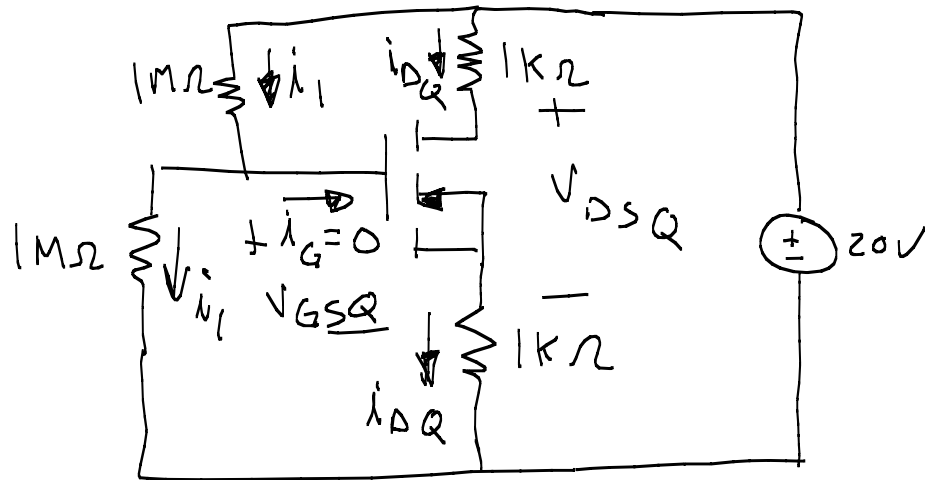


### Problem 3

Determine

$$i_{DQ} \text{ \& } V_{DSQ}$$



$$V_{to} = 4V, K = 1mA/V^2$$

KVL (Perimeter)

$$-i_1(2000k\Omega) + 20V = 0$$

$$i_1 = 0.01mA$$

KVL (Lower Left)

$$-(0.01mA)(1000k\Omega) + V_{GSQ} + i_{DQ}(1k\Omega) = 0$$

$$V_{GSQ} + i_{DQ} = 10$$

For Saturation Region

$$i_{DQ} = K (V_{GSQ} - V_{to})^2$$

$$i_{DQ} = (1 \text{ mA/V}^2) (V_{GSQ} - 4)^2$$

$$i_{DQ} = V_{GSQ}^2 - 8V_{GSQ} + 16$$

$$V_{GSQ} + (V_{GSQ}^2 - 8V_{GSQ} + 16) = 10$$

$$V_{GSQ}^2 - 7V_{GSQ} + 6 = 0$$

$$(V_{GSQ} - 6)(V_{GSQ} - 1) = 0$$

$$V_{GSQ} = 6 \text{ V} \quad \text{or} \quad \del V_{GSQ} = 1 \text{ V}$$

$$V_{GSQ} = 6 \text{ V}$$

$$i_{DQ} = 4 \text{ mA}$$

KVL (Right)

$$-(4\text{mA})(1\text{k}\Omega) - V_{\text{DSQ}} - (4\text{mA})(1\text{k}\Omega) + 20\text{V} = 0$$

$$V_{\text{DSQ}} = 12\text{V}$$

Check Saturation Region

$$V_{\text{GSQ}} > V_{\text{th}}$$
$$6\text{V} > 4\text{V} \checkmark$$

$$V_{\text{DSQ}} > V_{\text{GSQ}} - V_{\text{th}}$$

$$12\text{V} > \underbrace{6\text{V} - 4\text{V}}_{2\text{V}}$$
$$12\text{V} > 2\text{V} \checkmark$$

Saturation  
Region