

332:221 Principles of Electrical Engineering I – Fall 2003

Hourly Exam 1 – October 9, 2003

NAME OF THE STUDENT:

Last four digits of Student ID #:

Section # 1 (TTh4) or # 2 (W3,F4)

Circle one

Please make sure that there are 7 pages in this booklet excluding this cover page.

This is a closed-book closed-notes exam. Do all your work on these sheets. If more space is required, ask the instructor.

Problem #	Page	Maximum Points	Points earned	Description
1	1	12		<i>Chapters 1&2, KCL, KVL, Power</i>
2	2	18		<i>Chapter 3, Series – Parallel</i>
3	3	20		<i>Chapter 3, Δ – Y Transformations</i>
4	4	15		<i>Chapter 4, Nodal Analysis</i>
5	5	15		<i>Chapter 4, Mesh Analysis</i>
6	6	20		<i>Chapter 4, Source Transformations</i>

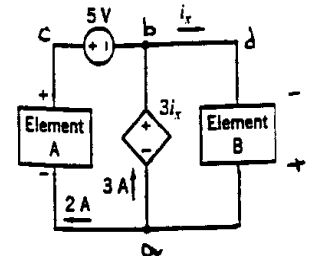
Total points earned by the student =

Announcement: Please be advised that there will be only one section of 14:332:222 Principles of Electrical Engineering II during Spring 2004. It is scheduled for MW6 to meet in Wright Lab AUD. Also, a new course 14:332:202 Discrete Mathematics for ECE will be a **required course** for all students in Class year 2006 and onwards. It is scheduled for TTh4 to meet in B120 Engineering BLDG.

Problem 1: Consider the circuit shown in figure. Answer the following questions by utilizing Kirchoff's laws appropriately.

Find i_x . Writing KCL at b, we get

(1 Point) $i_x = 3 + 2 = 5A$



Find the voltage across the dependent source in the direction shown.

(1 Point) $= 3 i_x = 15 V$

Find the voltage across element A in the direction shown.

(2 Points) Voltage across element A = Voltage between a and b + Voltage between b and c
 $= 15 + 5 = 20 V$

Find the voltage across element B in the direction shown.

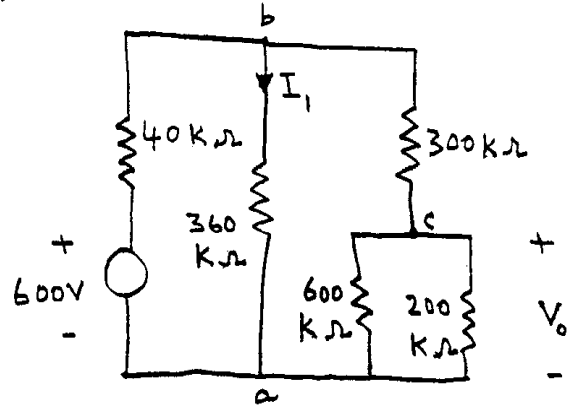
(2 Points) $= -15 V$

Fill the following table regarding power consumption or generation. A particular element either consumes or generates power. You must put the appropriate value for a particular element in one of the unfilled columns whichever is appropriate.

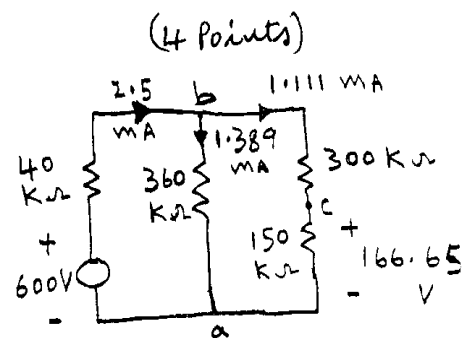
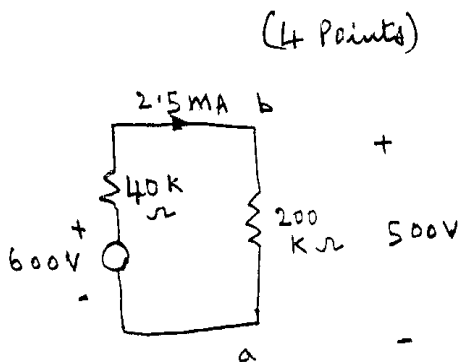
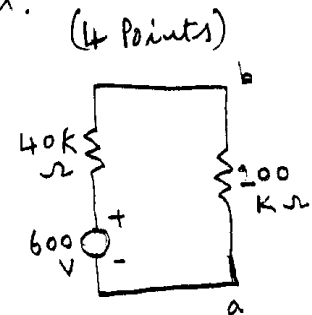
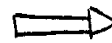
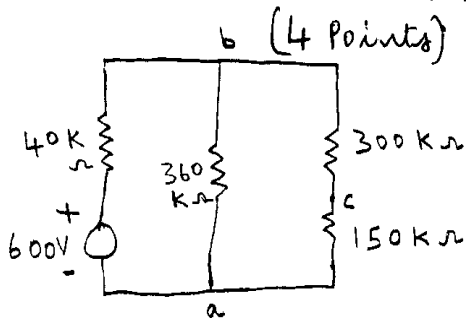
(6 Points)

Element	Power Consumed	Power Generated
Element A		40 W
Element B	75 W	
Independent Source	10 W	
Dependent Source		45 W

Problem 2: Consider the circuit shown in figure. Determine I_1 and V_0 . You may use series parallel equivalent circuits to simplify your work.



Network simplifications are as shown:

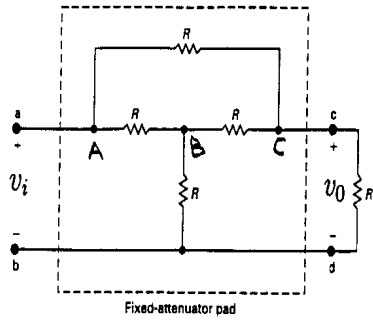
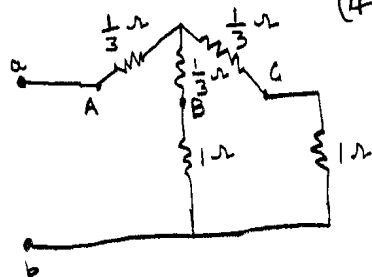


(2 Points)

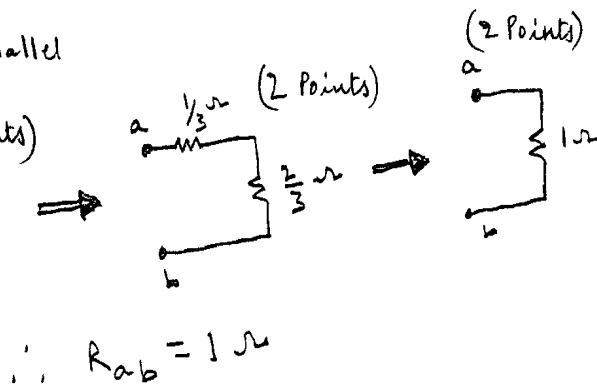
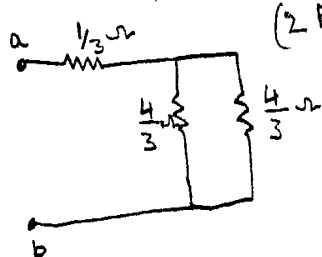
We note that $I_1 = 1.389 \text{ mA}$ and $V_0 = 166.65 \text{ V}$

Problem 3: This is a simplified version of the problem 3.60 of the text book which was an assigned Home-Work problem. A bridged tee circuit is often used as an attenuator pad. When the resistance connected to terminals c and d is $R_L = 1\Omega$ and when $R = 1\Omega$, determine the resistance as seen at the terminals a and b. Show all the details of your work, otherwise no credit will be given. You may use Y to Δ transformation to simplify your work. See last page for equations related to Y to Δ transformation.

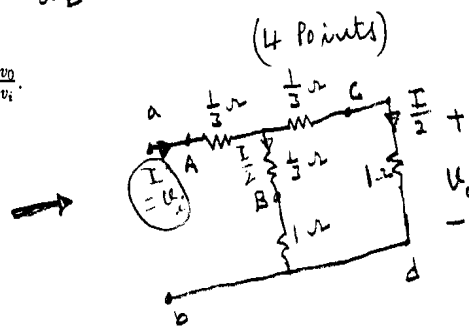
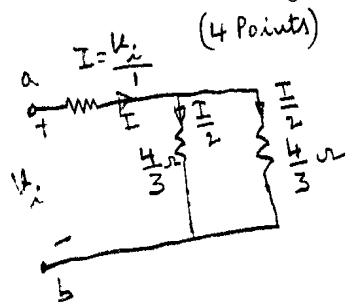
An equivalent of the circuit on the right is given by (4 Points)



By utilizing series-parallel equivalents, we get (2 Points)



When $R = R_L = 1\Omega$, determine the voltage ratio $\frac{v_o}{v_i}$.

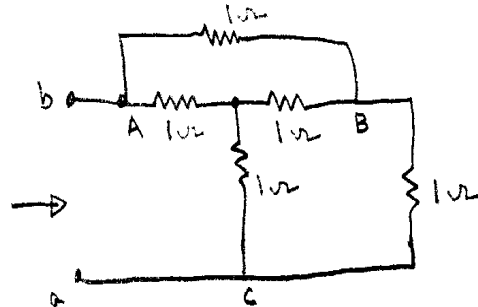


(2 Points)

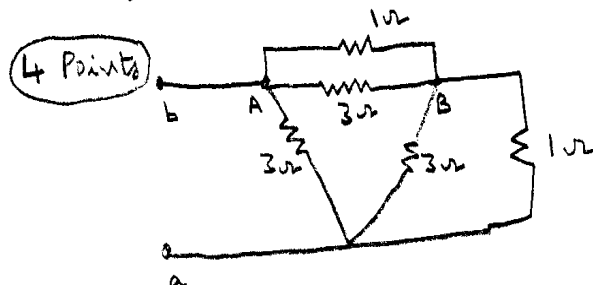
$$V_o = \frac{I}{2} R_L = \frac{I}{2} (1) = \frac{V_i}{2} (1) = \frac{V_i}{2}$$

$$\frac{V_o}{V_i} = \frac{1}{2}$$

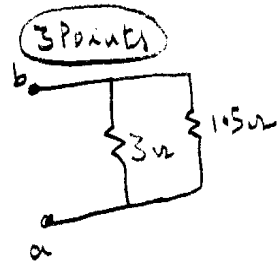
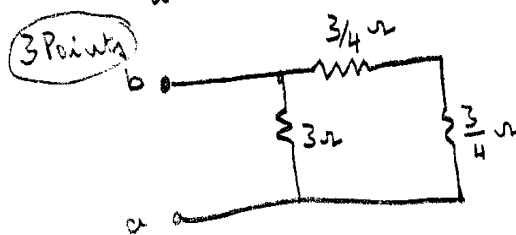
Problem 3: An alternate solution



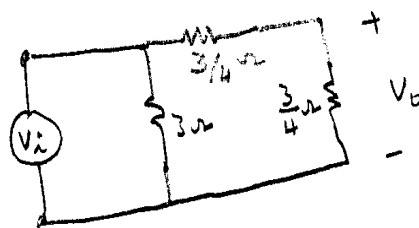
Given network



Equivalent circuit



∴ $R_{ab} = \frac{3(1.5)}{3+1.5} = 1 \Omega$ 2 Points



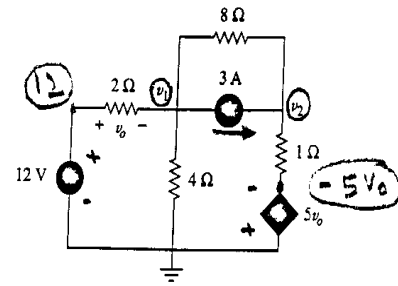
3 Points

By voltage divider principle,

$$\frac{V_o}{V_i} = \frac{1}{2}$$

Problem 4: Consider the circuit shown on the right in which the reference node and the voltages of two other nodes with respect to the reference are marked as v_1 and v_2 . Mark the other node voltages appropriately as you see fit, and write as many independent equations as necessary to solve for the unknowns.

It is not necessary to solve the equations.



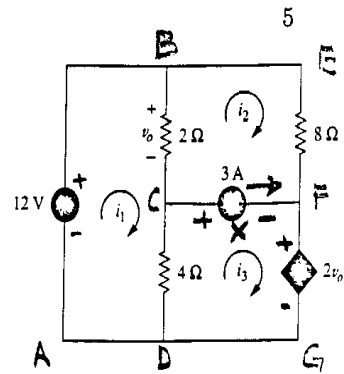
$$v_0 = 12 - v_1 \quad (5 \text{ Points})$$

$$3 + \frac{v_1 - 12}{2} + \frac{v_1 - v_2}{8} + \frac{v_1}{4} = 0 \quad (5 \text{ Points})$$

$$-3 + \frac{v_2 - v_1}{8} + \frac{v_2 + 5v_0}{1} = 0 \quad (5 \text{ Points})$$

Problem 5: Consider the circuit shown on the right in which certain independent mesh currents are marked. Write as many independent equations as necessary to solve for the unknowns.

It is not necessary to solve the equations.



$$V_0 = (i_1 - i_2)2 \quad , \quad i_3 - i_2 = 3$$

(3 Points) (3 Points)

ABCD $12 - 2(i_1 - i_2) - 4(i_1 - i_3) = 0$ (3 Points)

CBFC $-(i_2 - i_1)2 - 8i_2 + X = 0$ (3 Points each)

DCGD $4(i_3 - i_1) - 2V_0 - X = 0$ (3 Points each)

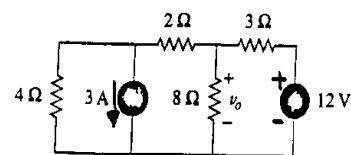
By adding these two equations, we get

DCBEGD $-4(i_3 - i_1) - 2(i_2 - i_1) - 8i_2 - 2V_0 = 0$

OR
6 Points

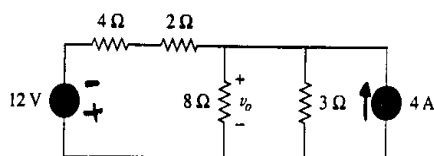
Super-loop equation

Problem 6: In the circuit shown on the right, determine the voltage v_o by utilizing source transformations.

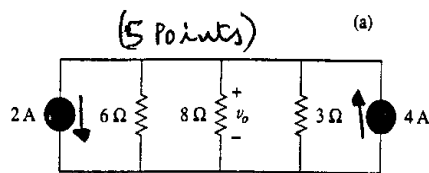


We first transform the current and voltage sources to obtain the circuit in Fig. (a). Combining the 4- Ω and 2- Ω resistors in series and transforming the 12-V voltage source gives us Fig. (b). We now combine the 3- Ω and 6- Ω resistors in parallel to get 2- Ω . We also combine the 2-A and 4-A current sources to get a 2-A source. Thus, by repeatedly applying source transformations, we obtain the circuit in Fig. (c).

(5 Points)

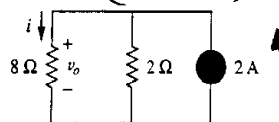


(5 Points)



(b)

(5 Points)



(c)

(5 Points)

We use current division in Fig. (c) to get

$$i = \frac{2}{2+8}(2) = 0.4$$

and

$$v_o = 8i = 8(0.4) = 3.2 \text{ V}$$

Alternatively, since the 8- Ω and 2- Ω resistors in Fig. (c) are in parallel, they have the same voltage v_o across them. Hence,

$$v_o = (8 \parallel 2)(2 \text{ A}) = \frac{8 \times 2}{10}(2) = 3.2 \text{ V}$$