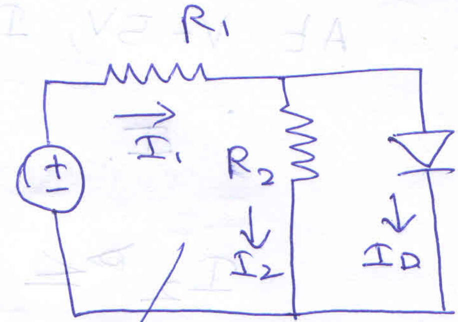
1.43

Min current at $V_{PS} = 5V$

~~5 = R1~~



$$I_2 = \frac{0.7}{R_2}$$

$$I_1 \geq \frac{.7}{R_2} + 2 \times 10^{-3}$$

$$5 = I_1 R_1 + .7$$

$$\leq \left(\frac{.7}{R_2} + 2\times10^{-3}\right) R_1 + .7$$

$$\leq \frac{.7 R_1}{R_2} + 2 \times 10^{-3} R_1 + .7$$

$$\Rightarrow \frac{.7 R_1}{R_2} + 2 \times 10^{-3} R_1 \geq 4.3$$

$$\Rightarrow .7 R_1 + 2 \times 10^{-3} R_1 R_2 \geq 4.3 R_2 .$$

Max current at $V_{PS} = 10V$.

4.

Max current $= \frac{10}{.7}$ mA

Min current $= 2$ mA.

This is the maximum and minimum diode current

$$\text{Diff} = \left(\frac{10}{.7} - 2\right) \text{mA} = \frac{10 - 1.4}{.7} \text{mA} = \frac{8.6}{.7} \text{mA}$$

$$= \frac{86}{7} \text{mA}.$$

When voltage changes from 5 to 10V, max diff in current through R_1

$$= \frac{86}{7} \text{mA} = \frac{10-5}{R_1}$$

$$\Rightarrow R_1 = \frac{5\times7}{86} k\Omega = \frac{35}{86} k\Omega \simeq 407\Omega$$

At $V = 5V$, $I_1 \simeq \dfrac{5 - .7}{R_1} = \dfrac{4.3}{407}$ A.

$$= 10.56\,mA.$$

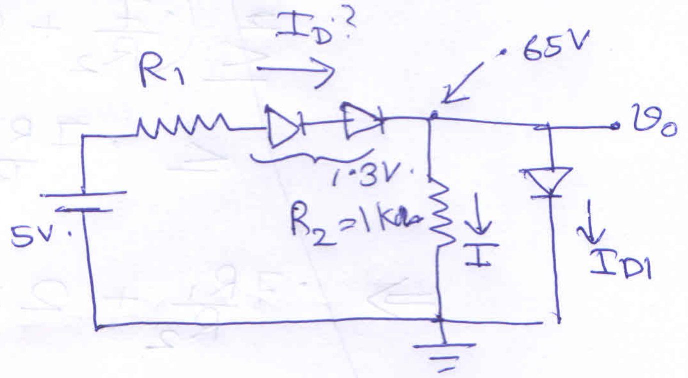
$$I_2 \leq 10.56 - 2$$

$$= 8.56\,mA$$

$$\therefore R_2 \geq \frac{.7}{8.56}\,k\Omega$$

$$\geq 81.77\,\Omega.$$

5.



(a) ~~$I_{D1} = .65V$~~

$$I_{D1} = I = \frac{.65V}{1\,k\Omega}$$

$$= 0.65\,mA.$$

$$I_{D2} = 2 \times 0.65\,mA$$

$$= 1.3\,mA.$$

$$\Rightarrow \cancel{5V}\ \frac{5 - .65 - 1.3}{R_1} = 1.3\,mA.$$

$$\Rightarrow \frac{5 - 1.95}{R_1} = 1.3\,mA.$$

$$\Rightarrow R_1 = \frac{3.05}{1.3}\,k\Omega$$

$$= 2.3461\,k\Omega$$

$$I_{D2} = \frac{8-1.95}{2\cancel{.346}} mA$$

$$= \frac{6.05}{2\cancel{.346}} mA = 3.025 mA.$$

$$\cancel{= 2.57 mA}$$

$$I_{D1} = I_{D2} - .65 mA$$

$$= \cancel{1.92 mA} \; (3.025 - .65) mA.$$

$$= \cancel{2.6 mA}. \; 2.375 mA.$$

(6)

$$I_d = I_s \exp\left(\frac{qV_D}{\eta V_T}\right).$$

$$\Rightarrow \cancel{r_d = \frac{25}{I} m\Omega}.$$

Small signal equivalent circuit

$$r_d = \frac{V_T}{I}$$

$$v_s = R_S i_D + \frac{V_T}{I} i_D.$$

$$\Rightarrow i_D = \frac{v_s}{R_S + \frac{V_T}{I}}$$

$$= \frac{v_s I}{R_S I + V_T}.$$

$$v_d = r_d i_D$$

$$= \frac{V_T}{I} \frac{v_s I}{R_S I + V_T}$$

$$= v_s \left(\frac{V_T}{V_T + R_S I}\right).$$

(a) $V_Z = 5.6 + (I_Z - .1) \times 10^{-2}$.

I_Z is in mA.

$10 = .5 \times I_Z + 5.6 + (I_Z - .1) \times 10^{-2}$

$\cancel{2} = .5 I_Z + 5.6 + .01 I_Z - .001$

$4.401 = .51 I_Z$

$\Rightarrow I_Z = \frac{4.401}{.51}$

$= 8.629$ mA.

$V_Z = V_o = 5.6 + (8.629 - .1) \times 10^{-2}$

$= 5.6 + 8.628 \times 10^{-2}$

$= 5.6 + .08628$

$= 5.68628$

(c).

$V_Z = 5.6 + (I_Z - .1) \times 10^{-2}$

$I_L = \frac{V_Z}{2}$ mA.

$10 = \left(I_Z + \frac{5.6 + (I_Z - .1) \times 10^{-2}}{2} \right) \times .5$

$+ 5.6 + (I_Z - .1) \times 10^{-2}$

$= \left(I_Z + 2.8 + \frac{I_Z \times 10^{-2}}{2} - .05 \times 10^{-2} \right) \times .5$

$+ 5.6 + (I_Z - .1) \times 10^{-2}$

$= \cdot 5 I_Z + 1 \cdot 4 + \cdot 0025 I_Z - \cdot 025 \times 10^{-2}$

$+ 5 \cdot 6 + \cdot 01 I_Z - \cdot 001$

$\Rightarrow 0 \cdot 5125 I_Z = 10 - 1 \cdot 4 + \cdot 00025$

$- 5 \cdot 6 + \cdot 001$

$= 3 \cdot 00125$

$I_Z = 5 \cdot 8561 \, mA.$

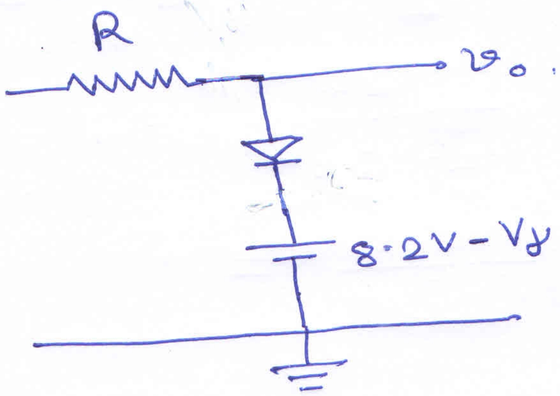
$V_Z = 5 \cdot 6 + (5 \cdot 8561 - \cdot 1) \times \cdot 01$

$= 5 \cdot 6 + 5 \cdot 7561 \times \cdot 01$

$= 5 \cdot 6 + 0 \cdot 057561$

$= 5 \cdot 65761.$

8)



There can also be other solutions to this problem.