28)
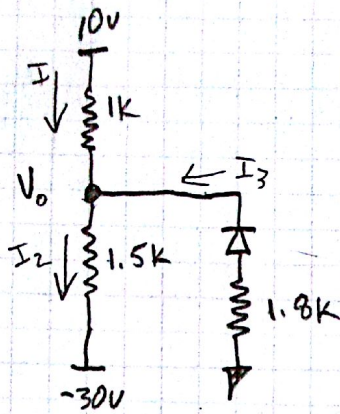

$$\frac{10v - V_o}{1k} - \frac{V_o - (-30v)}{1.5k} + \frac{0 - (V_o + 0.7v)}{1.8k} = 0$$

$$V_o = -4.675v$$

$$I_1 = \frac{10v - V_o}{1k} = 14.675 \, mA$$

$$I_2 = \frac{V_o - (-30)}{1.5k} = 16.883 \, mA$$

$$I_3 = \frac{0 - (V_o + 0.7)}{1.8k} = 2.208 \, mA$$

29)

a) $V_{BB} = 1v$

$$0 = 1v - I_D(50k) - (26mV) \ln\left(\frac{I_D}{I_s} + 1\right) - I_D(80k)$$

$$\boxed{I_D = 6.3997 \mu A}$$

$$V_D = \frac{kT}{q} \ln\left(\frac{I_D}{I_s}\right) = 26mV \ln\left(\frac{6.3997\mu A}{10nA}\right) \Rightarrow \boxed{V_D = 167.997 mV}$$
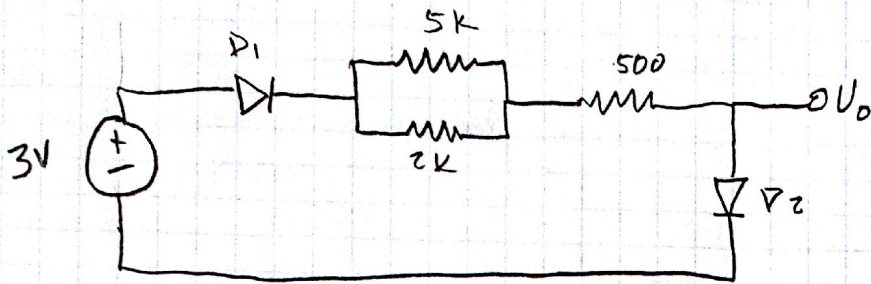
b) $V_{BB} = 10$

$$0 = 10v - I_D(50k) - (26mV) \ln\left(\frac{I_D}{I_s} + 1\right) - I_D(80k)$$

$$\boxed{I_D = 76.138 \mu A}$$

$$V_D = \frac{kT}{q} \ln\left(\frac{I_D}{I_s}\right) = 26mV \ln\left(\frac{75.138\mu A}{10nA}\right) = \boxed{V_D = 232.037 mV}$$
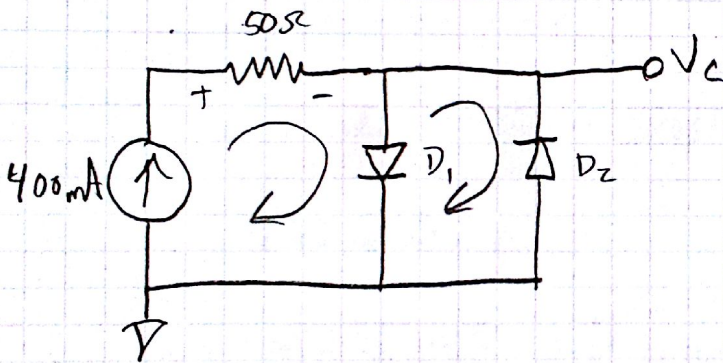
31)

$R_{eq} = 1.429 k\Omega$

$R_{eq} + 500 = 1.929 k\Omega$

$$3V - (26mv)\ln\left(\frac{I_D}{I_S} + 1\right) - I_D(1.929k) + (26mV)\ln\left(\frac{I_D}{I_S} + 1\right) = 0$$

$$\boxed{I_D = 1.97mA}$$

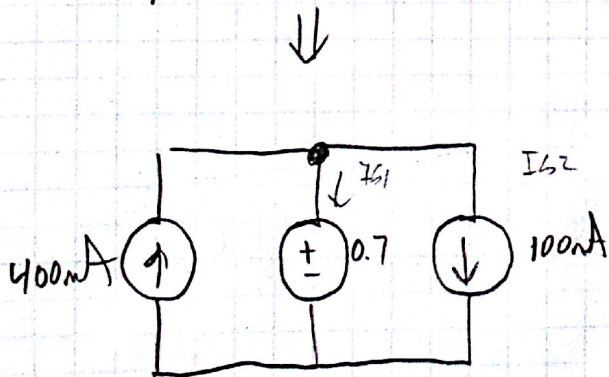$$V_o = V_{D_2} = 26mv\ln\left(\frac{1.537mA}{4nA} + 1\right) = 327.84mV$$

32)

$I_{S1} = 175uA$

$I_{S2} = 100nA$

$$400nA = I_{D1} + 100nA$$

$$I_{D1} = 399.99mA$$

$$V_{D1} = 0.026\ln\left(\frac{399.99mA}{175nA}\right)$$

$$\boxed{V_{D1} = 380.697mV}$$

33) $I_{D_1} = ?$, $V_{D_1} = ?$, $I_{5k} = ?$
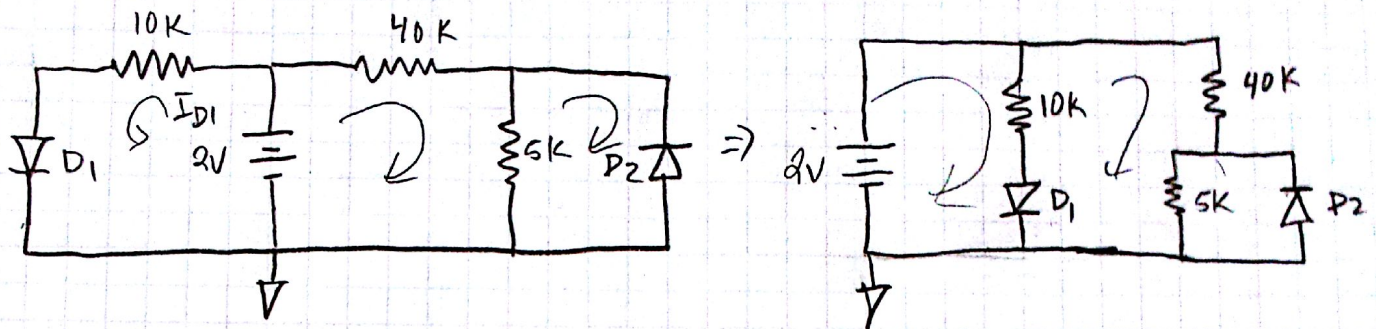
$$2 - I_{D_1}(10K) - 0.026 \ln\left(\frac{I_{D_1}}{100pA} + 1\right) = 0$$

$$\boxed{I_{D_1} = 162.81 \mu A}$$

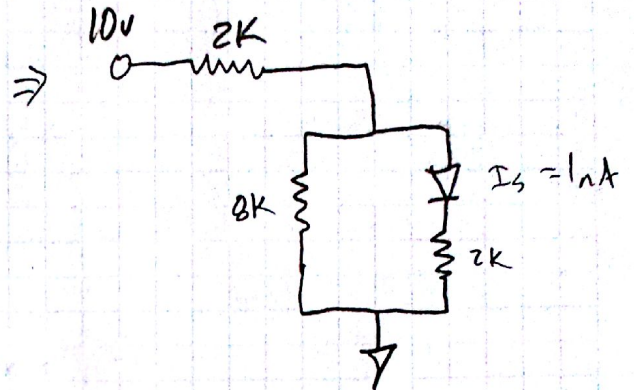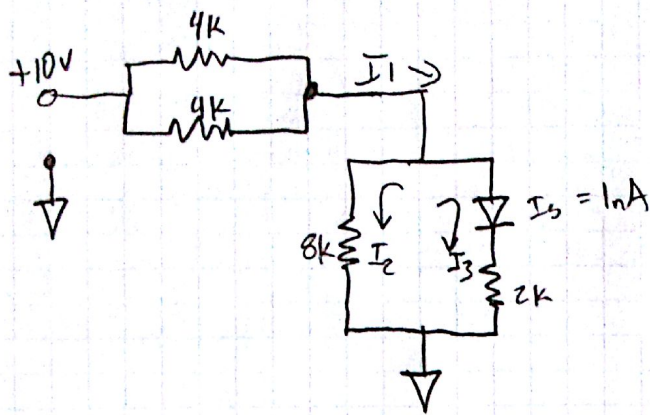$$V_{D_1} = 0.026 \ln\left(\frac{162.81\mu A}{100 pA} + 1\right)$$

$$\boxed{V_{D_1} = 371.876 mA}$$

I_{5k}

$$0 = \frac{2 - V_0}{40K} - \frac{V_0}{5k} - 100pA$$

$$V_0 = 222.222 mV$$

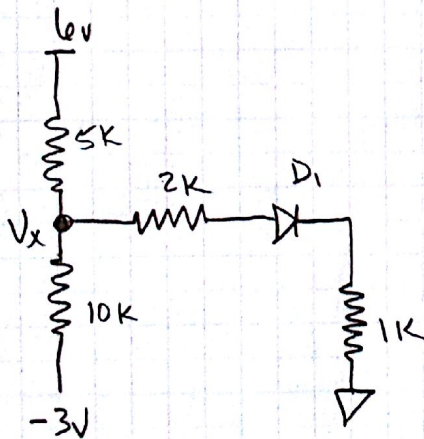$$I_{5k} = \frac{222.222mV}{5K} = \boxed{44.444\mu A = I_{5k}}$$

34)

$$V_d = 0 \qquad 8k // 2k = 1.6k$$

$$I_T = \frac{10v}{2K + 1.6K} \implies I_T = 2.778 \, mA$$

$$2.778 \, mA \left(\frac{8K}{8K + 2K} \right) = I_3 = 2.22 \, mA$$

$$V_D = 26mv \, ln \left(\frac{2.22mA}{1nA} + 1 \right) = 379.965 \, mV$$

36)

$$\frac{V_x - (-3)}{10K} + \frac{V_x - 6}{5k} + \frac{V_x}{3K} = 0$$

$$V_x = 1.421v$$

$$I_D = \frac{V_x}{3K} \implies \frac{1.421v}{3K} = \boxed{473.644 \, \mu A = I_D}$$

$$V_D = 0.026 \, ln \left(\frac{473.684}{1nA} + 1 \right) = \boxed{142.262 \, mV = V_D}$$