

**ENGR-4300**  
**Spring 2010**  
**Test 4**

Name Solution

Section 1(MR 8:00) 2(MR 4:00) 3(TF 8:00)  
(circle one)

Question I (20 points) \_\_\_\_\_

Question II (20 points) \_\_\_\_\_

Question III (20 points) \_\_\_\_\_

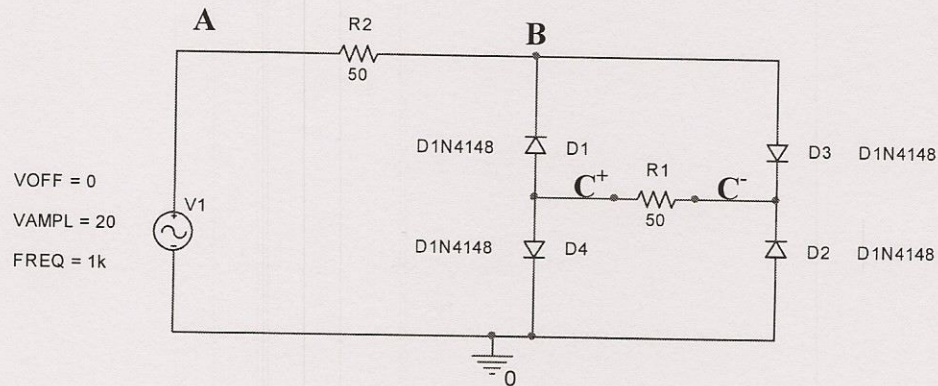
Question IV (20 points) \_\_\_\_\_

Question V (20 points) \_\_\_\_\_

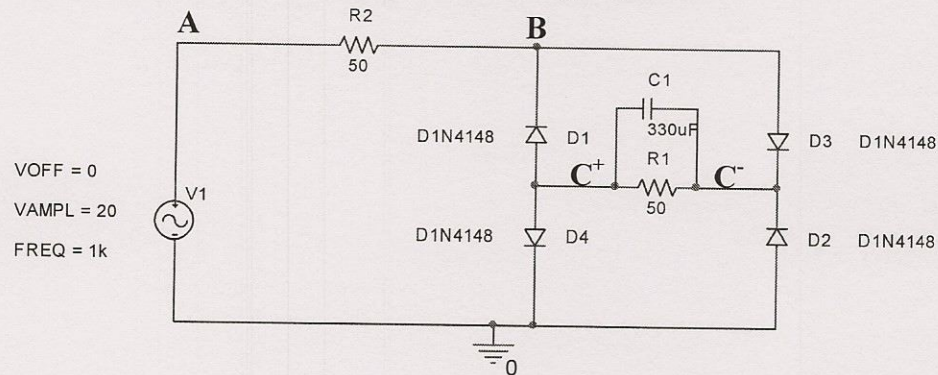
Total (100 points): \_\_\_\_\_

On all questions: SHOW ALL WORK. BEGIN WITH FORMULAS, THEN SUBSTITUTE VALUES AND UNITS. No credit will be given for numbers that appear without justification. Be sure to read the entire quiz over before starting to solve any problems.

## Question I – Diode Rectifier Circuits (20 points)



1. A rectifier bridge is used to produce a DC voltage from a sine wave with an amplitude of 20V. The circuit is analyzed with and without a smoothing capacitor.

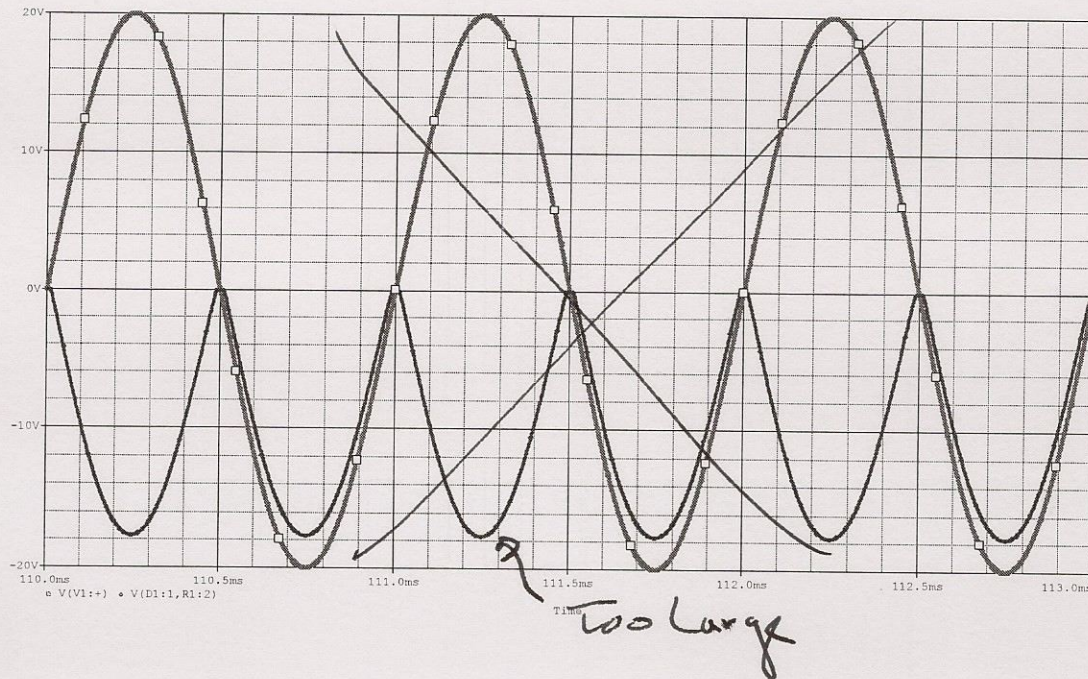
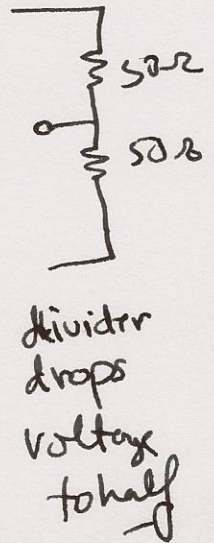
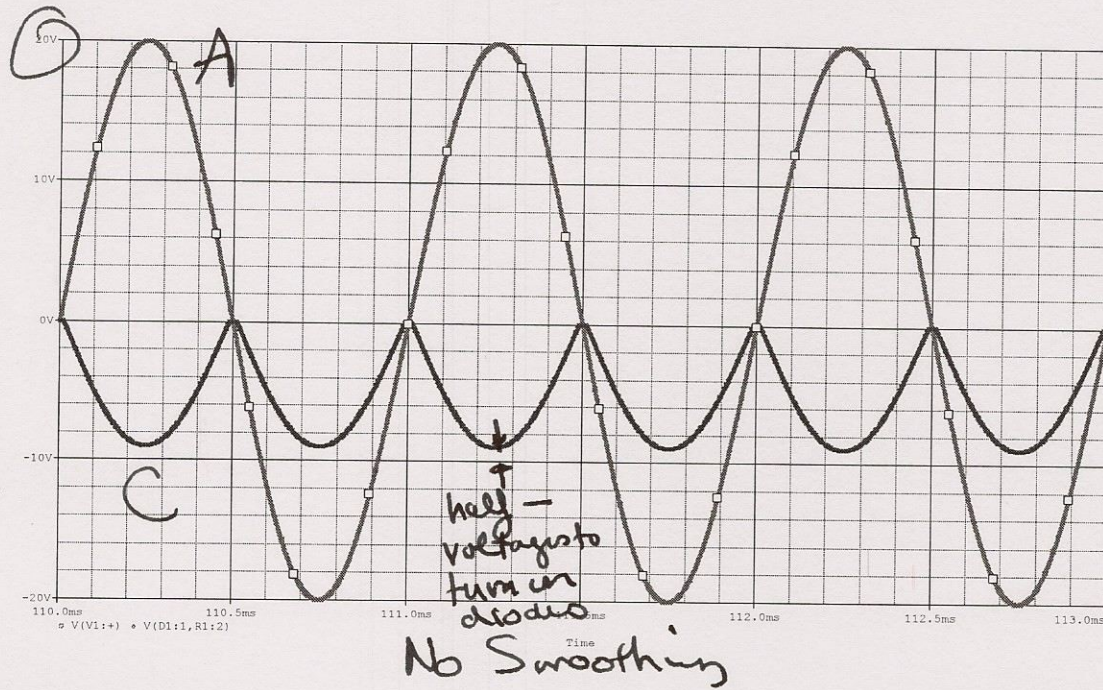


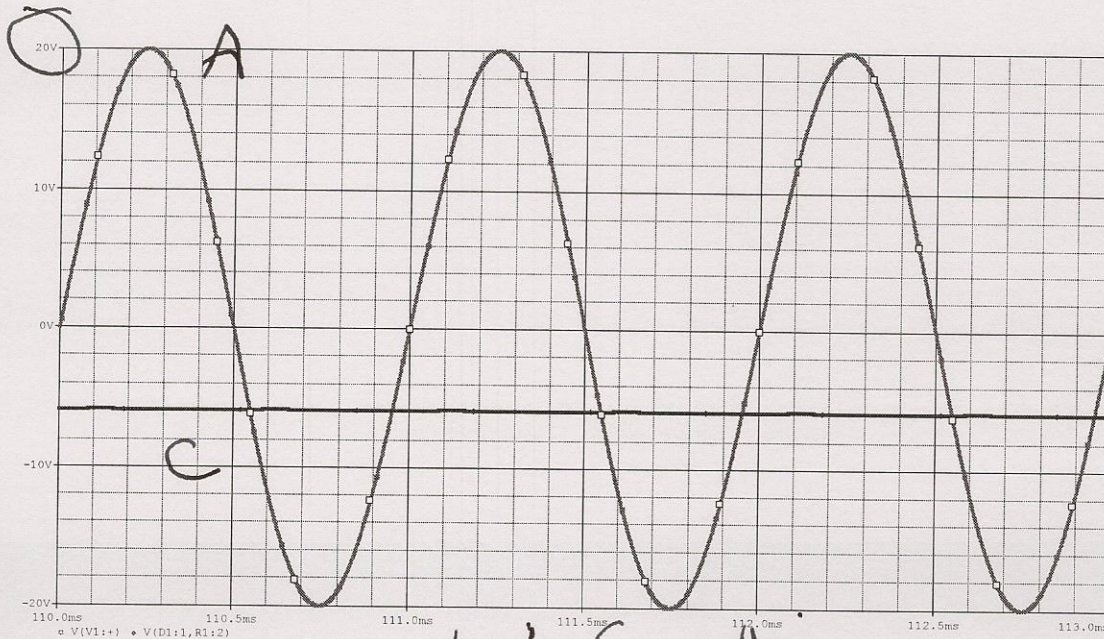
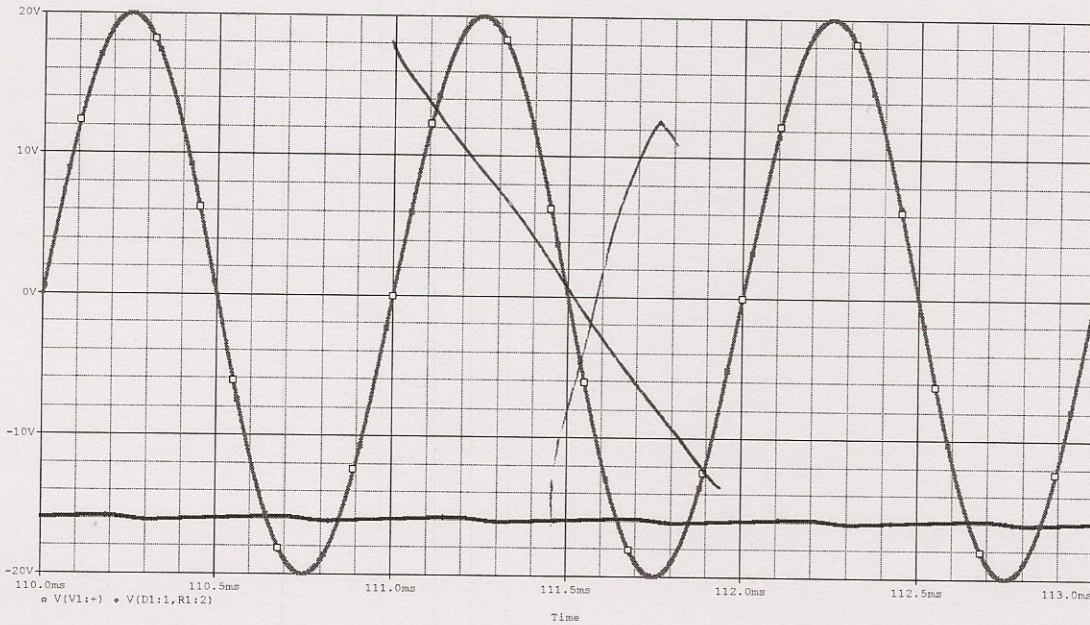
On the following pages are four figures. One shows the voltages for the case with no smoothing capacitor and one shows the voltages for the case with the smoothing capacitor. There are also two similar figures that show the voltages for somewhat different cases than the ones considered here.

- a) (5pt) Identify which figure shows the voltages for the case with no smoothing. (Label it 'No Smoothing') Explain your answer.
- b) (5pt) Identify which figure shows the voltages for the case with smoothing. (Label it 'Smoothing') Explain your answer.

There are three possible places to measure the voltages in these circuits: Pts A and B and across resistor R1 ( $C^+$  to  $C^-$ )

- c) (6pt) Label the two plots in each of the figures you selected for parts a) and b) above with the appropriate letter. That is, label them as A, B or C. Explain your answer.





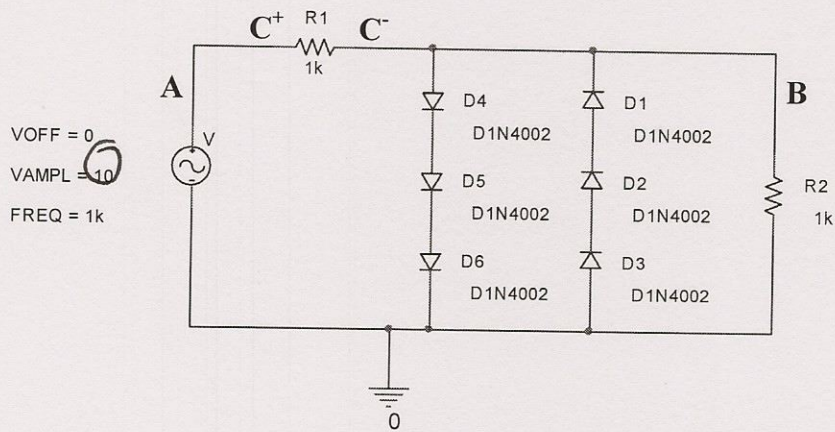
← less than half due to divide

With Smoothing

- d) (4pt) There are some banners in our classroom with the names and logos of some of the companies that have helped to support the courses (EI, LITEC, and Electric Circuits) offered in this room. Name one of the companies.

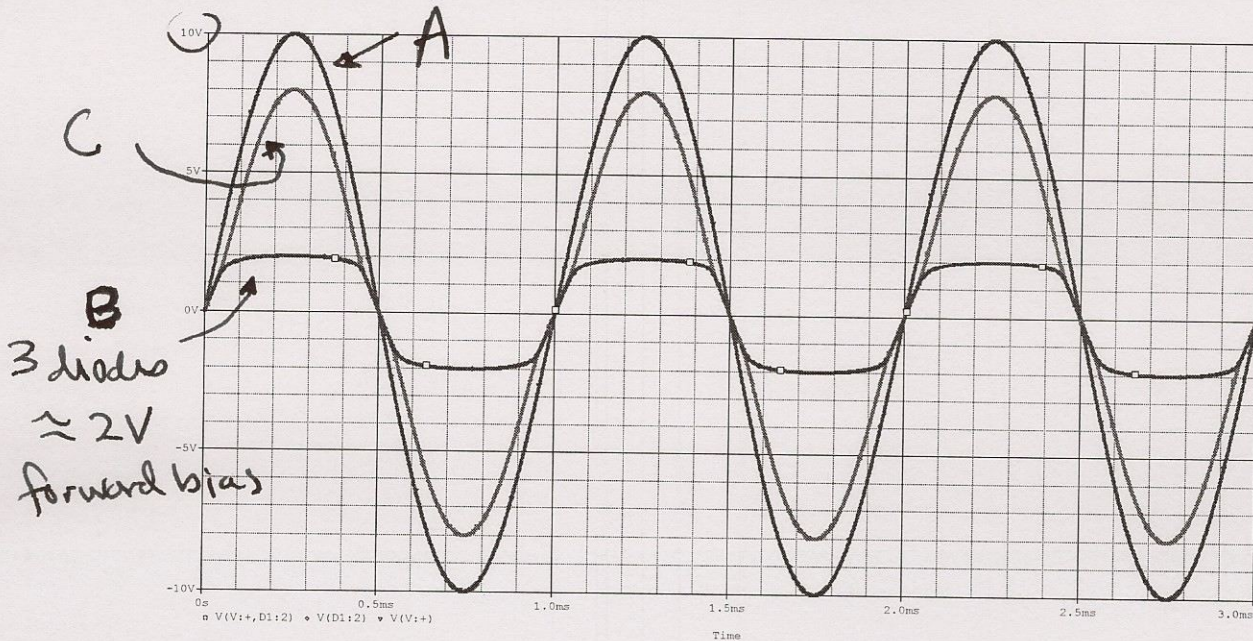
Analog. BAE, MAXIM  
 Actually 4 free points

Question II – Diode Limiter Circuits (20 points)



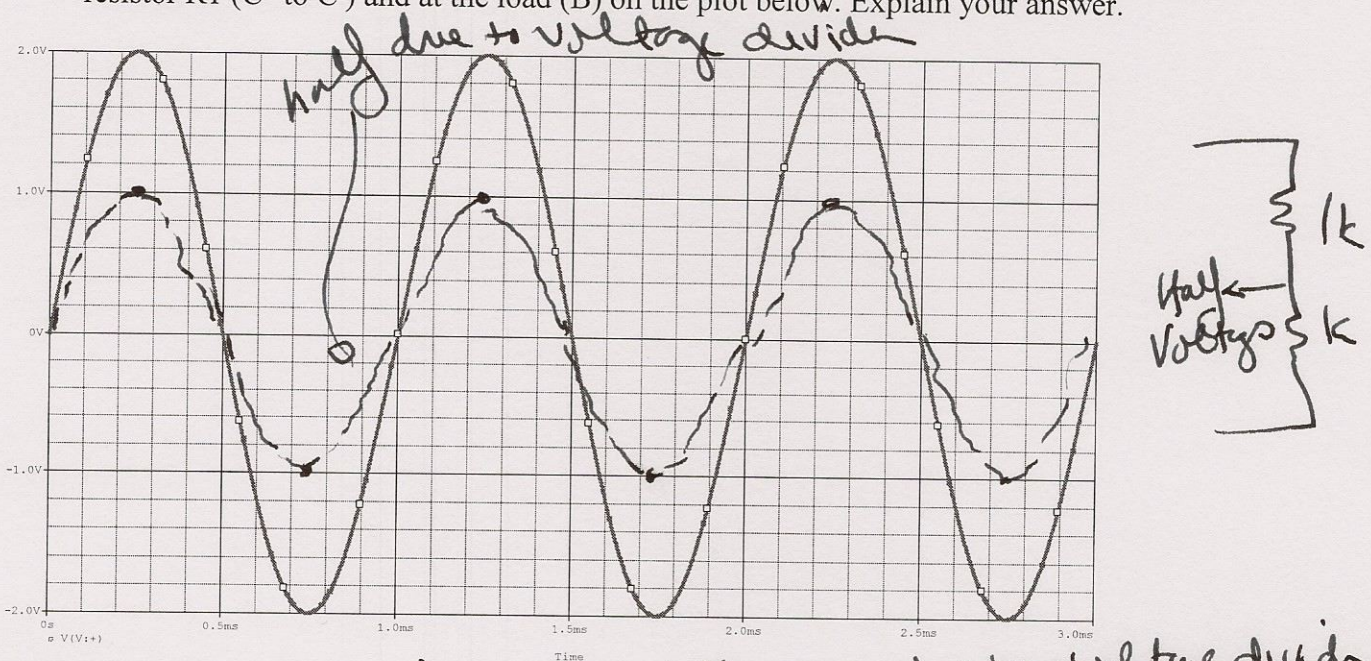
Six 1N4002 diodes are used to protect a load (in this case R2) from having too large a voltage across it. The 4002 diode has somewhat different properties than the 4148 diode we have studied in class.

- a) (9pts) This configuration is tested with the sinusoidal voltage source shown in the circuit above. The voltages measured are shown below. Label which plot is the voltage at pt A, at pt B and across resistor R1 (C<sup>+</sup> to C<sup>-</sup>). Explain your answer.



- A 10V sinusoid at input
- B cannot be larger than the forward bias of 3 diodes
- C what is left

b) (6 pts) The source voltage amplitude is changed to 2V. Sketch the resulting voltage across resistor R1 (C<sup>+</sup> to C<sup>-</sup>) and at the load (B) on the plot below. Explain your answer.

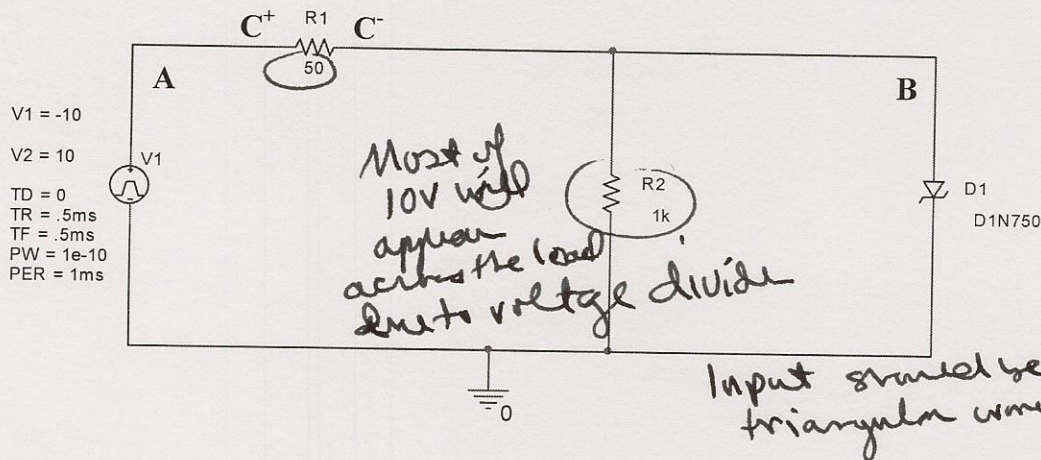


At 2V, the diodes do not turn on due to voltage divider  $\Rightarrow$  they are open  $\frac{1}{3}$  out of the circuit

c) (5pts) Using the given information, determine the forward voltage necessary to turn the 1N4002 diode on. Explain your answer.

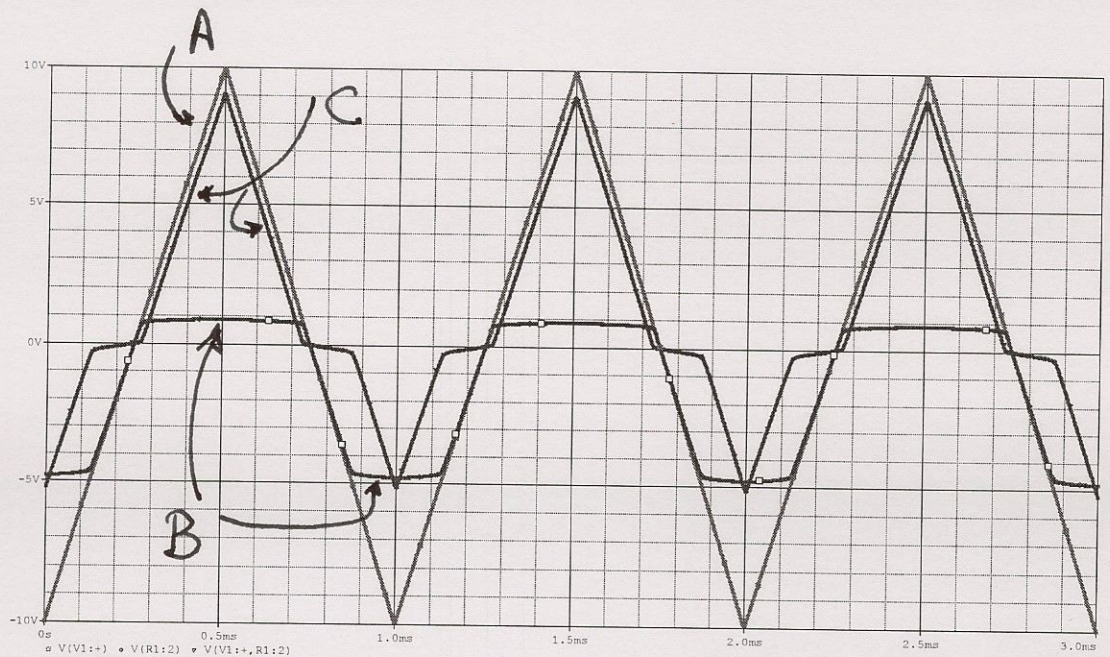
3 diodes  $\Rightarrow$  2V  
 $\Rightarrow \frac{2}{3}$  V to turn on diode  
 .6 < .67 < .7 which is the usual range for diodes

Question III – Zener Diode Circuits (20 points)

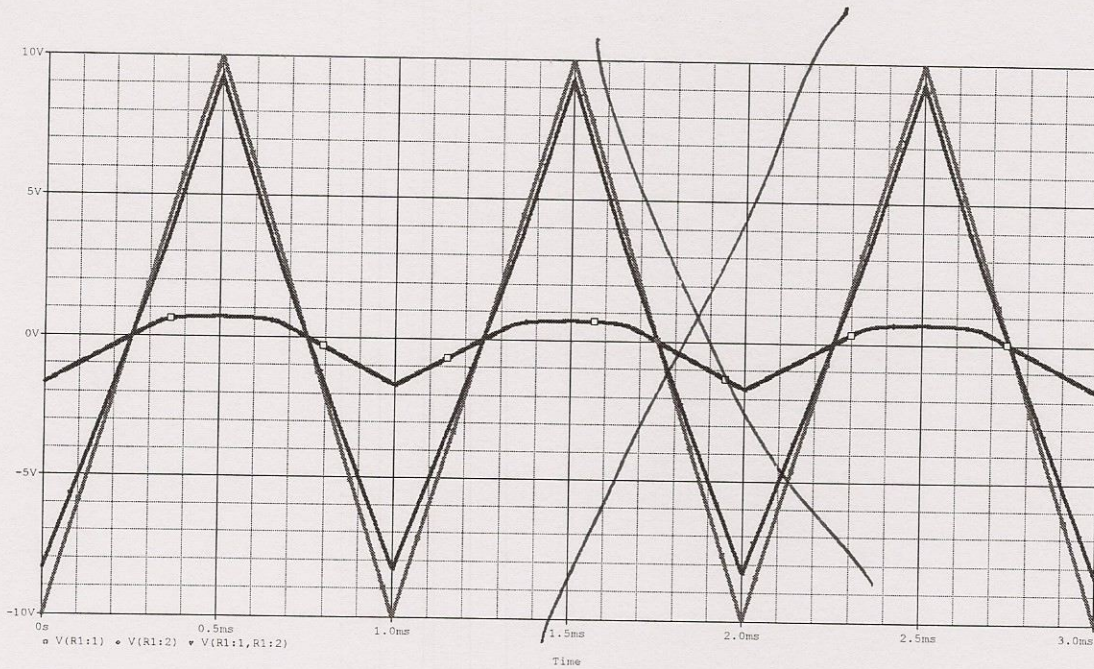


The circuit above is a Zener diode voltage regulator. A Zener diode is used to regulate the voltage across the load resistor R2 in the circuit. Shown below are two figures, one of which shows the correct voltages for this configuration.

- a) (5pts) Identify which of the two figures is correct by crossing out the one that is incorrect. Explain your answer. *most of 10V is enough to turn on Zener*
- b) (5pts) On the correct figure, label which plot corresponds to the voltages at points A and B and across resistor R1 (C+ to C-)



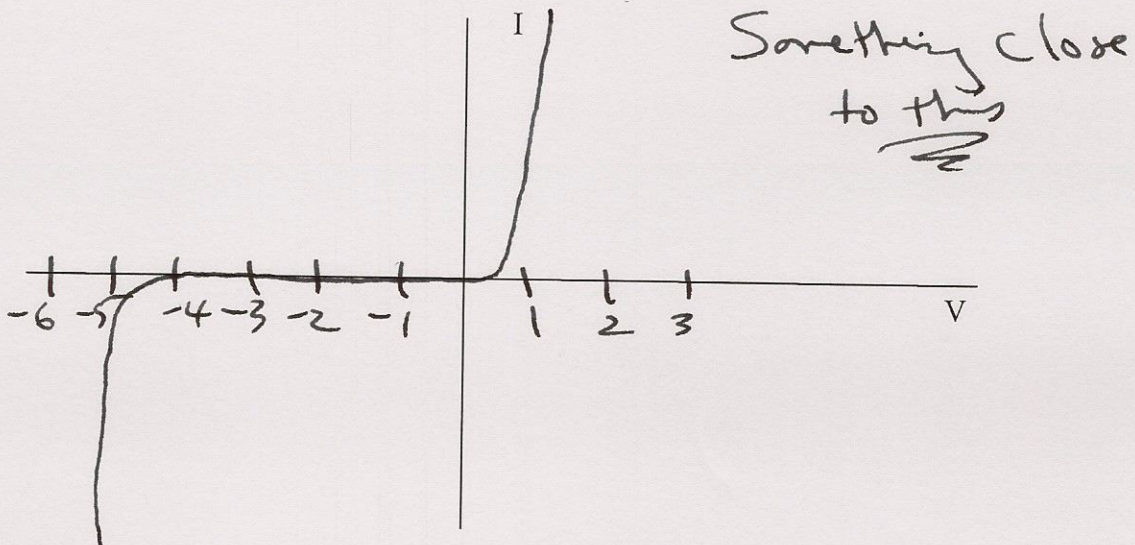
*Zener clamp voltage at Vforward ~ .7V  
Vz ~ 5V.*



c) (6pts) From the given information, determine the Zener voltage for this diode  $V_Z$  and the forward bias voltage necessary to turn the diode on in the forward direction. Exact answers are not required.

$V_Z$  a little less than 5V. Say 4.7V  
 $V_{forward}$  a little less than 1V. Say .8V  
 Range of answers accepted

c) (4pts) Sketch the V-I plot for this diode. Your sketch does not have to be perfect, but it should show the main characteristics of the diode.

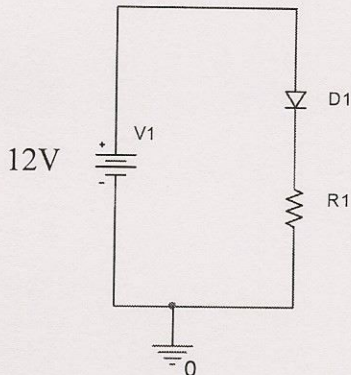




Question IV - LEDs and Phototransistor Circuits (25 points)

A high brightness LED is driven by a standard DC source. The source we have available is a 12 Volt wall wart capable of producing up to 15 Watts. We need a forward bias voltage of 3.5V and a current of 50 mA.

- a) (5pt) Using the 12 Volt supply, determine the resistance R1 necessary to achieve the desired operating conditions for the diode. Also determine the total power dissipated in the circuit.

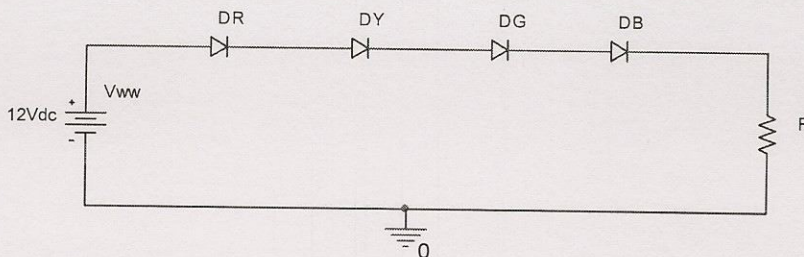
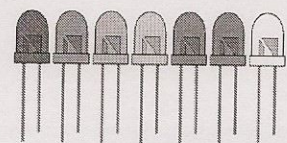


$$R = \frac{12 - 3.5}{.050} = \frac{8.50}{.05} = 170 \Omega$$

$$P_{TOTAL} = (12)(.050) = 600 \text{ mW} \lll 15 \text{ W ac}$$

- b) (10pt) We now want multiple LEDs like a short string of Christmas lights. For this purpose, we will use four different color LEDs: Red, Yellow, Green and Blue. The four LEDs we have are found in the table below. Our Red LED is labeled Bright Red in the table. Determine the resistance to achieve the desired operating conditions for the combination of 4 LEDs. Assume that the current is 25mA, since we have to be limited to the smallest maximum current for any of our four LEDs. Use the typical forward bias voltages from the table.

Type	Colour	I <sub>F</sub> max.	V <sub>F</sub> typ.	V <sub>F</sub> max.	V <sub>R</sub> max.	Luminous intensity	Viewing angle	Wavelength
Standard	Red	30mA	1.7V	2.1V	5V	5mcd @ 10mA	60°	660nm
Standard	Bright red	30mA	2.0V	2.5V	5V	80mcd @ 10mA	60°	625nm
Standard	Yellow	30mA	2.1V	2.5V	5V	32mcd @ 10mA	60°	590nm
Standard	Green	25mA	2.2V	2.5V	5V	32mcd @ 10mA	60°	565nm
High intensity	Blue	30mA	4.5V	5.5V	5V	60mcd @ 20mA	50°	430nm
Super bright	Red	30mA	1.85V	2.5V	5V	500mcd @ 20mA	60°	660nm
Low current	Red	30mA	1.7V	2.0V	5V	5mcd @ 2mA	60°	625nm



$$R = \frac{12 - 2 - 2.1 - 2.2 - 4.5}{.025} = \frac{1.2}{.025} = 48 \Omega$$

- c) (5pts) Determine the total power dissipated in the circuit and the power dissipated in the blue LED.

$$P = (12)(.025) = 300 \text{ mW}$$

$$P_{\text{Blue}} = (4.5)(.025) = 112.5 \text{ mW} \quad \leftarrow \text{most of the power.}$$

- d) (5pts?) For one of the first three problems on this quiz, you have the following options.

- Write 'do not grade' on it and you will receive the full 20 points, regardless of your actual answer

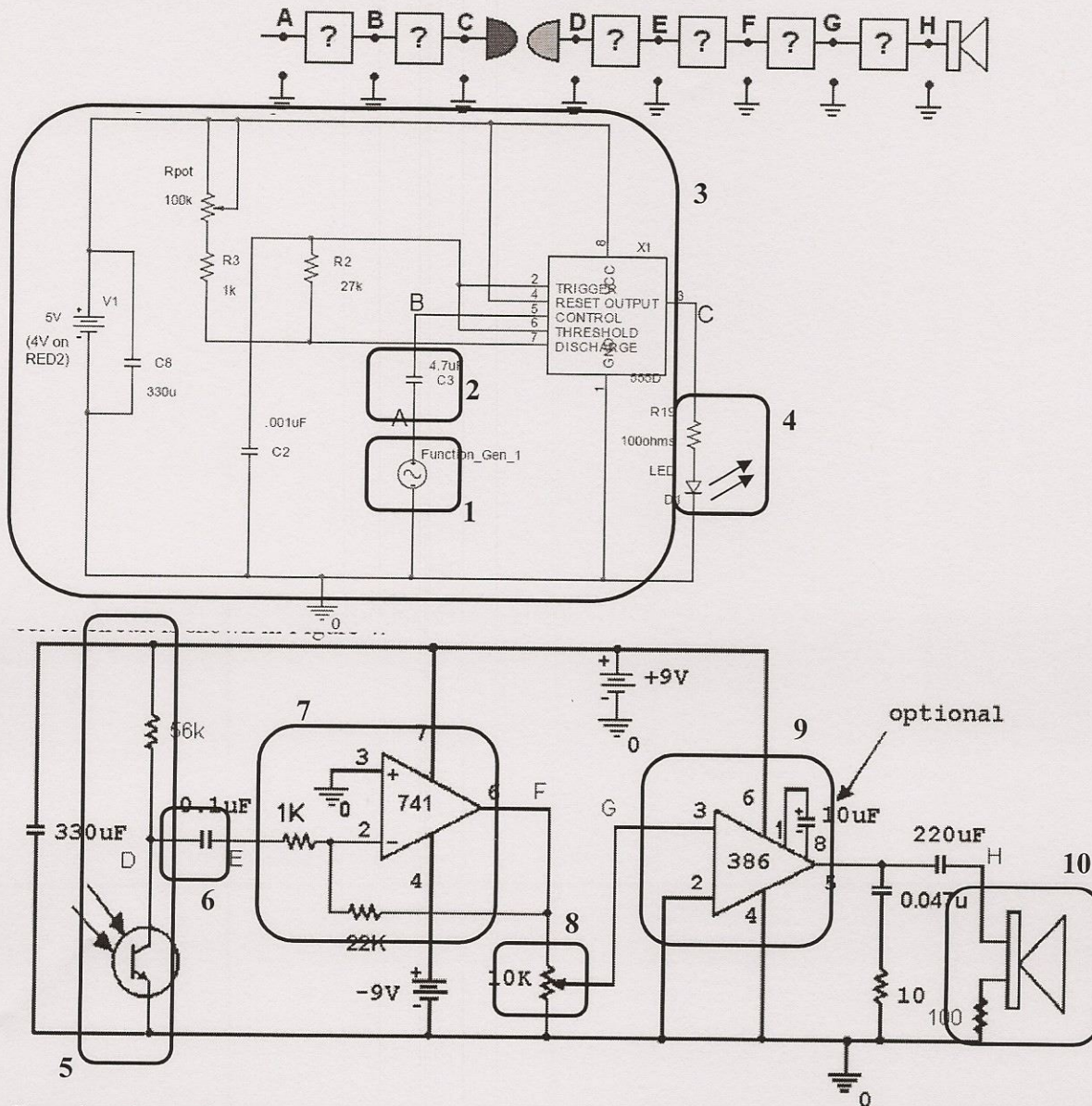
- Solve the problem and, if your answer is completely correct, you will receive 25 points

Note that you have this option for only one of the first three problems. You must solve the other two.

Must choose one option or the other not both

Question V – Functionality and Trouble Shooting (20 points)

The figures below are taken from the write-up for Project 4.



Counting the audio source, the speaker and the two optical devices, there are 10 separate blocks in this communication system.

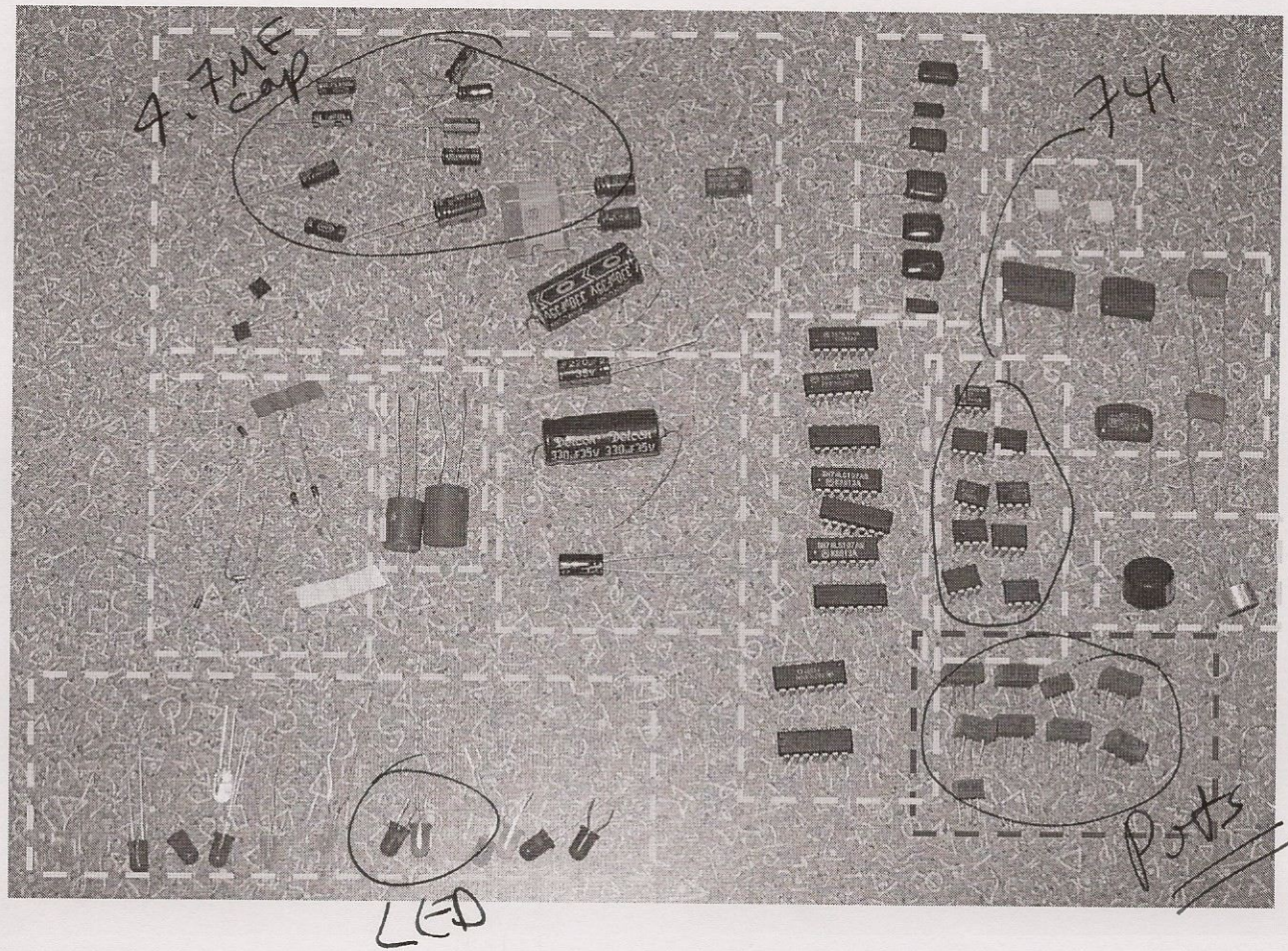
- a) (10pts) Identify the function of each of the blocks in the circuits above. Some blocks may match more than one function name, some functions may be used more than one, and some function names may not be used. One block is identified as a free example.

Monostable multivibrator circuit	<u>N/A</u>
Voltage divider	<u>8</u>
Speaker	<u>10</u>
Inverting amplifier	<u>7</u>
DC Blocking Capacitor	<u>2, 6</u>

Comparator	N/A
Buffer amplifier (voltage follower)	N/A
Schmitt trigger	N/A
Audio Signal Source	1
<del>Voltage divider</del>	
RL circuit	N/A
NAND Gate	N/A
A transistor circuit	N/A
Astable multivibrator circuit	3
RLC circuit	N/A
Phototransistor Light Sensor	5
Audio Amplifier	9
LED Light Emitter	4
JK Flip-Flop	N/A

← although the 555, 741 etc qualify

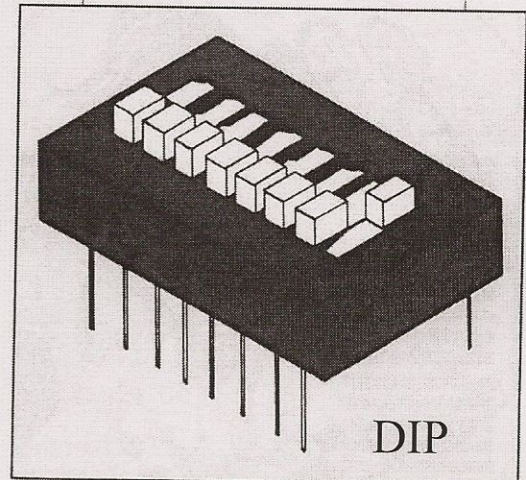
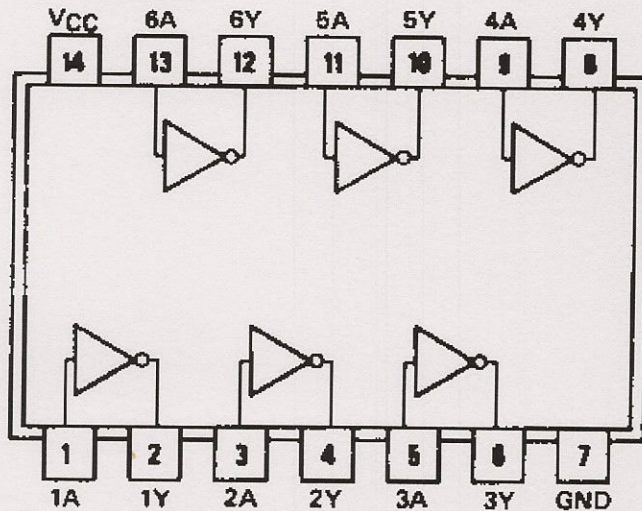
b) (5pts) Shown below is a photo of the components from an EI student's parts kit. The photos of each part are too small to read any detailed information, so this question has to do with general appearances rather than specific details. Circle and label components that could be one of the following from one of the circuit diagrams above: LED, 741 Op-Amp, 4.7uF Capacitor, Potentiometer. What general class of components is missing from this photo? Resistors



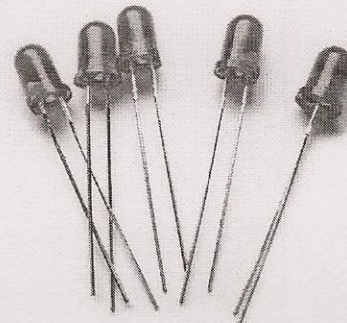
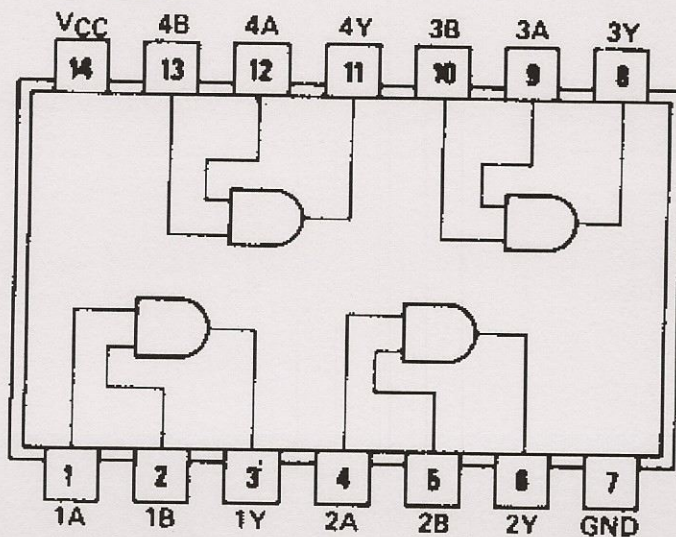
- c) (5pts) Note that for this question, there is a lot of pictorial information, but what you are asked to do is relatively simple. This is the usual case with practical problems.

Shown on the following two pages are three versions of the same circuit for four different operating conditions. Thus, each version of the circuit is shown four times. Two logic devices are used in the circuits, the 7404 Inverter and the 7408 AND Gate.

### 7404

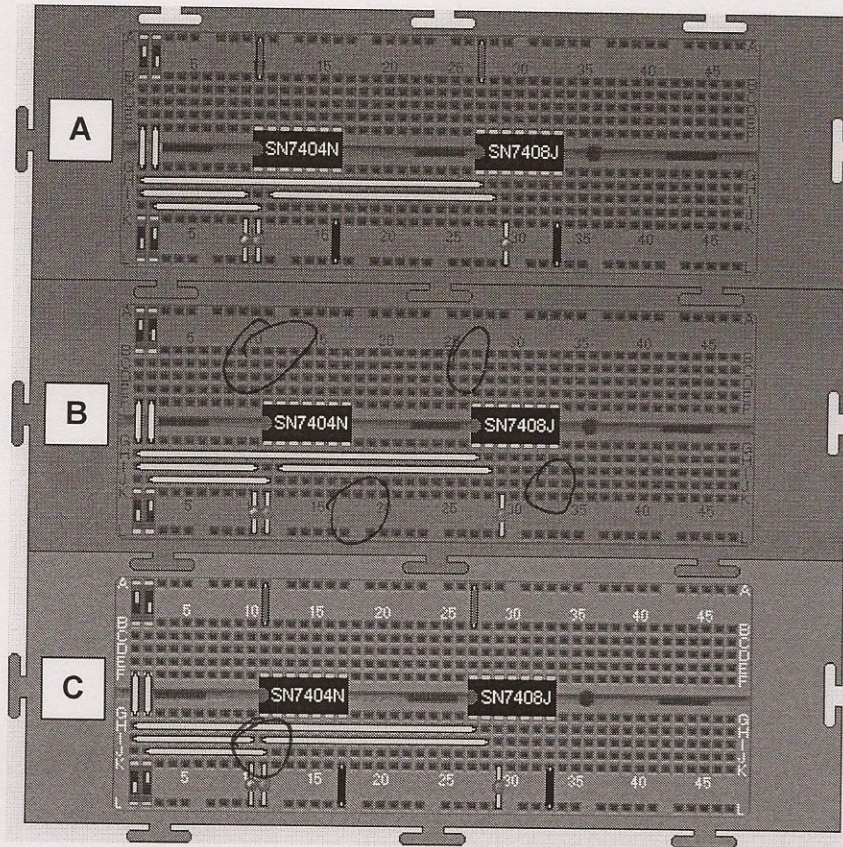


### 7408



Also used are LEDs to show when voltages are high or low, DIP switches (that fit nicely into protoboards), and wires. The top rail on each board is 5V and the bottom rail is ground.

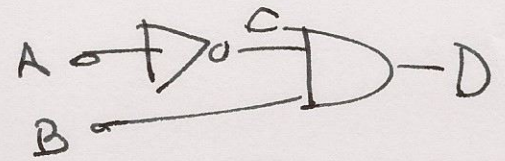
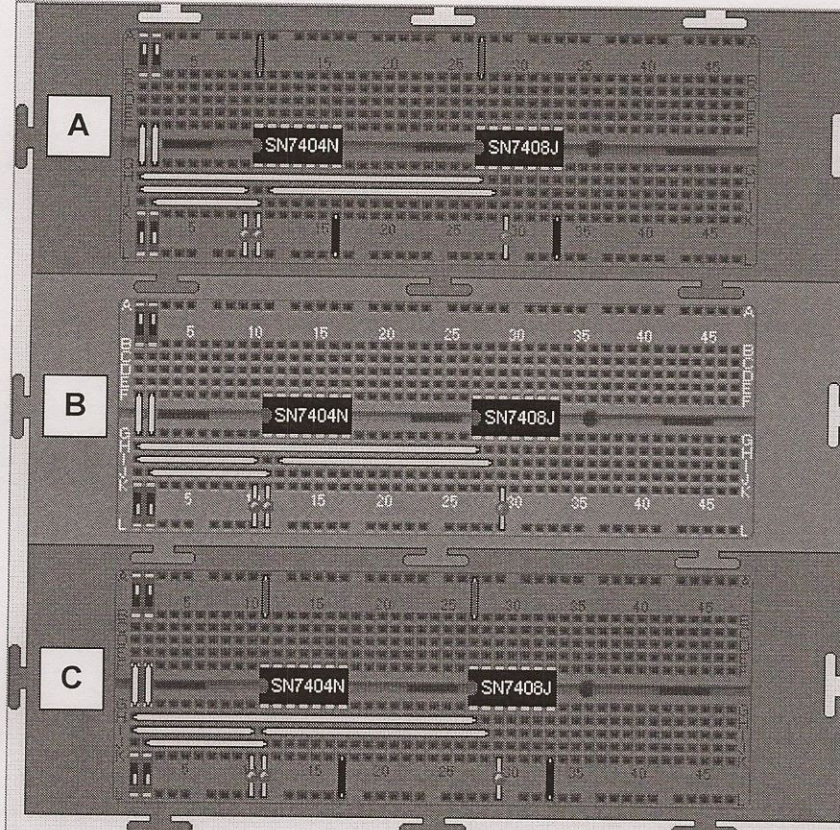
One of the three configurations (A, B or C) is wired and operates correctly. Two have wiring problems. Identify which one is correct and label it as such. Indicate one problem each with the other two.



Correct

No Power

Inverter not  
in circuit  
wires bypass  
inverter.



A	B	C	D
0	0	1	0
0	1	1	1
1	0	0	0
1	1	0	0

This function  
is shown  
correctly in  
circuit #1

