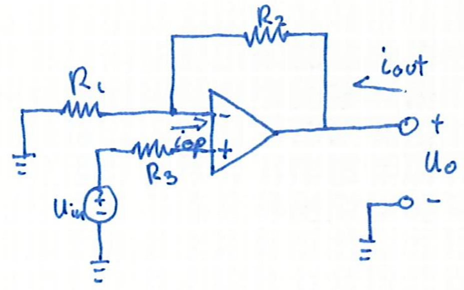
b)



$R_5 = 100\Omega$. Find V_{AB}

$V_{AB} = \underbrace{39.6V \cdot \frac{100\Omega}{99\Omega + 100\Omega}}_{\text{Voltage Divider}} = \boxed{19.9V}$

5)



Ideal Op-Amp $\Rightarrow$

$$\varepsilon = (V_-) - (V_+) = 0$$
$$R_i = \infty\Omega \Rightarrow i_{op} = 0A$$
$$R_o = 0\Omega$$

a) Gain $\left(\frac{U_o}{U_{in}}\right)$: $(V_+) = U_{in}$, $(V_-) = U_{in}$

$$U_o \cdot \frac{R_1}{R_1+R_2} = U_{in}$$ } Voltage Divider

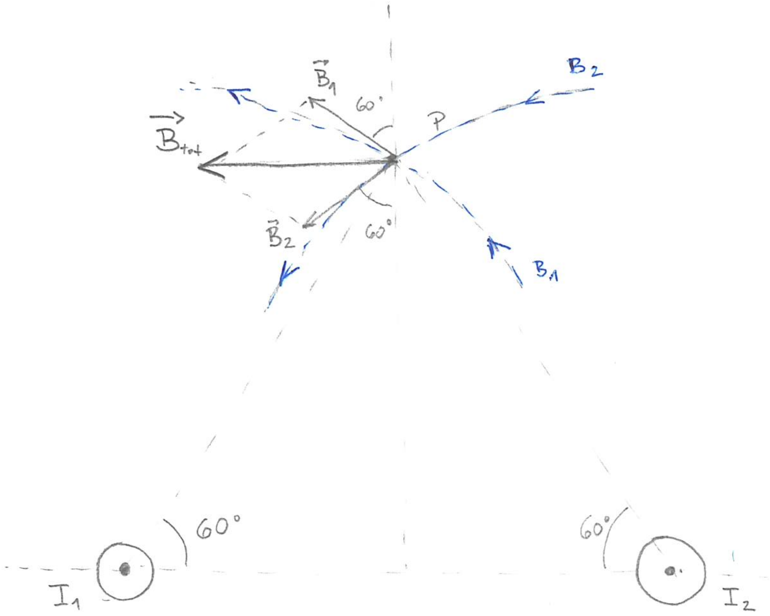
$$\frac{U_o}{U_{in}} = \frac{R_1+R_2}{R_1}$$

$$\boxed{\frac{U_o}{U_{in}} = 1 + R_2/R_1}$$

b) Input Resistance: $R_{in} = \frac{U_{in}}{i_{in}} = \frac{U_{in}}{0A} = \boxed{\infty\Omega}$

c) Output Resistance: $R_{out} = \frac{U_o}{i_{out}}\Big|_{U_{in}=0} = R_2 // R_o = R_2 // 0\Omega = \boxed{0\Omega}$

6a)



Bidragen $\vec{B}_1$ och $\vec{B}_2$ till flödestätheten ligger utefter tangenterna i P till respektive cirkelbågar och är lika stora;

$$|\vec{B}_1| = |\vec{B}_2| = \frac{\mu_0 I}{2\pi a} = 4\,\mu T$$

Vi uttrycker $\vec{B}_1$ och $\vec{B}_2$ i polära koordinater och får då

$$\vec{B}_1 = (4\,\mu T,\ 150°) \qquad \vec{B}_2 = (4\,\mu T,\ -150°)$$

i rektangulär form $\longrightarrow$

$$\vec{B}_1 = (-3{,}464\ ;\ 2)\,\mu T \qquad \vec{B}_2 = (-3{,}464\ ;\ -2)\,\mu T$$

$$\vec{B}_{TOT} = \vec{B}_1 + \vec{B}_2 = (-6{,}93\ ;\ 0)\ \mu T$$

$$\underline{|B_{TOT}| = 6{,}93\ \mu T}$$

6b)