The goal of this lab. is to learn how to design and analyze a common source amplifier.

Pre-Lab

1. Build a bias circuit resembling Figure 1.

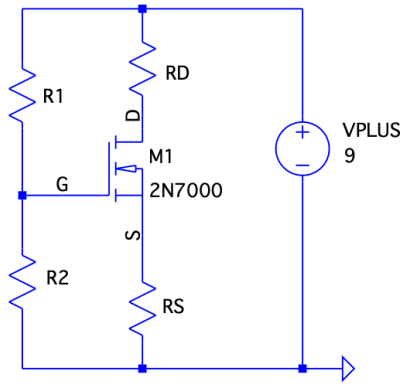


Figure 1.

Use the 2N7000 and a DC supply voltage of 9 V. Choose bias resistors R1, R2, RD and RS to establish a bias point of about ID=6mA, VD=7V, and VS=1V. The gate resistors (R1 and R2) should be larger than RS by at least a factor of 10.
For VTH and β=μCoxW/L of the 2N7000 use the values you derived in the lab. where you were asked to characterized your own device.

VTH = _____

β = _____

VOV = _____

VGS = VOV + VTH = _____

R1 = _____

R2 = _____

RD = RS = _____

gm = _____

2. Use the proposed bias circuit to build a common source (CS) amplifier and predict the following quantities two different ways. The first prediction is done using hand calculations. The second prediction is done using SPICE. The quantities that need to be predicted are: gm, gain, input impedance, and output impedance. The predictions should be made with and without a bypass capacitor across RS.

   In practice, use large capacitors for coupling and for creating AC shorts. For the capacitors to be sufficiently large make sure that $1/\omega C \ll R$, where R is the resistance facing the capacitor. If you use electrolytic capacitors pay attention to capacitor polarities.

For the 2N7000 use a nmos4 device (with the bulk terminal connected to the source terminal) and build your own "simple" SPICE model. Your spice model should look "somehow" similar to the following line:

```
.model 2N7000 VDMOS KP=0.236 VT0= 1.61 Cgdmax=80p Cgdmin=12p Cgs=50p Cjo=50p
```

Configuration	Predicted gm (Hand calculation)	Predicted gm (SPICE)	% Error
CS w/o bypass cap across RS			
CS w bypass across RS			

Configuration	Predicted Gain (Hand calculation)	Predicted Gain (SPICE)	% Error
CS w/o bypass cap across RS			
CS w bypass across RS			

Configuration	Predicted Rin (Hand calculation)	Predicted Rin (SPICE)	% Error
CS w/o bypass cap across RS			
CS w bypass across RS			

Configuration	Predicted Rout (Hand calculation)	Predicted Rout (SPICE)	% Error
CS w/o bypass cap across RS			
CS w bypass across RS			

Show the symbolic expressions you used for the hand prediction of the following quantities:

AV (w/o bypass cap) = _____

AV (w bypass cap) = _____

Rin (w/o bypass cap) = _____

Rin (w bypass cap) = _____

Rout (w/o bypass cap) =_____

Rout (w bypass cap) = _____

Draw the AC equivalent small signal circuit for both the case with and w/o bypass cap. across RS

a. AC circuit with bypass cap across RS

b. AC circuit w/o bypass cap across RS

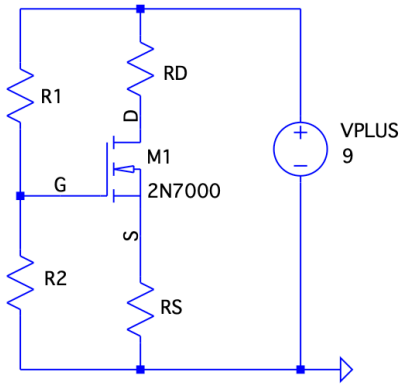
Attach the SPICE Bode plot for both the CS with and w/o bypass cap. across RS (hint: use .AC analysis). Clearly label the gain and the BW.

a. Attach the SPICE Bode Plot for CS w/o bypass cap across RS

b. Attach the SPICE Bode Plot for CS with bypass cap across RS

Lab.

1. First build the bias circuit and measure all the node voltages (VD, VG, VS). Clearly annotate all voltages and resistor values on the following figure. Hint: before adding to the circuit R1 and R2 figure out what value of VG is needed to set VD and VS to the approximate values specified, i.e. provide VG using the DC offset "feature" of the waveform generator before creating it through a resistive voltage divider.



Based on the measurement compute gm of the transistor.

gm = _____

2. Apply an AC signal to the gate (through a large coupling capacitor) and make a Bode Plot from 10 Hz to 100 KHz (hint: use the network analyzer tool). NOTE: before trying to use the network analyzer it is a good idea to look at the input signal and the output signal through the oscilloscope to make sure the amplifier works as expected.
   Attach the Bode plot and clearly label the gain and the BW.

3. Apply an AC signal to the gate (through a large coupling capacitor), and then connect a large capacitor across RS (i.e. connect a large cap. between the source of the transistor and ground). Make a Bode Plot from 10 Hz to 100 KHz (hint: use the network analyzer tool). NOTE: before trying to use the network analyzer it is a good idea to look at the input signal and the output signal through the oscilloscope to make sure the amplifier works as expected.
   Attach the Bode plot and clearly label the gain and the BW.