Lecture 16

Drain Resistance Calculation

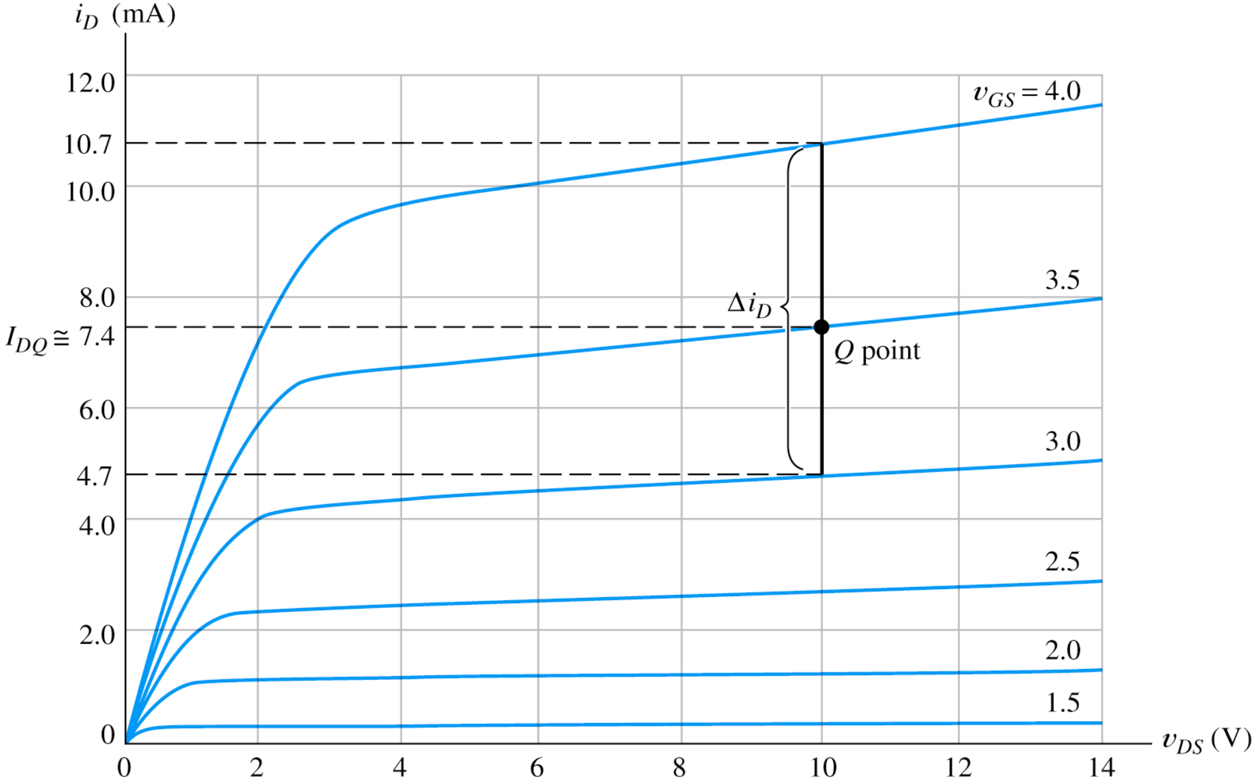


Figure 12.21 Determination of g_m and r_d. See Example 12.3.

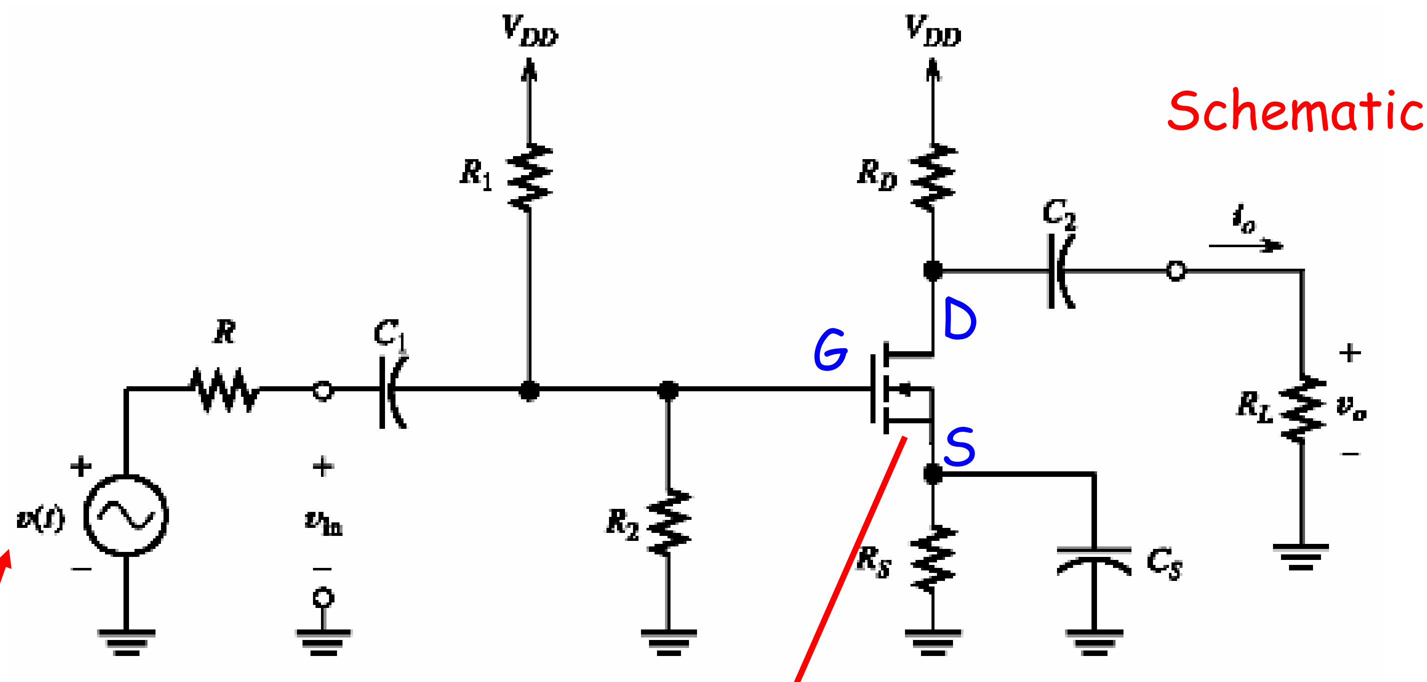
$$\frac{1}{r_d} = \frac{\Delta i_D}{\Delta v_{DS}}$$

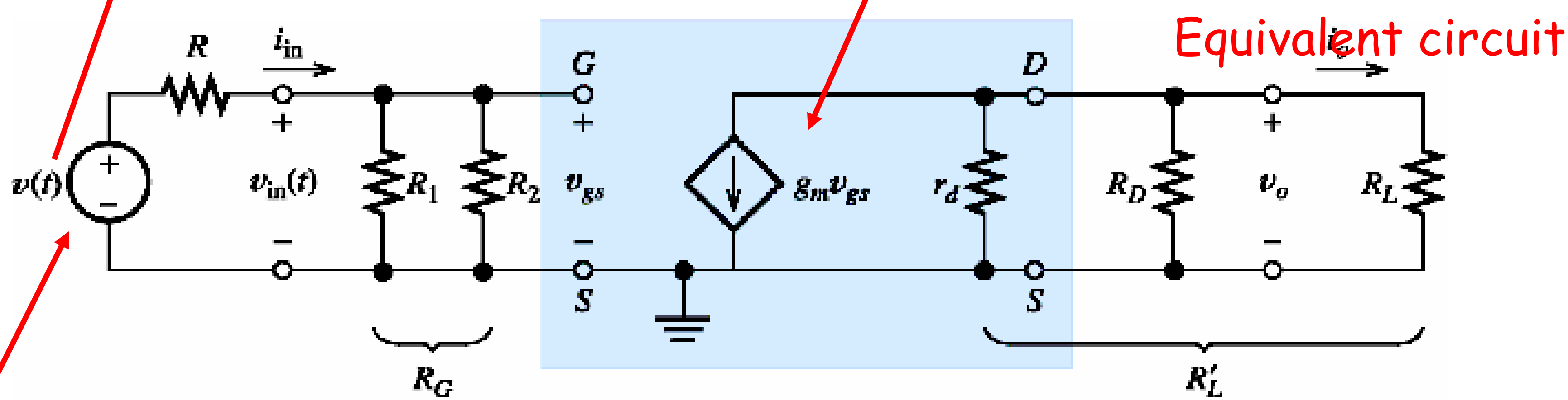
so at v_{GS}=4V

$$\frac{1}{r_d} = \frac{\Delta i_D}{\Delta v_{DS}} = \frac{(10.7 - 10)mA}{(10 - 6)V} = \frac{0.7}{4} mS = 0.175 mS$$

$$r_d = 5.7 k\Omega$$

Common-Source Amplifier

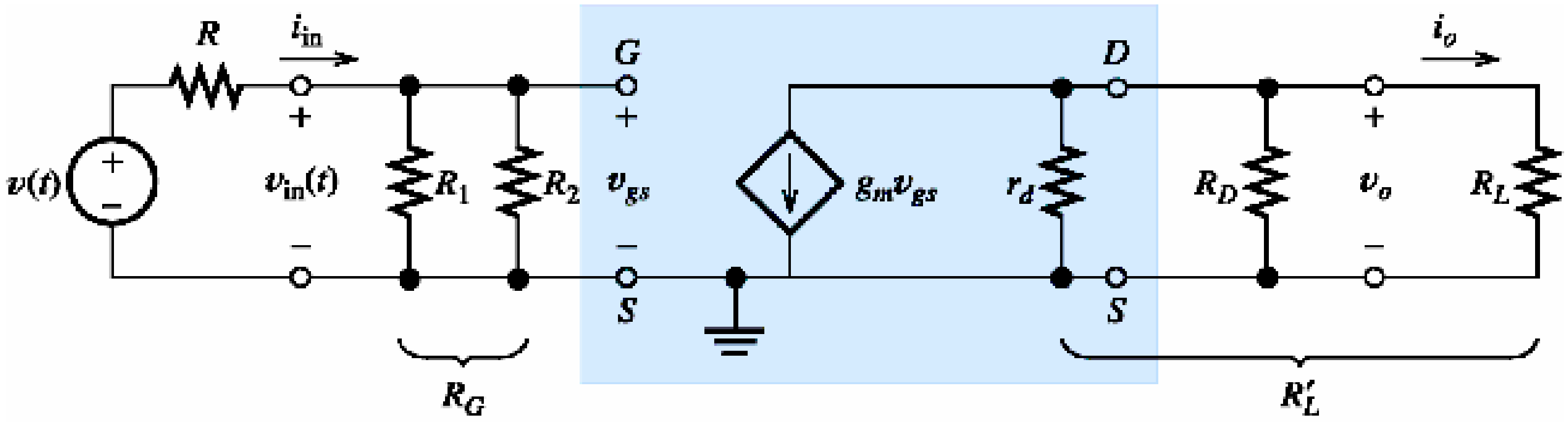




The dc supply voltage acts as a short circuit for the ac current.

Common-Source Amplifier: Gain, R_{in} and R_{out}

Equivalent circuit (once more)



$$R_L' = \frac{1}{1/r_d + 1/R_D + 1/R_L}$$

Input resistance

$$R_{in} = \frac{v_{in}}{i_{in}} = R_G = R_1 \| R_2$$

From bias point analysis

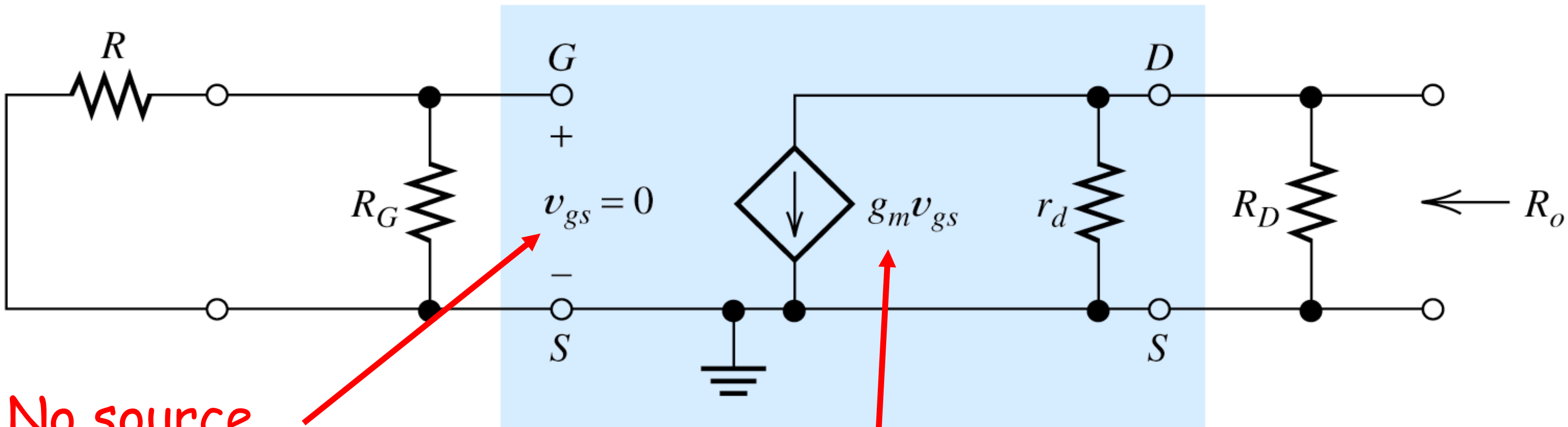
Voltage gain

$$v_0 = -\left(g_m v_{gs}\right) R_L' \qquad v_{in} = v_{gs}$$

$$A_v = \frac{v_0}{v_{in}} = -g_m R_L'$$

Common-Source Amplifier: Gain, R_{in} and R_{out}

To find out the R_{out} we have to: disconnect the load, replace the signal source by short circuit – Thevenin equivalent resistance



No source connected to the input

Figure 12.24 Circuit used to find R_o.

if $v_{gs}=0$ then $g_m v_{gs}=0$

Output resistance

$$R_{out} = \frac{1}{1/R_D + 1/r_d}$$

Example 12.4

Source Follower

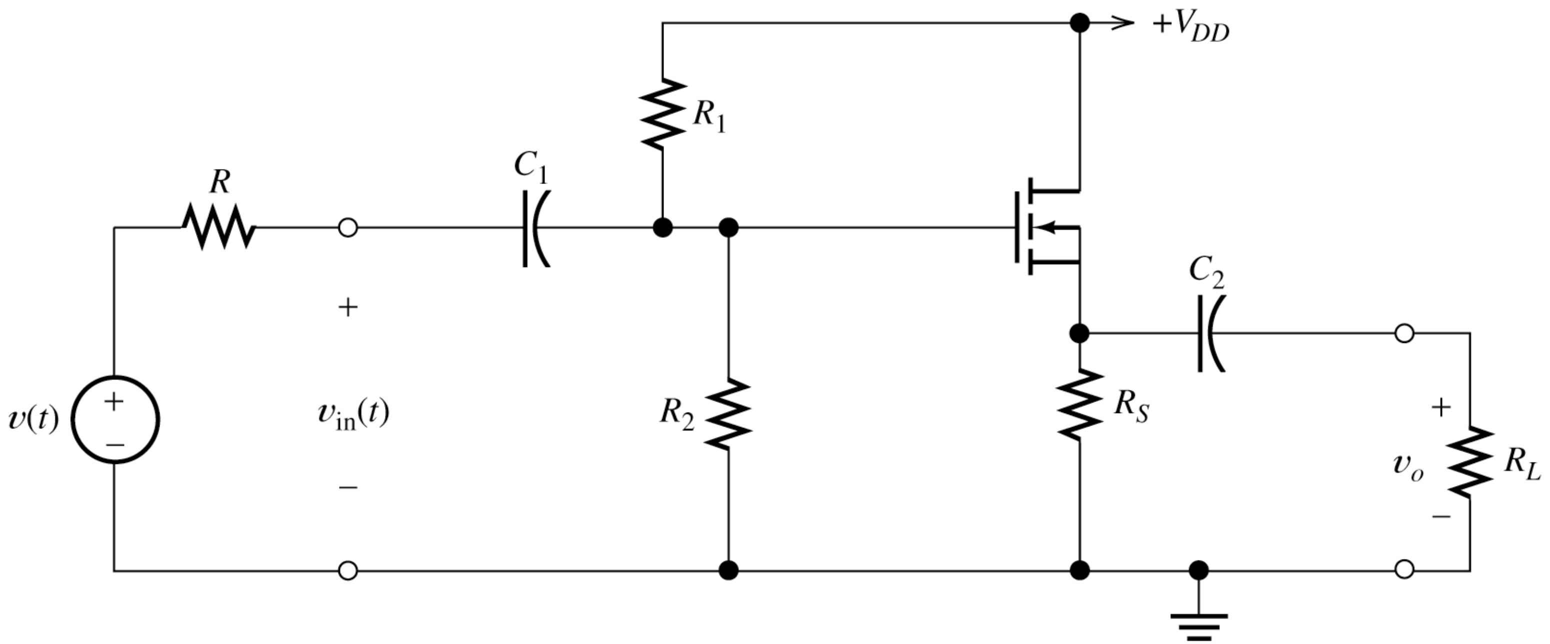


Figure 12.26 Source follower.

Small-Signal Equivalent Circuit –Source Follower

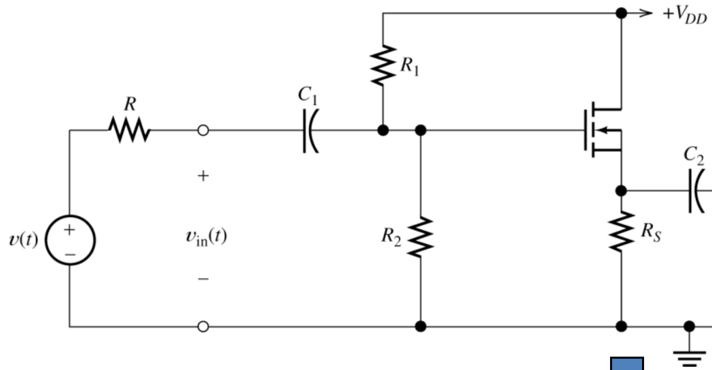


Figure 12.26 Source follower.

Notice that small signal I_{DS} goes up. Why?

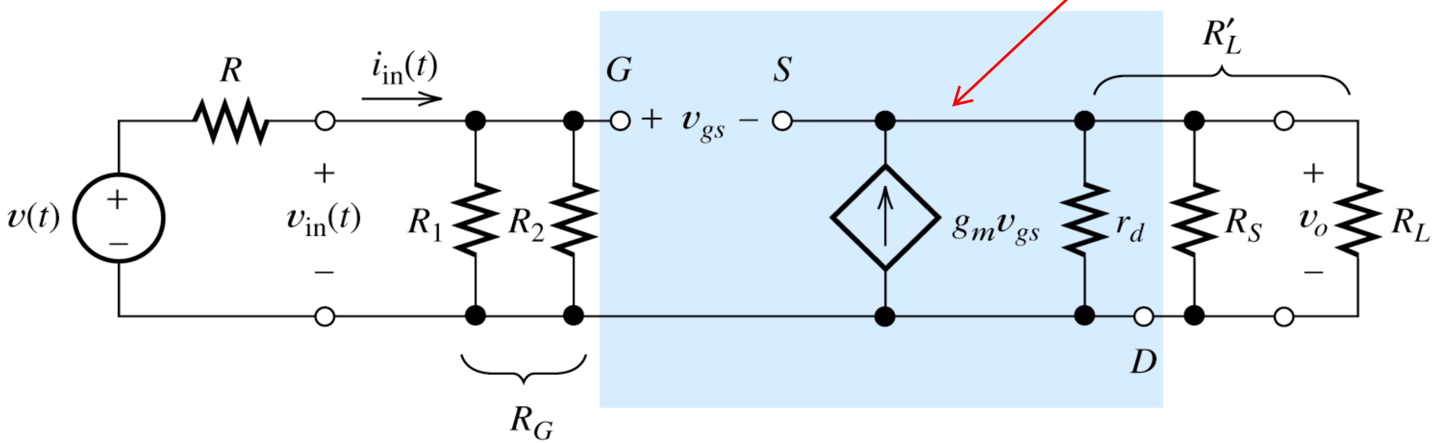


Figure 12.27 Small-signal ac equivalent circuit for the source follower.

Small-Signal Equivalent Circuit -Source Follower

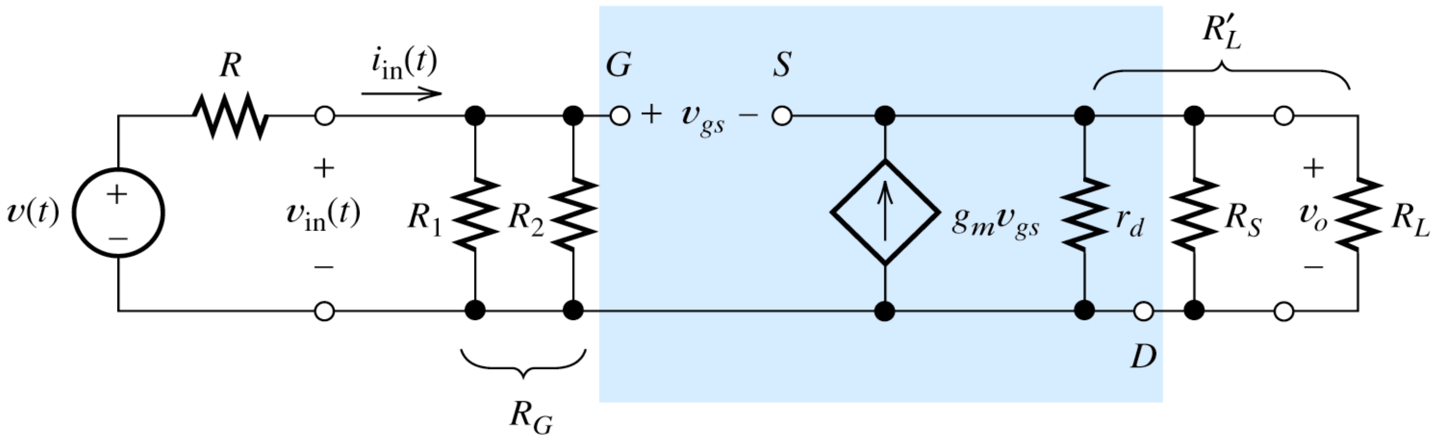


Figure 12.27 Small-signal ac equivalent circuit for the source follower.

$$R_L' = \frac{1}{1/r_d + 1/R_S + 1/R_L}$$

Input resistance

$$R_{in} = \frac{v_{in}}{i_{in}} = R_G = R_1 \| R_2$$

Voltage gain

$$v_0 = g_m v_{gs} R_L' \qquad v_{in} = v_{gs} + v_o = v_{gs}\left(1 + g_m R_L'\right)$$

$$A_v = \frac{v_0}{v_{in}} = \frac{g_m R_L'}{1 + g_m R_L'} \leq 1$$

Since the output voltage is almost equal to the input – hence the name source follower