UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE105 Lab Experiments

Prelab 9: MOS Characterization and Amplifiers

Solutions

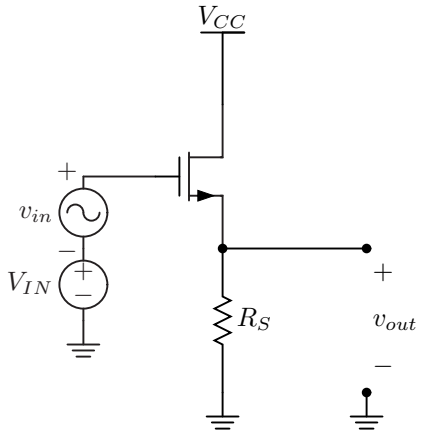
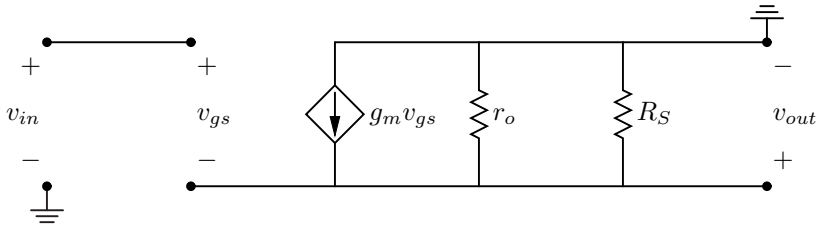


Figure 1: Common drain amplifier

1. Draw the small signal model for the common drain shown in Figure 1.



2. Derive the output impedance.

We short the input and apply a test source at the output.

$$v_t = -v_{gs}$$

$$g_m v_{gs} - \frac{v_t}{r_o \parallel R_S} + i_t = 0$$

$$v_t \left(g_m + \frac{1}{r_o \parallel R_S} \right) = i_t$$

$$R_{out} = \frac{v_t}{i_t} = \boxed{\frac{1}{g_m + \frac{1}{r_o \| R_S}}}$$

3. Derive the voltage gain.

$$
\begin{aligned}
v_{out} &= g_m v_{gs}(r_o \parallel R_S) \\
v_{in} &= v_{out} + v_{gs} \\
v_{out} &= g_m(v_{in} - v_{out})(r_o \parallel R_S) \\
v_{out}\,(1 + g_m(r_o \parallel R_S)) &= g_m v_{in}(r_o \parallel R_S) \\
A_v = \frac{v_{out}}{v_{in}} &= \boxed{\frac{g_m(r_o \parallel R_S)}{1 + g_m(r_o \parallel R_S)}}
\end{aligned}
$$

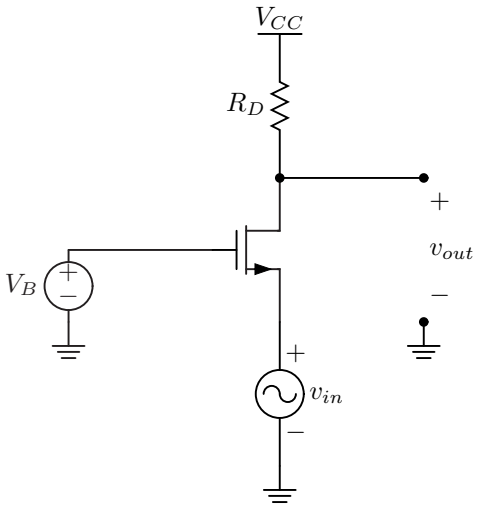


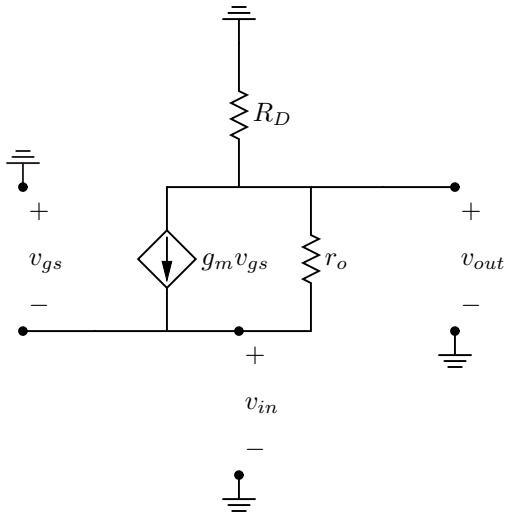
Figure 2: Common gate amplifier

4. Draw the small signal model for the common gate shown in Figure 2.

5. Derive the output impedance.

$$R_{out} = \boxed{r_o \parallel R_D}$$

6. Derive the voltage gain.



$$\frac{v_{out}}{R_D} = g_m v_{in} + \left(\frac{v_{in} - v_{out}}{r_o}\right)$$

$$v_{out}\left(\frac{1}{R_D} + \frac{1}{r_o}\right) = v_{in}\left(g_m + \frac{1}{r_o}\right)$$

$$A_v = \frac{v_{out}}{v_{in}} = \frac{g_m + \frac{1}{r_o}}{\frac{1}{R_D} + \frac{1}{r_o}}$$

$$= \boxed{g_m \left(r_o \parallel R_D\right) + \frac{r_o \parallel R_D}{r_o}}$$