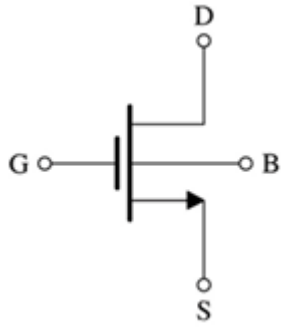
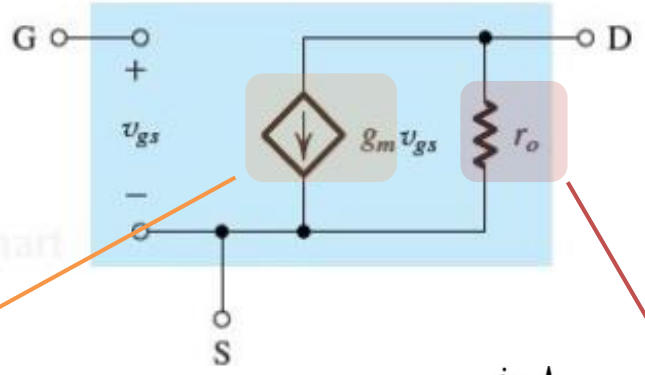
Last Lecture → Small Signal Parameters

11/12/2019

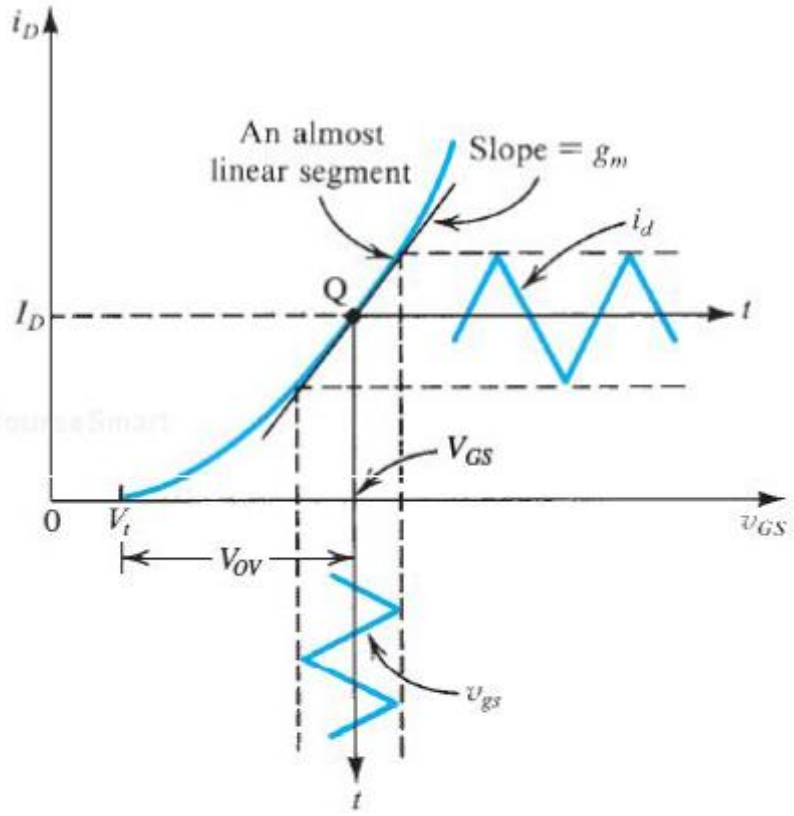
→ Trans-conductance (g_m)
→ Output Impedance (r_o)
→ Input Impedance

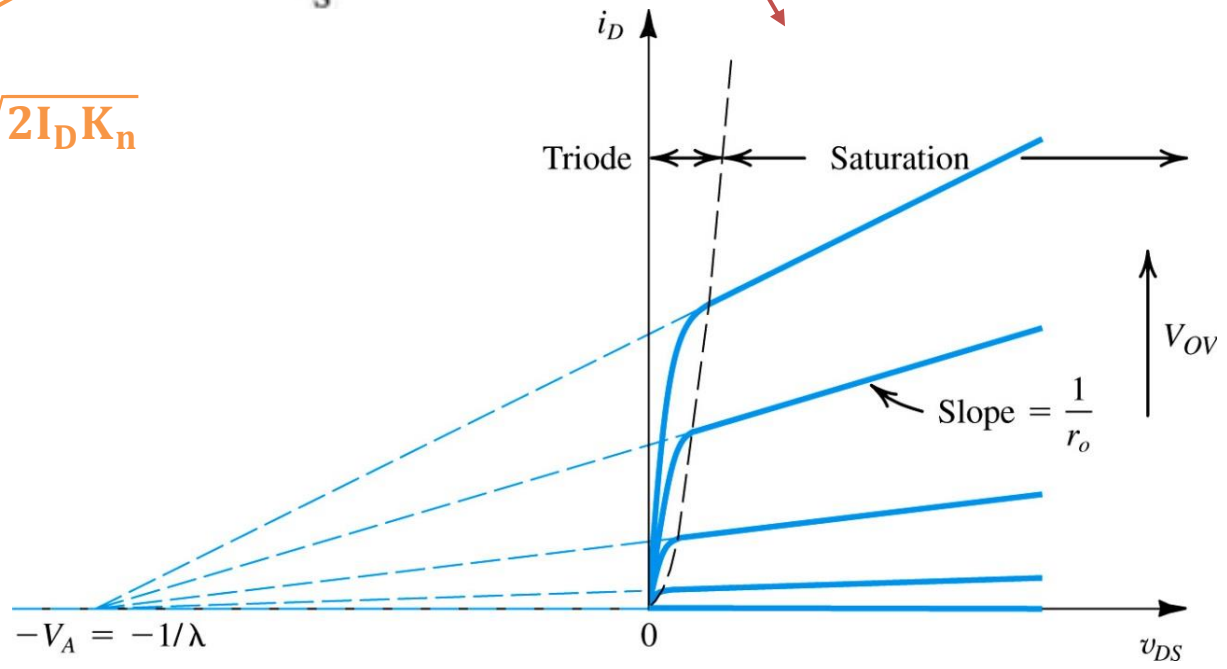




$$r_0 = \frac{1}{\lambda I_D}$$

$$g_m = \sqrt{2 I_D K_n}$$





Basic MOSFETs Amplifier Configuration

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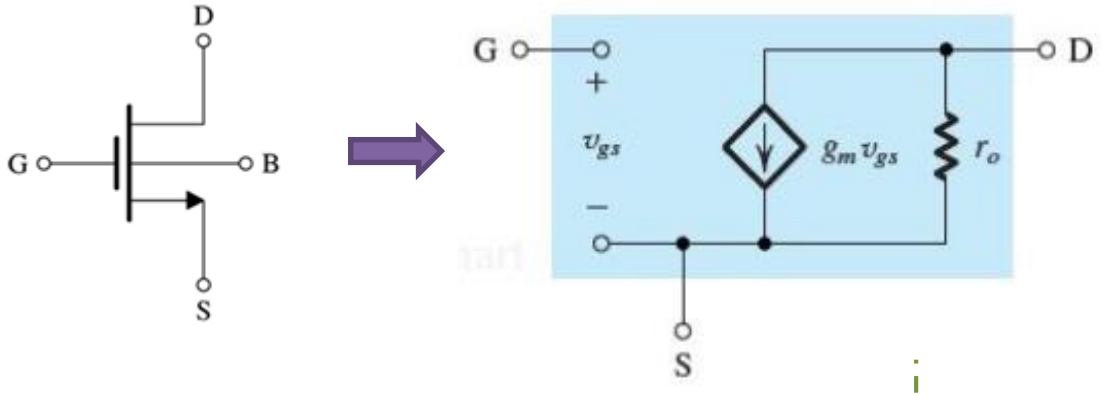
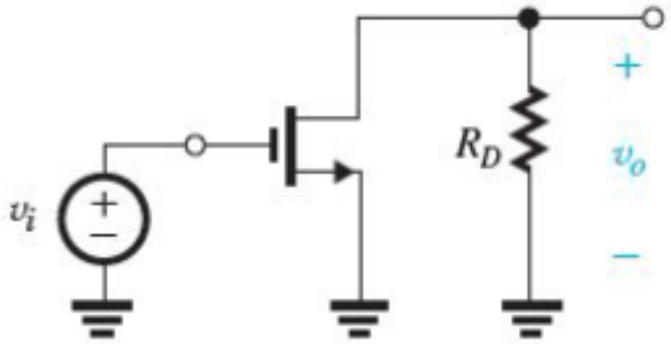
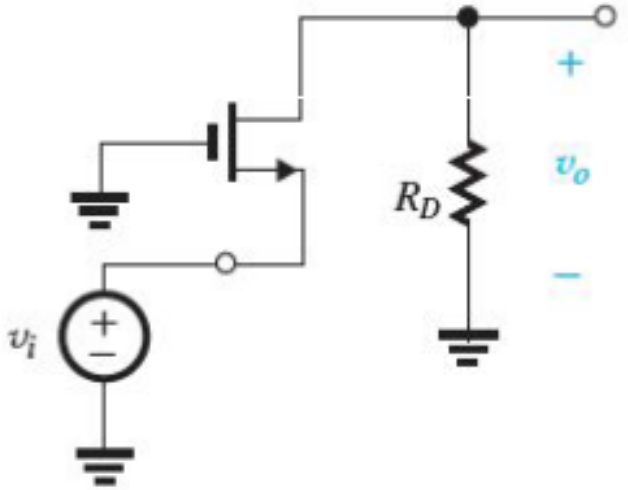
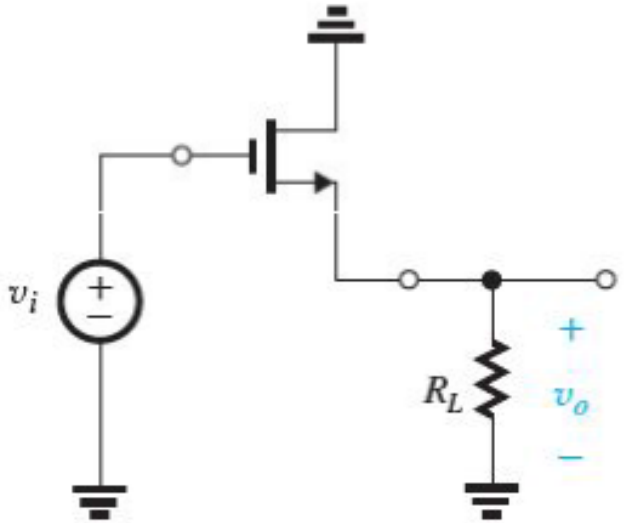




(a) Common Source (CS)



(b) Common Gate (CG)



(c) Common Drain (CD)

MOS Amplifiers

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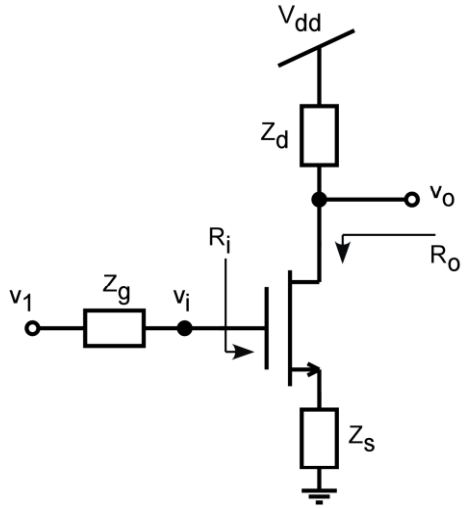
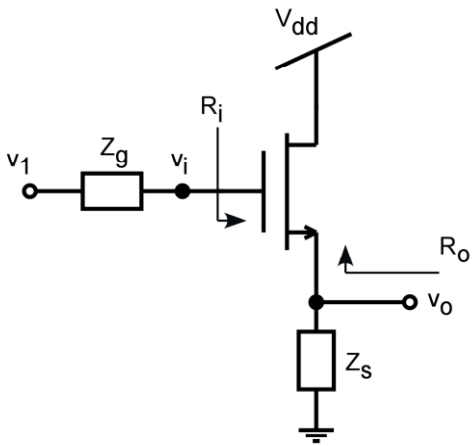
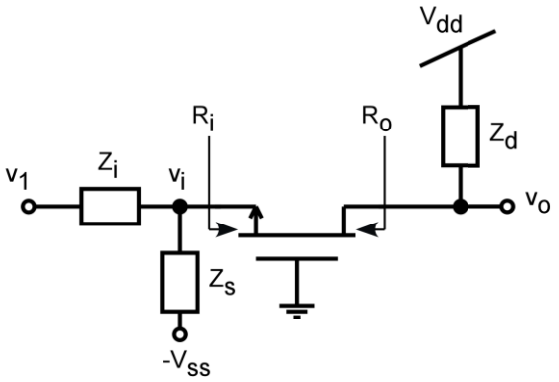


Common Source - CS



Common Drain - CD



Common Gate - CD

Single Transistor MOS Amplifier	Common-Source	Common-Drain	Common-Gate
Voltage Gain $A_v = \frac{v_o}{v_i}$	$= -\frac{g_m}{1 + g_m Z_s} \cdot R_o // Z_d$	$= +\frac{g_m}{1 + g_m Z_s} \cdot Z_s$	$= +g_m R_o // Z_d$
Input Resistance R_i	$= \infty$	$= \infty$	$= \frac{1}{g_m}$
Output Resistance R_o	$= r_{ds}(1 + g_m Z_s)$	$= \frac{1}{g_m}$	$= r_{ds}[1 + g_m(Z_i // Z_s)]$

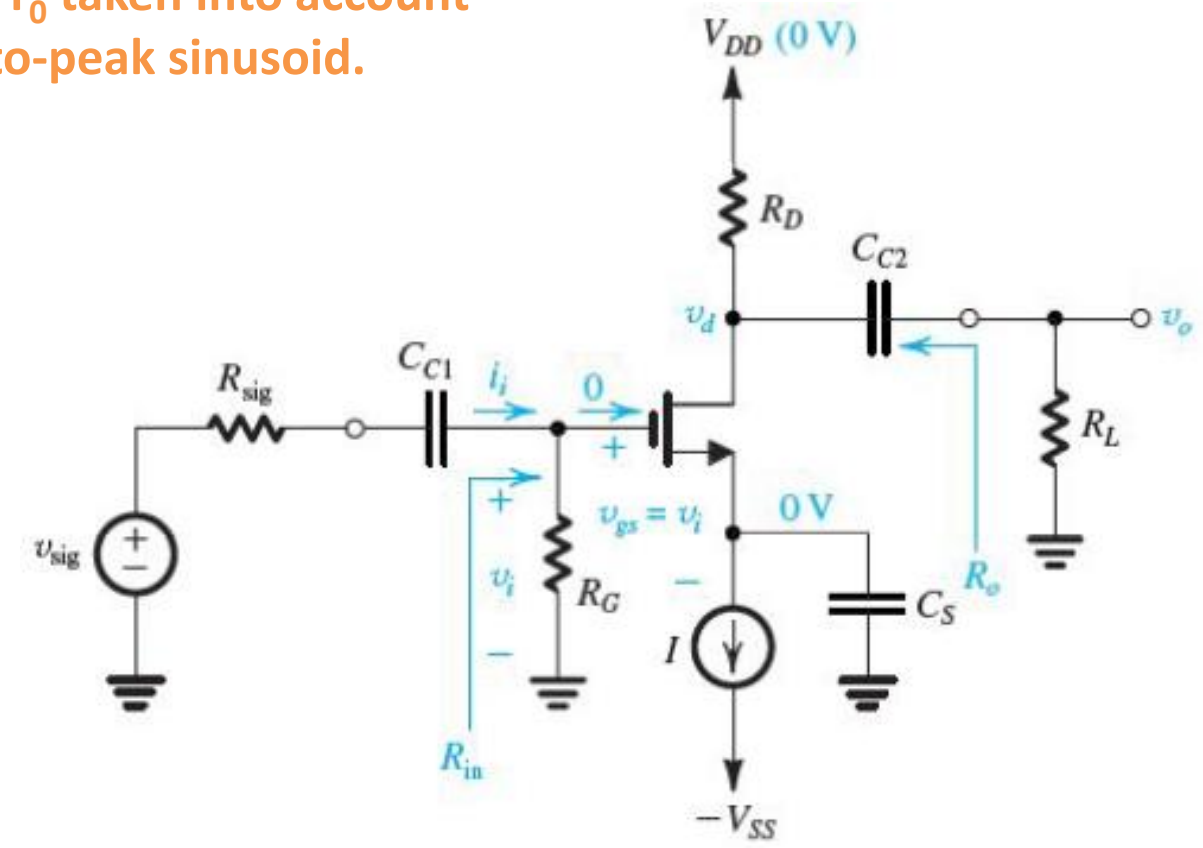
Exercise 5.38

Consider the given amplifier with g_m=1mA/V, r_0=150kΩ, R_{sig}=100kΩ, and R_L=15kΩ.

a) **Calculate R_{in}, $A_{v\_cs}=V_0/V_i$, and R_0, both without and with r_0 taken into account**

b) **Calculate the overall voltage gain $G_v=v_0/v_{sig}$, with r_0 taken into account**

c) **Determine output signal v_0 if v_{sig} is a 0.4-V peak-to-peak sinusoid.**



Exercise 5.41

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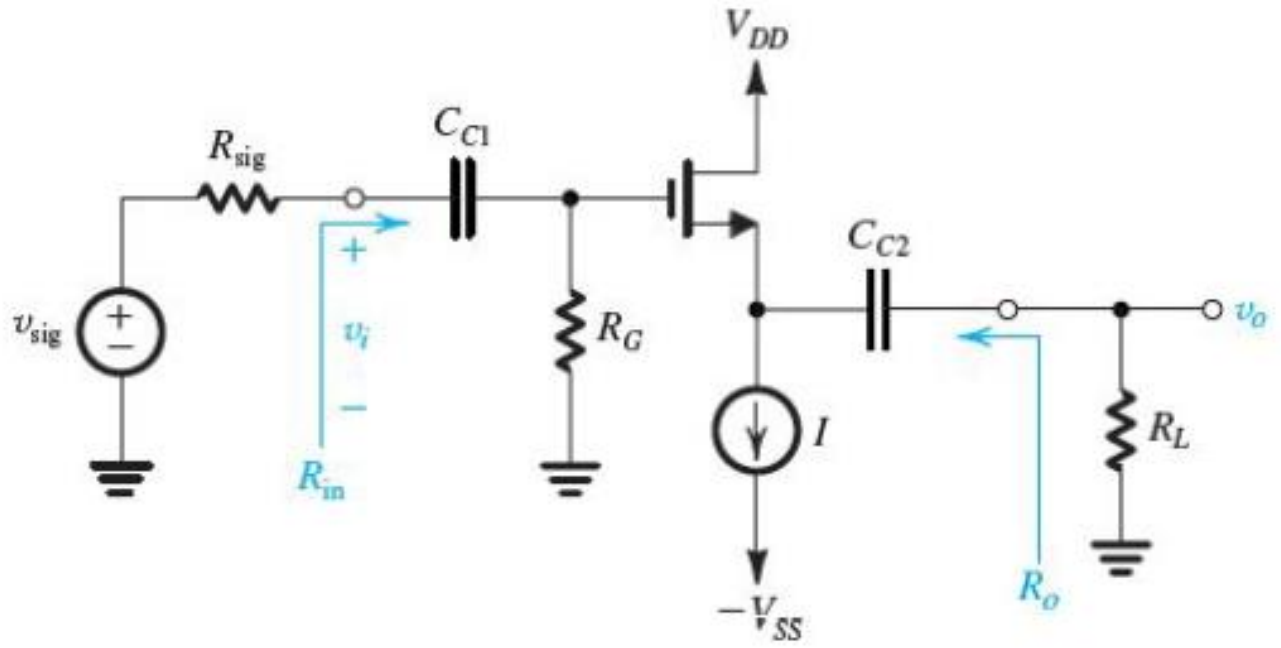
Consider the given common collector amplifier with g_m=1mA/V and r_0=150kΩ. Let R_{sig}=1MΩ, R_G=1MΩ, and R_L=15k Ω,

a) **Find R_{in}, $A_v=V_0/V_i$, and R_0 without and with r_0 taken into account.**

b) **Find the overall voltage gain $G_v=v_0/v_{sig}$ with r_0 taken into account,**



Problem

An common source NMOS amplifier is to be designed to provide a 0.5V peak output signal across a 50kΩ load that can be used as a drain resistor. If a gain of at least -5V/V is needed, what g_m is required? Using a dc supply of 1.8V, what values of I_d and V_{ov} would you choose? What W/L ratio is required if $k_n'=200\mu A/V^2$? If $V_t=0.4V$, find V_{gs}.