Solutions:

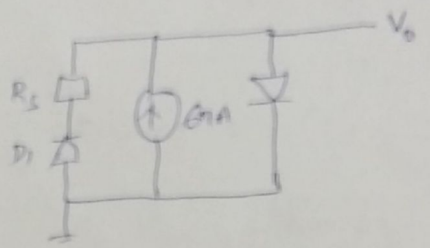
$V_0 = 26mV \ln\left(\frac{6nA}{1nA}\right)$

$V_0 = 0.046V$

1.30) $V_0 = V \ln\left(\frac{I}{I_S}+1\right)$ (or)

$= 0.026 \ln\left(\frac{6nA}{1nA}+1\right)$

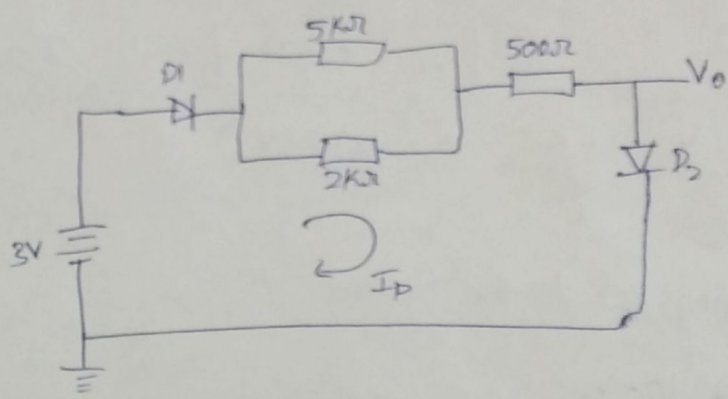
$V_0 = 50.59mV$



1.31) Given D_1 - reverse bias

$I_{S1} = 1nA$, $I_{S2} = 4nA$

$I_{D1} = I_2 = I_D$



Calculating Requ we have

$R_{equ} = (5K \| 2K) + 500$

$= 1.92K\Omega$

Applying KVL to the circuit

$$-3 + 0.026\left(\ln\frac{I_D}{1nA}+1\right) + 1.92\times10^3 I_D + 0.026\ln\left(\frac{I_D}{4nA}+1\right) = 0$$

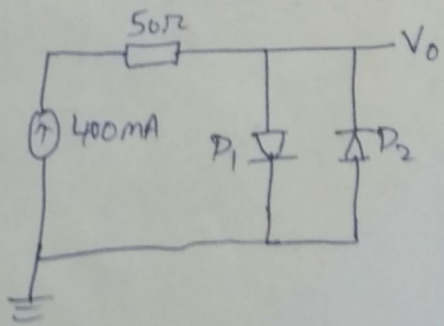
on solving we have $I_D = 1.196mA$

$$V_0 = V_D = 0.026\ln\left(\frac{1.196\times10^{-3}}{4\times10^{-12}}+1\right)$$

$\boxed{V_0 = 0.3278V}$

1.32) Given $I_{S1} = 175nA$,

$I_{S2} = 100nA$

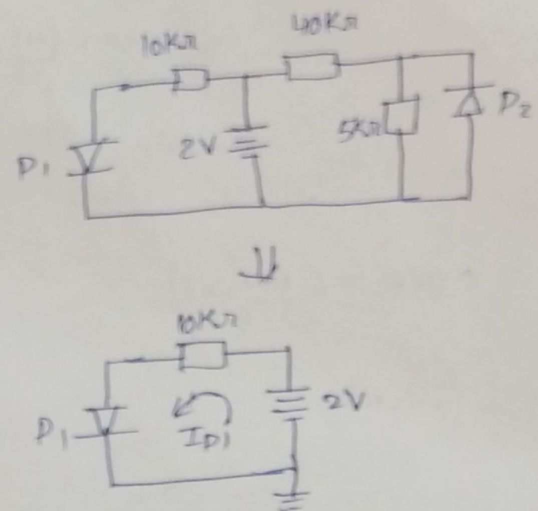


we know that

$$V_0 = 0.026\ln\left(\frac{400\times10^{-3}}{175\times10^{-9}}\right)$$

$\boxed{V_0 = 0.381V}$

1.33) Given $I_{DS1} = 100pA$



Applying KVL to the circuit we have

$$0.026 \ln\left(\frac{I_{D1}}{100\times10^{-12}}+1\right) + 10\times10^{3}\times I_{D1} + 2 = 0$$

$$\boxed{I_{D1} = 0.163mA}$$

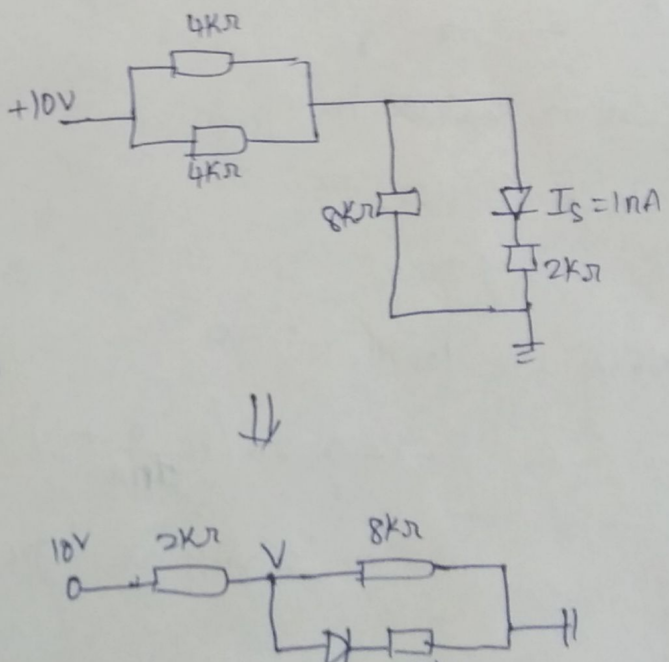
$$V_{D1} = 0.026 \ln\left(\frac{0.163\times10^{-3}}{100\times10^{-12}}+1\right)$$

$$\Rightarrow \boxed{V_{D1} = 0.372V}$$

$$I_{5K} = \frac{0.222V}{5K} = 44.44A$$

$$V_{D2} = \frac{5K\Omega}{40+5^{K}} \times 2 = 0.222V$$

1.34)



Applying KCL to the circuit

$$\frac{10-V}{2000} = \frac{V-0}{8000} + I_D \quad -(1)$$

$$V_D = I_D \times 2000 + 0.026 \ln\left(\frac{I_D}{1\times10^{-9}}+1\right) \quad -(2)$$

solving (1) & (2) we have

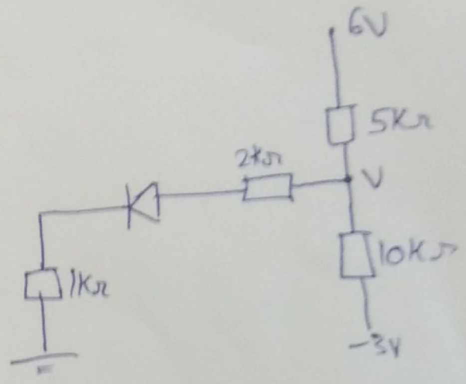
$I_D = 2.11mA$

$$V_D = 0.026 \ln\left(\frac{I_D}{1\times10^{-9}}+1\right)$$

$$= 0.026 \ln\left(\frac{2.11\times10^{-3}}{1\times10^{-9}}+1\right)$$

$$V_D = 0.3787V$$

1.35) Given $I_S = 2\mu A$



Applying KCL we hav

$$\frac{6-V}{5} = \frac{V+3}{10} + \frac{V-V_D}{3} \quad -①$$

$$V_D = 0.026 \ln\left(\frac{\frac{V-V_D}{3K}}{2\times10^{-6}} + 1\right) \quad -②$$

Solving ① & ② we have

$$V_D = 0.141V$$

$$I_D = 2\times10^{-6}\left(e^{\frac{V_D}{0.026}} - 1\right)$$

$$= 2\times10^{-6}\left(e^{\frac{0.141}{0.026}} - 1\right)$$

$$I_D = 0.4514mA$$