

## EXPERIMENT 5: MOSFET AMPLIFIER

### *Objectives*

The objective of this experiment is to obtain and learn the gain characteristic of MOSFET amplifier circuits practically.

### *Components Required:*

DC Voltage Source

Signal Generator

Multimeter

**Transistor:** BS108 transistor

**Resistors:** 220Ω, 1kΩ, 10kΩ, 330kΩ, 560Ω, 1MΩ

**Capacitor:** 1μF (x3)

### *Preliminary Work:*

#### ☐ *Theoretical:*

1. Study MOSFET amplifier circuits, gain, frequency characteristics, and explain how the frequency value affects the characteristics. Give the information about that in your report. Explain how the MOSFET works in the low and high frequency regions.
2. Analyze the circuit given in Figure 1 and find the gain for 100 kHz input signal (You can find a short video about MOSFET' AC analysis in the link- <https://www.youtube.com/watch?v=dLLN4fLsXb0>). Use the parameters given in 'Notes 1' for calculations.
  - Do dc analysis of the circuit to find the bias point of the circuit. Insert the  $I_D$  value into the equation below in order to find  $g_m$ .

$$g_m = \sqrt{2k_n \frac{W}{L} I_D}$$

- Calculate AC voltage gain. You may ignore the  $r_o$  resistance in the MOSFET in the AC equivalent circuit.
- Fill the part of 'Theoretical Value' in Table 1 according to your calculations.

#### ☐ *Simulation*

1. Set up the circuit given in Figure 1 in OrCAD. You can refer to Figure 3 to understand how to add the MOSFET in the circuit. Use the PSpice model given in 'Note 2' below. (Right click on the Mosfet and select the 'Edit Pspice Model' and then you can find a pane like in Figure 2. You must paste the model parameters given in 'Note 2' in the pane. Then click the 'Save Library'.)

Use AC Voltage Source for the input signal. Run AC simulation from 100 Hz to 100 MHz (100 MEG). Set type of sweep as “decade” with 101 point per decade. Plot the AC voltage gain ( $v_{out} / v_{in}$ ). What is the midband voltage gain as a ratio (not in dB)?

3. Change the input signal with a sinusoidal voltage source that has 240mV amplitude at **100kHz**. Run transient simulation. Plot the input and output signals for 5 periods of the signal. What is the gain based on the transient simulation? Does it agree with the AC gain in the question (3) and question (2)?
4. Determine if there is a phase difference between the input and output signal.
5. Design how to set the circuit in Figure 1 on the breadboard. Add your drawing to your report.
6. Set up the circuit given in Figure 1 in TincerCAD and add the results to the report.
7. Before coming to experiment, check that you have the components required.

### Experimental:

- Set up the circuit given in Figure 1.
- Apply the sinus signal to the input so that the  $V_{pp}$  value is 240 mV and the frequency value is 100 kHz.
- Measure the  $V_G$ ,  $V_D$ ,  $V_S$  and  $I_D$  values. Fill in Table 1.
- Determine the gain.
- Find the cut-off (corner) frequency points of the MOSFET by changing the frequency values of the input signal according to Table 2. Fill in Table 2 according to the values you obtained.

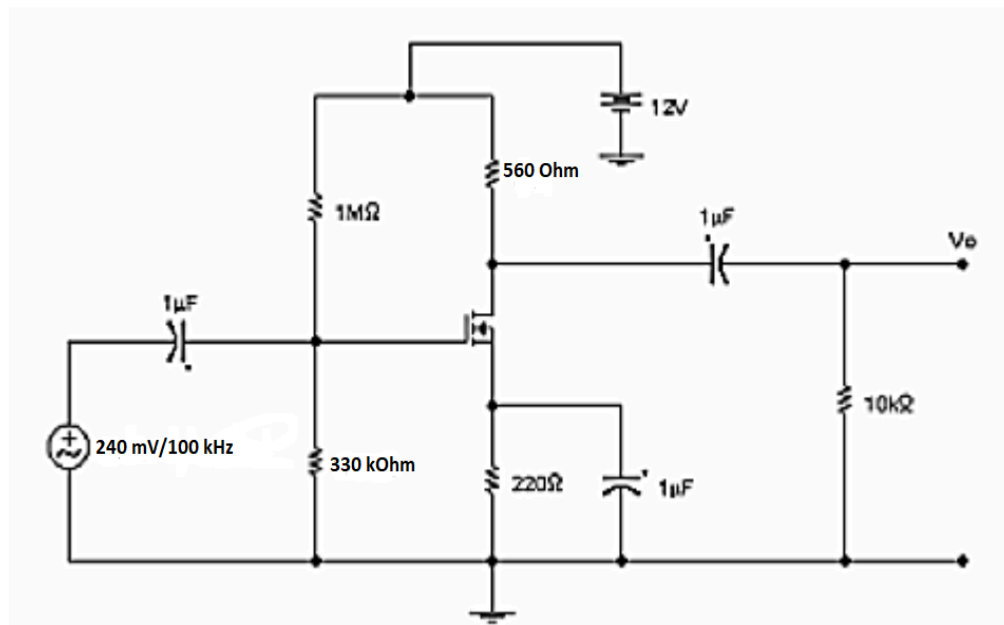


Figure 1

	Theoretical Value	Measured Value
<b>VD</b>		
<b>VG</b>		
<b>VS</b>		
<b>ID</b>		

*Table 1*

<b>FREQUENCY (f)</b>	<b>Vo</b>	<b>Vo/Vin</b>
<b>5 kHz</b>		
<b>10 kHz</b>		
<b>50 kHz</b>		
<b>100 kHz</b>		
<b>200 kHz</b>		
<b>500 kHz</b>		
<b>1 MHz</b>		
<b>1.5 MHz</b>		
<b>2 MHz</b>		
<b>3 MHz</b>		

*Table 2*

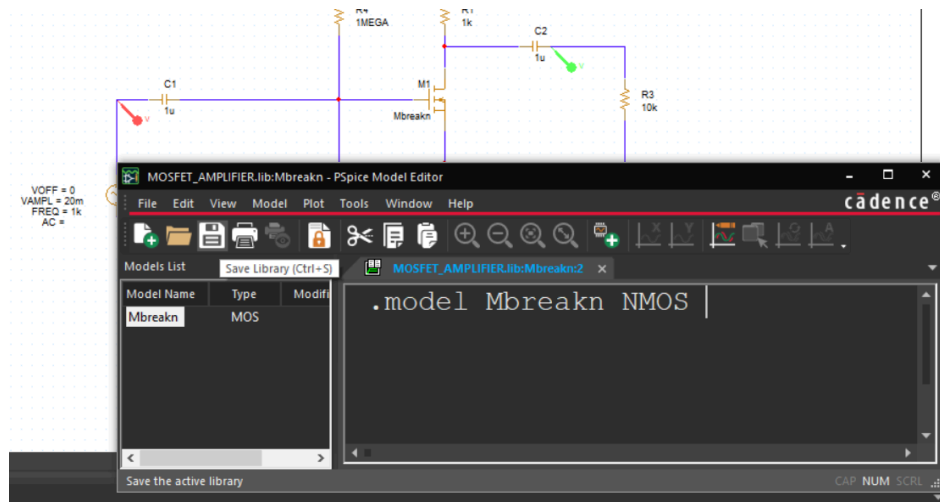


Figure 2

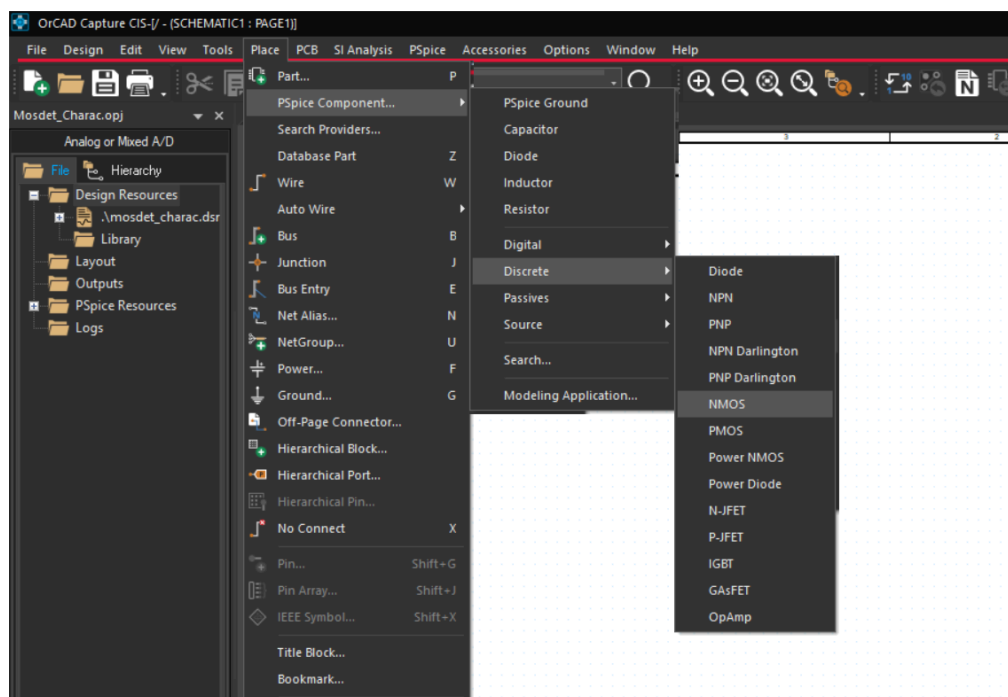


Figure 3

**Note 1:**

$V_{TN} = 0.675V$ ,  $k_n = 178.5 \text{ mA/V}^2$ ,  $W = 100\mu$ ,  $L = 100\mu$ ,  $\lambda = 0.02$

**Note 2:**

.model Mbreakn NMOS VTO=0.675 KP=0.1785 W=100u L=100u LAMBDA=0.02  
+CGSO=2.1u CGDO=2.1u CGBO=0