Example for Drain Current

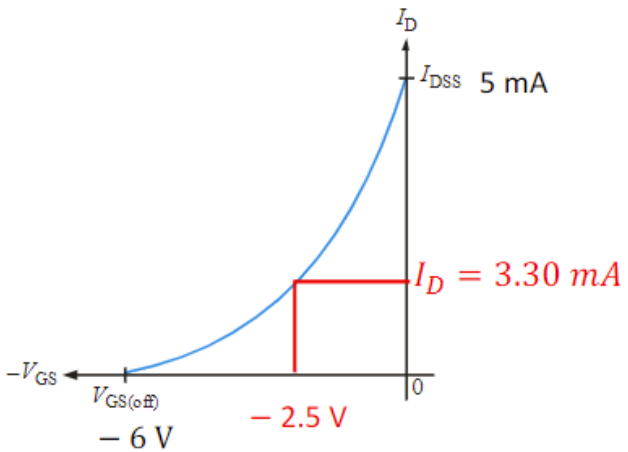
Problem 1: A JFET has the following parameters : I_{DSS}=5 mA and $V_{GS(off)} = -6$ V. Find I_D for $V_{GS} = -2.5$ V.

Solution 1:

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)^2$$

$$I_D = 5mA \times \left(1 - \frac{-2.5\ V}{-6\ V}\right)^2$$

$$I_D = 3.30\ mA$$



Example for Drain Current

Problem 2: Determine the transconductance of the given FET when the gate to source voltage changes from -3.5 V to -3.0 V and the drain current changes from 3 mA to 4 mA.

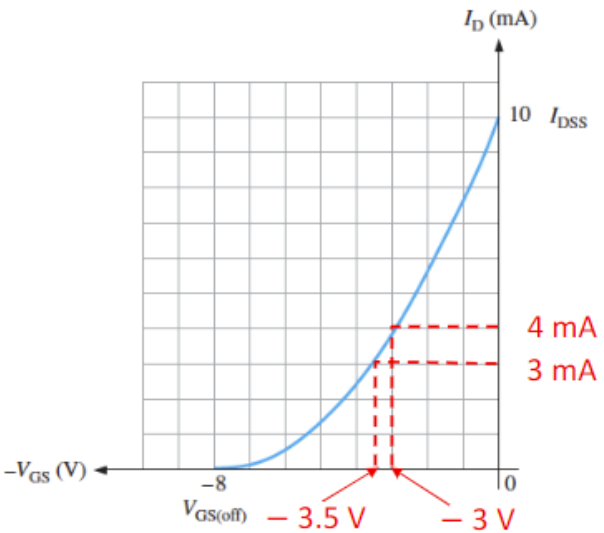
Solution 2:

$$\Delta V_{GS} = -3V - (-3.5\ V) = 0.5\ V$$

$$\Delta I_D = -4\ mA - 3.0\ mA = 1\ mA$$

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}}$$

$$g_m = \frac{1\ mA}{0.5\ V} = 2\ m\mho = 2\ mS$$



Example for V_{DS} and V_{GS}

Problem 3: Determine V_{DS} and V_{GS} for the given JFET when I_D=5 mA and V_{DD}=15 V.

Solution 3:

When I_G=0, V_G=0

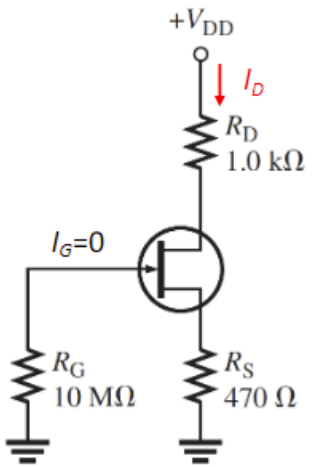
$$V_D = V_{DD} - I_D R_D$$

$$V_D = 15 - 5\ mA \times 1k\Omega = 10\ V$$

$$V_S = I_D \times R_S = 5\ mA \times 470\ \Omega = 2.35\ V$$

$$V_{GS} = V_G - V_S = 0 - 2.35\ V = -2.35\ V$$

$$V_{DS} = V_D - V_S = 10 - 2.35\ V = 7.65\ V$$



Example for I_D and V_{GS}

Problem 4: Determine I_D and V_{GS} for the given JFET if V_D=7 V.

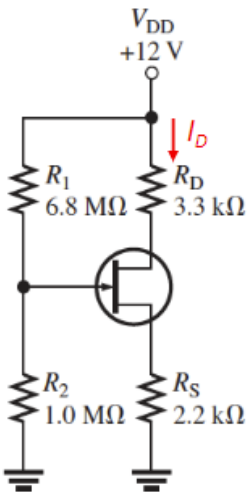
Solution 4:

$$I_D = \frac{V_{DD} - V_D}{R_D} = \frac{12\ V - 7\ V}{3.3\ k\Omega} = 1.52\ mA$$

$$V_s = I_D R_S = 1.52\ mA \times 2.2\ k\Omega = 3.34\ V$$

$$V_G = \frac{R_2}{R_1 + R_2} \times V_{DD} = \frac{1\ M\Omega}{7.8\ M\Omega} \times 12 = 1.54\ V$$

$$V_{GS} = V_G - V_S = 1.54\ V - 3.34\ V = -1.84\ V$$



Example for E-MOSFET Drain Current

Problem 1: The datasheet for an E-MOSFET gives $I_{D(ON)}$= 500 mA (minimum) at V_{GS}=10 V and $V_{GS(th)}$=1 V. Determine the drain current for V_{GS} = 5 V.

Solution 1:

$$K = \frac{I_{D(ON)}}{(V_{GS} - V_{GS(th)})^2}$$

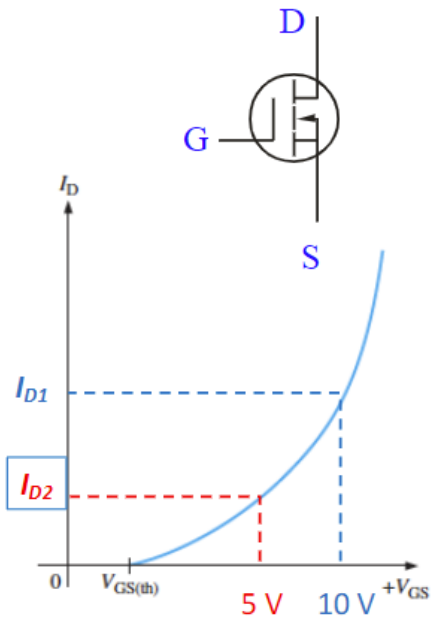
$I_{D(ON)}$=I_{D1}

$$K = \frac{500\ mA}{(10V - 1V)^2} = 6.17\ mA/V^2$$

Using V_{GS}=5 V,

$$I_{D2} = K(V_{GS} - V_{GS(th)})^2 = (6.17\ mA/V^2)(5V - 1V)^2$$

$I_{D2} = (6.17\ mA/V^2)(5V - 1V)^2 = 98.7\ mA$



Example for D-MOSFET Drain Current

Problem 2: For a certain D-MOSFET, I_{DSS} =10 mA and $V_{GS(off)}$= − 8V
Is this an n-channel or a p-channel? Calculate I_D at V_{GS}=±3 V.

Solution 2:

This is an n-channel MOSFET because it has negative V_{GS}.

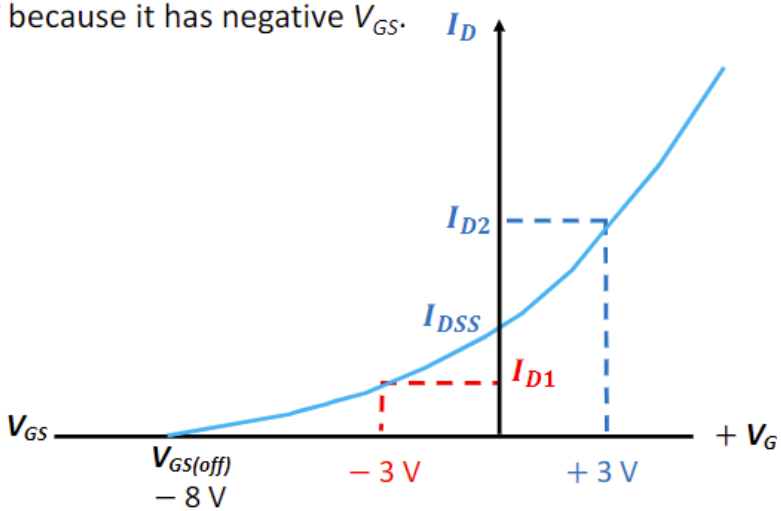
$$I_{D1} = I_{DSS}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)^2$$

$$I_{D1} = 10\ mA \times \left(1 - \frac{-3\ V}{-8\ V}\right)^2$$

$$I_{D1} = 3.91\ mA$$

$$I_{D2} = 10\ mA \times \left(1 - \frac{+3\ V}{-8\ V}\right)^2$$

$$I_{D2} = 18.9\ mA$$



Example for Drain Current and V_{DS}

Problem 3: The datasheet for this E-MOSFET shows that I_D= 10 mA when V_{GS}=V_{DS}. Find I_D and V_{DS}.

Solution 3:

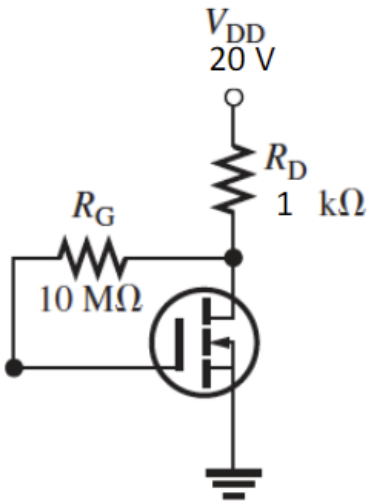
Since no current flows in R_G

$$V_{GS} = V_{DS} \quad I_D = 10\ mA$$

$$V_{DS} = V_{DD} - I_D R_D$$

$$V_{DS} = 20V - 10mA \times 1k\Omega = 10\ V$$

$$V_{DS} = V_{GS} = 10\ V$$



Example for Drain to Source Voltage

Problem 4: Determine the drain-to-source voltage in the given circuit. The MOSFET datasheet gives $V_{GS(off)}$ = -8 V and I_{DSS} = 12 mA.

Solution 4:

No current flows in R_G

$$V_{GS} = 0 \qquad I_D = I_{DSS}$$

$$V_{DS} = V_{DD} - I_D R_D$$

$$V_{DS} = 18V - 12mA \times 620\Omega = 10.56\,V$$

$$V_{DS} = 10.56\,V$$