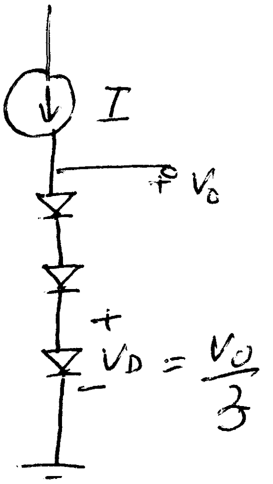
Solution to Hour Exam I

1.



$I_S = 10^{-14}$ $n = 1$

$V_0 = 2V$ $I_D = I = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)$

$\simeq 10^{-14} e^{\frac{0.667}{1 \times .025}}$

$= 3.86\ mA$

If current increases by 1 mA

$(V_D + v_d)(\text{per diode}) = 0.667 + 1 * .025 \times 2.3 \log_{10} \frac{4.86}{3.86}$

$= (0.667 + 0.0575)V$

$\therefore v_d$ (per diode) $= 0.0575V$

$\therefore v_o = 3 * .0575 = 17.25\ mV$

$r_d = \frac{nV_T}{I}$ (small sig model)

$\therefore v_o = 3 r_d \times 1mA$

$= \frac{25}{3.86} \times 3 = 19.4\ mV$

$\frac{19.4}{3} = 6.47$ is not much less than nV_T

2. $V_Z = 10V$ $I_Z = 25\ mA$ $r_Z = 10\Omega$

$V_{Z0} = V_Z - I_Z r_Z = 10 - 25(mA) * .01\ k\Omega$

$= 10 - 0.25 = 9.75V$

Line regulation $= 0.05 = \frac{10}{R + 10}$

$\therefore R + 10 = \frac{10}{.05} \Rightarrow R = 190\Omega$

Now $R = \frac{V_{S\,min} - V_{Z0} - r_Z I_{Z\,min}}{I_{Z\,min} + I_{L\,max}}$

$190 = \frac{V_{S\,min} - 9.75 - 0.01 * 5}{(5 + 20) \times 10^{-3}} = \frac{V_{S\,min} - 9.8}{25 \times 10^{-3}}$

$V_{S\,min} = 190 \times 25 \times 10^{-3} + 9.8 = 4.75 + 9.8 = 14.55V$

Max power $P_{max} = 1\,W$

$$1 = (V_{Z0} + I_{Zmax} r_Z)\, I_{Zmax}$$

$$= 9.75\, I_{Zmax} + 10\, I_{Zmax}^2$$

$$10\, I_{Zmax}^2 + 9.75\, I_{Zmax} - 1 = 0$$

$$I_{Zmax} = \frac{-9.75 \pm \sqrt{9.75^2 + 40}}{20} = 93.58\,mA$$

$$\therefore V_{Smax} = I_{Zmax}(R + r_Z) + 9.75$$

$$= 93.58\,(0.2k) + 9.75 = 28.46\,V$$

3.