SOLUTION First, the value of V_G is found by:

$$V_G = \frac{1\ \text{M}\Omega}{2\ \text{M}\Omega + 1\ \text{M}\Omega}(30\ \text{V}) = 10\ \text{V}$$

This value is plotted on the x-axis.

Next, find the second point:

$$I_D = \frac{V_G}{R_S} = \frac{10\ \text{V}}{2\ \text{K}} = 5\ \text{mA}$$

This value is plotted on the y-axis.

By drawing a line between these two points extending through the minimum and maximum transconductance curves, we find:

$$V_{GS(\text{min})} = -0.4\ \text{V} \qquad I_{D(\text{min})} = 5.2\ \text{mA}$$

and

$$V_{GS(\text{max})} = -2.4\ \text{V} \qquad I_{D(\text{max})} = 6.3\ \text{mA}$$

Fig. 13-16*b* shows that the measured MultiSim values fall between the calculated minimum and maximum values.

PRACTICE PROBLEM 13-9 Using Fig. 13-15*a*, find the maximum I_D value using graphical methods when $V_{DD} = 24$ V.

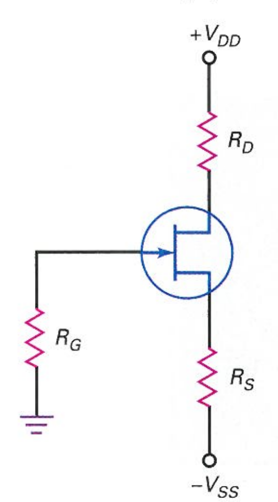
Two-Supply Source Bias

Figure 13-17 shows two-supply source bias. The drain current is given by:

$$I_D = \frac{V_{SS} - V_{GS}}{R_S} \approx \frac{V_{SS}}{R_S} \tag{13-12}$$

Again, the idea is to swamp out the variations in V_{GS} by making V_{SS} much larger than V_{GS}. Ideally, the drain current equals the source supply voltage divided by the source resistance. In this case, the drain current is almost constant in spite of JFET replacement and temperature change.

Figure 13-17 Two-supply source bias.



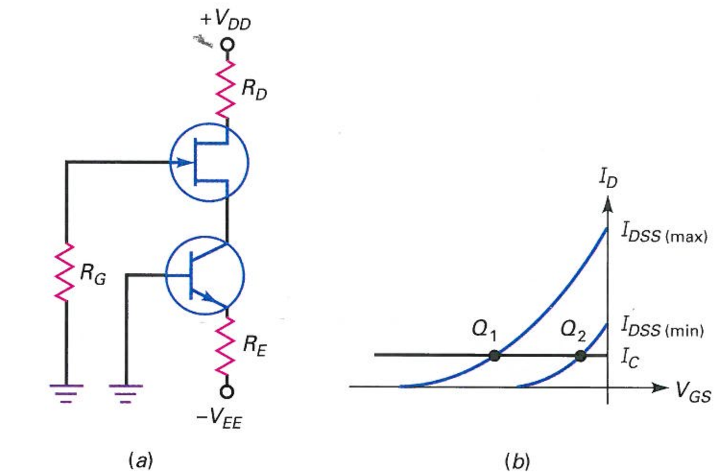
Current-Source Bias

When the drain supply voltage is not large, there may not be enough gate voltage to swamp out the variations in V_{GS}. In this case, a designer may prefer to use the **current-source bias** of Fig. 13-18*a*. In this circuit, the bipolar junction transistor pumps a fixed current through the JFET. The drain current is given by:

$$I_D = \frac{V_{EE} - V_{BE}}{R_E} \tag{13-13}$$

Figure 13-18*b* illustrates how effective current-source bias is. Both Q points have the same current. Although V_{GS} is different for each Q point, V_{GS} no longer has an effect on the value of drain current.

Figure 13-18 Current-source bias.



Example 13-10

What is the drain current in Fig. 13-19*a*? The voltage between the drain and ground?

SOLUTION Ideally, 15 V appears across the source resistor, producing a drain current of:

$$I_D = \frac{15\ \text{V}}{3\ \text{k}\Omega} = 5\ \text{mA}$$

The drain voltage is:

$$V_D = 15\ \text{V} - (5\ \text{mA})(1\ \text{k}\Omega) = 10\ \text{V}$$

Figure 13-19 Example.