Answer sheet

EE101 Midterm Examination 1

October 19, 2012

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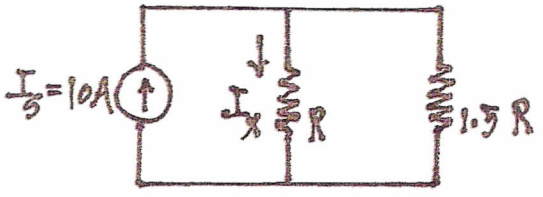
Please put boxes around your answers. Show all work on the sheets provided and if necessary you can use back pages, but indicate which problem your work applies to. Answer to two sub-decimal places (example, 10.33 rather than 10.326). You are not allowed to use any canned programs. Please honor the rules of academic integrity.

1.(10points) Points) Shown below is a current divider circuit.



(a). (5 points) what is the equivalent resistance seen by the current source Is?

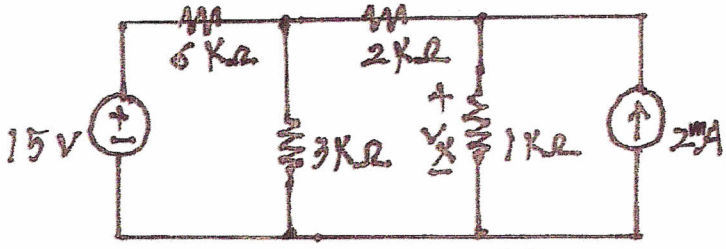
$$R \,||\, 1.5R = \frac{R(1.5R)}{R+1.5R} = \frac{1.5R^2}{2.5R} = \boxed{0.6R}$$

(b). (5 points) How much current flows through R, or what is Ix?

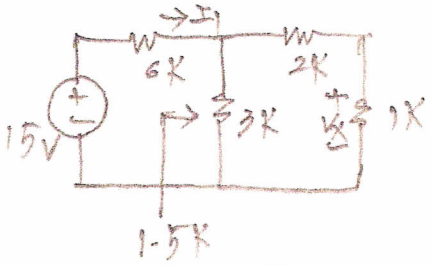
$$I_x = 10\,\frac{1.5R}{R+1.5R} = 10 \times 0.6 = \boxed{6\ A}$$

2.(20 points) Find the voltage Vx across the 1KΩ resistor.

(Hint: superposition method may be helpful.)



Step ① $V_x\big|_{15\,V\ only\ case}$

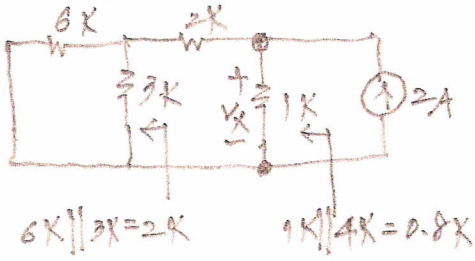


$I_1 = \frac{15}{(6+1.5)K} = 2\,mA$

$V_x = 1K \cdot 2mA \cdot \frac{3K}{3K+3K}$

$= \underline{1.0\,V}$

Step ② $V_x\big|_{2\,mA\ only\ case}$

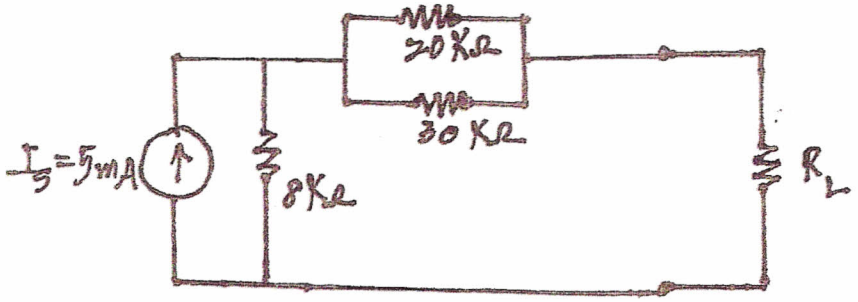


$V_x = 2mA \times 0.8K$

$= \underline{1.6\,V}$

Step ③ $V_x = V_x\big|_{15\,V\ only} + V_x\big|_{2mA\ only} = 1 + 1.6 = \boxed{2.6\,V}$

3.(20 Points)The following circuit shows that the load resistor R_L is connected to a current source through some resistors.

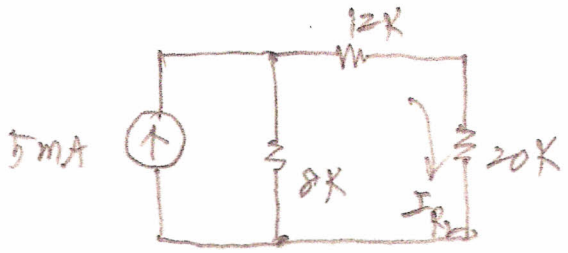


(a)(10 points) Find the value of R_L such that the power delivered to the load is maximized.

Find R_s first $\quad 20K \| 30K\Omega + 8K = 20K$

For max. power transfer $R_L = R_s = \boxed{20\,K\Omega}$

(b)(10 points) What is the maximum power delivered to the loadR_L?



$I_{R_L} = 5mA \dfrac{8K}{(8+32)K} = \dfrac{40}{40} mA = 1\,mA$

current division

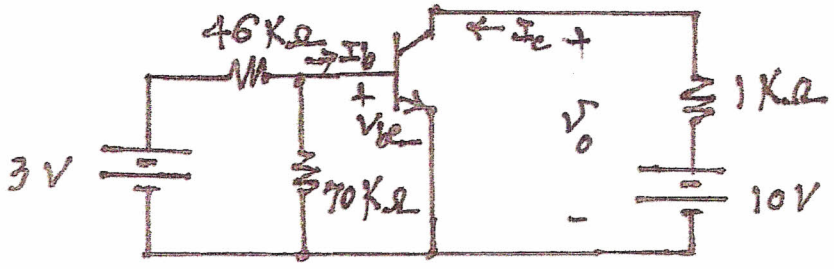
$P_{R_L} = I_{R_L}^2 \cdot R_L = (10^{-3})^2 \times 20 \times 10^3\ W$

$= \boxed{20\ mW}$

4.(25 point) Find the output voltage Vo in the circuit below.

Assume that Vbe=0.7V and β=100.

(Hint: Find Ib first and then Ic using the relationship Ic= β Ib.)

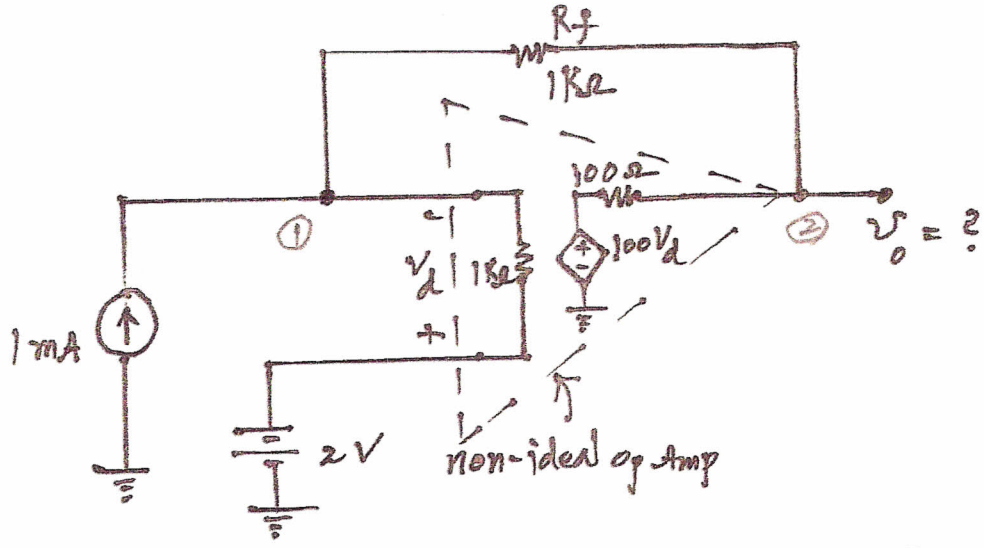


$$I_b = \frac{3-0.7}{46K} - \frac{0.7}{70K} = 0.05\,mA - 0.01\,mA = 0.04\,mA$$

$$I_C = 100\, I_b = 4\,mA$$

$$v_o = 10V - 1K(4mA) = \boxed{6V}$$

5.(25 points) Shown below is an Op Amp circuit powered by two input sources. The Op Amp is non-ideal with a finite input resistance of Ri=1 KΩ and a rather small voltage gain of A=100, with its output resistance Ro=100 Ω. What is the output voltage Vo?



KCL at ① $\quad 1mA + \frac{v_d}{1K\Omega} + \frac{v_o - [-v_d + 2V]}{1K\Omega} = 0 \quad (1)$

KCL at ② $\quad \frac{v_o - 100v_d}{100} + \frac{v_o - [-v_d + 2]}{1K\Omega} = 0 \quad (2)$

multiplying all equations by 1 KΩ,

$1 + v_d + v_o + v_d - 2 = 0 \quad (1)'$

$10v_o - 1000v_d + v_o + v_d - 2 = 0 \quad (2)'$

or

$v_o + 2v_d = 1 \quad (1)''$

$11v_o - 999v_d = 2 \quad (2)''$

$(1)'' \times 999 + (2)'' \times 2 \Rightarrow \quad 999v_o + 22v_o = 999 + 2(2) = 1003$

$v_o = \frac{1003}{1021} = \boxed{0.98\,V}$