Homework 2

4.20, 4.28 (both use diode equation, and assume $nV_T = 0.025$V),
4.40, 4.42, and 4.44

4.20 $I = I_S e^{V_D/V_T}$

$10^{-3} = I_S e^{0.7/V_T}$

For $V_D = 0.71$ V,

$I = I_S e^{0.71/V_T}$

Combining (1) and (2) gives

$I = 10^{-3} e^{(0.71-0.7)/0.025}$

$= 1.49$ mA

For $V_D = 0.8$ V,

$I = I_S e^{0.8/V_T}$

Combining (1) and (3) gives

$I = 10^{-3} \times e^{(0.8-0.7)/0.025}$

$= 54.6$ mA

Similarly, for $V_D = 0.69$ V we obtain

$I = 10^{-3} \times e^{(0.69-0.7)/0.025}$

$= 0.67$ mA

and for $V_D = 0.6$ V we have

$I = 10^{-3} e^{(0.6-0.7)/0.025}$

$= 18.3$ μA

To increase the current by a factor of 10, V_D must be increased by ΔV_D,

$10 = e^{\Delta V_D/0.025}$

$\Rightarrow \Delta V_D = 0.025 \ln 10 = 57.6$ mV

4.28 We can write the following node equation at the diode anodes:

$I_{D2} = 10\text{ mA} - V/R$

$I_{D1} = V/R$

We can write the following equation for the diode voltages:

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

We can write the following diode equations:

$I_{D2} = I_S e^{V_{D2}/V_T}$

$I_{D1} = I_S e^{V_{D1}/V_T}$

Taking the ratio of the two equations above, we have

$$\frac{I_{D2}}{I_{D1}} = \frac{10\text{ mA} - V/R}{V/R} = e^{(V_{D2}-V_{D1})/V_T} = e^{V/V_T}$$

To achieve $V = 50$ mV, we need

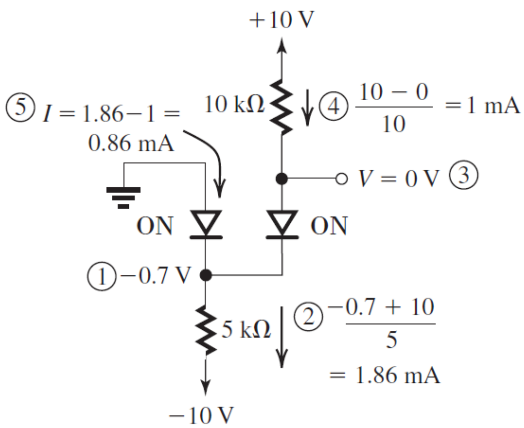
$$\frac{I_{D2}}{I_{D1}} = \frac{10\text{ mA} - 0.05/R}{0.05/R} = e^{0.05/0.025} = 7.39$$

Solving the above equation, we have

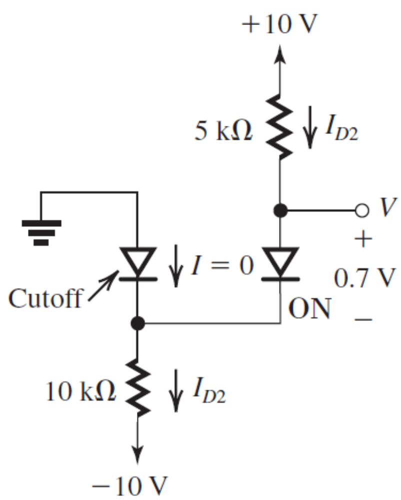
$R = 42\ \Omega$

4.40 Refer to Example 4.2.

(a)



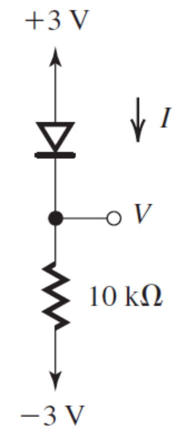
(b)



$$I_{D2} = \frac{10-(-10)-0.7}{15} = 1.29 \text{ mA}$$

$$V_D = -10 + 1.29\,(10) + 0.7 = 3.6 \text{ V}$$

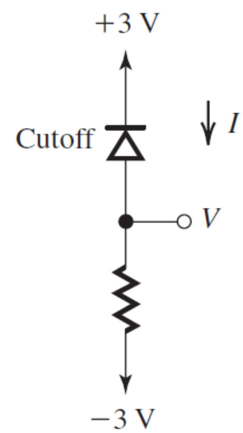
(c)



$$V = 3 - 0.7 = 2.3 \text{ V}$$

$$I = \frac{2.3+3}{10} = 0.53 \text{ mA}$$

(d)

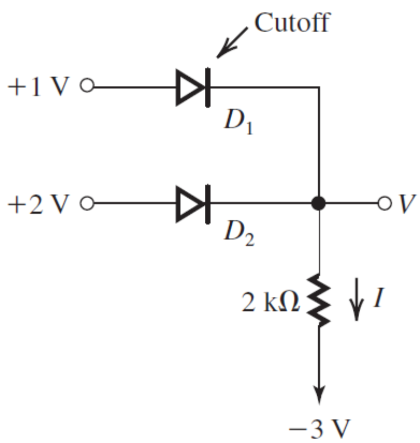


$$I = 0 \text{ A}$$

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

4.42

(a)



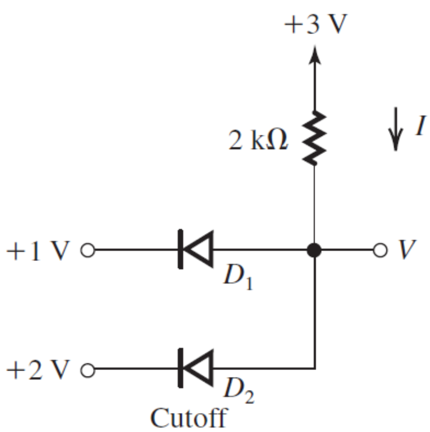
$$V = 2 - 0.7$$

$$= 1.3\text{ V}$$

$$I = \frac{1.3 - (-3)}{2}$$

$$= 2.15\text{ mA}$$

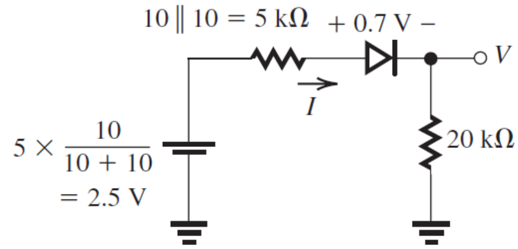
(b)



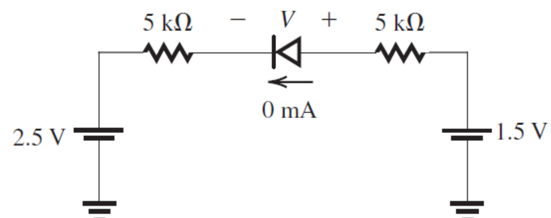
$$V = 1 + 0.7 = 1.7\text{ V}$$

$$I = \frac{3 - 1.7}{2} = 0.65\text{ mA}$$

4.44



(a)



(b)

(a) $I = \dfrac{2.5 - 0.7}{5 + 20} = 0.072\text{ mA}$

$V = 0.072 \times 20 = 1.44\text{ V}$

(b) The diode will be cut off, thus

$I = 0$

$V = 1.5 - 2.5 = -1\text{ V}$