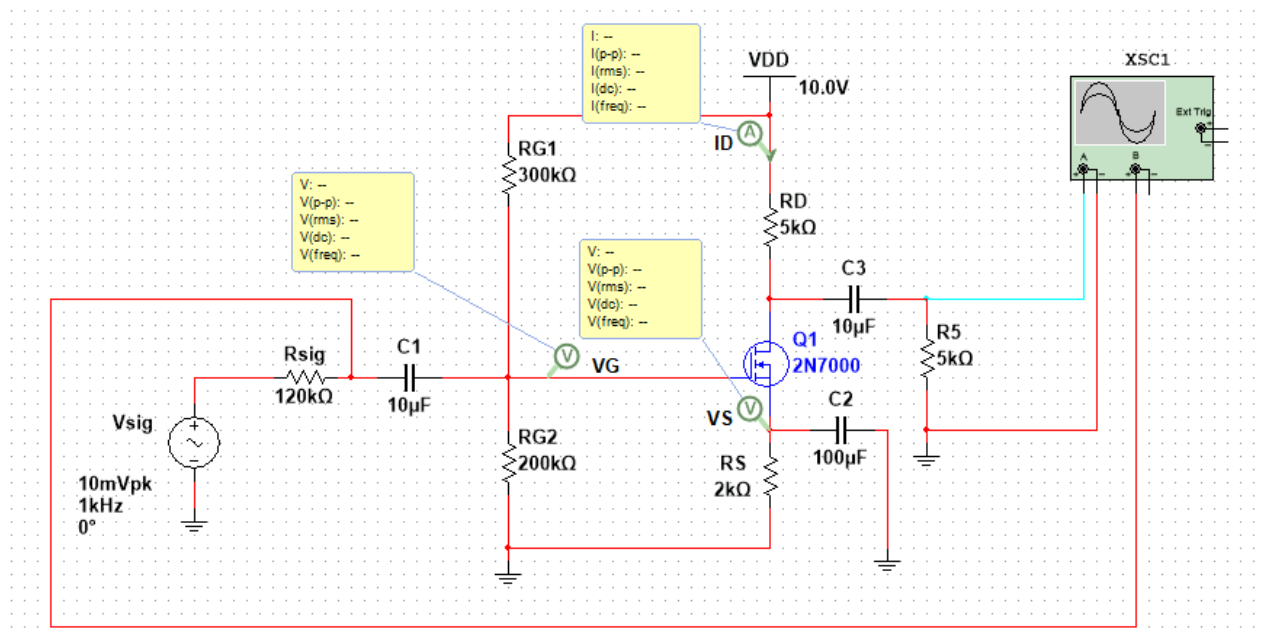# Lab 10

NMOS Amplifiers

Learning outcomes

1) Studying the amplification characteristics of Common Source Amplifiers
2) Studying the amplification characteristics of Common Source Amplifiers with source resistance
3) Studying the amplification characteristics of Common Drain Amplifiers or "Source Follower"
4) Studying the amplification characteristics of Common Gate Amplifiers

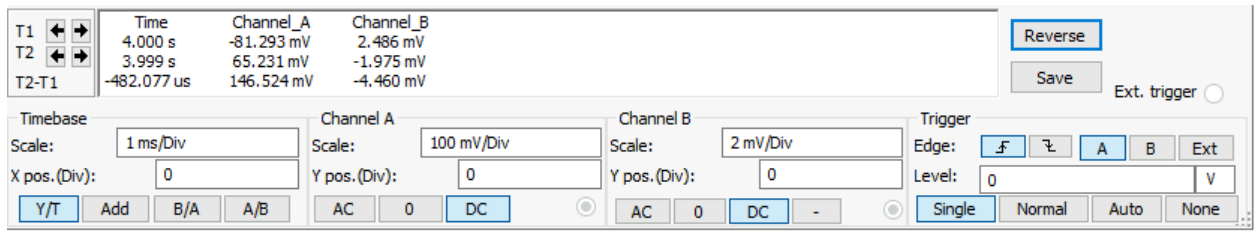**Experiment 1) Studying the amplification characteristics of CS amplifiers**

A) Create a new Multisim project and construct the circuit shown

B) Run the simulation and record I_D, V_G, V_S and calculate gm
C) Calculate the theoretical values of I_D, V_G, V_S then calculate gm
D) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{\|Measured-Theortical\|}{Theortical}$ x 100
I_D			
V_G			
V_S			
gm			

E) Read $v_{o\text{-}pp}$ and $v_{in\text{-}pp}$ after setting both ChA and ChB as shown below

	Time	Channel_A	Channel_B		
T1	4.000 s	-81.293 mV	2.486 mV		Reverse
T2	3.999 s	65.231 mV	-1.975 mV		
T2-T1	-482.077 us	146.524 mV	-4.460 mV		Save

Ext. trigger ○

Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Y/T | Add | B/A | A/B

Channel A
Scale: 100 mV/Div
Y pos.(Div): 0
AC | 0 | DC

Channel B
Scale: 2 mV/Div
Y pos.(Div): 0
AC | 0 | DC | -

Trigger
Edge: ƒ | ⅂ | A | B | Ext
Level: 0 | V
Single | Normal | Auto | None

F) Take a screenshot of the outputs of the oscilloscope and put it in the following place holder

Put a screenshot of your output ($v_{o\text{-}pp}$ and $v_{in\text{-}pp}$) here and Plz make $v_{o\text{-}pp}$ in green and $v_{in\text{-}pp}$ in red

G) Calculate voltage gain Av= $v_{o\text{-}pp}$ / $v_{in\text{-}pp}$

H) Calculate overall voltage gain Gv= $v_{o\text{-}pp}$ / $v_{sig\text{-}pp}$= $v_{o\text{-}pp}$ / 20mV

I) Calculate the theoretical values of Av = $-gm \cdot (R_L||R_D)$

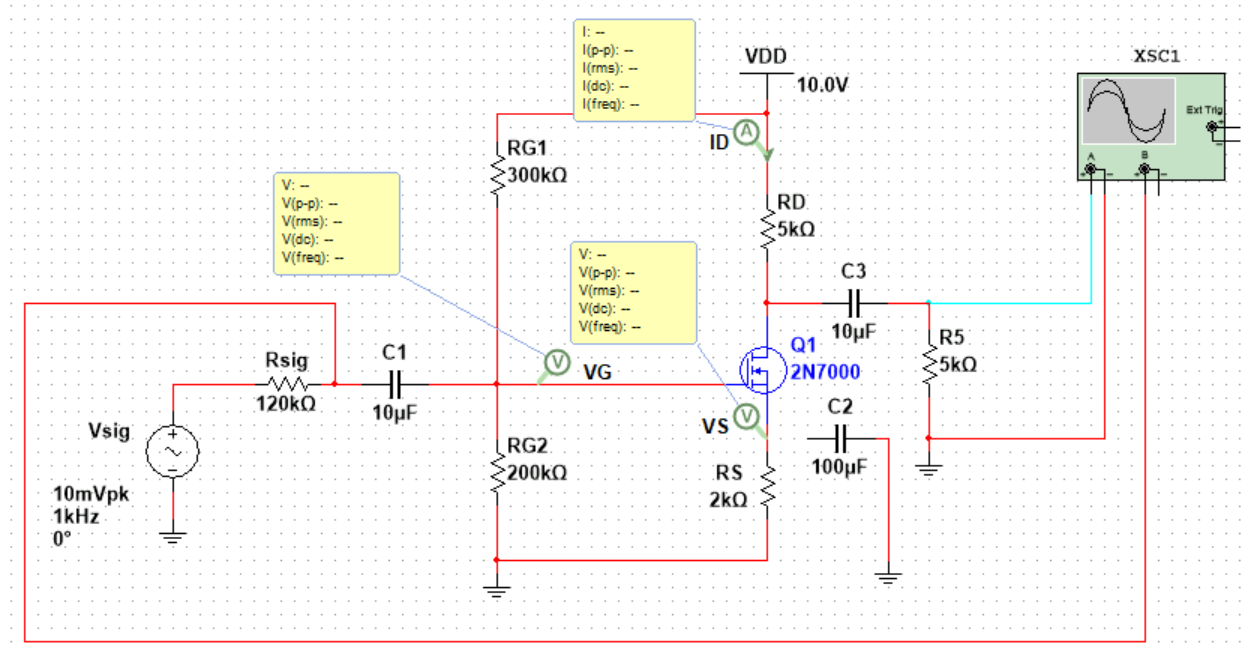J) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{||Measured-Theortical||}{Theortical}$ x 100
Av			

Answer the following questions:

1- Why Gv ≈ 0.5 Av?

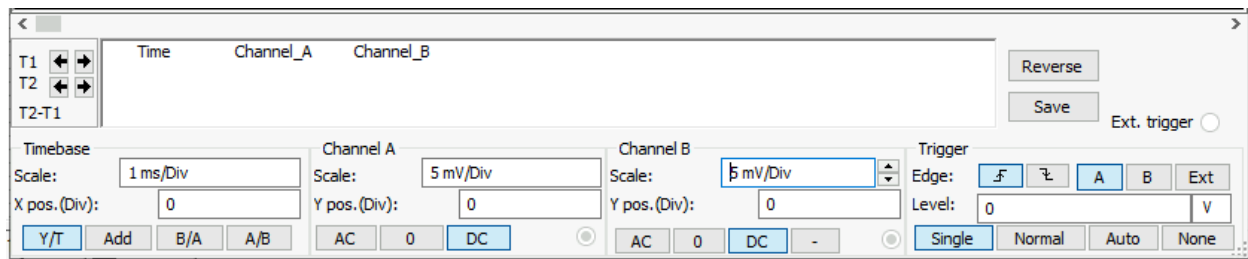# Experiment 2) Studying the amplification characteristics of CS amplifiers with Rs

A) Create a new Multisim project and construct the circuit shown

B) Run the simulation and record I_D, V_G, V_S and calculate gm
C) Calculate the theoretical values of I_D, V_G, V_S then calculate gm
D) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{\|Measured - Theortical\|}{Theortical}$ x 100
I_D			
V_G			
V_S			
gm			

E) Read $v_{o\text{-}pp}$ and $v_{in\text{-}pp}$ after setting both ChA and ChB as shown below

F) Take a screenshot of the outputs of the oscilloscope and put it in the following place holder

Put a screenshot of your output ($v_{o\text{-}pp}$ and $v_{in\text{-}pp}$) here and Plz make $v_{o\text{-}pp}$ in green and $v_{in\text{-}pp}$ in red

G) Calculate voltage gain Av= $v_{o\text{-}pp}$ / $v_{in\text{-}pp}$
H) Calculate overall voltage gain Gv= $v_{o\text{-}pp}$ / $v_{sig\text{-}pp}$= $v_{o\text{-}pp}$ / 20mV
I) Calculate the theoretical values of Av = $\frac{-gm \cdot (R_L || R_D)}{1 + gm \cdot Rs}$
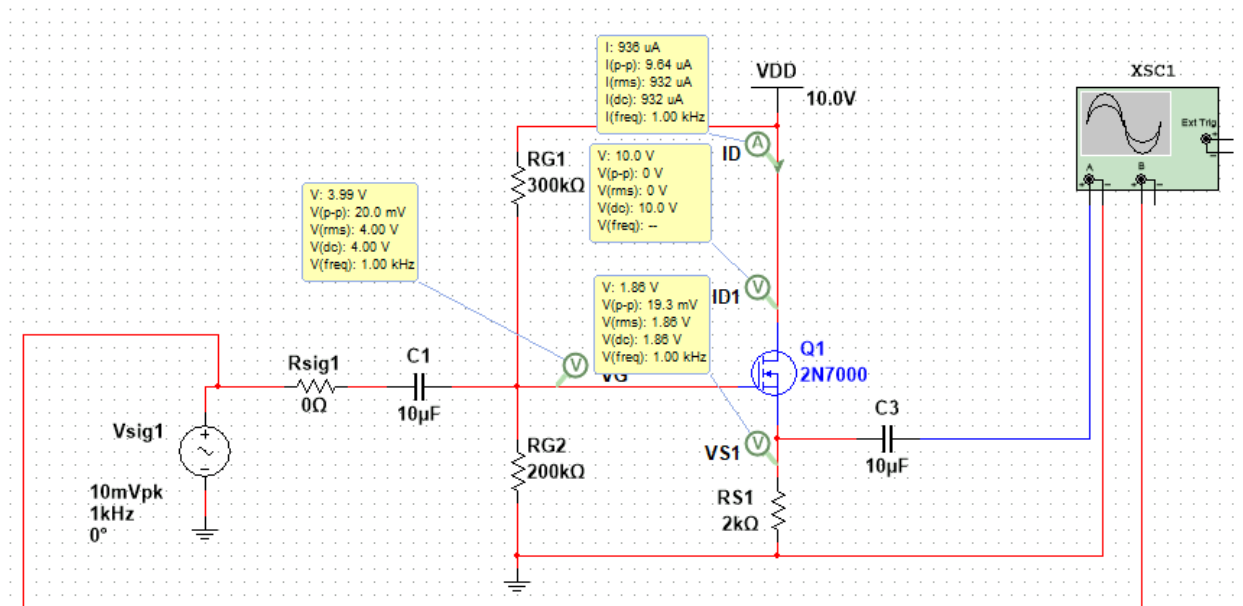J) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{\|Measured - Theortical\|}{Theortical}$ x 100
Av			

Answer the following questions:

1- Why DC values of currents and voltages does not change from exp 1?
2- Why Av is reduced when Rs is included in AC analysis?

Experiment 3) Studying the amplification characteristics of CD amplifiers "Source Follower"

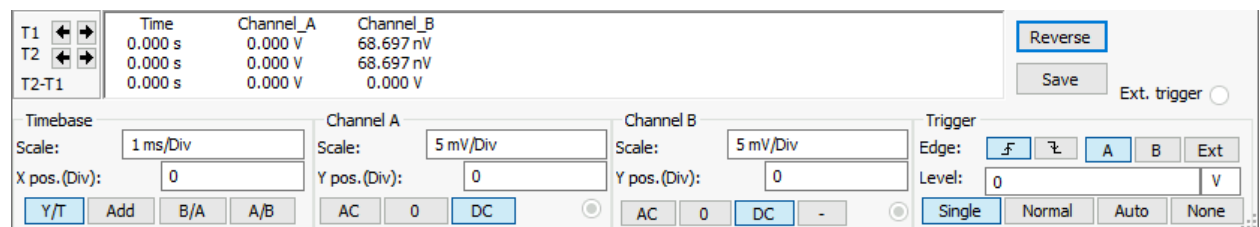A) Create a new Multisim project and construct the circuit shown

B) Run the simulation and record I_D, V_G, V_S and calculate gm
C) Calculate the theoretical values of I_D, V_G, V_S then calculate gm
D) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{\|Measured - Theortical\|}{Theortical}$ x 100
I_D			
V_G			
V_S			
gm			

E) Read v_{o-pp} and v_{in-pp} after setting both ChA and ChB as shown below

F) Take a screenshot of the outputs of the oscilloscope and put it in the following place holder

> Put a screenshot of your output (v_{o-pp} and v_{in-pp}) here and Plz make v_{o-pp} in green and v_{in-pp} in red

G) Calculate voltage gain Av= v_{o-pp} / v_{in-pp}

H) Calculate overall voltage gain Gv= v_{o-pp} / v_{sig-pp}= v_{o-pp} / 20mV

I) Calculate the theoretical values of Av = $\dfrac{R_S}{\frac{1}{gm}+Rs}$

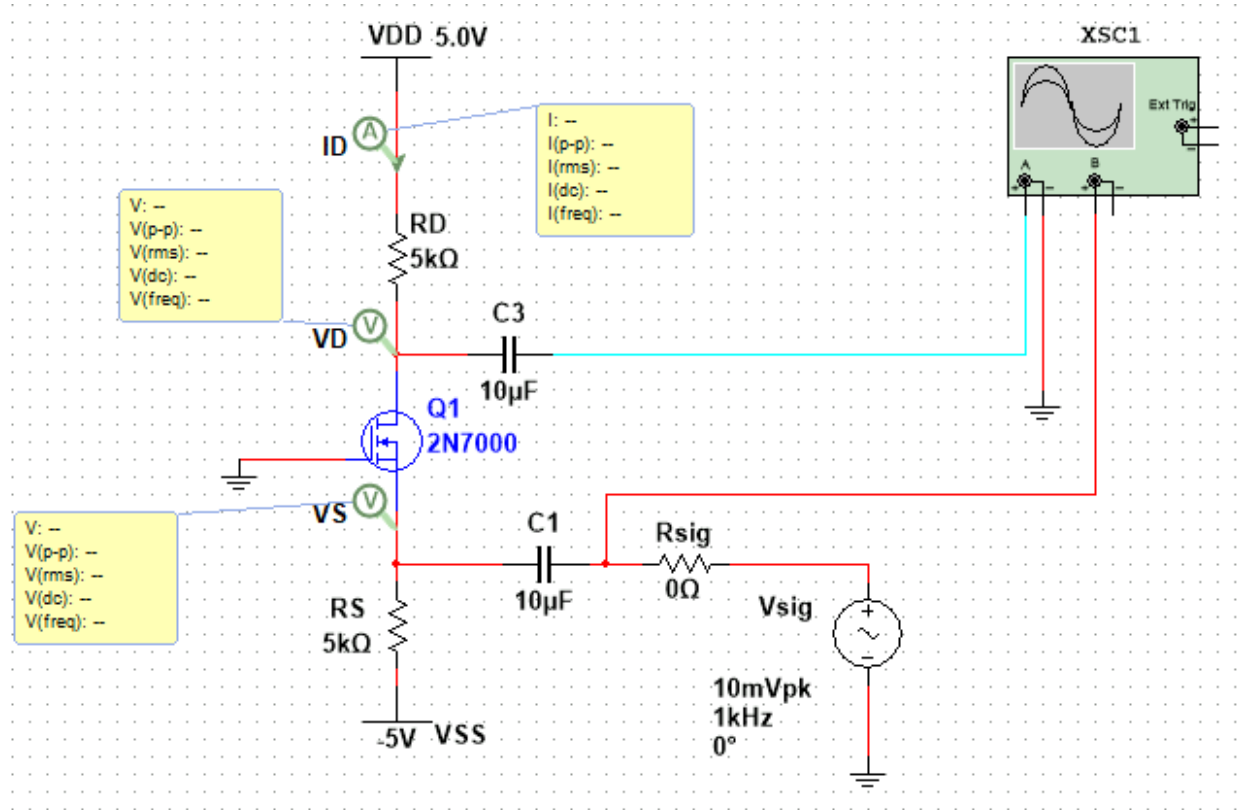J) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\dfrac{\|Measured-Theortical\|}{Theortical}$ x 100
Av			

Answer the following questions:

3- Why DC values of currents and voltages does not change from exp 1?

4- Why CD amplifier is called Source Follower?

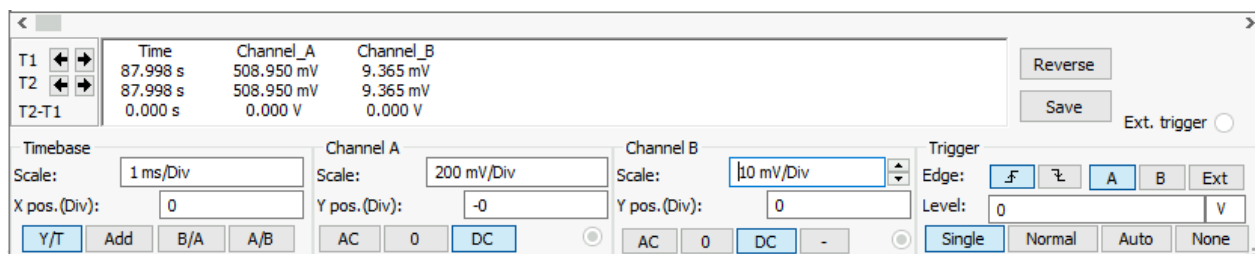**Experiment 4) Studying the amplification characteristics of CG amplifiers**

A) Create a new Multisim project and construct the circuit shown

B) Run the simulation and record I_D, V_G, V_S and calculate gm
C) Calculate the theoretical values of I_D, V_G, V_S then calculate gm
D) Based on your measurements and calculations fill the following table

	Measured	Theoretical	Error = $\frac{\|Measured - Theortical\|}{Theortical}$ x 100
I_D			
V_G			
V_s			
gm			

E) Read v_{o-pp} and v_{in-pp} after setting both ChA and ChB as shown below

F) Take a screenshot of the outputs of the oscilloscope and put it in the following place holder

> Put a screenshot of your output ($v_{o\text{-}pp}$ and $v_{in\text{-}pp}$) here and Plz make $v_{o\text{-}pp}$ in green and $v_{in\text{-}pp}$ in red

G) Calculate voltage gain Av= $v_{o\text{-}pp}$ / $v_{in\text{-}pp}$
H) Calculate overall voltage gain Gv= $v_{o\text{-}pp}$ / $v_{sig\text{-}pp}$= $v_{o\text{-}pp}$ / 20mV
I) Calculate the theoretical values of Av = $gm \cdot R_D$
J) Repeat G, H, and I for Rsig=100Ω and Rsig=1000 Ω and fill the following table

Rsig	Av	Measured	Theoretical	Error = $\frac{\|Measured - Theortical\|}{Theortical}$ x 100
0				
100				
1000				

Answer the following questions:

5- Why Av is reduced when Rsig increased in AC analysis?