(7.1) Assuming the diode is conducting the current is found to be

$$I = \frac{V_B - V_i}{5 + 10} = -\frac{2}{15} = -0.133 \text{ A}$$

The voltage across the diode is

$$V_D = (-10I + V_B) - (-5I + V_i)$$
$$= -1.33 + 10 - 0.667 - 12 = -3.997 \text{ V}$$

This result contradicts the assumption, since the diode cannot conduct if V_D is negative.

Thus, the diode must be off.

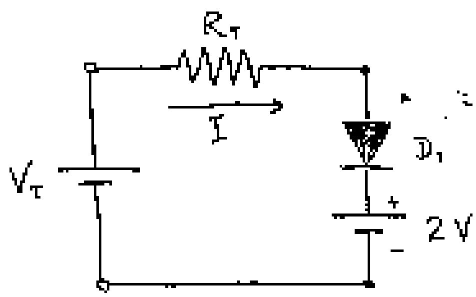
(7.4) a) $$R = \frac{5 - 0.7}{5 \times 10^{-3}} = 860 \ \Omega$$

b) $$I = \frac{E_{min} - 0.7}{860} = 1 \times 10^{-3}$$

$$\Rightarrow E_{min} = 0.86 + 0.7 = 1.56 \text{ V}$$

(7.6) a) RB
b) FB
c) RB
d) FB
e) FB

(7.7)



The Thèvenin equivalent resistance is

$$R_T = 500 \,\|\, 1000 = \frac{1000}{3}\ \Omega$$

The Thèvenin equivalent voltage is

$$V_T = \frac{V_{in}}{1500} \times 1000 = \frac{2}{3} \times V_{in}$$

The current I is

$$I = \frac{V_T - 2}{R_T} = \frac{\frac{2}{3} \times V_{in} - 2}{\frac{1000}{3}} = \frac{V_{in} - 3}{500}$$

To keep diode D_1 FB, the current I, must be greater than or equal zero.

Therefore, the range of V_{in} is

$$V_{in} \geq 3\ V$$

(7.8) If diode D_2 is conducting, the voltage at the node to the left of D_1 will be 5 V and D_1 will conduct.

To ensure that D_2 is conducting, voltage V_{in} must be greater than 5 V.

Assume D_2 is cut off. D_1 will conduct as long as V_{in} is greater than zero.

Thus, the value for D_1 to conduct is

$$V_{in} > 0$$

(7.9) a) D_2 and D_4 are FB ; D_1 and D_3 are RB.

$$V_{out} = -5 + 0.7 = -4.3\text{ V}$$

b) D_1 and D_2 are RB ; D_3 is FB.

$$V_{out} = -10 + 0.7 = -9.3\text{ V}$$

c) D_1 is RB ; D_2 is FB.

$$V_{out} = 5 - 0.7 = 4.3\text{ V}$$

(7.11) Assume D_1 is conducting ; the diode current is

$$I = \frac{V_{in} - 2}{1500} = \frac{6}{1500} = 4\text{ mA}$$

Since the current is positive, the initial assumption was correct.

The output voltage V_o is

$$V_o = 500\,I + 2 = 4\text{ V}$$

(7.15) a) The voltage across the diode is

$$V_Z = V_s\left(\frac{50 + 50}{100 + 50 + 50}\right) = 6 < 7.7\,V$$

Therefore, the Zener diode is off. Thus, the output voltage is :

$$V_{out} = 6\left(\frac{50}{100}\right) = 3\,V$$

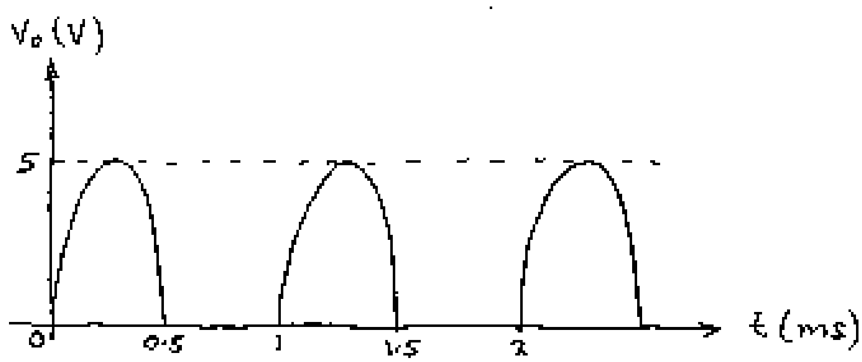
b) The voltage across the diode is

$$V_Z = 20\left(\frac{100}{200}\right) = 10 > 7.7\,V$$

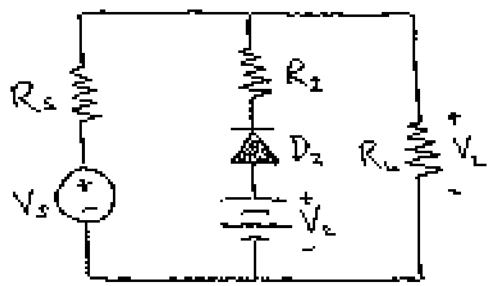
In this case, the Zener diode is on and the output voltage is :

$$V_{out} = 7.7\left(\frac{50}{100}\right) = 3.85\,V$$

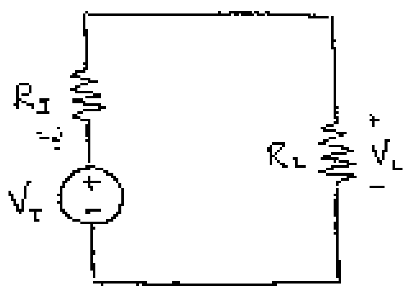
(7.24)



(7.36) For $0 < V_S < V_Z = 12\,V$, the circuit is shown below.



The Thevenin equivalent circuit is the following:



where,

$$V_T = \frac{V_S - V_Z}{R_S + R_Z} \times R_Z + V_Z$$

$$= \frac{1}{3} V_S + 8\,V$$

$$R_T = \frac{5 \times 10}{15} = \frac{10}{3}\,\Omega$$

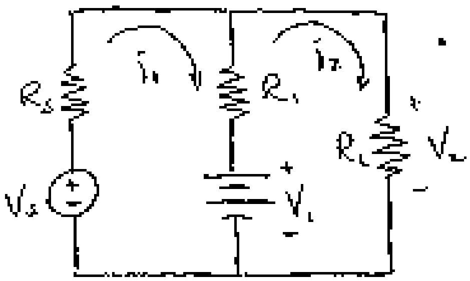
Thus, the load voltage is given by the expression

$$V_L = \frac{R_L}{R_L + R_T} \times V_T = 0.3125\,V_S + 7.5\,V$$

For $12 < V_S < 15$, V_L is given by

$$V_L = \frac{5}{6} V_S = 0.833\,V_S$$

For $15 < V_S < 20$, the equivalent circuit is shown below.



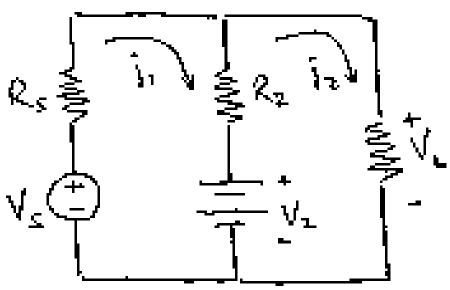
Applying mesh analysis,

$$i_1(R_s + R_1) - i_2 R_1 = V_s - V_1$$
$$i_2(R_1 + R_L) - i_1 R_1 = V_1$$

We find that

$$V_L = R_L \times i_2 = R_L \times \frac{V_s + 15}{110}$$
$$= 0.4545\,V_s + 6.818$$

For $-20 < V_s < 0$, the circuit is the following:



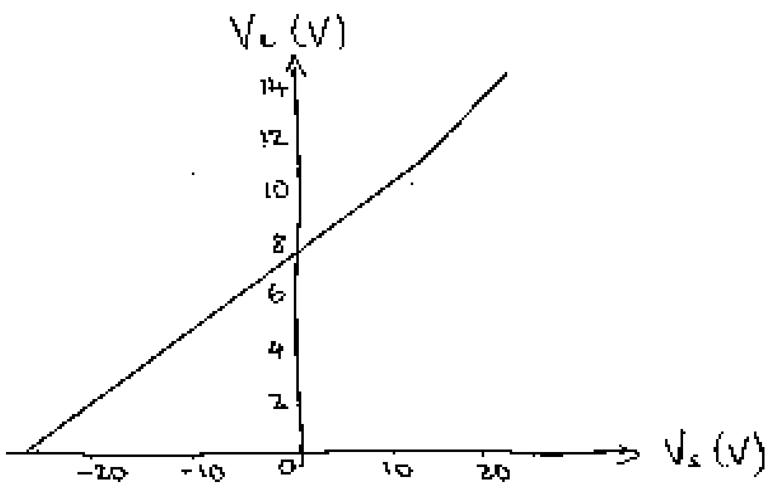
and

$$i_1(R_s + R_2) - i_2 R_2 = -V_2 + V_s$$
$$i_2(R_2 + R_L) - i_1 R_2 = V_2$$

so that

$$V_L = i_2 \times R_L = \frac{24 + V_s}{160} \times 50$$
$$= 7.5 + 0.3125\,V_s$$

The $V_L - V_s$ characteristic:



7.39 For fig. P7.36 (a):

a) At $t = t_1^-$, before the switch S_1 closes, we have

$$I_{sw} = 0$$

$$I_s = I_B = \frac{V_s - V_{battery}}{R_s + R_B}$$

$$= \frac{13 - 9.6}{11} = 0.31\text{ A}$$

b) At $t = t_1^+$, we have

$$I_s = 13\text{A}, \quad I_B = -0.96\text{ A}$$

$$I_{sw} = I_s - I_B = 13.96\text{ A}$$

c) The battery voltage will drop quickly because of the small resistance in the circuit.

For fig. 7.36 (b):

a) At $t = t_1^-$, we have

$$I_{sw} = 0$$

$$I_s = I_B = \frac{V_s - V_{battery} - V_\gamma}{R_s + R_B}$$

$$= \frac{13 - 9.6 - 0.6}{11} = 0.25\text{ A}$$

b) At $t = t_1^+$, we have

$$I_s = I_{sw} = 13\text{A}, \quad I_B = 0$$

c) The battery will not be drained, because of the large reverse resistance of the diode.