Electrical Engineering Department
School of Engineering
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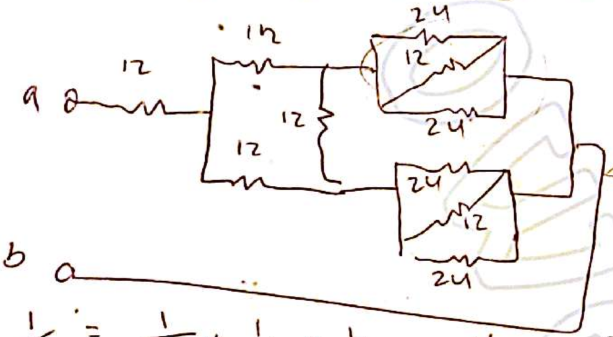
Electrical Circuits (1) (EE211)
First Exam
2nd Term, 2015-2016
March 13th, 2016. ⌛ 15:00 – 15:50

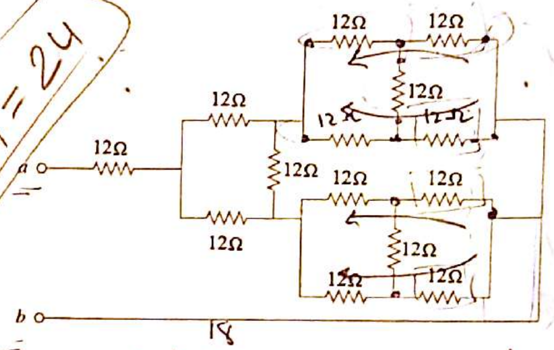
[redacted]

Problem 1: (5 points)

a) Find the equivalent resistor (R_{ab}) in the four-way power divider circuit.
(Hint: Before attempting to solve; examine the circuit carefully, redraw, look for patterns and symmetry. You should get an integer answer)



$Req = 24$



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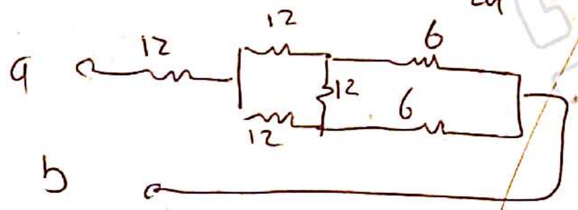
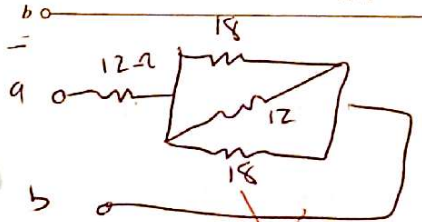
$\frac{1}{R} = \frac{1}{12} + \frac{1}{24} + \frac{1}{24} = \frac{4}{24} \Rightarrow R = 6$





$\frac{1}{R} = \frac{1}{12} + \frac{1}{18} + \frac{1}{18}$

$R = 5.14$

$R_{ab} = 12 + 5.14\ \Omega = 17.14\ \Omega$

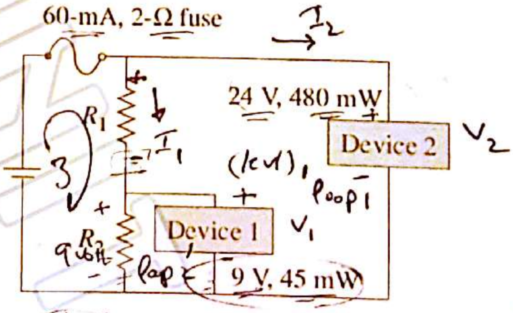
b) Two delicate devices are rated as shown in Fig. 2.142. Find the values of the resistors and needed to power the devices using a 24-V battery.
(Hint: force the fuse to work to its maximum limit)

@ Device 2:

$P = V * I$

$I_2 = P/V = \frac{480 * 10^{-3}}{24} = 0.02$ Ampere

@ Device 1: $I_1 = \frac{P}{V} = \frac{45 * 10^{-3}}{9} = 5 * 10^{-3}$ Ampere



By KVL : loop (1)

$-V_2 + I_1 R_1 + V_1 = 0$

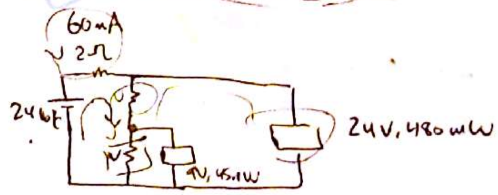
$-24 + 5*10^{-3} * R_1 + 9 = 0$

$\Rightarrow R_1 = \frac{15}{5*10^{-3}} = 3\ k\Omega$

$V_{R_2} = V_1 = 9$ Volt (By KVL) loop (2)

~~By KVL for loop 3:~~

~~-24~~



~~By KVL (loop 1 & 2)~~

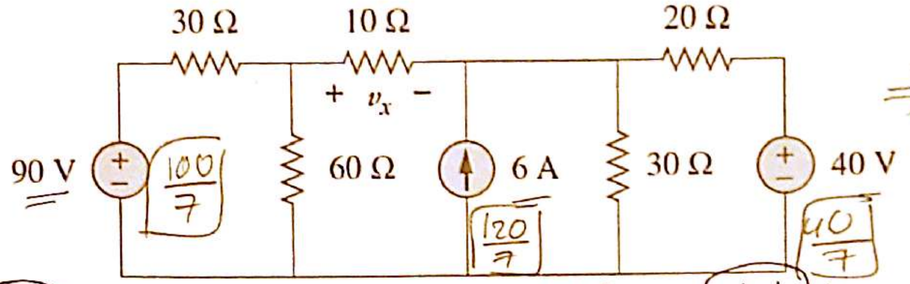
~~$I_1 R_1 + I_2 R_2$~~

$R_2 = V / I =$

$R_1 = 375$
$R_2 = 257.14$

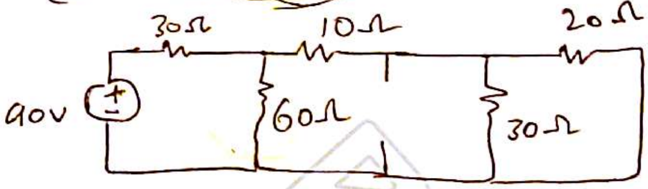
1

Problem 2: (5 points)
Use superposition to obtain v_x in the circuit shown.

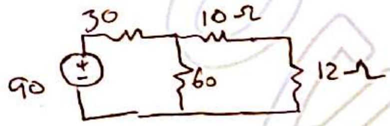


$\Rightarrow U_x = \frac{260}{7}$

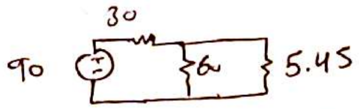
@ Source (90 Volt):



$R_{20} // R_{30} \Rightarrow \frac{20 * 30}{20 + 30} = 12\,\Omega$



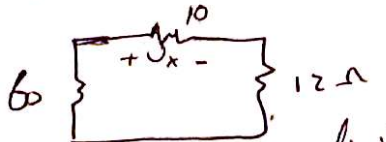
$R_{12} // R_{10} \Rightarrow \frac{12 * 10}{10 + 12} = 5.45\,\Omega$



$R_{5.45} // R_{60} \Rightarrow \frac{60 * 5.45}{60 + 5.45} = 5\,\Omega$

$I_1 = \frac{90}{30+5} = \frac{90}{35} = 2.571$ Ampere

V@ 5Ω = I * R = 2.571 * 5 = 12.857 Volt = Voltage @ 60Ω

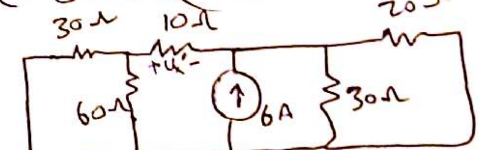


By voltage division

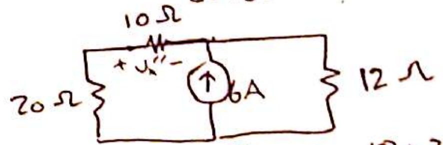
$U_x' = U_T \frac{10}{10+12} = 12.857 \frac{10}{22}$

$U_x' = 5.844$ Volt

@ Source (6 A):



$R_{30} // R_{60} = \frac{30 * 60}{30 + 60} = 20\,\Omega$



R_{10} Series with $R_{20} \Rightarrow 10 + 20 = 30\,\Omega$

By Current division

$I_1 = I_T \frac{R_{12\Omega}}{R_{12\Omega} + R_{30\Omega}}$

$I_1 = 6 * \frac{12}{12 + 30} = 3.4285$ Ampere

Voltage @ 10 Ω = $V_x'' = I_1 R_{10}$

$V_x'' = 3.4285 * 10 = 34.28$ Volt

@ Source 40 Volt:

3.5

$\frac{30 * 30}{60} = 15\,\Omega$

$I = \frac{40}{20+15} = 1.14$ Ampere

$U_{15} = 1.14 * 15 = 17.14$ Volt

By voltage division:

$U_x''' = 17.14 * \frac{10}{10+20} = 5.1714$ Volt

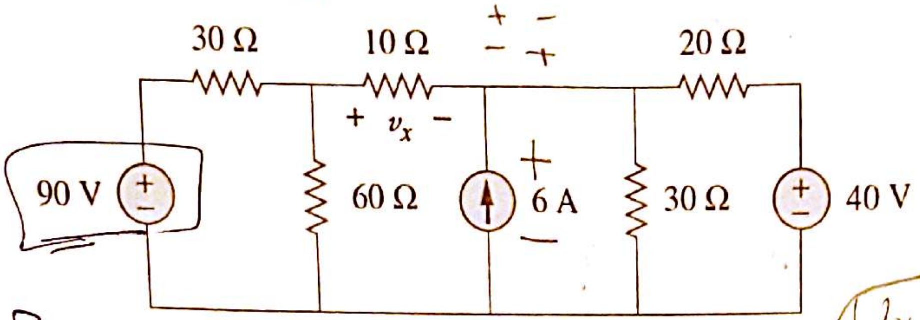
$\therefore U_x = U_x' + U_x'' + U_x'''$

$= 5.844 + 34.28 + 5.1714$

$= 45.838$ Volt

Problem 3: (5 points)

Use source transformation to obtain v_x in the circuit shown.

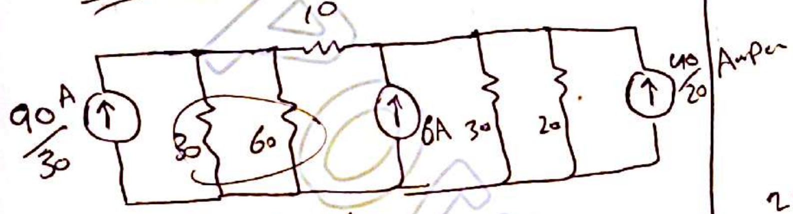


$v_x = I_x R_x$

$v_x = \frac{60}{7}$

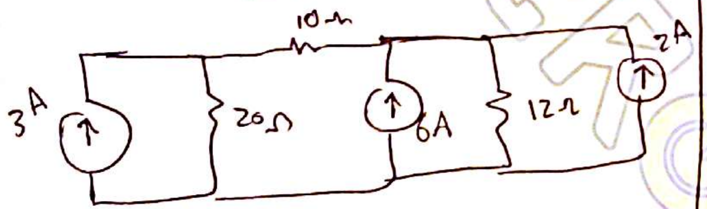
So

(1):

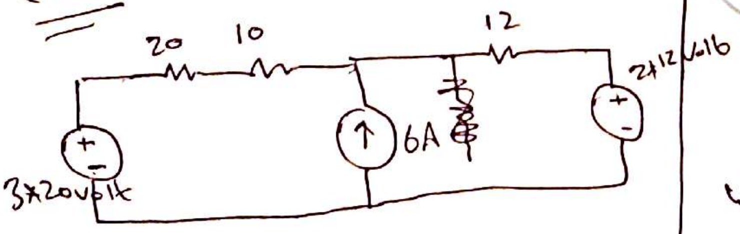


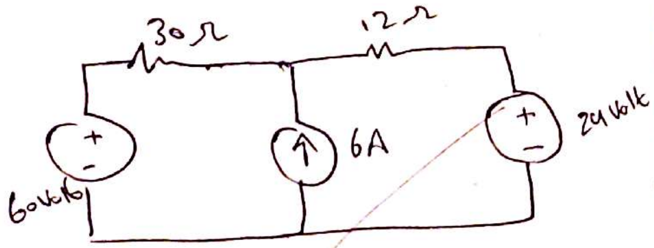
$30 // 60 \Rightarrow \frac{30 * 60}{30 + 60} = 20\ \Omega$

$30 // 20 \Rightarrow \frac{30 * 20}{30 + 20} = 12\ \Omega$

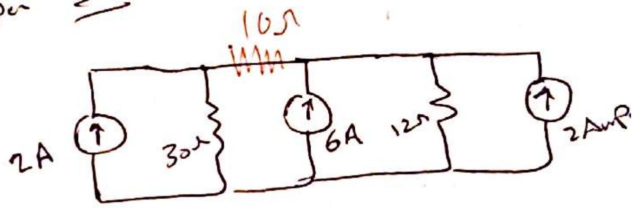


(2):

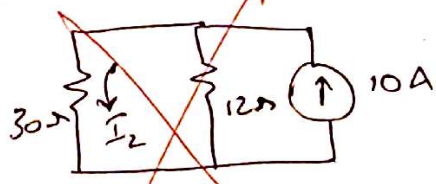




(3):



$\Sigma (\uparrow) = 6 + 2 + 2 = 10$ Ampere



By current division:

3

$I_2 = 10 * \frac{12}{12 + 30}$

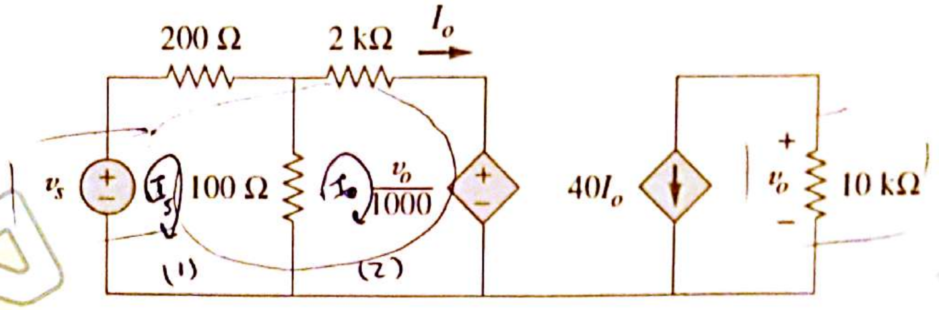
$I_2 = 10 * \frac{12}{42} = 2.85714$

$v_x = v @ 10\Omega = I_2 * R_{10}$

$= 2.857142 * 10$

$v_x = 28.5714$ Volt

Problem 4: (5 points)
Determine the gain v_o/v_s of the transistor amplifier circuit.
(Note that some resistor values are given in KΩ)

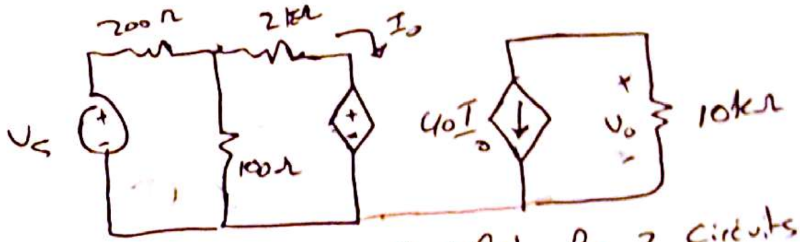


$\frac{V_o}{V_s} \Rightarrow$ gain

$\therefore V_o = I * R_{10k\Omega}$

$= -40 I_o * 10 k\Omega$

$V_o = -400 * 10^3 \; I_o$ ---(3)



$\Rightarrow$ we divided it for 2 circuits

By Mesh :

(1): $-V_s + 200 I_s + 100 (I_s - I_o) = 0$

$-V_s + 200 I_s + 100 I_s - 100 I_o = 0$

$-V_s + 300 I_s - 100 I_o = 0$ --(1)

Solve $V_o/V_s = -80$

3.5

(2): $\frac{V_o}{1000} + 100\Omega (I_o - I_s) + 2 k\Omega \; I_o = 0$

$\frac{V_o}{1000} + 100 I_o - 100 I_s + 2000 I_o = 0$

$\frac{V_o}{1000} + 2100 I_o - 100 I_s = 0$ ---(2)

~~$2100 I_o = 100 I$~~ $\quad 100 I_s = \frac{V_o}{1000} + \frac{2100 (400 * 10^3) V_o * 1000}{1000}$

$I_s = \frac{V_o}{100 * 1000} (1 + 2100 * 400 * 10^3 + 1000) = 8400 \; V_o$

Sub @ equation (1):

$-V_s + 300 * 8400 \; V_o - 100 \left(\frac{V_o}{400 * 10^3} \right) = 0$

$V_s = 2520 \; k\Omega \; V_o - 0.25 * 10^{-3} \; V_o$

$V_s = V_o (2520 * 10^3 - 0.25 * 10^{-3}) \Longrightarrow \boxed{\frac{V_o}{V_s} \approx \frac{1}{2520 * 10^3}}$

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