Questions about Diodes

Fall 2004

The figure below is a dual voltage limiter. Assume R1=1K



Here is a picture of the output of the above circuit when simulated with an input signal of amplitude equals to 0.5V



1. Explain the reason why both the input and the output are the same (2 points)

- 2. Each diode in the circuit can either be forward bias, reverse bias, or in the breakdown region, from the above PSPICE plot, what is the region of operation of: (4 points)
 - D1
 - D2
 - D3
 - D4

3. Here is a picture of the output of the above circuit when simulated with an input signal of amplitude equals to 5V



4.In the marked area, what is the region of operation of the 4 diodes (4 points)

- D1 D3
- D2 D4

5. What is the value of current through the resistor R1 when the input voltage is at the values listed below. Assume Von for each diode is 0.7V

3 volts (2 points)

-3 volts (2 points)

0.2V (2 points)

-0.2V (2 points)

If the 4 diodes (D1-D4) are replaced with one zener diode. The input and output will be as shown in the figure below





6. What is the current in the two marked regions (4 points)

1.

2.

Fall 2004 Solution

The figure below is a dual voltage limiter. Assume R1=1K



Here is a picture of the output of the above circuit when simulated with an input signal of amplitude equals to 0.5V



3. Explain the reason why both the input and the output are the same (2 points)

In this circuit, diodes D2 and D3 will turn on when the voltage tries to go above 1.4 volts and diodes D1 and D4 will turn on when the voltage tries to go below -1.4 volts. Between 1.4 and -1.4 volts, both pairs of diodes will be off. The circuit looks like the one pictured on the following page. In this circuit Vout = Vin. Since the amplitude of the input pictured above is only 0.5 V, it never tries to go above 1.4 volts or below -1.4 volts. The diodes never turn on and the output remains equal to the input.



- 4. Each diode in the circuit can either be forward bias, reverse bias, or in the breakdown region, from the above PSPICE plot, what is the region of operation of: (4 points)
 - D1: reverse bias (off)
 - D2: reverse bias (off)
 - D3: reverse bias (off)
 - D4: reverse bias (off)

3. Here is a picture of the output of the above circuit when simulated with an input signal of amplitude equals to 5V



4.In the marked area, what is the region of operation of the 4 diodes (4 points)

D1: reverse bias (off)

D2: forward bias (on)

D3: forward bias (on)

D4: reverse bias (off)

5. What is the value of current through the resistor R1 when the input voltage is at the values listed below. Assume Von for each diode is 0.7V

3 volts (2 points) I = (3-1.4)/1K = 1.6mA

-3 volts (2 points) I = (-3-(-1.4)) = -1.6 mA

0.2V (2 points) I = 0 mA

-0.2V (2 points) I = 0 mA

If the 4 diodes (D1-D4) are replaced with one zener diode. The input and output will be as shown in the figure below





I am assuming that region 1 is the upper region which cuts off at about 4.7 volts and region 2 is the lower region which cuts off at about -0.7 volts.

6. What is the current in the two marked regions (4 points)

Method I: Assume that we are at the extremes where Vin = 10V or -10V

1.
$$I = [10-4.7]/1K = 5.3mA$$

2. I = [-10 - (-0.7)] / 1K = -9.3 mA

Method II: Assume the general case, where Vout is a function of Vin.

- 1. I = [Vin-4.7] / 1K
- 2. I = [Vin (-0.7)] / 1K = [Vin + 0.7] / 1K

Spring 2004 Question 2 – Diodes (23 points)

The figure below is a dual voltage limiter. Assume R1=1K.



Here is a picture of the output for the above circuit:



a) Indicate the input and output signals on the plot (4 points)

b) The input is in the form $v(t)=Asin(\omega t)$. What is the general equation for the input signal to the circuit? Please give the numerical values for A and ω . (4 points)

c) Each diode in the circuit has a forward bias region, a reverse bias region and a breakdown region. Answer the following questions with regard to the circuit and PSpice output on the previous page.

- i) Which of the three regions does not affect the input signal pictured in the output on the previous page? (1 point)
- ii) Circle and label the area on the PSpice output where diode D1 and D2 are in the reverse bias region. (2 points)
- iii) Circle and label the area on the PSpice output where diode D3 and D4 are in the reverse bias region. (2 points)
- iv) Circle and label the area on the PSpice output where diodes D1 and D2 are in the forward bias region. (2 points)
- v) Circle and label the area on the PSPice output where the diodes D3 and D4 are in the forward bias region. (2 points)

d) What is the value of the current through the resistor when the input voltage is at the values listed below. Assume V_{on} for each diode is 0.7 Volts.

i) 4 volts (3 points)

ii) -4 volts (3 points)

Spring 2004 solution Question 2 – Diodes (23 points)

The figure below is a dual voltage limiter. A: Assume R1=1K. B: Assume R1=3K.



Here is a picture of the output for the above circuit:



b) Indicate the input and output signals on the plot (4 points)

b) The input is in the form $v(t)=Asin(\omega t)$. What is the general equation for the input signal to the circuit? Please give the numerical values for A and ω . (4 points)

$$A=5V T=250us=.25ms=(1/4)ms f=4K Hz \quad \omega=2\pi f=8K\pi rad/sec=25.1Krad/sec$$

v(t) = 5V sin(25.1K t)

c) Each diode in the circuit has a forward bias region, a reverse bias region and a breakdown region. Answer the following questions with regard to the circuit and PSpice output on the previous page.

vi) Which of the three regions does not affect the input signal pictured in the output on the previous page? (1 point)

breakdown region

- vii) Circle and label the area on the PSpice output where diode D1 and D2 are in the reverse bias region. (2 points)
- viii) Circle and label the area on the PSpice output where diode D3 and D4 are in the reverse bias region. (2 points)
- ix) Circle and label the area on the PSpice output where diodes D1 and D2 are in the forward bias region. (2 points)
- x) Circle and label the area on the PSPice output where the diodes D3 and D4 are in the forward bias region. (2 points)

d) What is the value of the current through the resistor when the input voltage is at the values listed below. Assume V_{on} for each diode is 0.7 Volts.

| iii) | 4 volts (3 points) | |
|------|----------------------------------|---------------------|
| | A: $R3 = 1K$ 4 – 2(0.7) = 2.6V | I=2.6/1K $I=2.6mA$ |
| | B: $R3 = 3K$ $4 - 2(0.7) = 2.6V$ | I=2.6/3K $I=0.87mA$ |
| | | |

iv) -4 volts (3 points)

A: -4 - 2(-0.7) = -2.6V I=-2.6/1K I = -2.6mA

A: -4 - 2(-0.7) = -2.6V I=-2.6/3K I = -0.87mA

Fall 2003 Question 2 -- Diodes (25 points)

The figure below is a half wave rectifier.



Let R1 = 2K. Here is the Capture/Pspice output for the above circuit:



a) Indicate the input and output signals on the plot. (4 points)

b) The input is in the form $v(t) = A \sin(\omega t)$. What is the general equation for the input signal to this circuit? Please give numerical values for A and ω . (4 points)

c) How would you fill in the following Capture parameters to get this output plot? Note: Any reasonable step size will be accepted. (*3 points*)

| Run to time: | | seconds | (TSTOP) | | | |
|--------------------------|---|---------|---------|--|--|--|
| Start saving data after: | | seconds | | | | |
| - Transient options | | | | | | |
| Maximum step size: | s | econds | | | | |

d) A diode has three active regions: forward bias region, reverse bias region, and breakdown region. Answer the following two questions in regard to the circuit and PSpice output on the previous page.

i. Which of the three regions does not affect the input signal pictured in the Pspice output on the previous page? (2 points)

ii. Circle and label the areas on the output signal when the diode is in the other two regions. (4 points)

- e) What is the value of the *current* through the resistor when the input voltage is at the values listed below. Assume Von for the diode is 0.7V.
 - *i.* 4 volts (4 points)

ii. –4 volts (4 points)

Fall 2003 Solution

Question 2 -- Diodes (25 points)

The figure below is a half wave rectifier.



Let R1 = 2K. Here is the Capture/Pspice output for the above circuit:



f) Indicate the input and output signals on the plot. (4 points)

g) The input is in the form $v(t) = A \sin(\omega t)$. What is the general equation for the input signal to this circuit? Please give numerical values for A and ω . (4 points)

 $A = 4V \text{ w}=2\pi/T=2\pi/1\text{ms}=2K\pi \text{ rad/sec}$

 $v(t) = 4V \sin(2K\pi t) = 4V \sin(6.28Kt)$

h) How would you fill in the following Capture parameters to get this output plot? Note: Any reasonable step size will be accepted. (*3 points*)

| Run to time: | 1m | seconds (TSTOP) | | | | |
|--------------------------|------|-----------------|--|--|--|--|
| Start saving data after: | 0 | seconds | | | | |
| - Transient options | | | | | | |
| Maximum step size: | lu s | econds | | | | |

Step sizes between 100m and 0.1u are reasonable.

i) A diode has three active regions: forward bias region, reverse bias region, and breakdown region. Answer the following two questions in regard to the circuit and PSpice output on the previous page.

i. Which of the three regions does not affect the input signal pictured in the Pspice output on the previous page? (2 points)

breakdown region

ii. Circle and label the areas on the output signal when the diode is in the other two regions. (4 points)

j) What is the value of the *current* through the resistor when the input voltage is at the values listed below. Assume Von for the diode is 0.7V.

j. 4 volts (4 points)

Test A: V=4-0.7=3/3V I=V/R=3.3/2K=1.65mA I=1.65mA

Test B: V=4-0.7=3/3V *I*=V/R=3.3/1K=3.3mA *I*=3.3mA

ii. -4 volts (4 points)

V = 0 V I=0mA (a very small Is is also ok)

Fall 2002 2. Diodes (25 points)

In the full wave rectifier below, each of the diodes turns on at 0.6 volts and the resistances are as shown.



a. (10 points) Draw a circuit which shows:

i) the positive half cycle of the circuit. (when current flows in the positive direction).

ii) the negative half cycle of the circuit. (when current flows in the negative direction.)

b. (9 points) What will the voltage between V_{out}^+ and V_{out}^- be when

i.) Vin = 5 V

ii) Vin = -5 V

iii) Vin = 0V



c. Which of the plots below represents Vin and Vout for this circuit (6 points)?

Fall 2002 Solution (not available)

Spring 2002 2. Diodes (25 points)

In the figure below, each of the diodes turns on at between 0.6 volts and R=2k.



1. Give the voltage at Vout for each of the following values of the input voltage, Vin (2 points each).

- a. Vin = 5 Volts b. Vin = 2 Volt
- c. Vin = 1Volts d. Vin = 0.4 Volts
- e. Vin = 0 Volts f. Vin = -0.4 Volts
- g. Vin = -1 Volt h. Vin = -2 Volt
- 2. Use the above data to plot Vout vs Vin for the range $-5 \le Vin \le +5$ (4 points)

Vout Vout



3. Which of the plots below represents Vout for this circuit (5 points)?



Spring 2002 solution (not available)

Fall 2001 Solution ENGR4300 Test 2A Fall 2001 Name_

2. Diode Circuits (25 points)

In figure below the diode is not ideal (turns on at $V_D = 0.7v$), and $R = 1k\Omega$.



Section

a) Determine Vout for

i.
$$Vin=-iv$$
 $D_{i_1}D_{i_2}P_{i_3}$, $D_{i_1}: OFF$

$$-M-\int_{i_1}^{i_2} J_{i_2}$$
ii. $Vin=0v$ $D_{i_2}D_{i_3}$, $D_{i_4}: OFF$

iii.
$$Vin = 2v^{-1}$$

 $D_{i_1}D_{i_2}: \sigma N$ $D_{i_2}D_{i_1}: \sigma P F$
 $D_{i_2}D_{i_1}D_{i_2}: \sigma N$ $D_{i_2}D_{i_1}: \sigma P F$
 $D_{i_1}D_{i_2}: \sigma N$ $D_{i_2}D_{i_1}: \sigma P F$

b) Plot Vout versus Vin for the range $-5v \le Vin \le 5v$. Make sure that the three points you calculated in part a fits on your plot. (This is equivalent to *DC Sweep* that you have performed in PSPICE)



c) If Vin = $ASin(2\pi f t)$, where A = 5v and f = 1kHz, which of the following plots represents Vout.? Why?

Since it is dipped at ± 1.4V

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