# ENGR-4300
# Spring 2009
# Test 4

**Name _____**

**Section 1(MR 8:00) 2(TF 2:00) 3(MR 6:00)**
**(circle one)**

Question I (20 points) _____

Question II (20 points) _____

Question III (15 points) _____

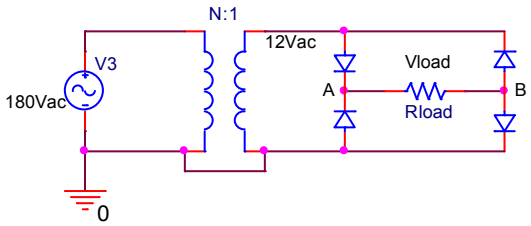
Question IV (25 points) _____

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.

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



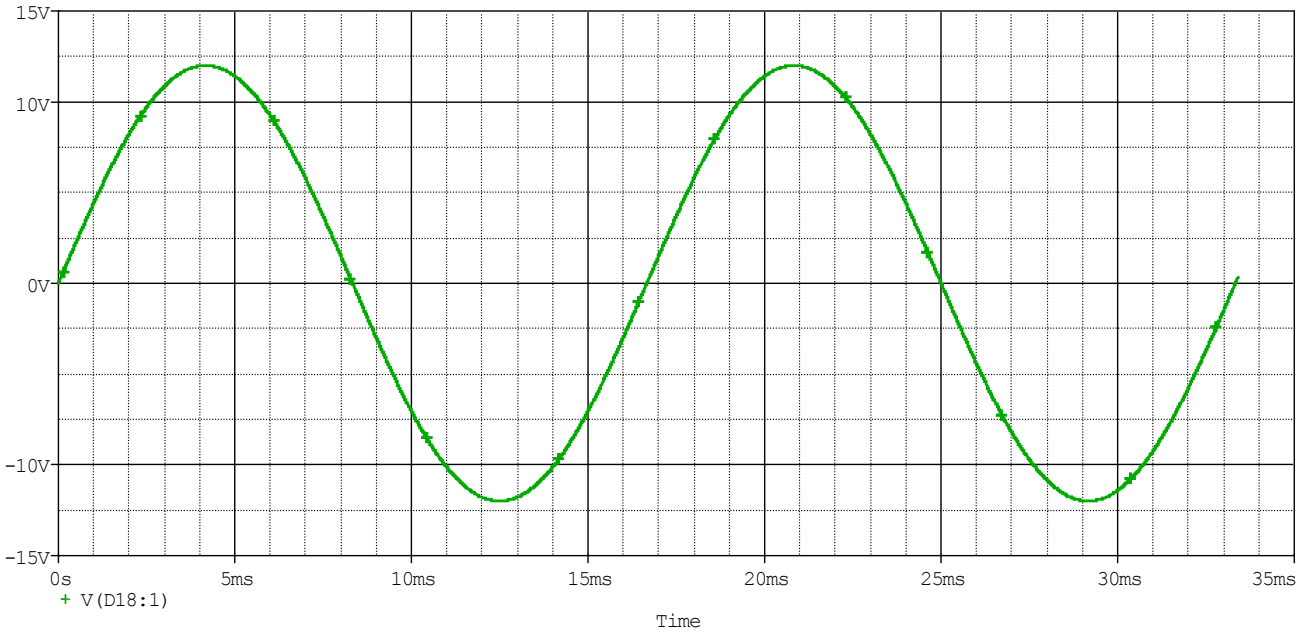

1. Designing a low-voltage DC power source from a 180Vpeak AC supply, requires a transformer and rectifier bridge.

a) (***3pt***) What should the transformer turns ratio N:1 be to output 12Vpeak on the secondary side from the 180Vpeak on the primary?

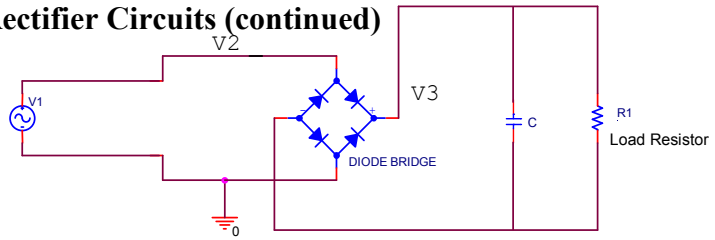
b) (***3pt***) Given the rectifier bridge circuit with 4 diodes (0.6V turn-on), what will be the peak voltage Vload across the load resistor Rload?

c) (***1pt***) Which side, **A** or **B**, of Rload is the positive (high) voltage of Vload?

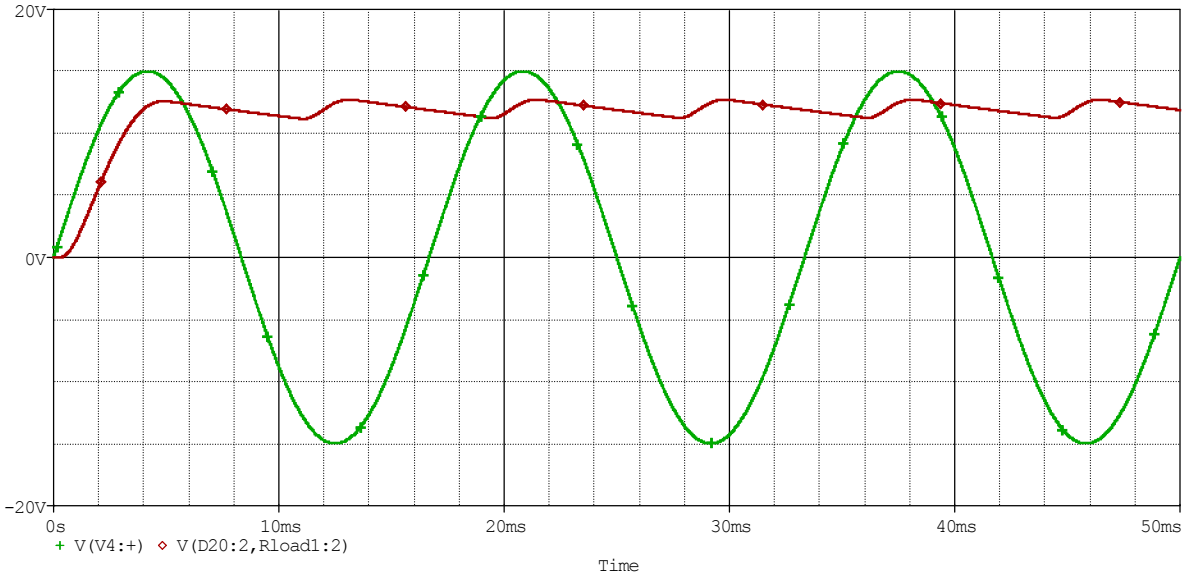
d) (***4pt***) With 12Vac applied to the rectifier bridge circuit shown on the plot below, sketch Vload, the voltage across Rload.



**Question I – Diode Rectifier Circuits (continued)**



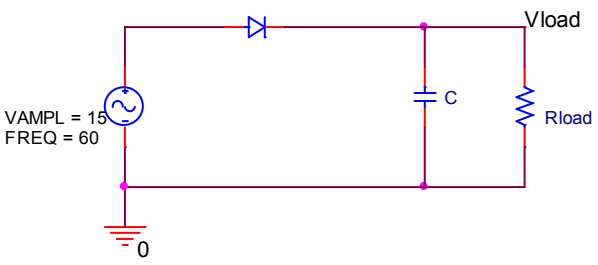

2. For the following full-wave rectifier above, with Rload = 100Ω and C = 500μF, the plot below shows the input voltage and the voltage across the load.



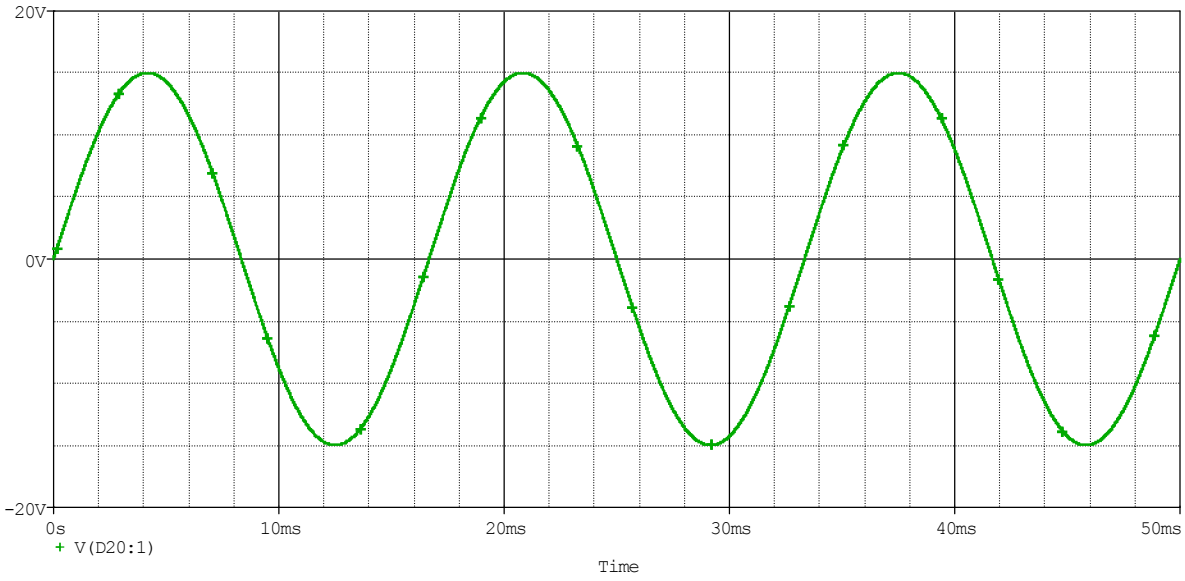

a) (***3pt***) On the plot, show how the voltage across the load would change if Rload is reduced to 50Ω.

b) (***2pt***) What new value for C would restore the voltage waveform back to its original form when Rload was 100Ω?

**Question I – Diode Rectifier Circuits (continued)**

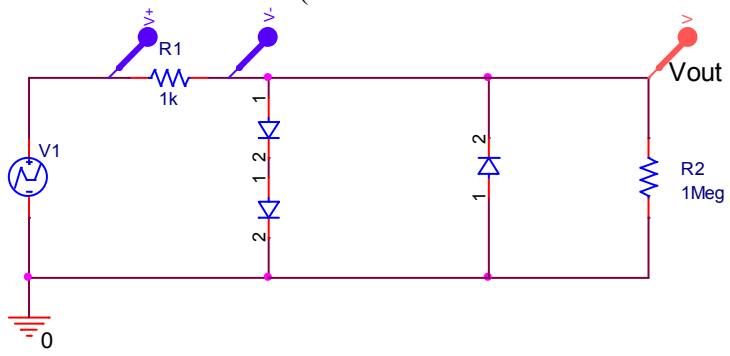


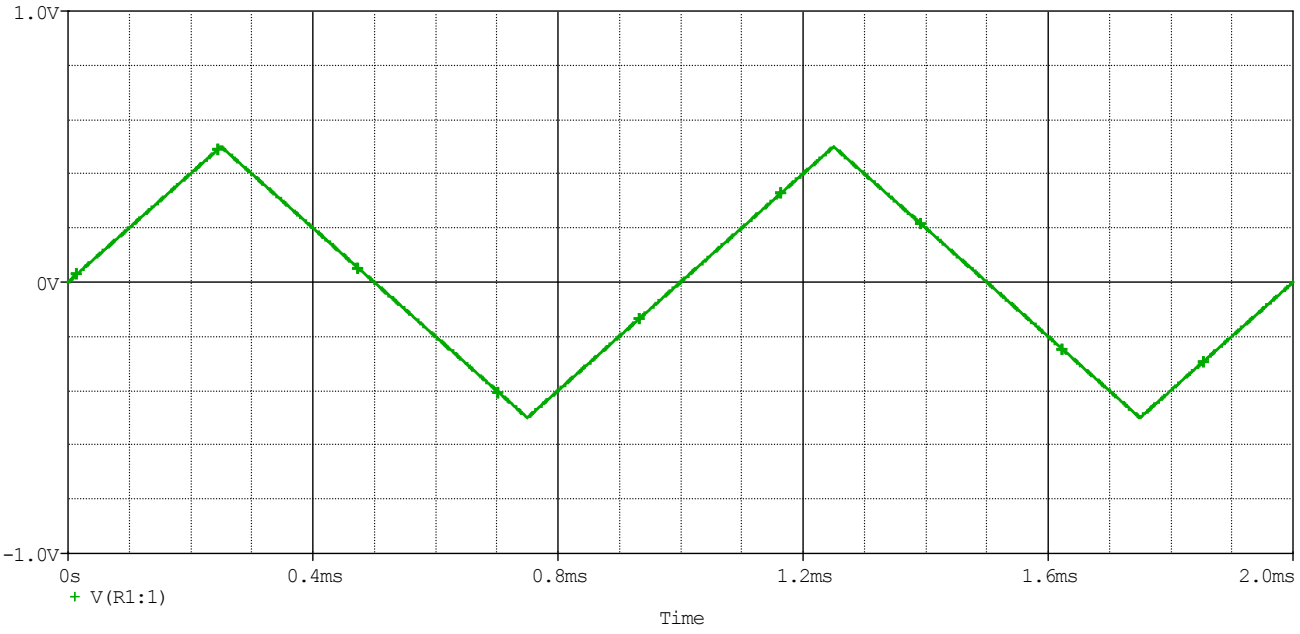

c) (***4pt***) For an essentially equivalent half-wave rectifier circuit replacing the full-wave above, with Rload = 100 and C = 500μF as in the circuit in 1, sketch the voltage across Rload on the 15V input voltage plotted below.



**Question II – Diode Limiter Circuits (20 points)**

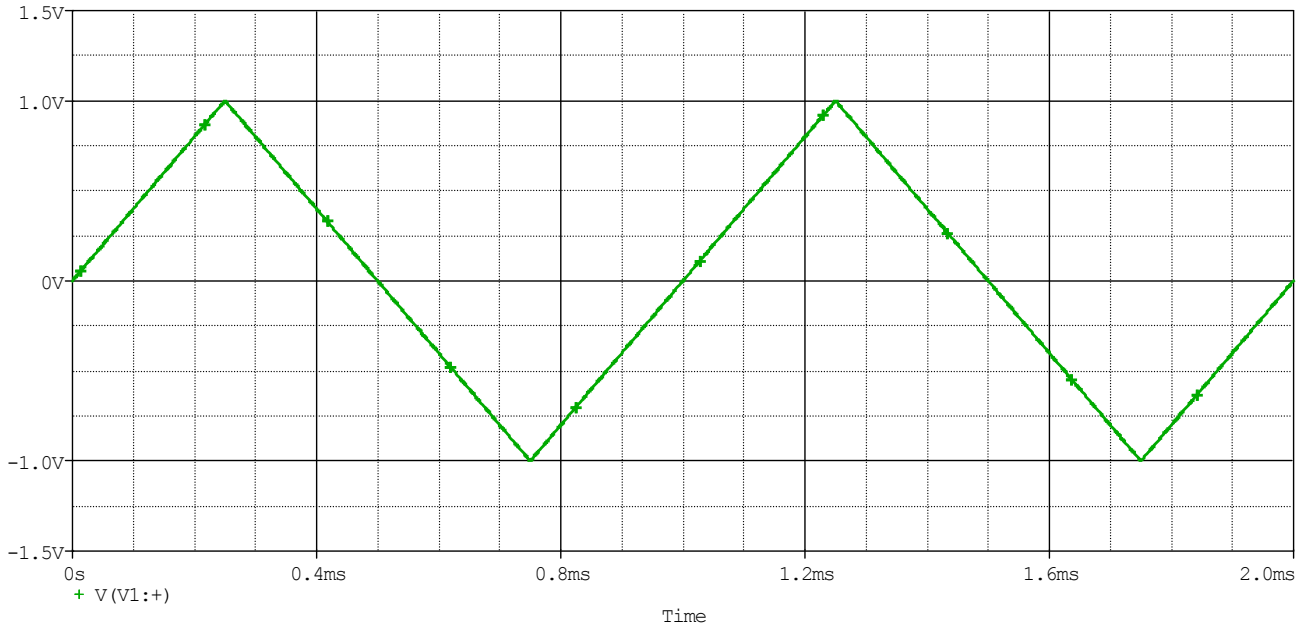
1. (***6pt***) Draw and labelVout and Vr (the voltage across R1) on the plot below showing V1. The diodes turn on at 0.5V. (***Label the maximum and minimum of the output.***)



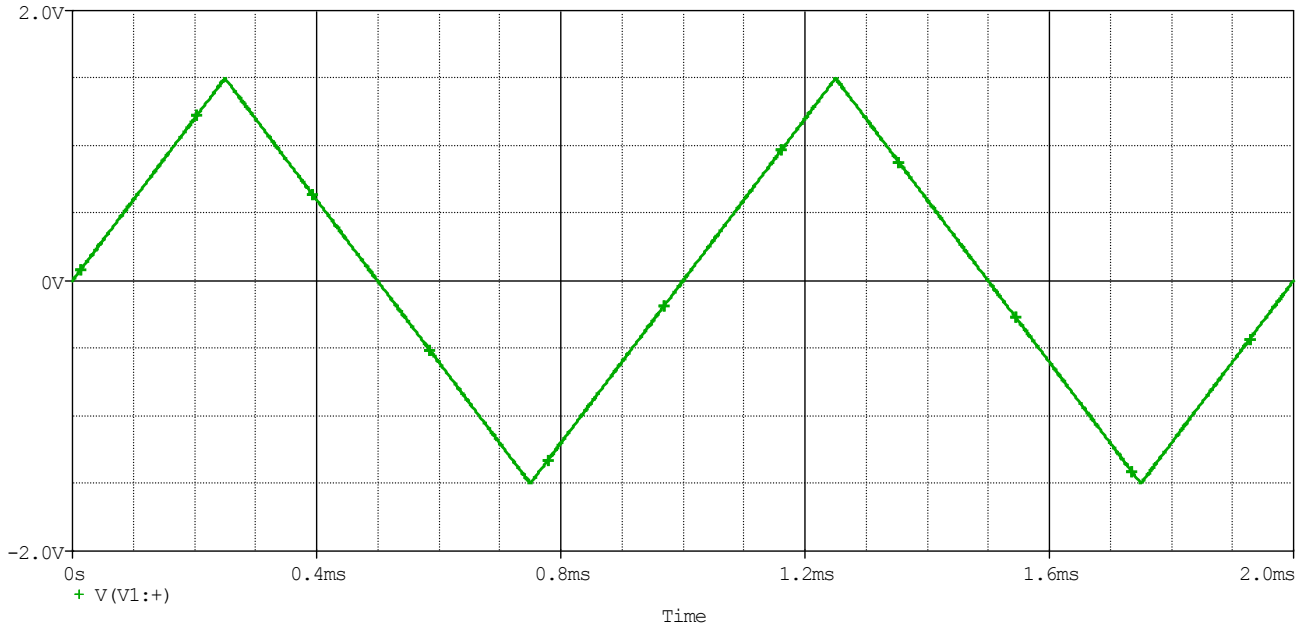
**Question II – Diode Limiter Circuits (continued)**

2. (***6pt***) Draw Vout and Vr on the plot below with V1 increased to $2V_{p\text{-}p}$. (***Label the maximum and minimum of the output.***)



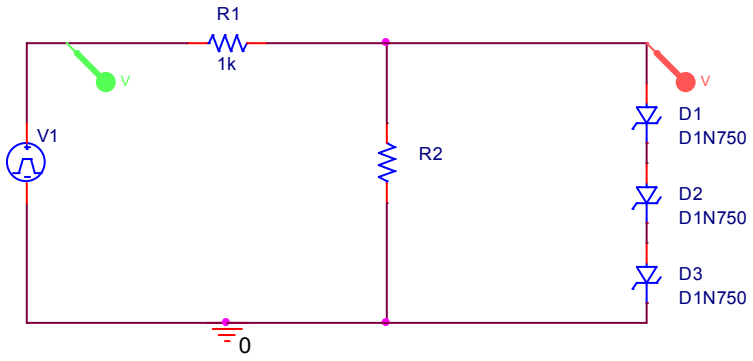
**Question II – Diode Limiter Circuits (continued)**

3. (***6pt***) Draw Vout and Vr on the plot below with V1 increased to $3V_{p\text{-}p}$. (***Label the maximum and minimum of the output.***)



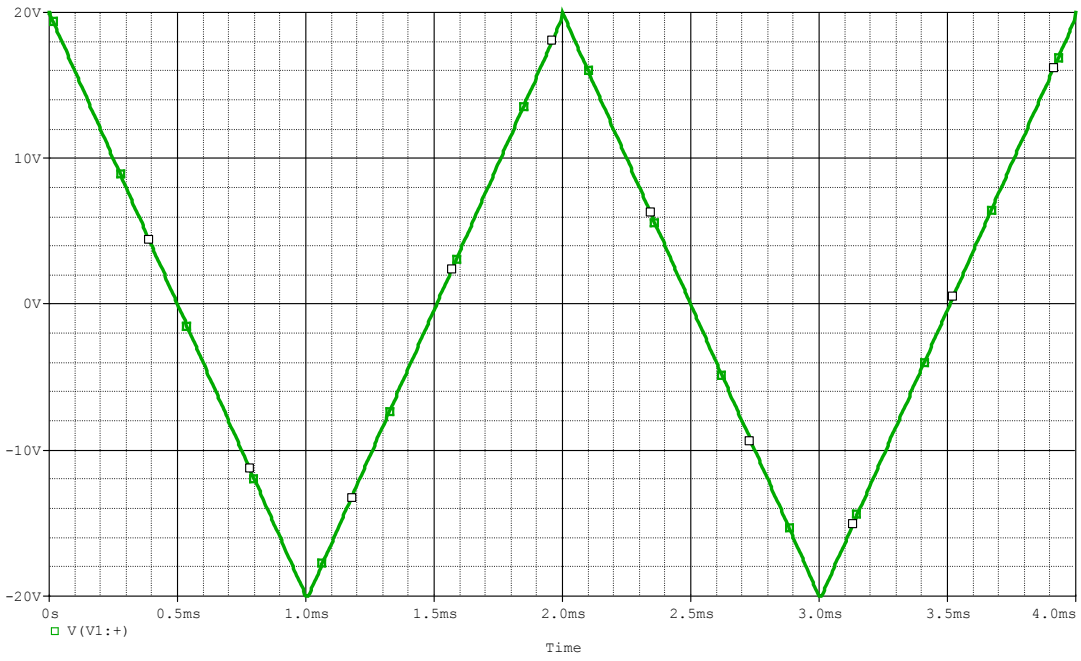

4. (***2pt***) TRUE or FALSE: With a diode that turns on at 0.7V and one that turns on at 0.6V, it is possible to build a limiter circuit that turns on at 0.1V by wiring them in series, but switching the 0.6V diode's connections around.

**Question III – Zener Diode Circuits (15 points)**

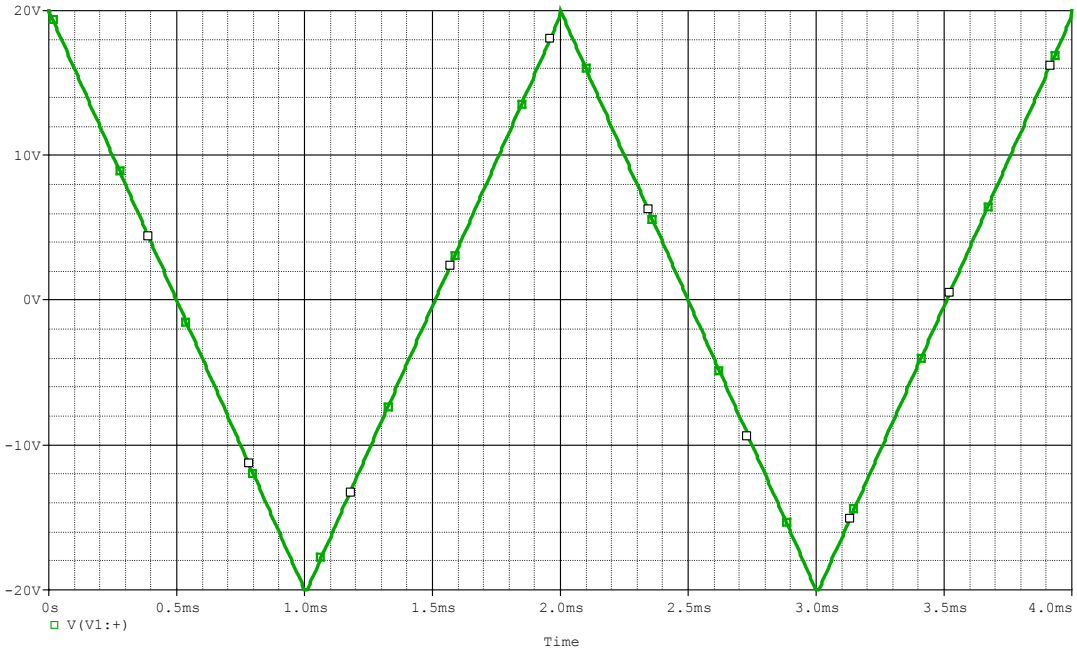



The circuit above is a zener diode voltage regulator. Three Zener diodes are used to regulate the voltage across the load resistor R2 in the circuit below. Three different values of R2 are tried (100Ω, 1kΩ, and 10kΩ) Draw the voltage on the output probe above D1. ***Calculate your answers.***

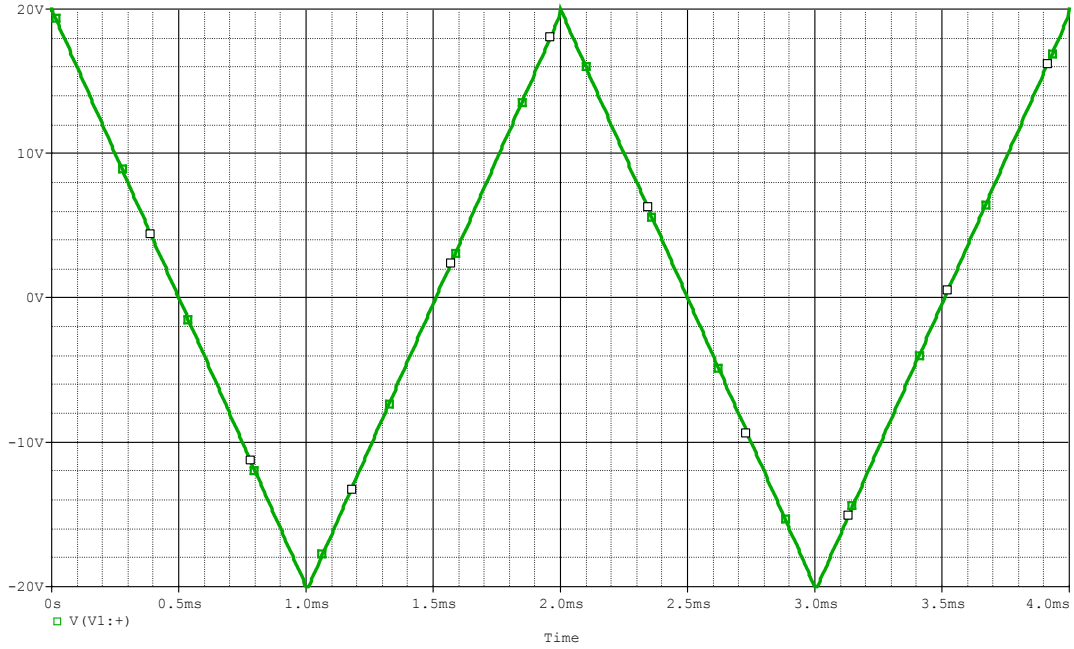
1. (***3pt***) Plot the output voltage when R2 = 100Ω



2. (***3pt***) Plot the output voltage when R2 = 1kΩ




3. (***3pt***) Plot the output voltage when R2 = 10kΩ



4. (***3pt***) What is the voltage across R2 when R2 is 10kΩ and the input voltage is 5V?

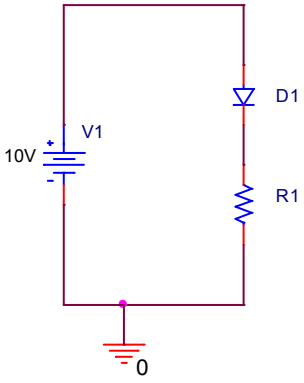
5. (***2pt***) What is the current through R2 when R2 is 10K and the input voltage is -17V?

6. (***1pt***) Which of the 4 Electronic Instrumentation projects could have benefitted most from a voltage regulated circuit? (***A major component was highly sensitive to voltage in this project***)

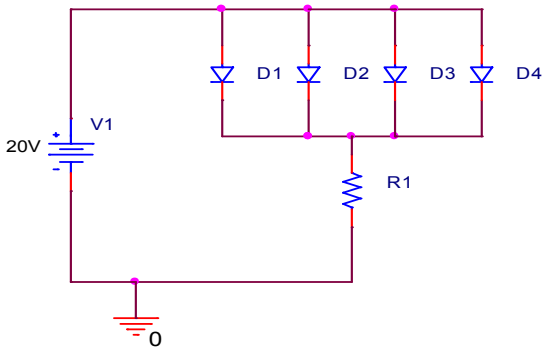
**Question IV - LEDs and Phototransistor Circuits (25 points)**

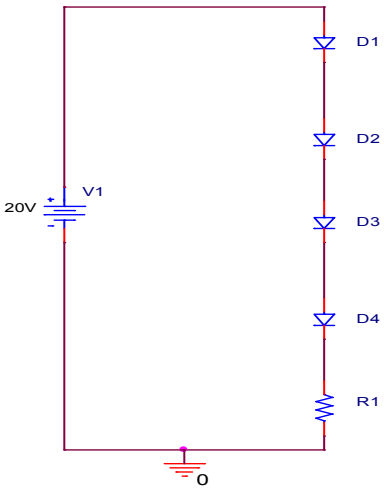
A high brightness LED is driven by a standard DC source. The source we have available is a 10 Volt wall wart capable of producing up to 5 Watts. We need a forward bias voltage of 4V and a current of 50 mA.

1. (***5pt***) Using the 10 Volt supply, determine the resistance R1 necessary to achieve the desired operation conditions for the diode. Also determine the total power dissipated in the circuit.




2. (***10pt***) We now want multiple LEDs like a short string of Christmas lights. ***Find R1 for both circuits below.*** Choose the circuit below that will operate with a 20 Volt wall wart capable of producing 4.5 Watts. The LEDs need 4V and 50 mA of current each to operate. ***You may also choose neither or both. Explain with calculations of current, voltage, and power limits in your answer.***

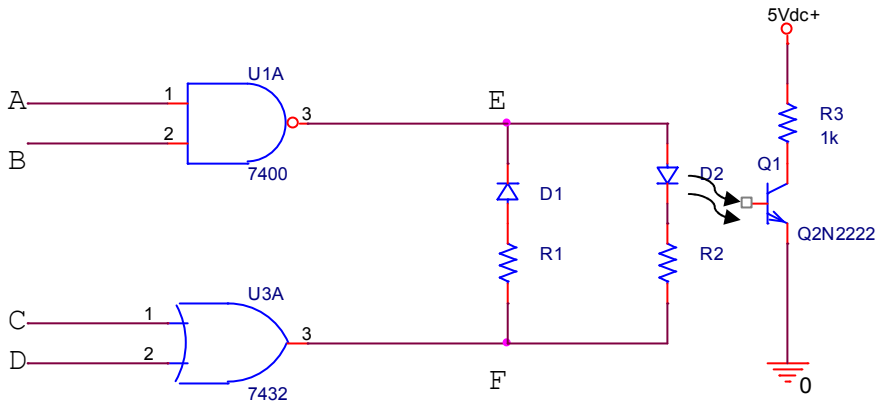


**Question IV - LEDs and Phototransistor Circuits (continued)**

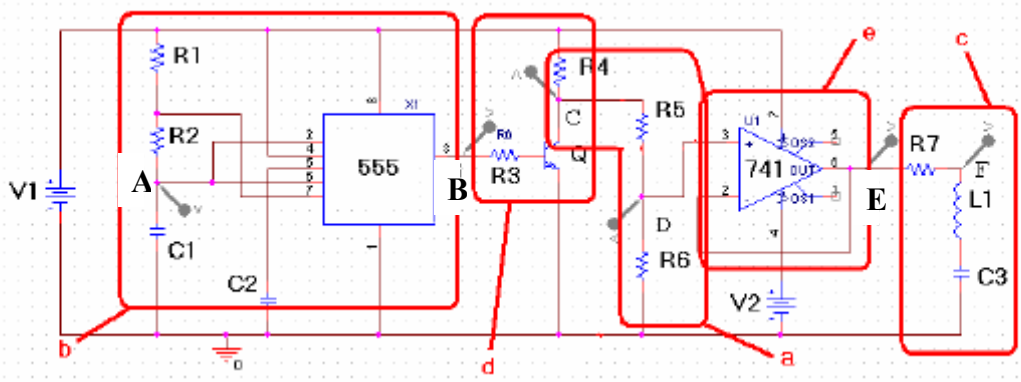
3. (***4pt***) If you add one more diode in parallel to the parallel circuit above, which of the limits (current, voltage, and/or power) will it surpass? *This can be in addition to the limit it may surpass in the previous problem; mention all that apply now.*

4. (***6pt***) Given the logic circuit below, fill in the chart using ***ON and OFF for D1 and D2***. ***Mark the collector voltage in Volts***. Assume that 0 is a low enough voltage to turn the diodes off, 1 is a high enough voltage to turn the diodes on, and the output voltages are identical for both logic gates.




| A | B | C | D | E | F | D1 | D2 | collector |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | | | | | |
| 0 | 1 | 0 | 1 | | | | | |
| 1 | 0 | 1 | 0 | | | | | |
| 1 | 1 | 1 | 1 | | | | | |

**Question V – Signal Modulation and Functionality (20 points)**




Assume the components have the following values:

C1=0.2 µF, C2=0.02µF, C3=0.068 µF
R1=1kΩ, R2=5kΩ, R3=1KΩ, R4=1kΩ, R5=6kΩ, R6=1kΩ, R7=50Ω
L1=5mH
V1=+15V
V2=-15V

1. (***5pt***) Identify the function of each of the blocks in the signal conditioning circuit above. Some blocks may match more than one function name and some function names may not be used.

Monostable multivibrator circuit _____
Voltage divider _____
Inverting amplifier _____
Comparator _____
Buffer amplifier (voltage follower) _____
Schmitt trigger _____
Voltage divider _____
RL circuit _____
A transistor circuit _____
Astable multivibrator circuit _____
RLC circuit _____

**Question V – Signal Modulation and Functionality (continued)**

2. (***2pt***) What is the general purpose of the circuit circled in **e**?

3. (***3pt***) Calculate the frequency of the circuit in **b** in Hz

4. (***10pt***) Fill in the voltages in the chart below based on the theoretical behavior of the circuit during normal astable (oscillating) operating mode. What are the min and max voltages that appear at each of the given points? ***Calculate or explain below for full or chances of partial credit.***

| Voltage at pin 3 | Point A | Point B | Point C | Point D | Point E |
|---|---|---|---|---|---|
| LOW | | | | | |
| HIGH | | | | | |