EE 101 Winter 2018

Midterm Exam (February 12)

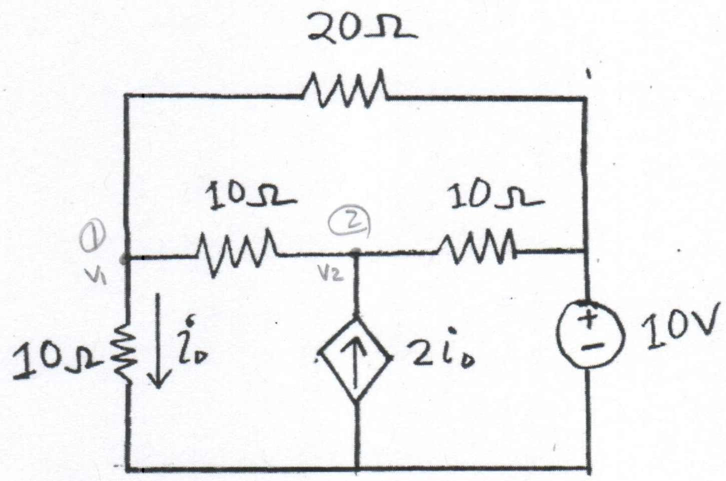
Name : Solution

Student Id: ……………………………………………..….

Presented here are one of many different ways to solve these problems.

Problem	Maximum points	score
1	20	
2	20	
3	20	
4	20	
5	20	

1. (12+4+4 points) Using nodal analysis, (a) calculate the value of i_0 in the following circuit. Calculate the power generated/consumed by (b) the current dependent current source ($2i_0$) and (c) 20Ω resistance.



KCL at ① : $\frac{V_1 - 10}{20} + \frac{V_1}{10} + \frac{V_1 - V_2}{10} = 0$

② : $\frac{V_1 - V_2}{10} + 2i_0 + \frac{10 - V_2}{10} = 0$, $i_0 = \frac{V_1}{10}$

$V_1 - 10 + 2V_1 + 2V_1 - 2V_2 = 0$ $\quad 5V_1 - 2V_2 = 10$

$V_1 - V_2 + 2V_1 + 10 - V_2 = 0$ $\quad 3V_1 - 2V_2 = -10$

$2V_1 = 20$. $\quad V_1 = 10$

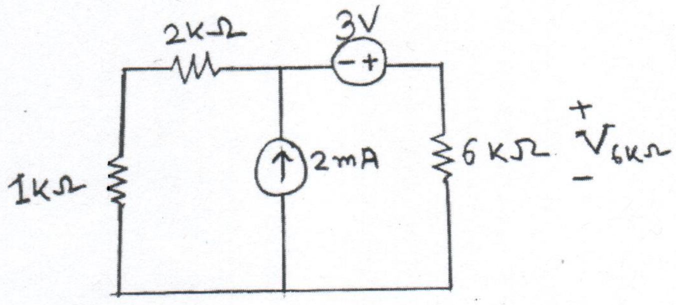
$V_2 = 20$

a) $i_0 = \frac{V_1}{10} = \frac{10}{10} = 1\,A$

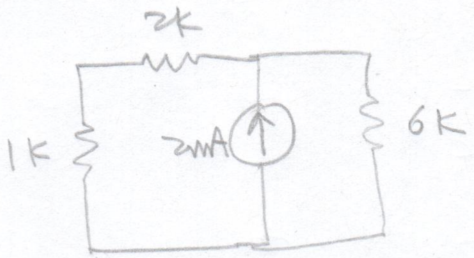
b) $P_{2i_0} = V_2 \cdot 2i_0 = 20 \times -(2 \times 1) = -40\,W$ (provide power).

c) $P_{20\Omega} = (V_1 - 10) \cdot i_{20\Omega} = 0\,W$ (no power consumed).

2. (15+5 points) Using superposition theorem, calculate the voltage and the power of 6kΩ resistor in the following circuit.



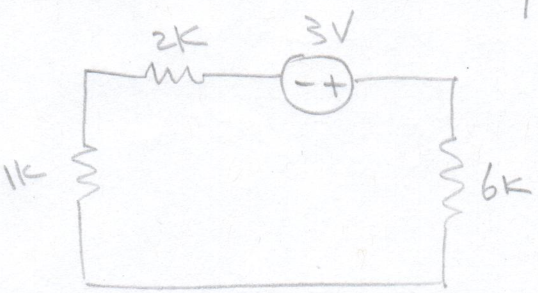
With 2mA Source only.



$$i_{6K} = 2m \cdot \frac{(2K+1K)}{6K+(2K+1K)} = \frac{2}{3}\,mA$$

$$V_{6K} = \frac{2}{3}m \cdot 6K = \frac{12}{3} = 4V$$

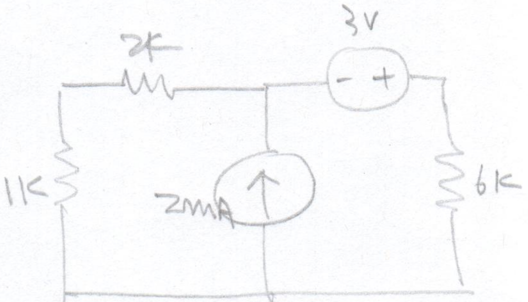
With 3V Source only.



$$i_{6K} = \frac{3}{(6+1+2)K} = \frac{1}{3}\,mA.$$

$$V_{6K} = 3 \cdot \frac{6K}{(6+2+1)K} = 2V.$$

$\Rightarrow$

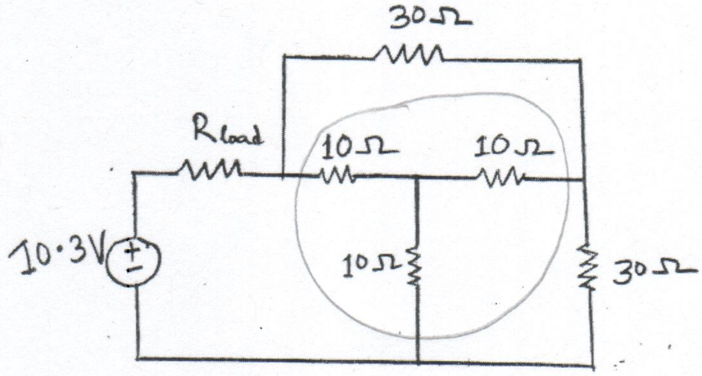


$$i_{6K} = \frac{2}{3}m + \frac{1}{3}m = 1\,mA$$

$$V_{6K} = 4 + 2 = \underline{6V.}$$

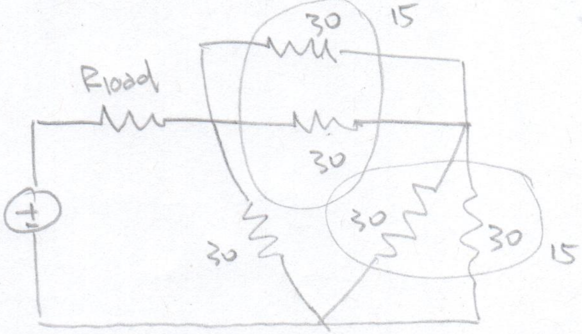
$$P_{6K} = V_{6K} \cdot i_{6K} = 6 \cdot 1m = \underline{6mW}.$$

3. (<u>20 points</u>) For the following circuit determine the value of R_{load} that would result in maximum power being transferred to R_{load}. (Hint: Δ-Y conversion would help you simplify the network.)

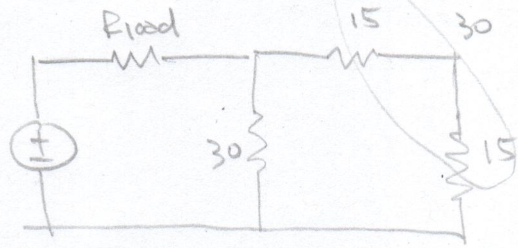


Using Δ-Y conversion with Y network in the circuit drawn

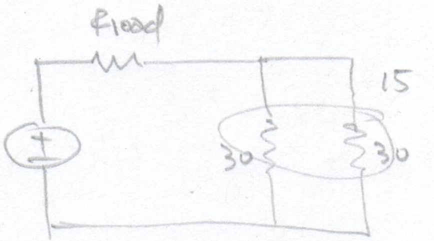
$(R_\Delta = 3R_Y)$



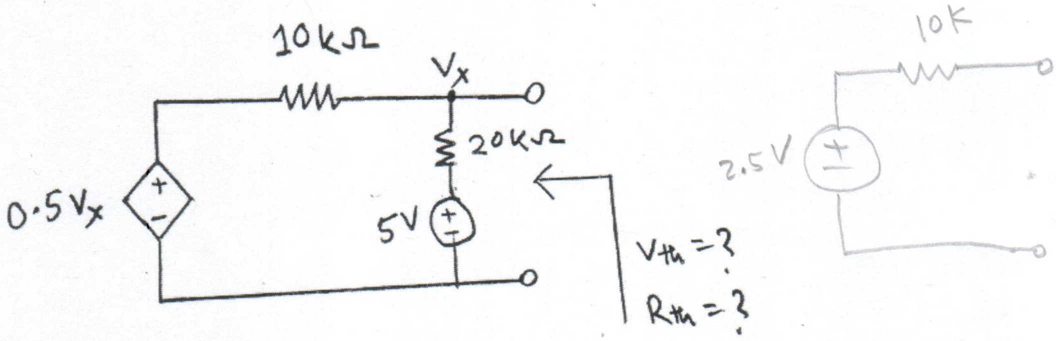
For maximum power transfer



$R_{load} = 15\,\Omega$



4. (10+10 points) Determine the Thevenin equivalent for the following circuit:



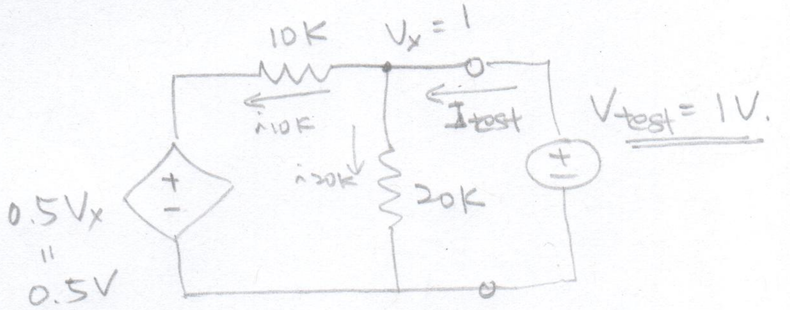
$V_{th} = V_{oc} = V_x$

KCL at X, $\frac{5 - V_x}{20K} + \frac{0.5V_x - V_x}{10K} = 0$

$5 - V_x + V_x - 2V_x = 0$

$V_x = \frac{5}{2} V$

To find R_{th}, turn off the independent source and apply test source to the port. then $R_{th} = \frac{V_{test}}{I_{test}}$.



$I_{test} = i_{20K} + i_{10K}$

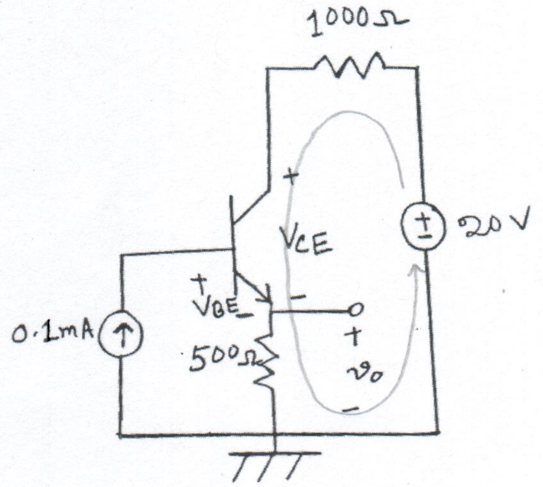
$= \frac{V_x}{20K} + \frac{V_x - 0.5V_x}{10K}$

$= \frac{1}{20K} + \frac{1}{20K}$ $(V_x = V_{test} = 1V)$

$= \frac{1}{10K}$.

$R_{TH} = \frac{1}{\left(\frac{1}{10K}\right)} = 10K\Omega$

5. (10+10 points) Consider the following transistor circuit with V_{BE}=0.7V and β=99. Determine the v_o and V_{CE}.



$I_B = 0.1$ mA

$I_C = \beta I_B = 99 \times 0.1 = 9.9$ mA

$I_E = (\beta+1) I_B = 100 \times 0.1 = 10$ mA

$V_o = I_E \cdot 500 = 10m \cdot 500 = 5$ V

KVL along the loop in the figure

$-20 + i_E \cdot 1000 + V_{CE} + V_o = 0$

$V_{CE} = 20 - 9.9m \times 1000 - 5$

$= 20 - 9.9 - 5$

$= 5.1$ V