

Massachusetts Institute of Technology  
Department of Electrical Engineering and Computer Science

6.002 – Electronic Circuits  
Fall 2000

Quiz 1

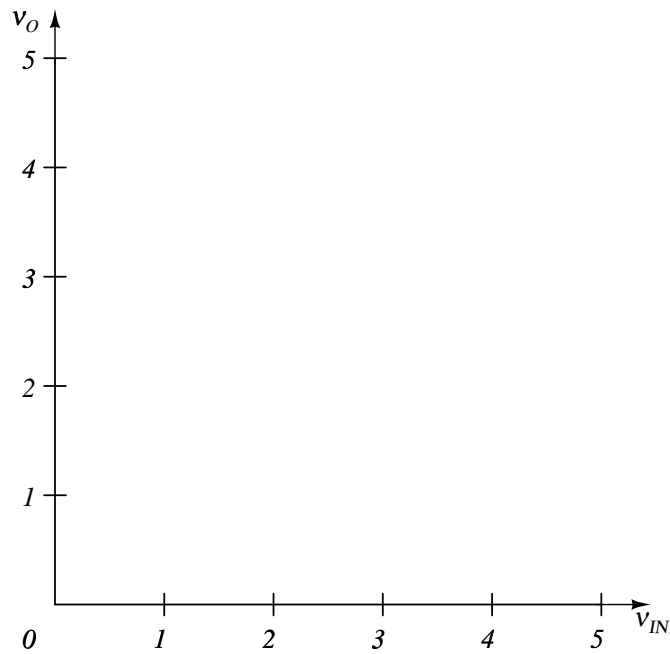
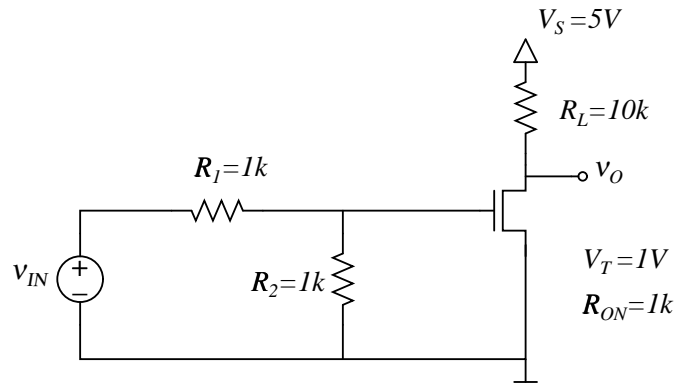
- Please put your name in the space provided below, and circle the name of your recitation instructor and the time of your recitation.
- Please verify that there are six problems in your exam.
- To the extent possible, do all of your work on the pages contained within this exam. In particular, try to do your work for each question within the boundaries of the question, or on the back side of the page preceding the question. Extra pages are also available at the end of your exam.
- You may use one double-sided page of notes while taking this exam.
- Good luck!

Name: \_\_\_\_\_

<b>Instructor:</b>	Senturia	Wilson	Parker	Hagelstein	Sussman
<b>Time:</b>	9 10	10 11	11 12	12	2 3

**Problem 1 – 15 Points**

Using the SR MOSFET model with the circuit parameters shown in the figure, plot  $v_O$  versus  $v_{IN}$  for  $0 \leq v_{IN} \leq 5V$ . Clearly mark the values of  $v_{IN}$  and  $v_O$  at each point in the graph where there is a change of slope.

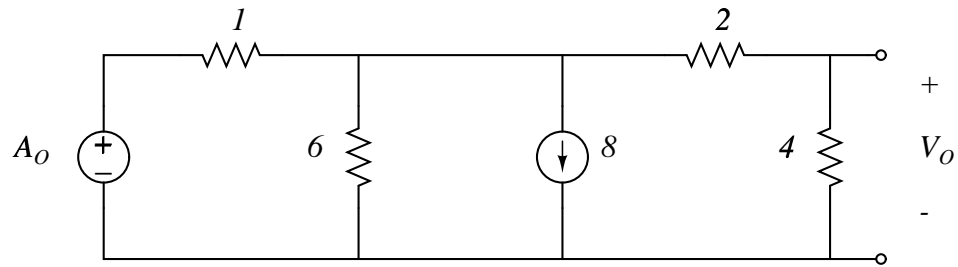


**Problem 2 – 15 Points**

Using the node method, develop a set of simultaneous equations for the network shown in the figure that can be used to solve for the unknown node voltages. Express these equations in the form

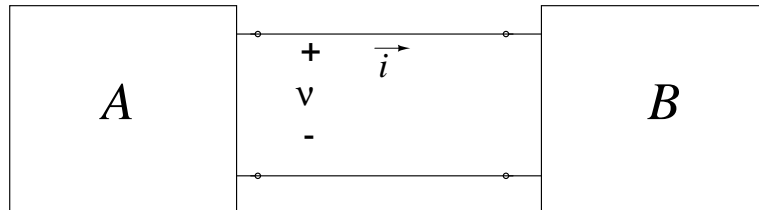
$$Ge = S$$

where  $G$  is the conductance matrix,  $e$  is a vector of unknown node voltages, and  $S$  is a vector involving the sources.

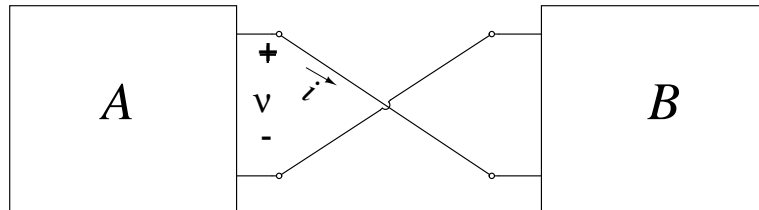


**Problem 3 – 20 Points**

Two networks A and B composed only of resistors and sources are connected together as shown below,



and the voltage and current indicated are found to be  $v = 1V$ ,  $i = 0mA$ . When the connection is reversed, as shown below,



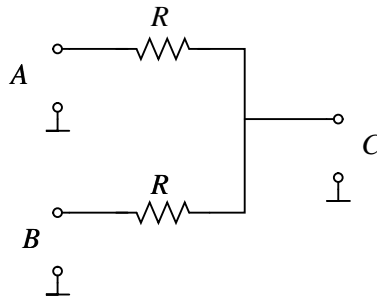
the voltage and current become  $v = 0.5V$ ,  $i = 0.5mA$ . Determine the Thevenin equivalent networks for the networks A and B.

**Problem 4    –    15 Points**

Yikes Inc. announces that it has discovered an AND gate built of resistors alone as shown below. A and B are the inputs, and C is the output. They claim that their AND-gate circuit satisfies the static discipline for the following voltage thresholds:

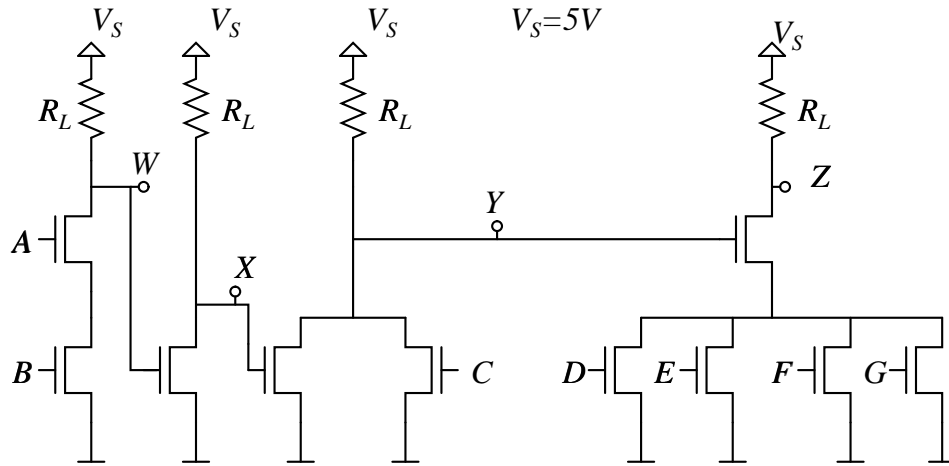
$$V_{OH} = 5V, V_{OL} = 3V, V_{IH} = 4.5V, \text{ and } V_{IL} = 3.5V.$$

A competitor looking for an expert with a 6.002 background hires you as a consultant to determine whether their claim is true. Find a set of valid inputs for which the circuit produces an invalid output, clearly explaining why the output is invalid, or show that no such case exists.



**Problem 5 – 20 Points**

(A) Assuming that the circuit shown below satisfies the static discipline, determine the logical values of  $W$ ,  $X$ ,  $Y$  and  $Z$  given that the inputs are set as follows:  $A=1$ ,  $B=0$ ,  $C=0$ ,  $D=1$ ,  $E=0$ ,  $F=1$ ,  $G=0$ .



(B) Using the SR model for the MOSFETs with on resistance  $R_{ON}$ , determine the lowest voltage possible at  $Z$ .

**Problem 6    –    15 Points**

Lois Bass is hooking up her hifi system. Her amplifier can pump 100 Watts of instantaneous power into a 4 Ohm speaker. From the point of view of the speaker, the amplifier can be modeled as a Thevenin source with an internal resistance of 0.1 Ohm.

**(A)** What is the maximum open-circuit voltage that the amplifier can deliver?

**(B)** Lois buys a roll of #16AWG speaker wire at Radio Hack. She needs to run 25 feet of wire (50 feet round trip) to the speaker from her amplifier. The resistance of #16AWG copper wire is about 4 Ohms per 1000 feet. If Lois uses the wire she bought to connect the amplifier to the speaker, then when her amplifier is putting out 1 Volt at the amplifier terminals, what is the voltage at the speaker terminals?