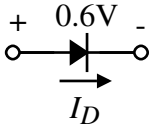
QUIZ NO. 1 – SOLUTION

(Average Score = 8.0)

The following questions give the dc voltages at the terminals of an active device. You are to calculate the designated dc current.

a.) Find the diode current, I_D, where I_S = 100fA and V_T = 0.025V (2 pts).

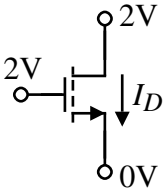


F02Q01P1A

Obviously, the diode is forward biased. Therefore,

$$I_D = I_S \exp\left(\frac{V_D}{V_T}\right) = 10^{-13} \exp\left(\frac{0.6}{0.025}\right) = \underline{2.65 \text{ mA}}$$

b.) Find the drain-source current, I_{DS}, where $K_n' = 25\mu A/V^2$, V_{TN} = 1V and W/L = 10 (2 pts).

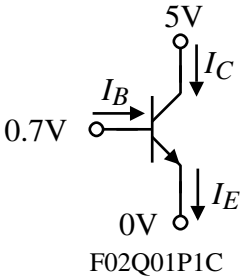


F02Q01P1B

We see that the enhancement, n-channel MOSFET is in the saturation region. Therefore,

$$I_{DS} = \frac{K_n' W}{2L}(V_{GS} - V_{TN})^2 = \frac{25 \cdot 10}{2}(2\text{-}1)^2 = \underline{125\ \mu A}$$

c.) Find the collector, emitter, and base currents, I_C, I_E, and I_B if I_S = 100fA, V_T = 0.025V and β_F = 100 (4 pts).



F02Q01P1C

We see that the npn BJT is in the forward active region. Therefore,

$$I_C = I_S \exp\left(\frac{V_{BE}}{V_T}\right) = 10^{-13} \exp\left(\frac{0.7}{0.025}\right) = \underline{144.6 \text{ mA}}$$

$$I_B = \frac{I_C}{\beta_F} = \underline{1.446 \text{ mA}} \qquad \text{and} \qquad I_E = I_C + I_B = \underline{146 \text{ mA}}$$

d.) Repeat (b.) if V_D = 1V and V_G = 3V (2 pts).

We see that the enhancement, n-channel MOSFET is in the linear region. Therefore,

$$I_{DS} = K_n' \frac{W}{L}\left(V_{GS} - V_{TN} - \frac{V_{DS}}{2}\right) V_{DS} = 25 \cdot 10(3\text{-}1\text{-}0.5)(1) = \underline{375\ \mu A}$$