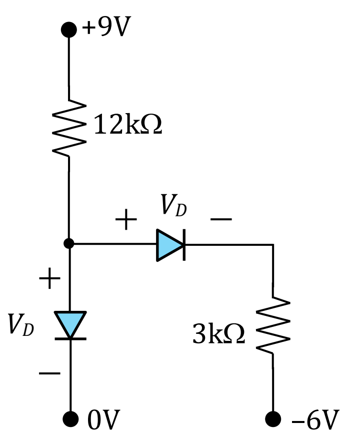
ECEN 325

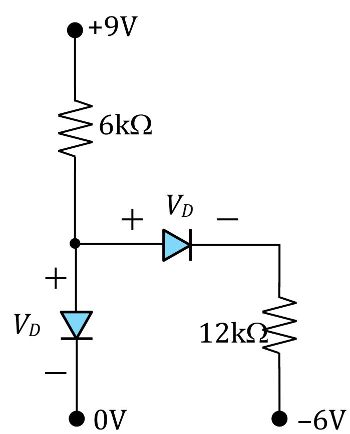
Homework #3

- Upload your solution in a single document in pdf or MS Word format only.
- Do not upload separate pictures or separate files:
    - Use this word document to prepare your solution. Your options are:
        - Type your equations
        - Write your equations using stylus computer or tablet
        - Insert images of your paper and pencil notes using a scanner (or camera). Scanning is preferred as pictures often have shadows or were taken at an angle that makes it difficult to understand and therefore points may be subtracted when graded.

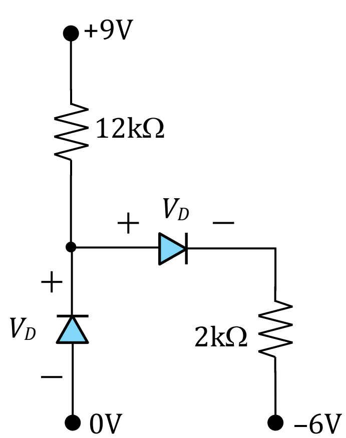
1. Find the current Voltage V_D and current I_D in the following circuit assuming (a) ideal diode. (b) Constant voltage drop model with V_{on} = 0.75V (c) using the exponential model ($I_0 = 1 \times 10^{-14}$). Verify your results through Multisim simulation



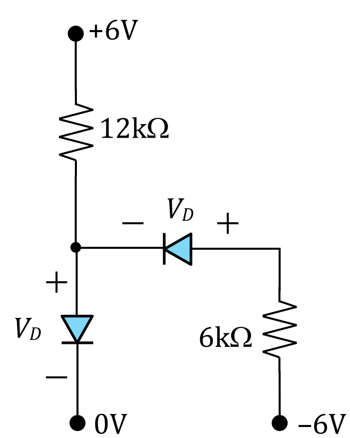
(a)



(b)



(c)

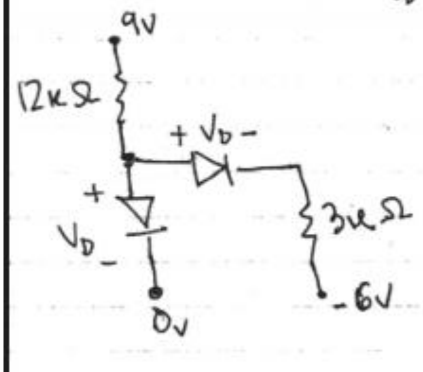


(d)

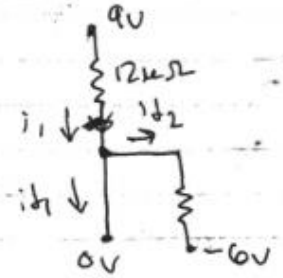
HW #3

ELEN 325

find V_D and I_D



ideal config:

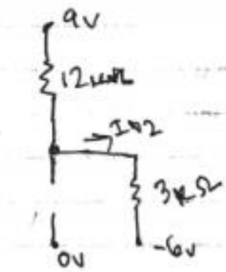


$I_1 = \frac{9-0}{12k} = .75mA$

$I_{d_2} = \frac{0--6}{3k} = 2mA$

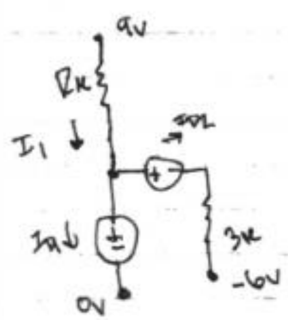
$I_{d_1} = .75 - 2 = -1.25mA$

reverse bias so switch off.



$$\boxed{\begin{array}{l} I_{D_2} = \frac{9-(-6)}{15k} = 1mA \\ I_{D_1} = 0A \\ V_{D_2} = 0V \\ V_{D1} = \text{open circuit.} \end{array}}$$

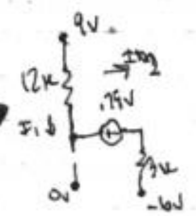
Now with .75 V = V_D (when on)



$I_1 = \frac{9-.75}{12k} = .688\ mA$

$I_{D2} = \frac{.75--6}{3k} = 2.25mA$

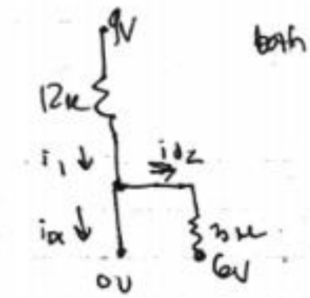
$I_{D1} = -1.562mA$ ← switch off.



$I_{D2} = \frac{9-.75--6}{15k}$

$$\boxed{\begin{array}{l} I_{D2} = .95mA \\ I_{D1} = 0A \\ V_{D2} = .75v \\ V_{D1} = \text{open circuit.} \end{array}}$$

now with $I_0 = 1E\text{-}14$

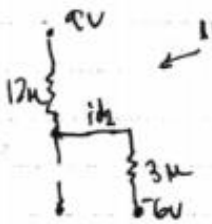


both on

$i_1 = \frac{9 - 1E\text{-}14}{12k} = \frac{\cancel{9}\ 8.999}{12k} = .738\,mA$

$i_2 = \frac{1E\text{-}14 - -6}{3k} = 1.23\,mA$

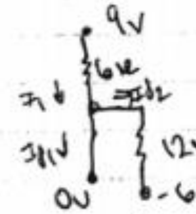
i_{d1} = negative = off



D1 off

$$\boxed{\begin{array}{l} i_{d2} = \frac{9 - 1E\text{-}14 - 6v}{15k} = .732\,mA \\ i_{d1} = 0A \\ V_{d2} \quad .732\ V \\ V_{d1} = \text{open circuit.} \end{array}}$$

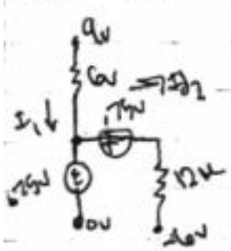
b) both on and ideal



$$\boxed{\begin{array}{l} I_1 = \frac{9-0}{6k} = 1.5\,mA \\ I_{D2} = .5\,mA \\ I_{D1} = 1\,mA \\ V_{D1} = 0V \\ V_{D2} = 0V \end{array}}$$

$\frac{0 - (-6)}{12k} =$

now with $V_D = .75$ (when on)



$$\boxed{\begin{array}{l} I_1 = \frac{9 - .75}{6k} = 1.375\,mA \\ I_{D2} = \frac{\cancel{A-0.75}\ - -6}{\cancel{12k}} = .563\,mA \\ I_{d1} = .812\,mA \\ V_{D1} = .75V \quad V_{D2} = .75\,V \end{array}}$$

now with $I_0 = 1E\text{-}14$

both Diode on.

$I_1 = \dfrac{9 - 1E\text{-}14}{6k} = 1.48\ mA$

$I_{D2} = \dfrac{1E\text{-}14 - -6}{12k} = .512\ mA$

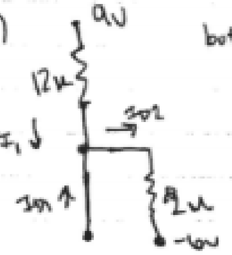
~~V_{D}~~.

$I_{D1} = .968\ mA$

$V_{D1} = V_{D2} = 1E\text{-}14$

---

c) both on and ideal



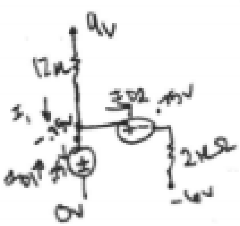
$I_1 = \dfrac{9-0}{12k} = .75\ mA$

$I_{D2} = \dfrac{0 - -6}{2k} = 3\ mA$

$I_{D1} = -I_1 + I_{D2} = 2.25\ mA$

$V_{D1} = V_{D2} = 0V$

both on and $V_D = .75$ (when on)



$I_1 = \dfrac{9 - .75}{12k} = .813\ mA$

$I_{D2} = \dfrac{-.75 - -6V}{2k} = 2.625\ mA$

$I_{D1} = 1.812\ mA$

$V_{D1} = V_{D2} = .75V$

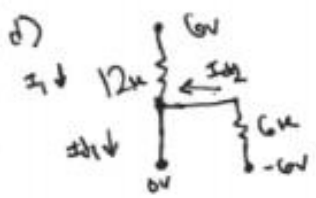
now with $I_0 = 1E\text{-}14$

$I_{D2} = 2.5490\ mA$

$I_{D1} = .759\ mA$

$V_{D1} = V_{D2} = 1E\text{-}14\ V$

d)



both on, ideal $V_D = 0$ V

$$I_1 = \frac{6-0}{12k} = .5\text{mA}$$

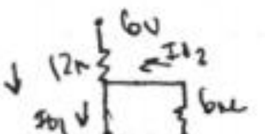
$$I_{D2} = \frac{-6-0}{6k} = -1\text{mA}$$

$$I_{D1} = I_1 + I_{d2} = -.5\text{mA}$$

turn both OFF

$$\boxed{\begin{array}{ll} I_{D1} = 0A & I_{d2} = 0A \\ V_{D1} = \text{open} & = V_{D2} \end{array}}$$

both on, .75 drop



$$I_1 = \frac{6V - .75}{12k} = .438\text{mA}$$

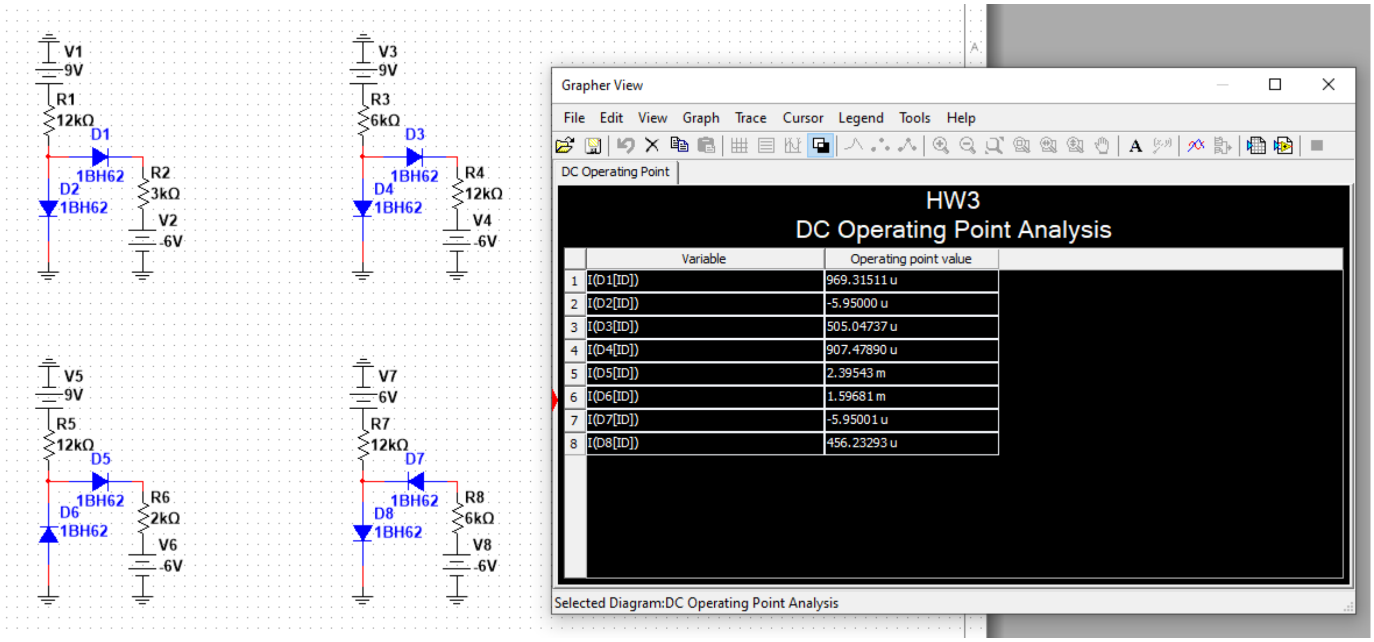
$$I_{d2} = \frac{-6 - .75}{6k} = -1.125\text{mA}$$

I_{d1} = negative

both will be off

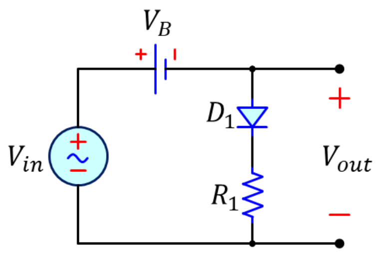
$$\boxed{\begin{array}{ll} I_{D1} = 0A & I_{d2} = 0A \\ V_{D1} = \text{open} = V_{D2} & \end{array}}$$

same for
$i_0 = 1\text{E-}14$

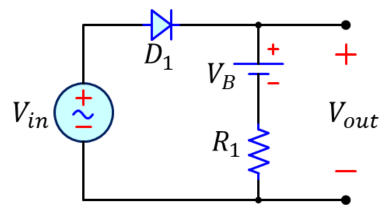


	Variable	Operating point value
1	I(D1[ID])	969.31511 u
2	I(D2[ID])	-5.95000 u
3	I(D3[ID])	505.04737 u
4	I(D4[ID])	907.47890 u
5	I(D5[ID])	2.39543 m
6	I(D6[ID])	1.59681 m
7	I(D7[ID])	-5.95001 u
8	I(D8[ID])	456.23293 u

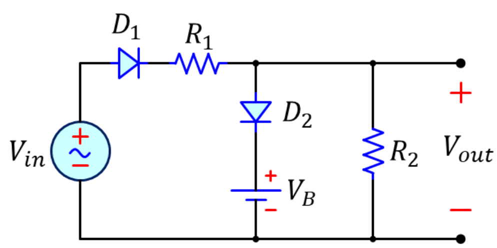
2. If the input is given by V_{in} = 5 cos (2π 1000 t), plot the output of each circuits shown as a function of time. Assume constant drop model ($V_{D,on}$ = 600 mV) and V_B = 2.5V, R_1 = 3kΩ and R_2 = 6KΩ. Verify your result through Multisim simulation.



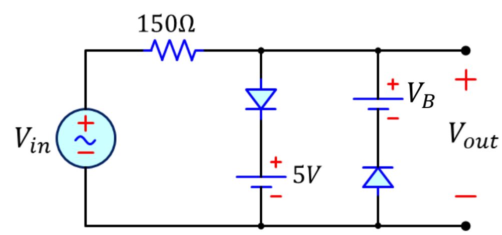
(a)



(b)

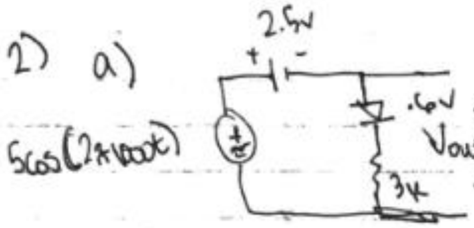


(c)



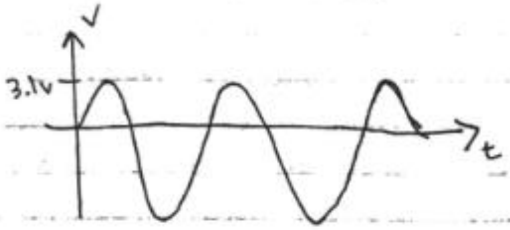
(d)

2) a)



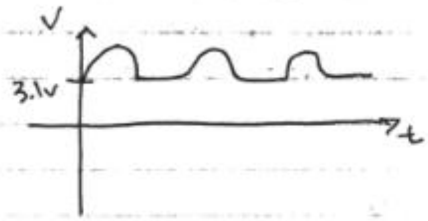
$V_{ton} = .6v \quad V_B = 2.5v$

$.6 + 2.5 = 3.1V$

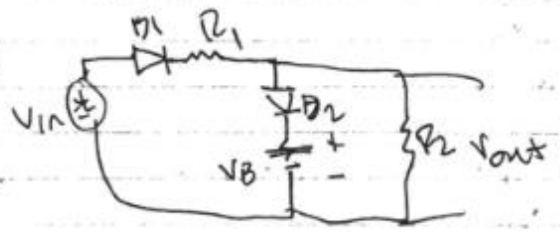


b)

diode turns off when under 3.1v

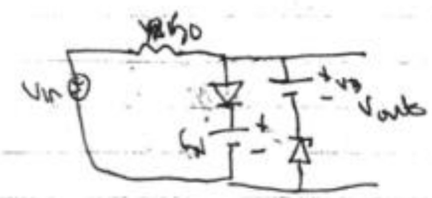


c)

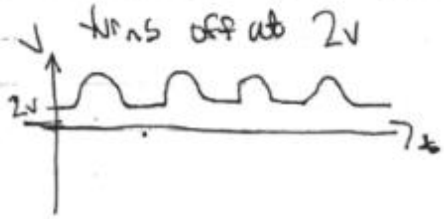


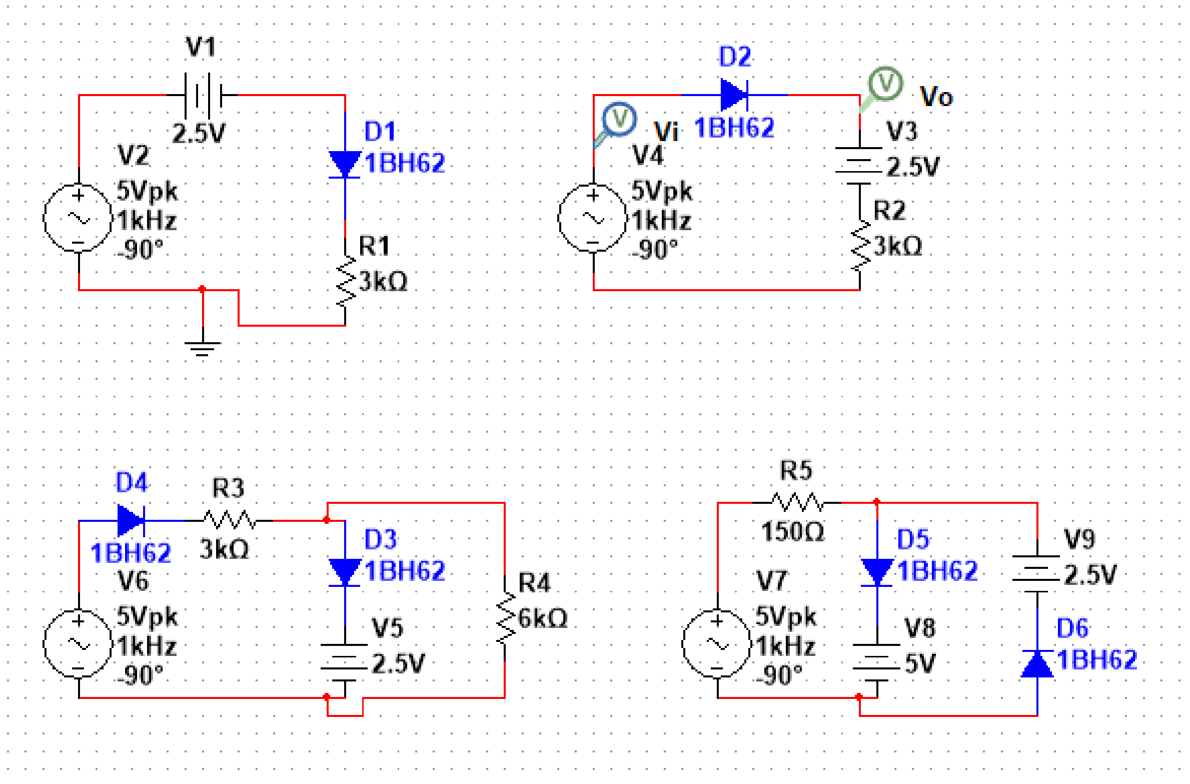
turns off at 0v.

d)



turns off at 2v




V1
2.5V
D1
1BH62
V2
5Vpk
1kHz
-90°
R1
3kΩ
D2
1BH62
Vo
Vi
V3
2.5V
V4
5Vpk
1kHz
-90°
R2
3kΩ
D4
1BH62
R3
3kΩ
D3
1BH62
V6
5Vpk
1kHz
-90°
V5
2.5V
R4
6kΩ
R5
150Ω
D5
1BH62
V9
2.5V
V7
5Vpk
1kHz
-90°
V8
5V
D6
1BH62

3. Consider the following rectifiers

   a. While constructing a full-wave rectifier, a student mistakenly has swapped the terminals of D_3 as depicted in Fig. 3.82. Explain what happens to $V_{in}, V_{out}, and\ I_{in}$

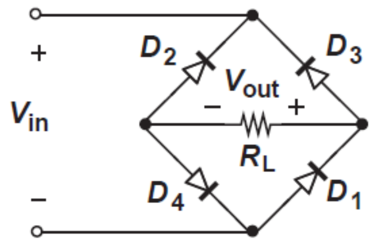
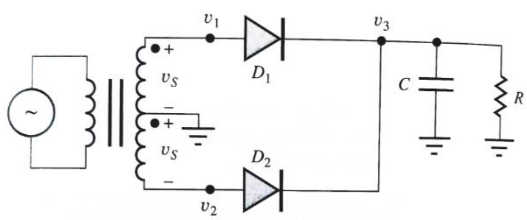


Figure 3.82

   b. The full-wave rectifier circuit shown was designed to have a maximum ripple of 1V, but is not operating properly. The measured waveforms at the three nodes are also shown next. What is wrong with the circuit.



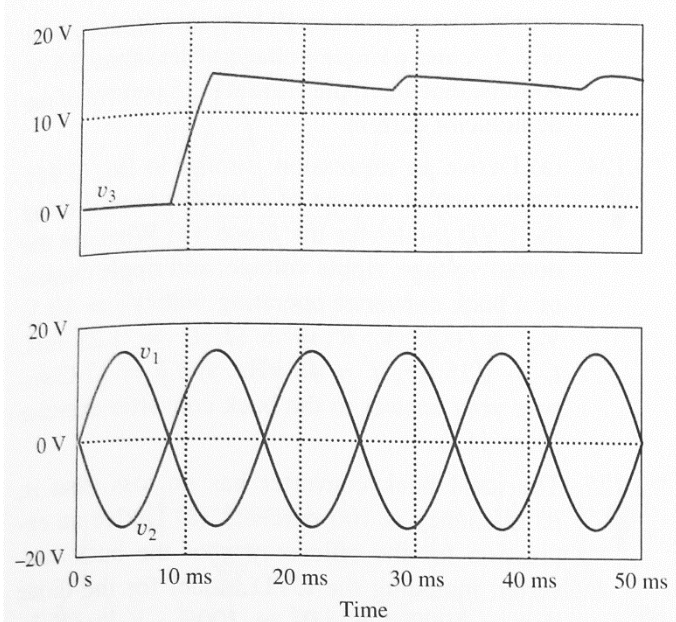
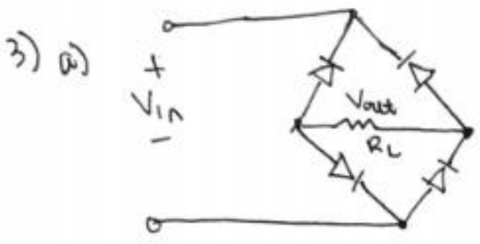


Figure 3.107(b) Waveforms for the circuit in Fig. 3.105(a).

3) a)



If Vin is positive then Diode 2 and Diode 3 are off. → $V_o = 0v$

If Vin is negative then Diode 1 and diode 3 are on and Diode 2 and 4 are off (open circuit). → $V_o = 0v$

The circuit does not work because during negative and positive inputs of Vin, Vo is always 0v.

b)

During the first half cycle, the output is 0V so this shows that Diode 1 is off. After the first half cycle, the diode turns on which then charges the output, which is shown in the output. So this is a half cycle rectifier, not a full wave.

4. The op amp in the circuit of Fig. P4.84 is ideal with output saturation levels of ±5 V. The diodes exhibit a constant 0.6-V drop when conducting. Find $v_m, v_A, and\ v_o$ for:
   (a) $v_I = +1.5V$
   (b) $v_I = +2.5V$
   (c) $v_I = -1.5V$
   (d) $v_I = -2.5V$

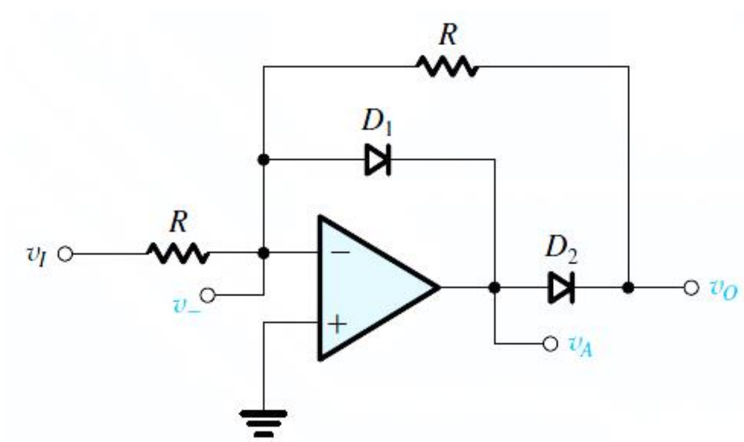
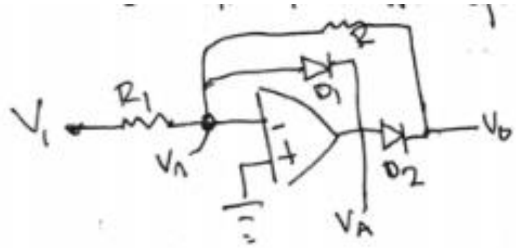


Figure P4.84

4)



$V_1 = 1.5v$ → $\boxed{V_n = 0v \quad V_A = 0 - .6 = -.6v \quad V_o = 0V}$

$V_1 = 2.5v$ → $\boxed{V_n = 0V \quad V_A = 0 - .6 = -.6v \quad V_o = 0v}$

Inverter
$V_i = -V_1$

$V_1 = -1.5v$ → $\boxed{V_n = 0V \quad V_o = 1.5v \quad V_A = .6 + 1.5 = 2.1v}$

$V_1 = -2.5v$ → $\boxed{V_n = 0v \quad V_o = 2.5v \quad V_A = .6 + 2.5 = 3.1v}$