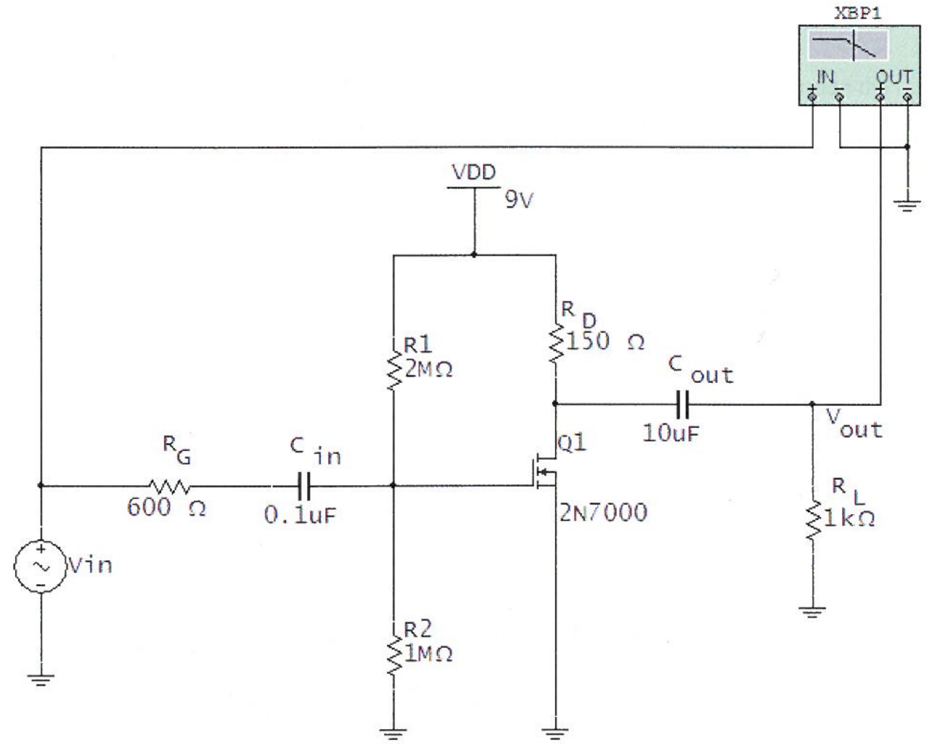
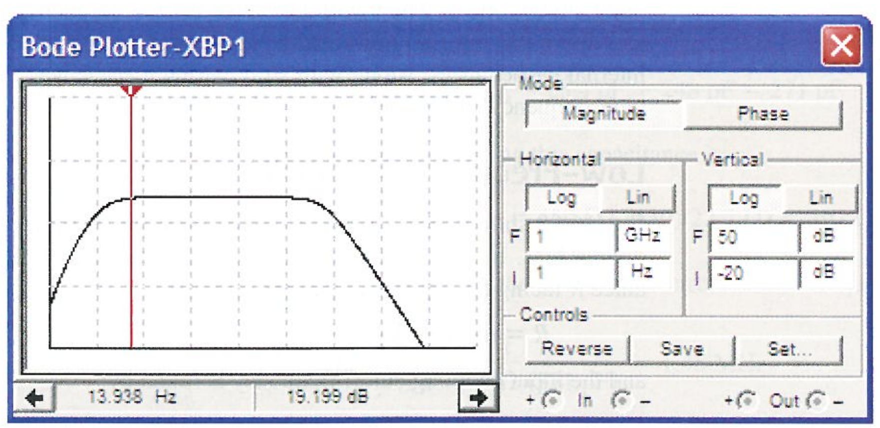
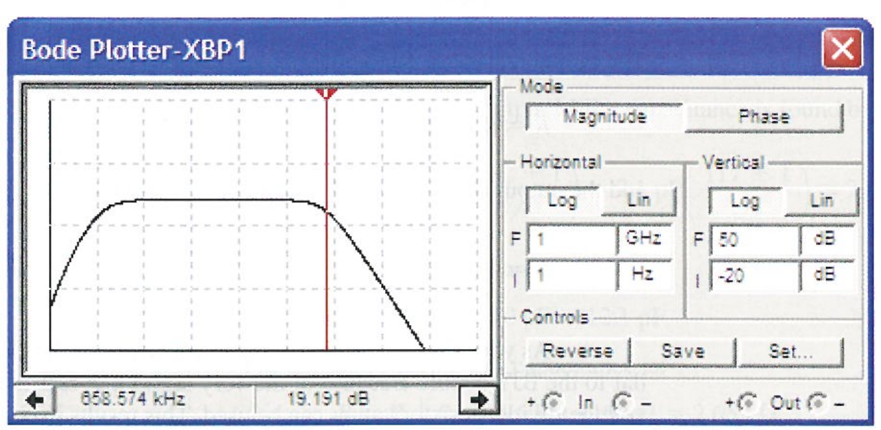
Figure 16-32 FET frequency analysis: (a) E-MOSFET amplifier; (b) low-frequency response; (c) high-frequency response.



(a)



(b)



(c)

Example 16-21 MultiSim

Using the circuit shown in Fig. 16-32, determine the input-coupling circuit and output-coupling circuit low-frequency cutoff points. Compare the calculated values to a Bode plot using MultiSim.

SOLUTION The Thevenin resistance facing the input-coupling capacitor is:

$$R = 600\ \Omega + 2\ \text{M}\Omega \| 1\ \text{M}\Omega = 667\ \text{k}\Omega$$

and the input-coupling cutoff frequency is:

$$f_1 = \frac{1}{(2\pi)(667\ \text{k}\Omega)(0.1\ \mu\text{F})} = 2.39\ \text{Hz}$$

Next, the Thevenin resistance facing the output coupling capacitor is found by:

$$R = 150\ \Omega + 1\ \text{k}\Omega = 1.15\ \text{k}\Omega$$

and the output coupling cutoff frequency is:

$$f_1 = \frac{1}{(2\pi)(1.15\ \text{k}\Omega)(10\ \mu\text{F})} = 13.8\ \text{Hz}$$

Therefore, the dominant low-frequency cutoff value is 13.8 Hz. The midpoint voltage gain of this circuit is 22.2 dB. The Bode plot in 16-32*b* shows a 3 dB loss at approximately 14 Hz. This is very close to the calculated value.

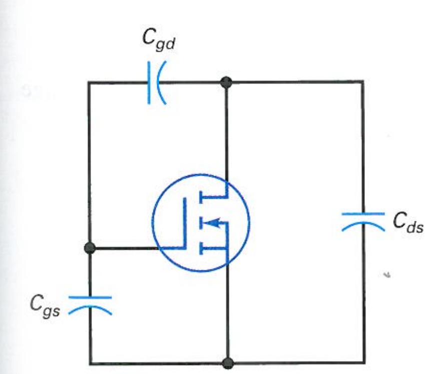
High-Frequency Analysis

Like the high-frequency analysis of a BJT circuit, determining the high-frequency cutoff point of a FET involves a significant amount of detail and requires the use of accurate values. As with the BJT, FETs have internal capacitances C_{gs}, C_{gd}, and C_{ds} as shown in Fig. 16-33*a*. These capacitance values are not important at low frequencies, but become significant at high frequencies.

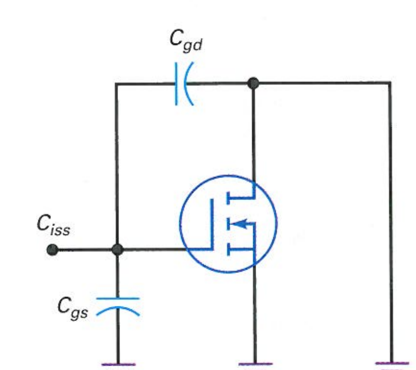
Because these capacitances are difficult to measure, manufacturers measure and list the FET capacitances under short-circuit conditions. For example, C_{iss} is the input capacitance with an ac short across the output. When doing this, C_{gd} becomes in parallel with C_{gs} (Fig. 16-33*b*) so C_{iss} is found by:

$$C_{iss} = C_{ds} + C_{gd}$$

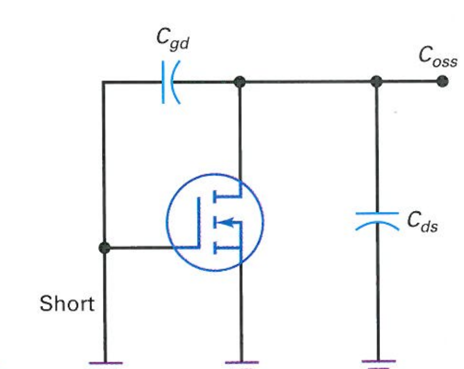
Figure 16-33 Measuring FET capacitances.



(a)



(b)



(c)