University of Anbar
College of Engineering
Dept. of Electrical Engineering



# Fundumantal of Electronic II

**Second Class**

Chapter08: FET Amplifier

Lec08_p2

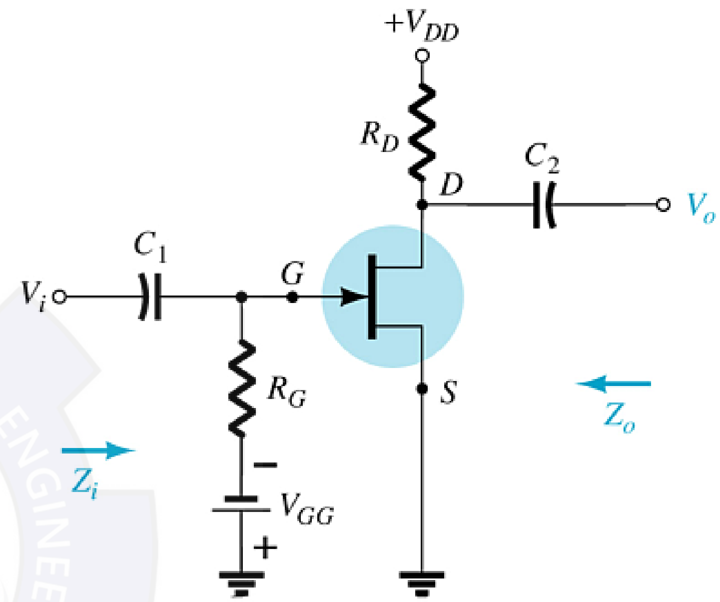
**Munther N. Thiyab**

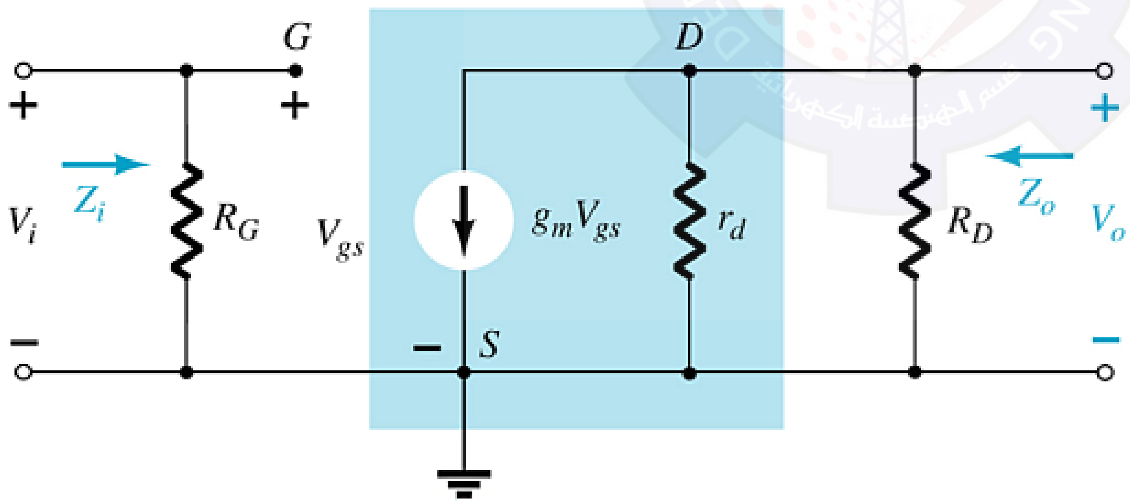
**2019-2020**

# Common-Source (CS) Fixed-Bias Circuit

**The input is on the gate and the output is on the drain**

**There is a 180° phase shift between input and output**



# Calculations

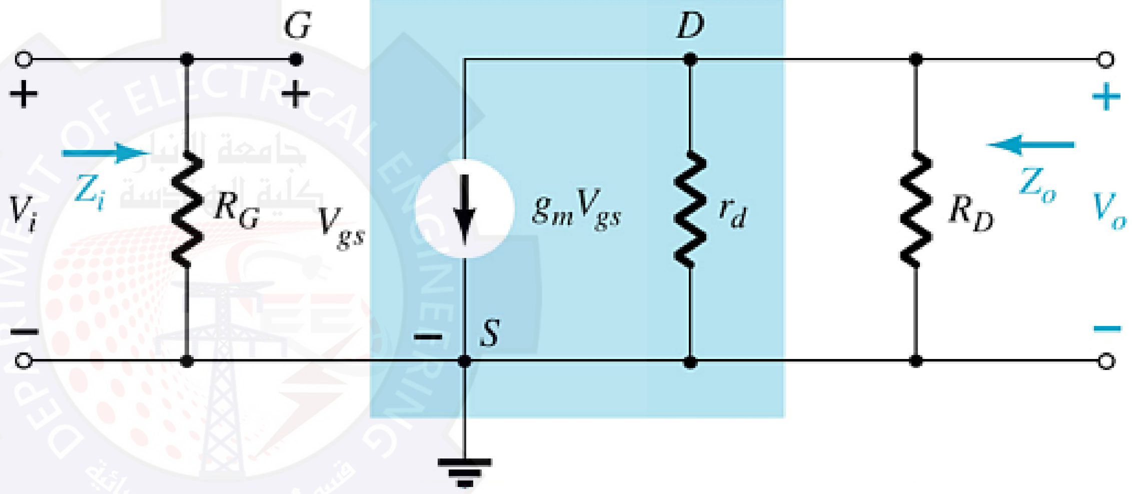
**Input impedance:**

$$Z_i = R_G$$

**Output impedance:**

$$Z_o = R_D \parallel r_d$$

$$Z_o \cong R_D \Big|_{r_d \geq 10R_D}$$

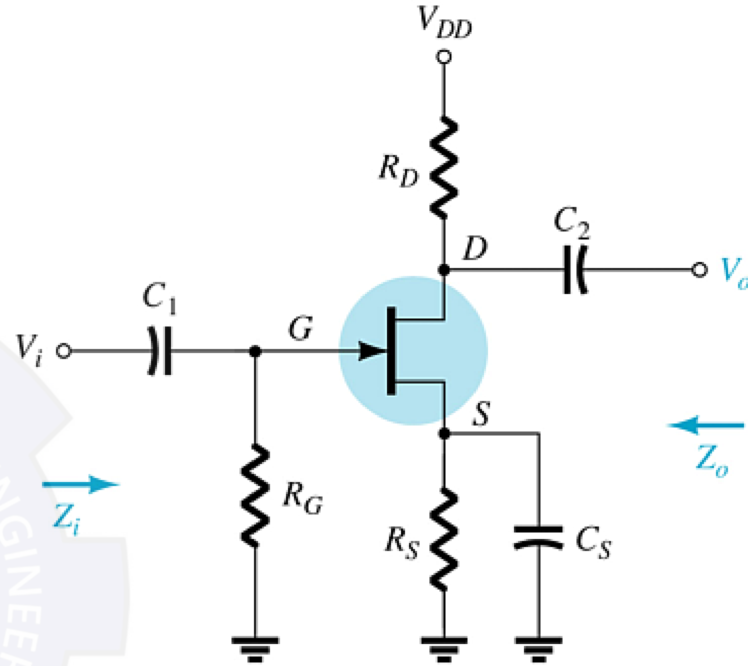



**Voltage gain:**

$$A_v = \frac{V_o}{V_i} = -g_m (r_d \parallel R_D)$$

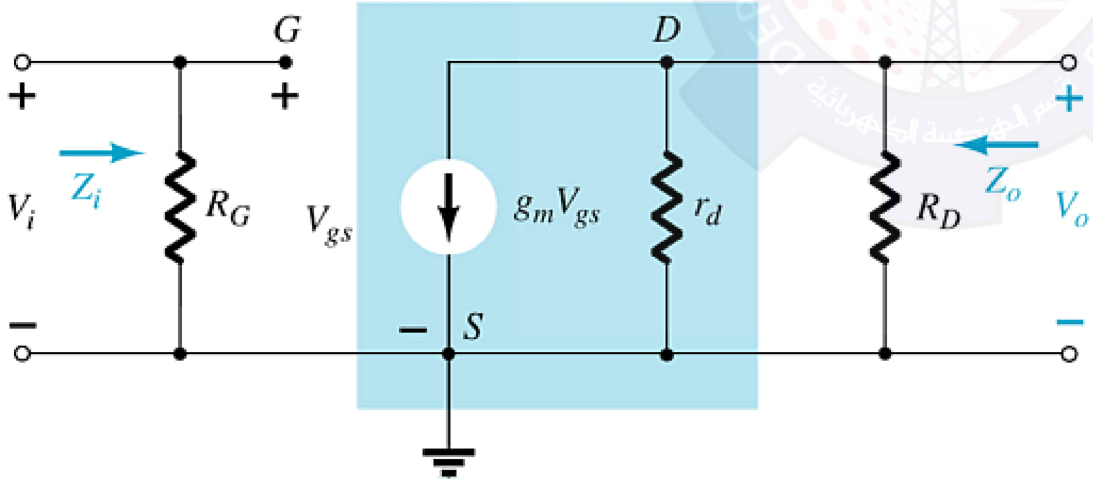
$$A_v = \frac{V_o}{V_i} = -g_m R_D \Big|_{r_d \geq 10R_D}$$

# Common-Source (CS) Self-Bias Circuit




This is a common-source amplifier configuration, so the input is on the gate and the output is on the drain

There is a 180° phase shift between input and output



# Calculations

**Input impedance:**

$$Z_i = R_G$$

**Output impedance:**

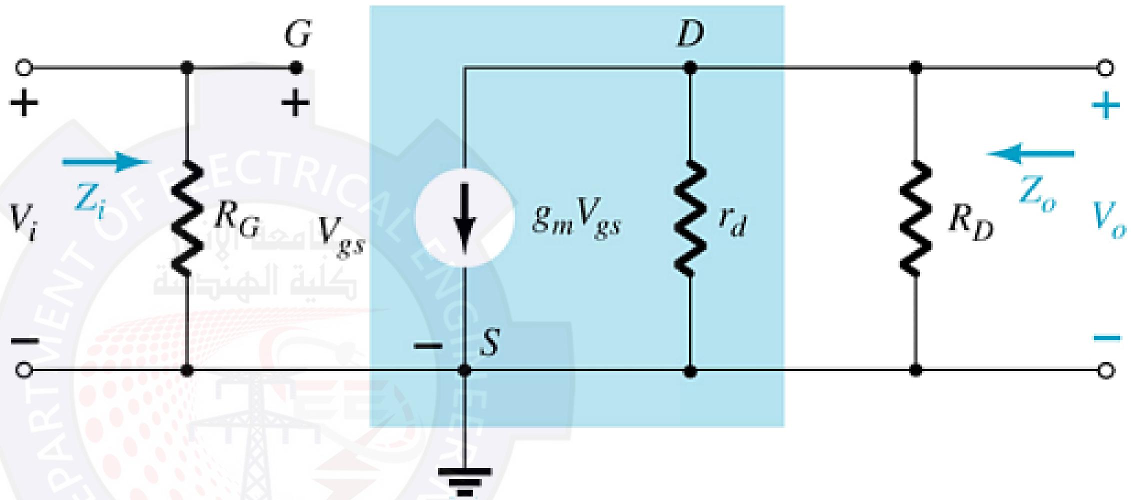
$$Z_o = r_d \parallel R_D$$

$$Z_o \cong R_D \Big|_{r_d \geq 10R_D}$$

**Voltage gain:**

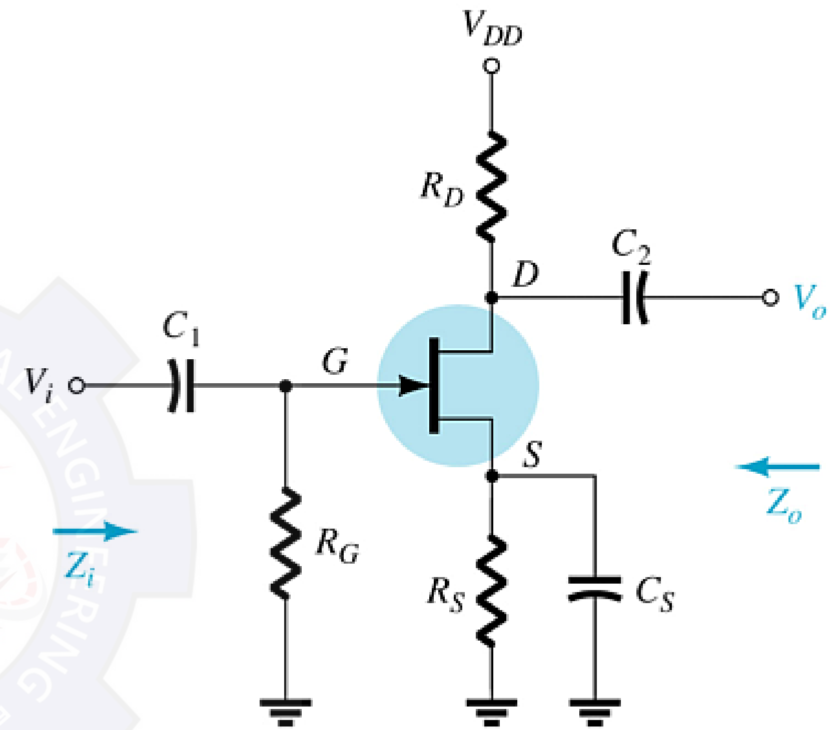
$$A_v = -g_m(r_d \parallel R_D)$$

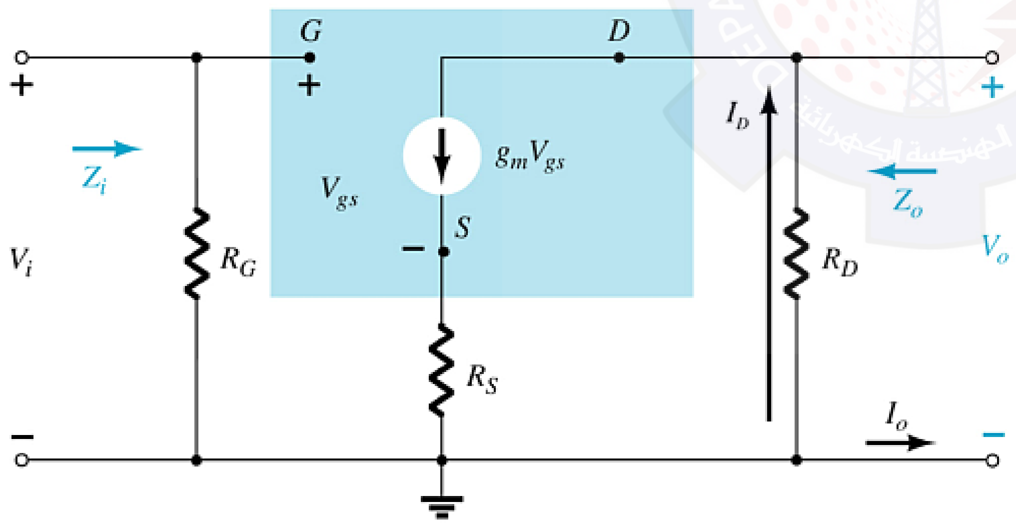
$$A_v = -g_m R_D \Big|_{r_d \geq 10R_D}$$



# Common-Source (CS) Self-Bias Circuit

**Removing $C_s$ affects the gain of the circuit.**






Electronic Devices and Circuit Theory, 10/e
Robert L. Boylestad and Louis Nashelsky

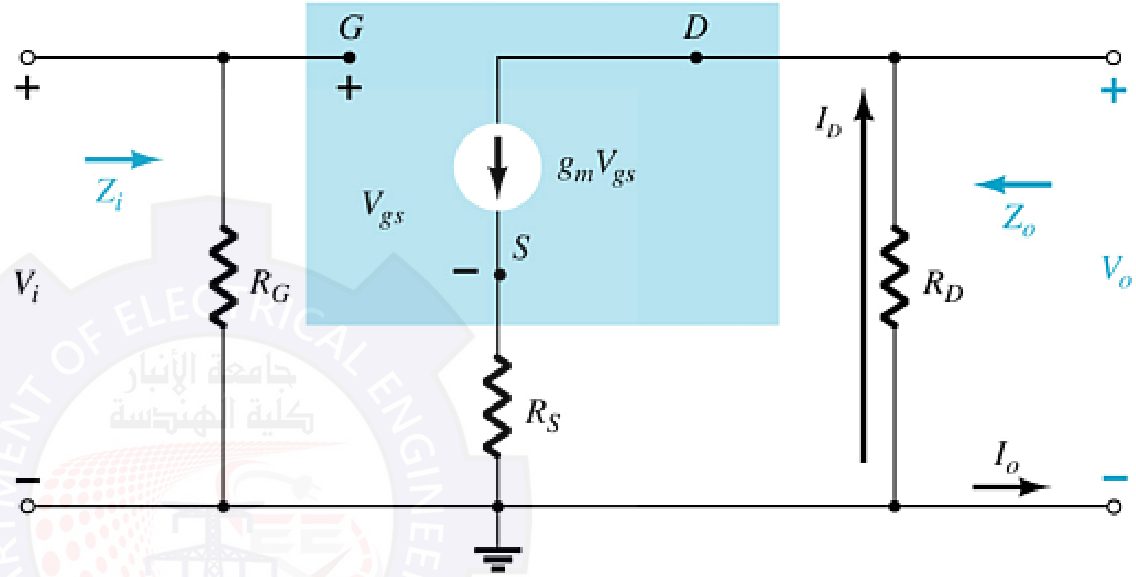
# Calculations

**Input impedance:**

$$Z_i = R_G$$

**Output impedance:**

$$Z_o \cong R_D \Big|_{r_d \geq 10 R_D}$$



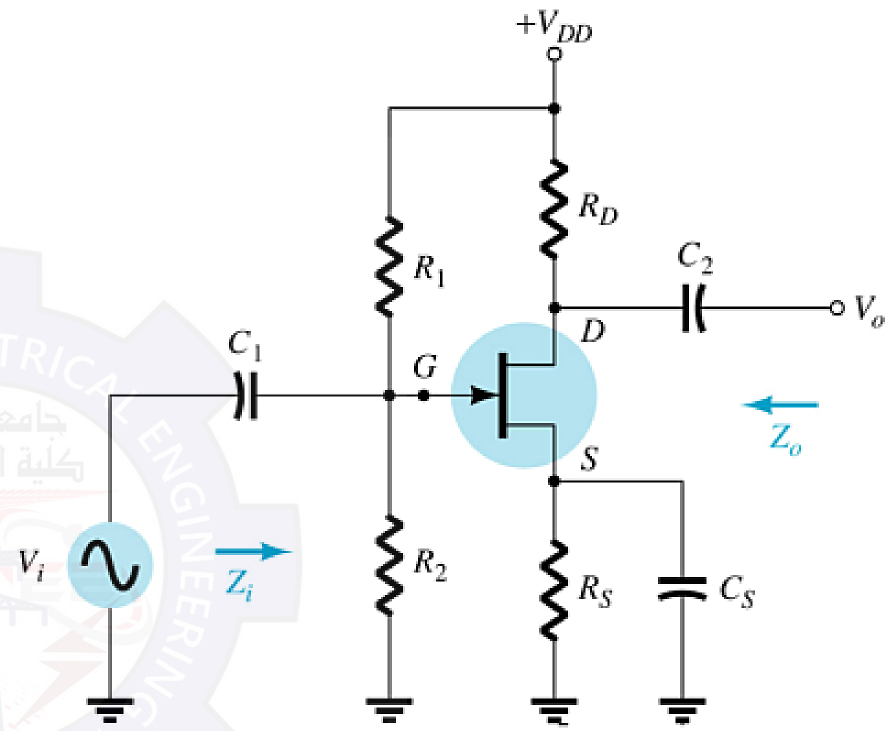

**Voltage gain:**

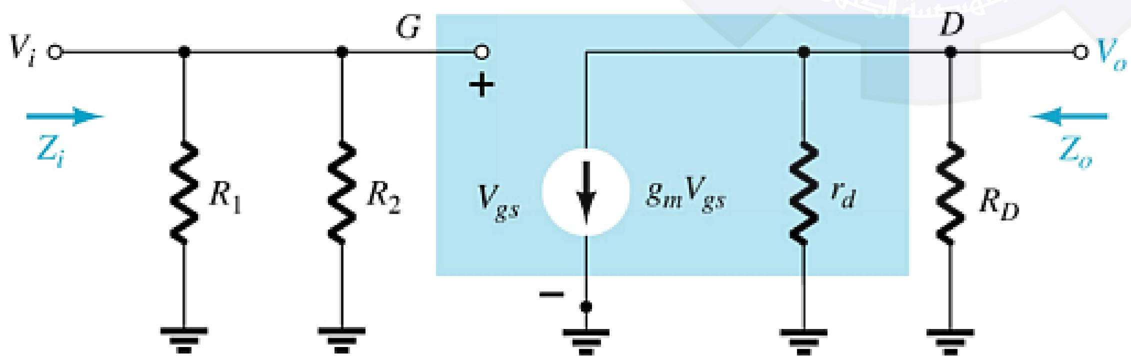
$$A_v = \frac{V_o}{V_i} = -\frac{g_m R_D}{1 + g_m R_S + \dfrac{R_D + R_S}{r_d}}$$

$$A_v = \frac{V_o}{V_i} = -\frac{g_m R_D}{1 + g_m R_S}\Bigg|_{r_d \geq 10(R_D + R_S)}$$

# Common-Source (CS) Voltage-Divider Bias

**This is a common-source amplifier configuration, so the input is on the gate and the output is on the drain.**



# Impedances

**Input impedance:**

$$Z_i = R_1 \parallel R_2$$

**Output impedance:**

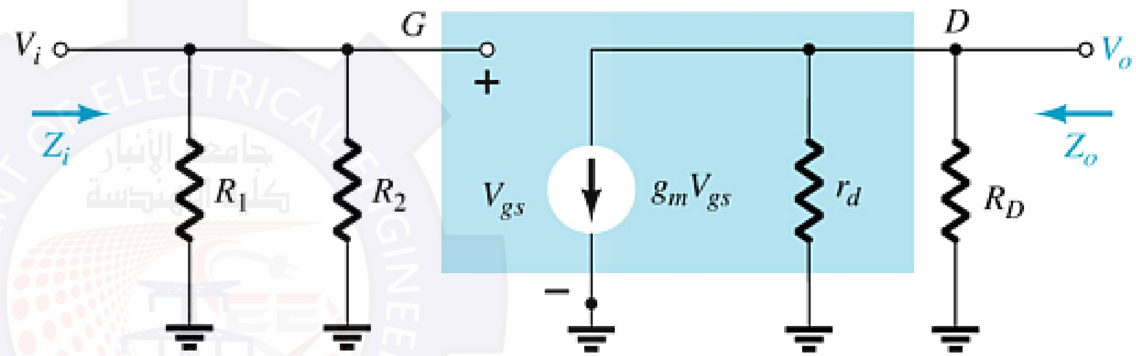
$$Z_o = r_d \parallel R_D$$

$$Z_o \cong R_D \Big|_{r_d \geq 10R_D}$$

**Voltage gain:**

$$A_v = -g_m(r_d \parallel R_D)$$

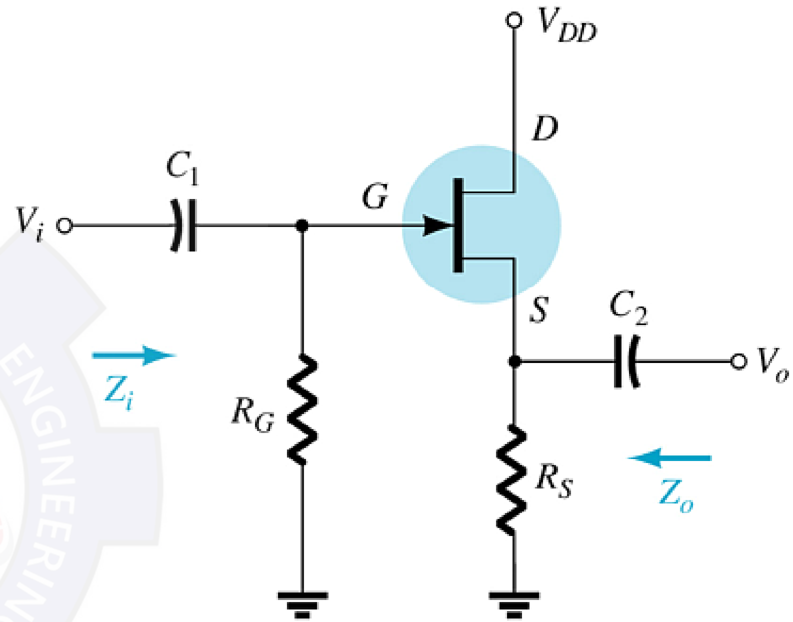
$$A_v = -g_m R_D \Big|_{r_d \geq 10R_D}$$

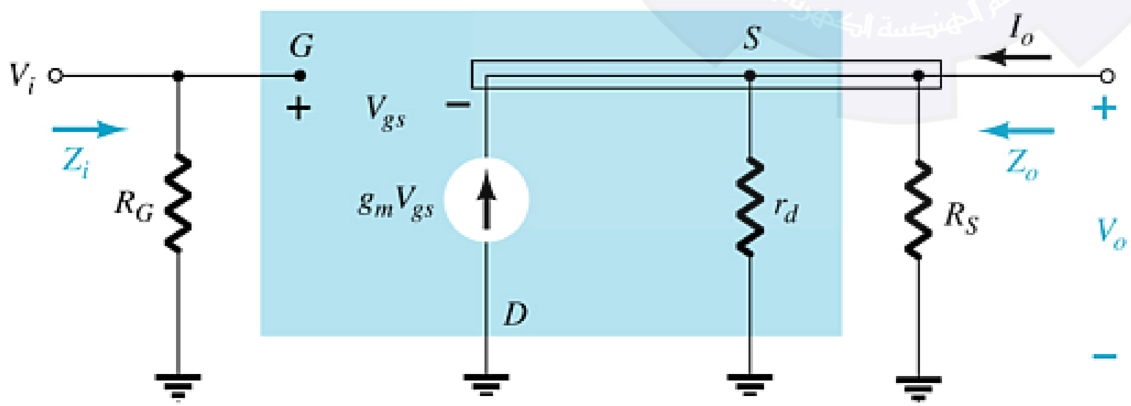


# Source Follower (Common-Drain) Circuit

In a common-drain amplifier configuration, the input is on the gate, but the output is from the source.

There is no phase shift between input and output.



# Impedances

## Input impedance:

$$Z_i = R_G$$

## Output impedance:

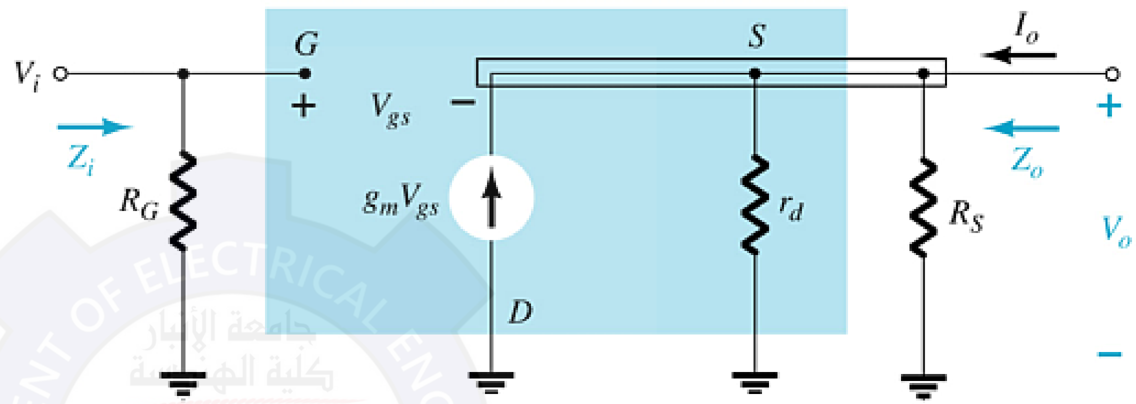
$$Z_o = r_d \parallel R_S \parallel \frac{1}{g_m}$$

$$Z_o \cong R_S \parallel \frac{1}{g_m} \Bigg|_{r_d \geq 10R_S}$$

## Voltage gain:

$$A_v = \frac{V_o}{V_i} = \frac{g_m(r_d \parallel R_S)}{1 + g_m(r_d \parallel R_S)}$$

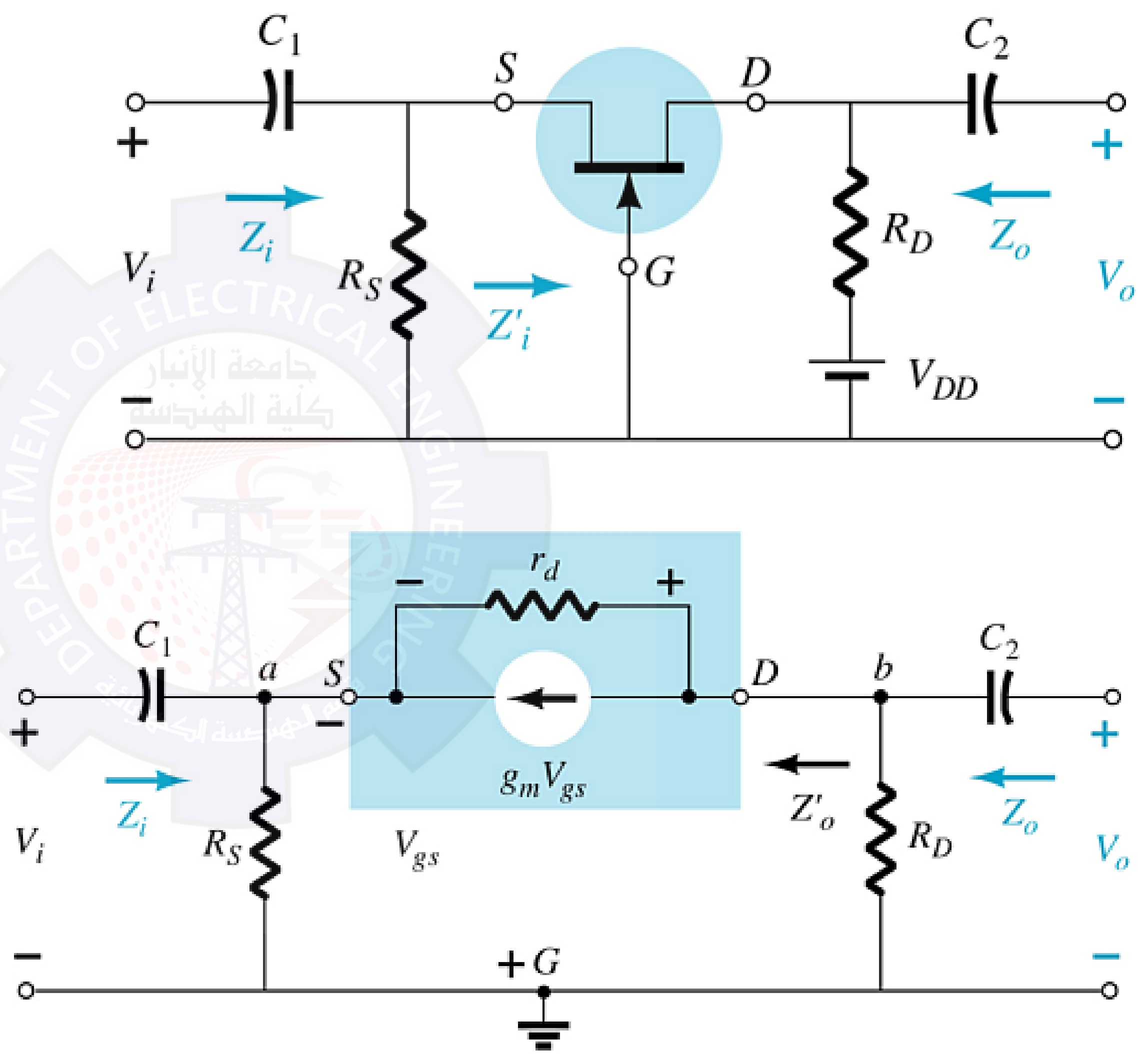
$$A_v = \frac{V_o}{V_i} = \frac{g_m R_S}{1 + g_m R_S} \Bigg|_{r_d \geq 10}$$



# Common-Gate (CG) Circuit

**The input is on the source and the output is on the drain.**

**There is no phase shift between input and output.**

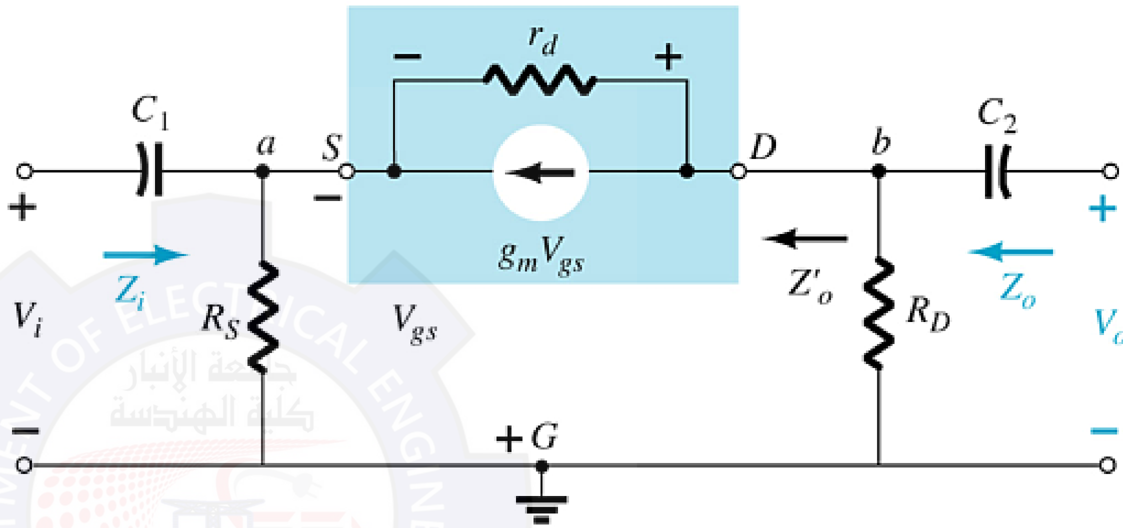


# Calculations

## Input impedance:

$$Z_i = R_S \parallel \left[ \frac{r_d + R_D}{1 + g_m r_d} \right]$$

$$Z_i \cong R_S \parallel \frac{1}{g_m} \Big|_{r_d \geq 10 R_D}$$




## Output impedance:

$$Z_o = R_D \parallel r_d$$

$$Z_o \cong R_D \Big|_{r_d \geq 10}$$

## Voltage gain:

$$A_v = \frac{V_o}{V_i} = \frac{\left[ g_m R_D + \frac{R_D}{r_d} \right]}{\left[ 1 + \frac{R_D}{r_d} \right]} \qquad A_v = g_m R_D \Big|_{r_d \geq 10 R_D}$$