Part 2 (Graded)

Q1. Textbook Problem 9.40

The circuit shown in Figure P9.40(a) is a type of logic gate. Assume that the diodes are ideal. The voltages V_A and V_B independently have values of either 0V (for logic 0, or low) or 5V (for logic 1, or high). For which of the four combinations of input voltages is the output high (i.e., $V_O = 5V$)? What type of logic gate is this? Repeat for the circuit of Figure P9.40(b).

Forward bias = short circuit

Reverse bias = open circuit

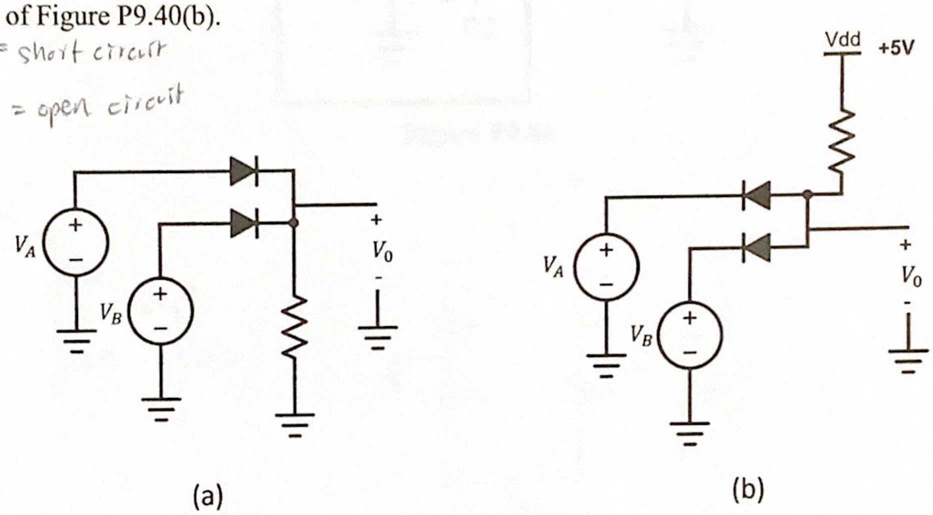


Figure 9.40

a)

V_A	V_B	V_o
Low open	Low open	0
Low open	High short	1
High short	Low open	1
High short	High short	1

b)

V_A	V_B	V_o
Low short	Low short	0
Low short	High open	0
High open	Low short	0
High open	High open	1

V_A	V_B	(a) V_O	(b) V_O
Low	Low	Low (0)	Low
Low	High	High (5)	Low
High	Low	High (5)	Low
High	High	High (5)	High

⇓ OR Gate

⇓ AND Gate

Q2. Textbook Problem 9.66

Sketch the transfer characteristic (v_0 versus v_{in}) to scale for the circuit shown in Figure P9.66. Allow v_{in} to range from -5V to +5V and assume that the diodes are ideal.

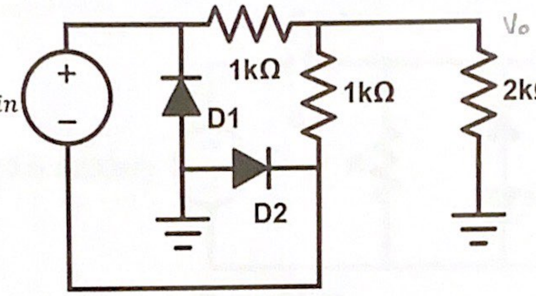
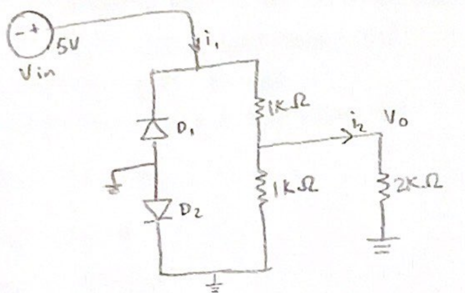


Figure P9.66

$0 < V_{in} < 5V$



$V_o = 2000\, i_2$

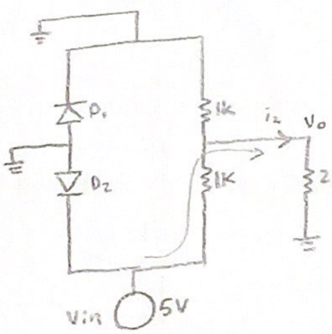
$R_{eq} = 1000 + \frac{1000 \times 2000}{1000 + 2000} = 1666.67 = \frac{5}{3}K$

$i = \frac{V_{in}}{R_{eq}} = \frac{3}{5} V_{in}$

$i_2 = \frac{i}{2+1} \times 1 = \frac{V_{in}}{5K}$

$V_o = \frac{2}{5} V_{in}\ V$

$-5V < V_{in} < 0$



$V_o = 2000\, i_2$

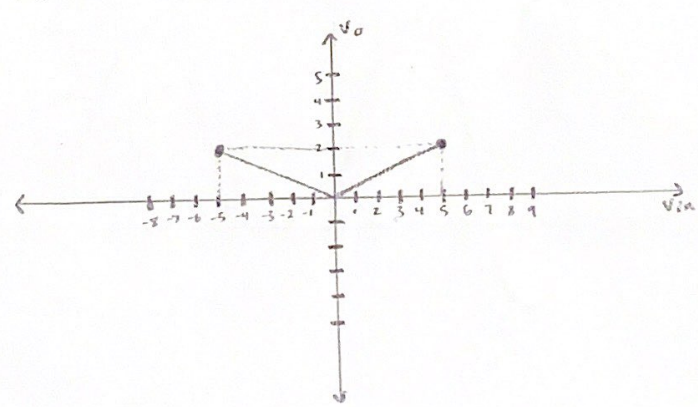
$R_{eq} = \frac{5}{3}K$

$i_2 = \frac{V_{in}}{\frac{5}{3}K} \cdot \frac{1}{3} = \frac{V_{in}}{5K}$

$V_o = \frac{2}{5} V_{in}\ V$

$$V_o = \begin{cases} \frac{2}{5}|V_{in}| & 0 < V_{in} < 5 \\ \frac{2}{5}|V_{in}| & -5 < V_{in} < 0 \end{cases}$$

Add your sketch here:



Q3. Textbook Problem 9.70

Sketch to scale the steady-state output waveform for the circuit shown in Figure P9.70. Assume that RC is much larger than the period of the input voltage and that the diodes are ideal.

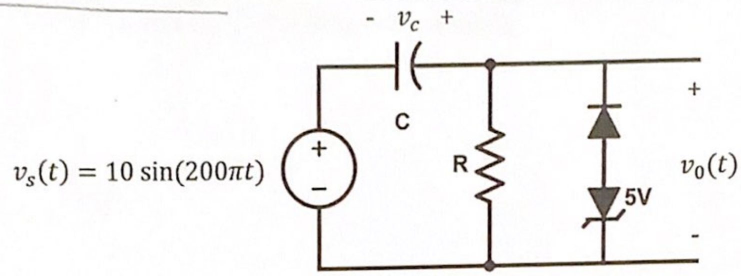


Figure P9.70

For the negative peak of the sinusoidal input:

- If output voltage falls below -5V, capacitor gets charged
- capacitor can not drop below -5V

$V_o = V_s + V_c$

$V_c = V_o - V_s$

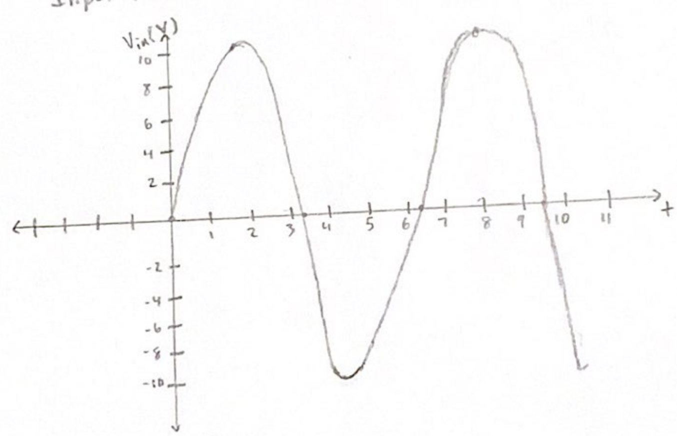
$V_c = -5 - (-10)$

$V_c = 5V$ [capacitor voltage]

$V_o = V_s(t) + V_c$

$V_o = 10\sin(200\pi t) + 5$ [output voltage]

Input Waveform (tried my best to sketch it nicely)



Negative peak of output voltage

$V_o = 10\sin(200\pi t) + 5$

(negative peak occurs at -10V)

$V_o = -10 + 5$

$V_o = -5$ V

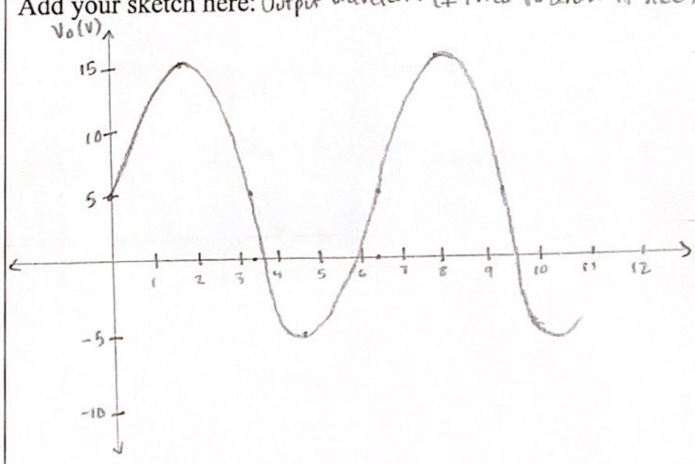
Positive peak of output voltage

(positive peak occurs at 10V)

$V_o = 10 + 5$

$V_o = 15$ V

Add your sketch here: Output Waveform (I tried to draw it nice)

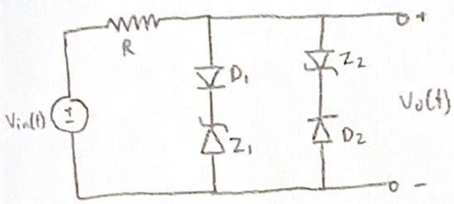


529

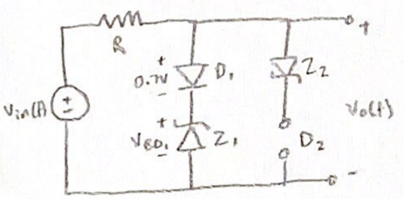
Q4. Textbook Problem 9.72

Design a clipper circuit to clip off the portions of an input voltage that fall above 3V or below -5V. Assume that diodes having a constant forward drop of 0.7V are available. Ideal Zener diodes of any breakdown voltage required are available. DC voltage sources of any value are available.

Basic Clipper Circuit Design



Positive Cycle



$V_o(t) = V_{D_1} + V_{BD_1}$

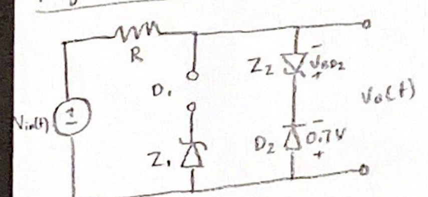
$V_o = 3V$

$V_{D_1} = 0.7V$

$3 = 0.7 + V_{BD_1}$

$V_{BD_1} = 2.3V \Rightarrow$ 3V output

Negative Cycle



$V_o(t) = -V_{D_1} - V_{BD_2}$

$V_o = -5V$

$V_{D_2} = 0.7V$

$-5 = -0.7 - V_{BD_2}$

$V_{BD_2} = 4.3V \Rightarrow -5V$ output

Combine positive and negative $\Rightarrow$

Answer: