ENGR 305- Homework 2 solutions

4.2 For an ideal diode, we assume zero volts across the diode.

(a) Diode is conducting, V = -5 V and $I = \frac{+5V-(-5V)}{10\ k\Omega} = 1.0\ mA$

(b) Diode is reverse biased, thus
$I = 0$
$V = +5$ V

(c) Diode is conducting, thus
$V = +5$ V
$I = \frac{+5\text{V} - (-5\text{V})}{10\ k\Omega} = 1.0\ mA$

(d) Diode is reverse biased, thus
$I = 0$
$V = -5$ V

4.15 The maximum reverse voltage arises when
$v_I = V_+ - 10 = 3 - 10 = -7$ V

The maximum forward current arises when
$v_I = I_{\text{max}} \times R + V_+ = 50 \times 0.1 + 3 = 8$ V

Thus, the safe operating range is
$-7\text{ V} \le v_I \le 8$ V.

4.21 $I = I_S\, e^{V_D/V_T}$
$10^{-3} = I_S\, e^{V_D/V_T}$ (1)
For $V_D = 0.71$ V,
$I = I_S\, e^{0.71/V_T}$ (2)
Combining (1) and (2) gives

$I = 10^{-3}\, e^{(0.71-0.7)/0.025}$
= 1.49 mA

For $V_D = 0.8$ V,
$I = I_S\, e^{0.8/V_T}$ (3)
Combining (1) and (3) gives
$I = 10^{-3}\, e^{(0.8-0.7)/0.025}$
= 54.6 mA
Similarly, for $V_D = 0.69$ V we obtain
$I = 10^{-3}\, e^{(0.69-0.7)/0.025}$

= 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 2, V_D must be increased by ΔV_D,

$2 = e^{\Delta V_D/.025} \Rightarrow \Delta V_D = 0.025 \ln 2 = 17.3$ mV

4.36 $I_S = 10^{-15}A = 10^{-12}mA$

Use the iterative analysis procedure:

1. $V_D = 0.7\,V,\ I_D = \frac{(1.5-0.7)V}{2k\Omega} = 0.4\,mA$
2. $V_D = V_T ln\left(\frac{I_D}{I_S}\right) = 0.025\,ln\left(\frac{0.4\,mA}{10^{-12}mA}\right) = 0.6679\,V$

   $$I_D = \frac{(1.5-0.6679)V}{2\,k\Omega} = 0.4161\,mA$$
3. $V_D = 0.025\,ln\left(\frac{0.4161\,mA}{10^{-12}mA}\right) = 0.6689\,V$

   $$I_D = \frac{(1.5-0.6689)V}{2\,k\Omega} = 0.4156\,mA$$
4. $V_D = 0.025\,ln\left(\frac{0.4156\,mA}{10^{-12}mA}\right) = 0.6688\,V$

   $$I_D = \frac{(1.5-0.6688)V}{2\,k\Omega} = 0.4156\,mA$$

   Since the values are almost the same, we stop the iteration.

4.41 Here we use $V_D = 0.7\,V$

(a) $V = -5\,V + 0.7V = -4.3\,V$

$$I = \frac{5V-(-4.3V)}{10\,k\Omega} = 0.93\,mA$$

(b) The diode is reverse-biased (cutoff).

I = 0 and V = +5 V

(c) V = 5V – 0.7 V = + 4.3 V

I = $\frac{4.3\,V-(-5V)}{10\,k\Omega} = 0.93\,mA$

(d) The diode is reverse-biased and cutoff.

I = 0 and V = -5V.