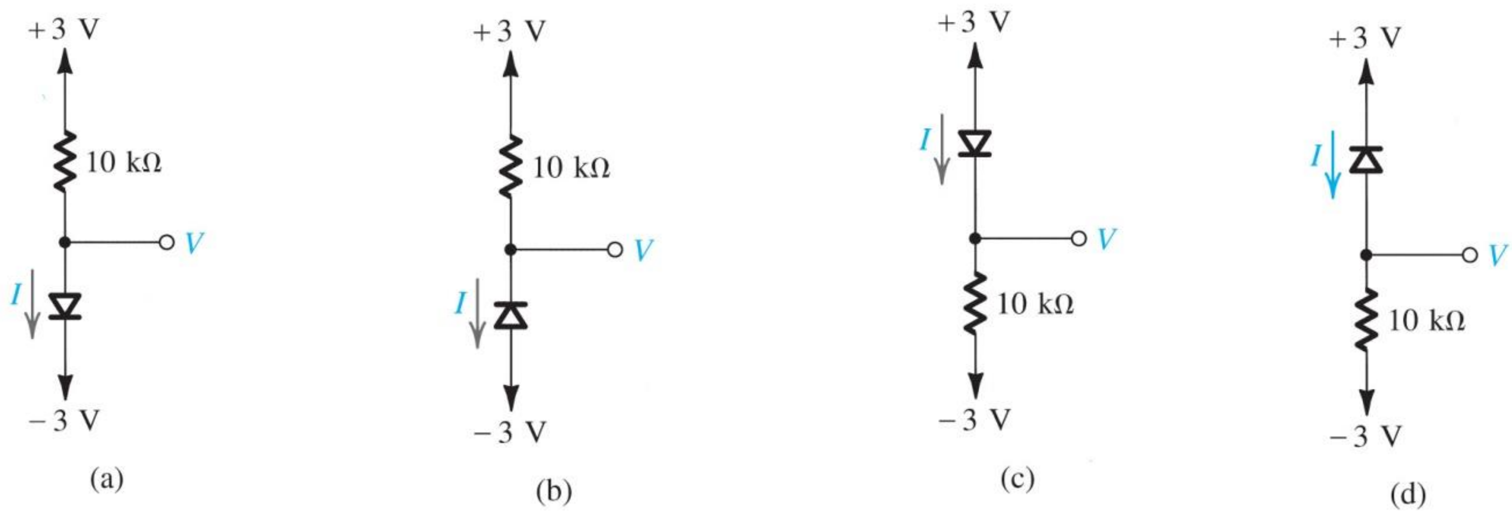
Homework #7

Problems 4.2, 4.3, 4.9, 4.17, and 4.23

Problem 4.2

For the circuits shown in Fig. P4.2 using ideal diodes, find the values of the voltages and currents indicated.

Figure P4.2



(a)

$$I = \frac{3\text{V} - -3\text{V}}{10\text{k}\Omega} = 0.6\text{mA}$$

$$V = -3\text{V}$$

(b)

$$I = 0\text{mA}$$

$$V = +3\text{V}$$

(c)

$$I = \frac{3\text{V} - -3\text{V}}{10\text{k}\Omega} = 0.6\text{mA}$$

$$V = +3\text{V}$$

(d)

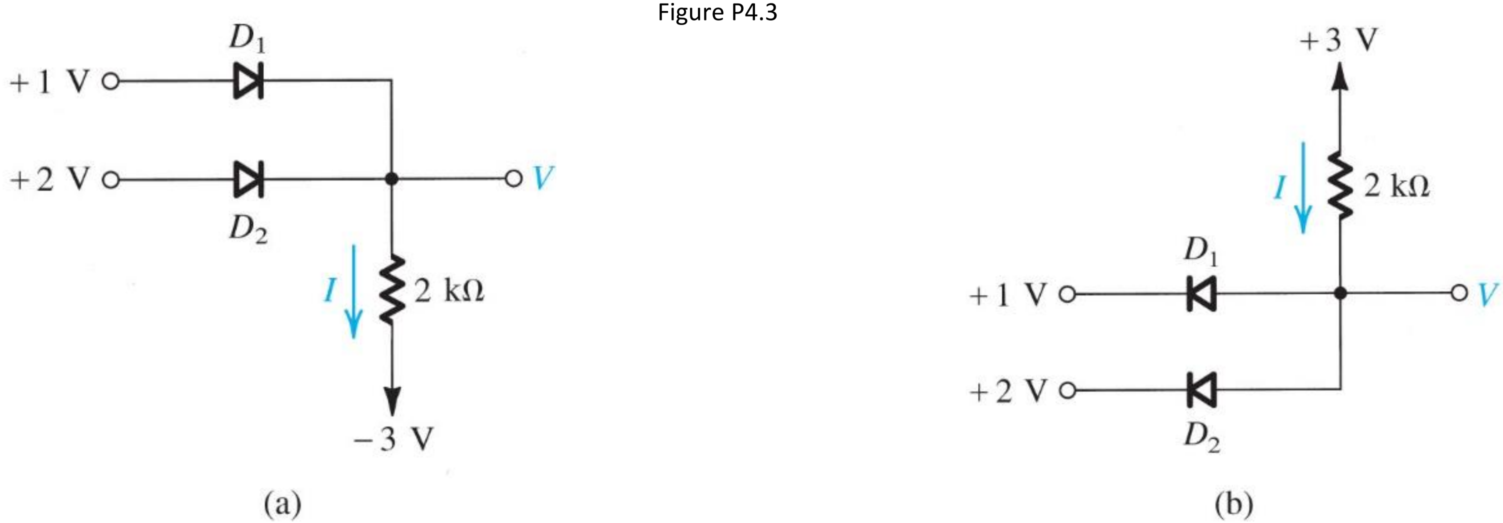
$$I = 0\text{mA}$$

$$V = -3\text{V}$$

Problem 4.3

For the circuits shown in Fig. P4.3 using ideal diodes, find the values of the voltages and currents indicated.

Figure P4.3



$$I = \frac{2\text{V} - -3\text{V}}{2\text{k}\Omega} = 2.5\text{mA}$$

$$V = +2\text{V}$$

$$I = \frac{3\text{V} - 1\text{V}}{2\text{k}\Omega} = 1\text{mA}$$

$$V = +1\text{V}$$

Problem 4.9

Assuming that the diodes in the circuits of Fig. P4.9 are ideal, find the values of the labeled voltages and currents.

Assume D_1 is conducting, then the voltage at the anode is 0 V and D_2 is also conducting and the output voltage, V = 0 V.

$$I = \frac{3\text{V}}{12\text{k}\Omega} - \frac{3\text{V}}{6\text{k}\Omega} = 0.25\text{mA}-0.5\text{mA}$$

$$I = -0.25\text{mA}$$

Not possible!! so D_1 is off.

$$I = 0\text{mA}$$

$$V = -3\text{V}+6\text{V}\frac{6\text{k}\Omega}{18\text{k}\Omega} = -1\text{V}$$

Which verifies that D_1 is off.

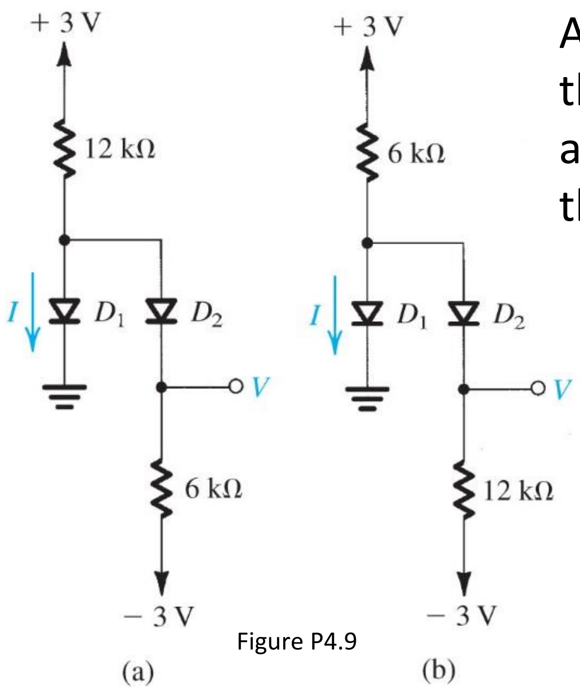


Figure P4.9

Assume D_1 is conducting, then the voltage at the anode is 0 V and D_2 is also conducting and the output voltage, V = 0 V.

$$I = \frac{3\text{V}}{6\text{k}\Omega} - \frac{3\text{V}}{12\text{k}\Omega} = 0.5\text{mA}-0.25\text{mA}$$

$$I = 0.25\text{mA}$$

$$V = 0\text{V}$$

Problem 4.17

Calculate the value of the thermal voltage, V_T, at -55°C, 0°C, +40°C, and +125°C. At what temperature is V_T exactly 25 mV?

$$V_T = 0.0862T \text{ mV}$$

Problem 4.17		
Temp (C)	**Temp (K)**	**V_T (mV)**
-55	218	18.79
0	273	23.53
40	313	26.98
125	398	34.31

$$T = \frac{V_T}{0.0862}$$

$$T = \frac{25\text{mV}}{0.0862} = 290.0232019\text{K}$$

Problem 4.23

The circuit in Fig. P4.23 utilizes three identical diodes having $I_S = 10^{-14}$ A. Find the value of the current I required to obtain an output voltage $V_O = 2.0$ V. If a current of 1 mA is drawn away from the output terminal by a load, what is the change in output voltage?

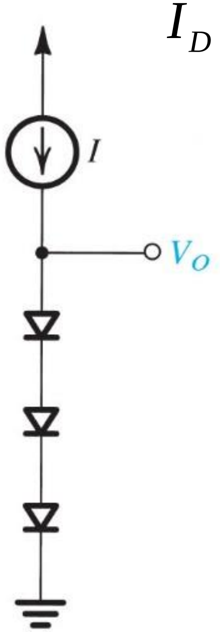


Figure P4.23

$$I_D = I_S e^{V_D/V_T} \qquad V_D = \frac{V_O}{3} = \frac{2.0\text{V}}{3} = 0.667\text{V}$$

$$\Rightarrow I = I_D = I_S e^{V_D/V_T} = 10^{-14}\text{A} \times e^{0.667\text{V}/0.025\text{V}} = 3.86\text{mA}$$

If 1 mA of I is taken away by the load then $I_D = 2.86$ mA

$$V_D = V_T \ln\left(\frac{I_D}{I_S}\right) = 25\text{mV} \times \ln\left(\frac{0.00286\text{A}}{10^{-14}\text{A}}\right) = 659\text{mV}$$

$$\Delta V_O = 3(667\text{mV} - 659\text{mV}) = 24\text{mV}$$