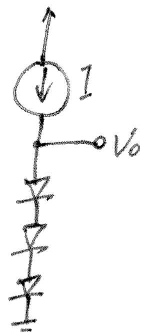
EE20242 Electronics I HW4.

4.23



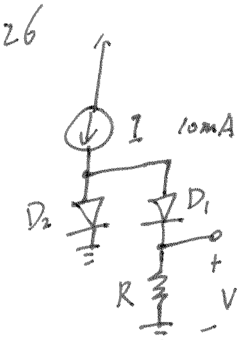
① $V_O = 2.4V$. $I_S = 10^{-16}A$ $V_D = \frac{V_O}{3} = 0.8V$

$I_D = I_S e^{V_D/V_T} = 10^{-16} \times e^{(0.8/0.025)} = 7.9mA$

② $I_D = 6.9mA \Rightarrow V_D = 0.794V$ $V_O = 3 \times V_D = 2.39V$

~~$\Delta V = 2.4V - 2.39V =$~~ $\Delta V = 2.39 - 2.4 = -10.15mV$

4.26



$V = 80mV$

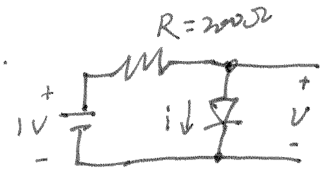
$V = V_{D2} - V_{D1}$, $I_{D1} = V/R = I_S e^{V_{D1}/V_T}$, ~~$I_{D2} =$~~

$I_{D2} = I - I_{D1} = I_S e^{V_{D1}/V_T}$

$\frac{I_{D2}}{I_{D1}} = \frac{10mA - 0.08/R}{0.08/R} = e^{0.08/0.025} = 23.3$

$\Rightarrow R = 194\Omega$

4.34.



(a) $I_D = \frac{1V - 0.7V}{200\Omega} = 1.5mA$

(b) i) $V = 0.7V$ $i = \frac{1-0.7}{200} = 1.5mA$

ii) $V = 0.7 + 2.3 \times 0.025 \log\left(\frac{1.5}{1}\right) = 0.7101V$

$i = \frac{1-0.7101}{200} = 1.4494mA$

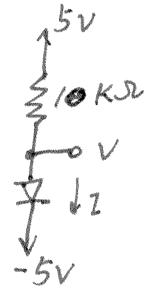
iii) $V = 0.7 + 2.3 \times 0.025 \log\left(\frac{1.4494}{1}\right) = 0.7093V$

$i = \frac{1-0.7093}{200} = 1.4537mA$

iv) $V = 0.7 + 2.3 \times 0.025 \log\left(\frac{1.4537}{1}\right) = 0.7093V$

$i = \frac{1-0.7093}{200} = 1.4537mA$ same as iii)

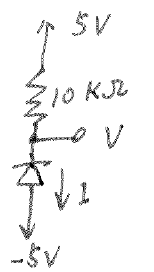
4.39. (a)



$V = -5V + 0.7V = -4.3V$

$I = \frac{5V + 4.3V}{10k\Omega} = 0.93mA$

(b)

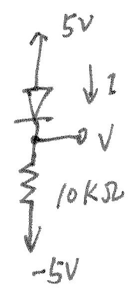


cutoff

$V = 5V$

$I = 0$

(c)

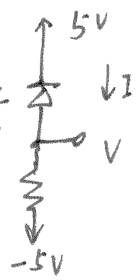


$V = 5V - 0.7V = 4.3V$

$I = \frac{4.3V + 5V}{10K\Omega} = 0.93mA$

(d)

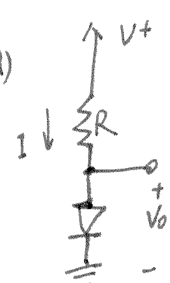
cutoff



$V = -5V$

$I = 0$

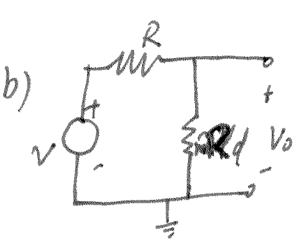
4.52. (a)



$I = \frac{V^+ - V_o}{R}$

$\frac{\Delta V_o}{\Delta V^+} = \frac{R_d}{R + R_d} = \frac{V_T/I}{R + \frac{V_T}{I}} = \frac{V_T}{RI + V_T} = \frac{V_T}{V^+ - V_o + V_T} = \frac{V_T}{V^+ + V_T - 0.7}$

(b)



$\frac{\Delta V_o}{\Delta V^+} = \frac{mR_d}{mR_d + R} = \frac{mV_T}{IR + mV_T} = \frac{mV_T}{mV_T + V^+ - 0.7m}$

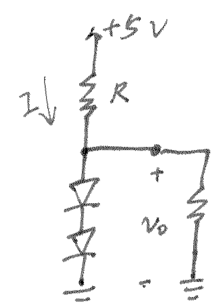
(c) (i) $m = 1 \quad V^+ = 10V$

$$\frac{\Delta V_O}{\Delta V^+} = \frac{V_T}{V_T + V^+ - 0.7} = 2.68\,mV/V$$

(ii) $m = 3 \quad V^+ = 10V$

$$\frac{\Delta V_O}{\Delta V^+} = \frac{3V_T}{3V_T + 10V - 0.7} = 9.4\,mV/V$$

4.54



0.7V drop at $I_D = 10\,mA$:

$$I_S = \frac{I_D}{e^{\frac{V_D}{V_T}}} = \frac{10\,mA}{e^{\frac{0.7}{0.025}}} = ~~8.64\times10~~\ 6.91\times10^{-15}A$$

when $V_O = 1.5V \qquad V_D = \frac{1.5V}{2} = 0.75V$

$$I_D = I_S\, e^{\frac{V_D}{V_T}} = 6.91\times10^{-15}A \cdot e^{\frac{0.75}{0.025}} = 73.84\,mA$$

$$I_L = \frac{V_O}{R_L} = \frac{1.5V}{150\Omega} = 10\,mA$$

$$I = I_D + I_L = 83.84\,mA$$

$$R = \frac{5V - 1.5V}{83.84\,mA} = 41.75\Omega$$

If the diode is disconnected, use the small signal ~~mod~~ diode modle

$$r_d = \left(\frac{dv_D}{di_D}\right)\Big|_{I_D = 73.84mA} = \frac{V_T}{I_D} = \frac{0.025V}{73.84\,mA} = 0.34\Omega$$

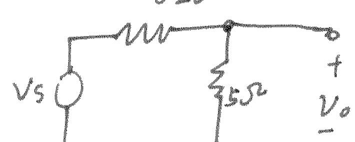
The change of output voltage is $\Delta V_o = 2\Delta I_D \cdot r_d = 2\times10\,mA\times0.34\Omega = 6.8\,mV$

If the load resistance reduced to 100Ω: $\Delta V_o = 2\times\left(\frac{1.5}{150} - \frac{1.5}{100}\right)\times0.34 = 3.4\,mV$

If the load resistance reduced to 75Ω: $\Delta V_o = 2\times\left(\frac{1.5}{150} - \frac{1.5}{75}\right)\times0.34 = 6.8\,mV$

If the load resistance reduced to 50Ω: $\Delta V_o = 2\times\left(\frac{1.5}{150} - \frac{1.5}{50}\right)\times0.34 = 13.6\,mV$

4.59



small-signal model

$$\frac{\Delta V_O}{\Delta V_S} = \frac{5}{82+5} = \frac{5}{87}$$

$$\Delta V_O = \Delta V_S \cdot \frac{5}{87} = 1V \times \frac{5}{87} = 57.5\,mV$$

P3.