UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering and Computer Scences
EECS 100/42
Midterm Examination Fall 2009

T.K. Gustafson
Oct 2 2009

PRINT YOUR NAME: Answers

S.I.D. :

SIGNATURE:

Do your work on the exam.
If you do need to use extra sheets
attach these to the exam
so that these are considered as well.

Make your methods clear so that partial credits is possible.

There are three problems
THE PROBLEMS ARE EACH WORTH 12

Problem Number One) (Total 12)

A power supply is observed to produce a current of 1 mA when the output is shorted. When connected to a 10 kΩ resistor the observed voltage across the resistor is 3 V.

2/ 12 a) What is the Norton equivalent of the supply? That is, give the values of I and R_{eq} in the following Figure.

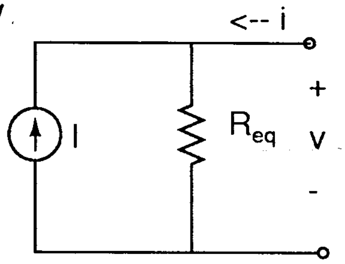
$I \times \frac{R_{eq}(10k\Omega)}{R_{eq} + 10k\Omega} = 3V$

$\therefore I\, R_{eq}\, 10^4 = 3 R_{eq} + 3\, 10^4$

$I = 10^{-3}$

$7 R_{eq} = 3 \times 10^4$

$\therefore R_{eq} = 3/7 \times 10^4$



I = 1 mA

R_{eq} = $3/7 \times 10^4\ \Omega$

2/12 b) Plot the straight line i-v characteristic corresponding to the answer of part a). Give the numerical values of the i and v intercepts.

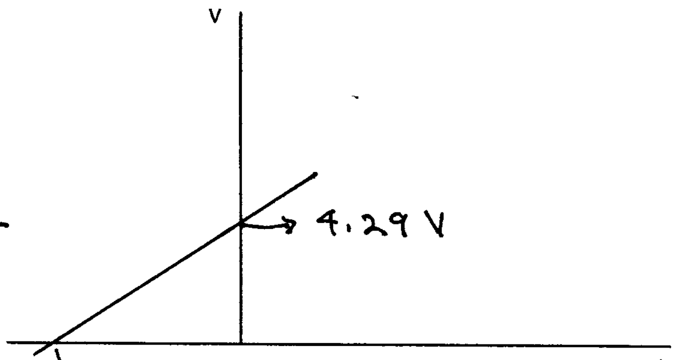
$i = -I + v/R_{eq}$

$v = R_{eq} I + i R_{eq}$

$= 3/7 \times 10^4\ 10^{-3} + i R_{eq}$

$= \frac{30}{7} + i R_{eq}$

$= 4.29 + i R_{eq}$



$-\frac{4.29}{3/7 \times 10^4}$ A $= -4.29 \times 7/3 \times 10^{-4}$ A $= -1$ mA

i-intercept = − 1 mA

v-intercept = 4.29 V

2/12 c) What open circuit voltage, V_{oc} would be measured?

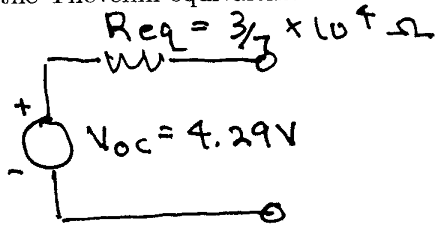
$V_{oc} =$ $4.29 = \frac{30}{7}$ V

Check

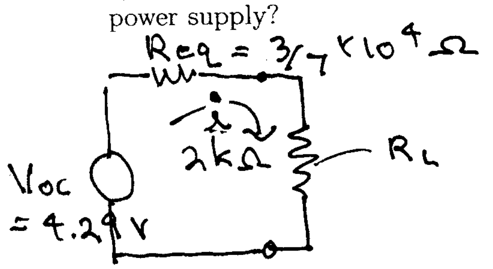
$I \times R_{eq}$

$= 10^{-3} \times \frac{3}{7} \times 10^{4} = \frac{30}{7}$ V

2/12 d) Draw the Thevenin equivalent.



2/12 e) How much power, P, would be dissipated in a $R_L = 2k\Omega$ resistor connected to the power supply?



$i = \frac{30/7}{3/7 \times 10^4 + 2 \times 10^3} = \frac{30/7 \times 10^{-3}}{(30+14)/7}$

$= \frac{30}{44} \times 10^{-3} = \frac{15}{22}$ mA

$i^2 R_L = \left(\frac{15}{22}\right)^2 \times 2 \times 10^3 \times (10^{-3})^2 = \frac{225}{484} \times 2$ mW

$= 225/242$

P = .93 mWatts

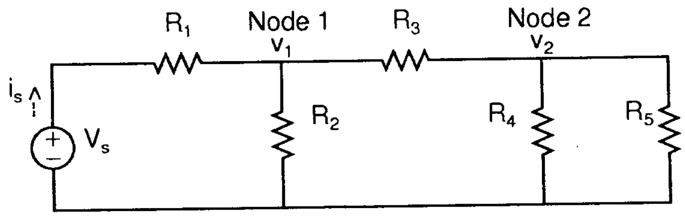
2/12 f) Is it possible to state how much power the supply dissipates when no load is connected to it? If yes, state its value.

Possible? Yes or No ___No in general___

If answer is yes $P_{Diss} =$ ______

If answer is no state why ___Dissipation Depends upon internal configuration of the power suppy elements If Thev or Norton represents the actual configuration then this would give disc but in general No.

Problem Number Two) (Total 12)
For the circuit shown below:



2/12 a) What is the node equation at node 1 in terms if v_1 and v_2 (and v_s) and the resistors?

Node Eq 1 $\frac{v_1 - v_s}{R_1} + \frac{v_1}{R_2} + \frac{v_1 - v_2}{R_3} = 0$

2/12 b) Similarly what is the node equation at node 2 in terms if v_1 and v_2 (and v_s) and the resistors ?

Node Eq 2 $\frac{v_2 - v_1}{R_3} + v_2\left(\frac{1}{R_4} + \frac{1}{R_5}\right) = 0$

3/12 c) The combined resistance of R_2 to R_5 between node 1 and ground, R_c can be expressed as follows:

$$\frac{1}{R_c} = \frac{1}{\frac{1}{\frac{1}{A}+\frac{1}{B}} + C} + \frac{1}{D} \quad (1)$$

Specify A to D in terms of R_1 to R_5.

A= R_4 } or R_5
B= R_5 } R_4
C= R_3
D= R_2

For R_4 and R_5

$$\frac{1}{R_4} + \frac{1}{R_5} = \frac{1}{R_{eq}}$$

R_3 in series so including that

$$R_3 + \frac{1}{\frac{1}{R_4} + \frac{1}{R_5}}$$

; R_2 is in parallel with this

$$\frac{1}{R_c} = \frac{1}{R_2} + \frac{1}{R_3 + \frac{1}{\frac{1}{R_4} + \frac{1}{R_5}}}$$

3/12 d) For $V_s = 3V$, $R_1 = R_2 = 2\Omega$, $R_3 = 1\Omega$ $R_4 = R_5 = 2\Omega$, what is the voltage v_2 and the source current i_s

$$\frac{1}{R_c} = \frac{1}{2} + \frac{1}{1 + \frac{1}{\frac{1}{2}+\frac{1}{2}}} = \frac{1}{2} + \frac{1}{1+1} = 1$$

$$\therefore v_1 = \frac{1}{1+2} * 3V = 1 \text{ V} - \text{Voltage Divider}$$

$$\frac{1}{R_4} + \frac{1}{R_5} = 1\ \Omega^{-1} \qquad R_3 = 1\,\Omega$$

$$\therefore v_2 = \frac{1}{2} \text{ V}$$

$$R_c = 1\,\Omega \qquad \therefore i_s = \frac{3}{R_1 + R_c} = 1 \text{ Amp}$$

$v_2 =$ ½ V

$i_s =$ 1 Amp

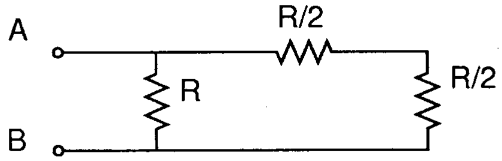
2/12 e) Give an expression for the fraction of the source power delivered to R_5 in terms of v_2, R_5, v_1 V_s, and R_1

$$\text{Fraction of Power Delivered} = \frac{(v_2/R_5)^2 R_5}{\left(\frac{V_s - v_1}{R_1}\right) V_s}$$

fraction = $\frac{v_2^2 / R_5}{\left(\frac{V_s - v_1}{R_1}\right) V_s}$

Problem Number Three) (Total 12)

What is the equivalent resistance between the terminals A and B (or resistance operator in terms of $p = \frac{d}{dx}$) between the terminals for the following circuit elements and combinations?
3/12 a)



$R \parallel (R/2 + R/2) = R \parallel R = R/2$

r(p) = $R/2$

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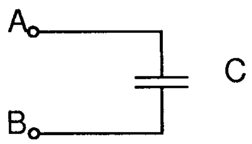
3/12 b)

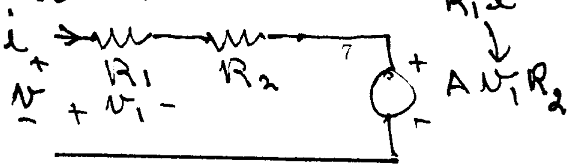


r(p) = $1/pC$

$p = d/dt$

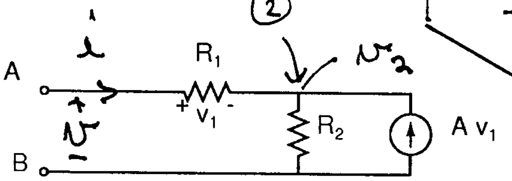
3/12

Alternative: Use Norton to Thevenin



$v = i(R_1 + R_2 + AR_1R_2)$

$= i R$



excite with v → calculate i

$$i = \frac{v - v_2}{R_1} = v_1/R_1 \quad \text{since } v - v_2 = v_1 \text{ or } v_2 = v - v_1$$

Node ② $\frac{v_2}{R_2} - Av_1 - i = 0$

$\therefore \frac{v - v_1}{R_2} - Av_1 - i = 0$

$\frac{v - R_1 i}{R_2} - AR_1 i - i = 0$

$\therefore v = (R_1(1 + AR_2) + R_2) i$

$= r i$

r(p) = $R_1 + R_2 + AR_1R_2$

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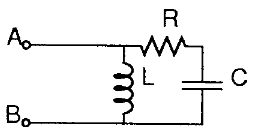
3/12



$pL \parallel (R + 1/pC)$

$$= \frac{pL(R + 1/pC)}{pL + R + 1/pC}$$

$$r(p) = \frac{1}{\frac{1}{pL} + \frac{1}{\frac{1}{pC} + R}}$$