ELEC 313 Lab 6
MOSFET Circuit Operation

REFERENCE: Appropriate chapters of ELEC 306 text.

OBJECTIVE: The objective of this experiment is to observe the basic operation of a MOSFET inverter circuit and an amplifier circuit.

EQUIPMENT: MOSFET 2N7000
Resistors 100K Ω, 33K Ω, 10K Ω, 1K Ω, 470 Ω
Capacitors 1μF, 0.1μF
Power Supply (Vdc), Function Generator, Multi Meter(s), Oscilloscope, hair dryer

PRIOR PREPARATION (Pre-Lab):
In the circuit shown in figure 1, with $V_{DD} = 18$ V, determine the values of $R_1$ and $R_s$ that make the voltage at the MOSFET gate 4 V and the drain current 4 mA. The transistor is a 2N7000. Use a gate threshold voltage of 2 V and $K_n = 75$ mA/V$^2$.

![Figure 1: MOSFET Amplifier Circuit.](image)

EXPERIMENT

Amplifier

1) Build the circuit of figure 1. Set $V_{DD} = 18$ V.
2) Measure and record the dc voltages at all terminals of the MOSFET. Compute the drain current.
3) Set the function generator for a 20-kHz sinewave with 0 offset and connect it to the input.
4) Connect CHANNEL 1 of the oscilloscope to the input and CHANNEL 2 to the output.
5) Adjust the function generator for an amplitude of 200 mV\textsubscript{pp} as measured on CHANNEL 1 of the oscilloscope.
6) Measure the peak-to-peak output voltage on CHANNEL 2 of the oscilloscope.
7) Repeat step 7 for input amplitudes from the function generator of 300, 400, 500, 600, 700, 800, 900, and 1000 mV\textsubscript{pp}.

**Temperature Sensitivity**

1) Adjust the function generator for an amplitude of 200 mV\textsubscript{pp}.
2) Measure the peak-to-peak output voltage swing.
3) Heat the transistor with a hair dryer for approximately 30 seconds.
4) Re-measure the peak-to-peak output voltage under this warmer condition.

**Inverter**

1) Construct the circuit of figure 2 using the 2N7000 MOSFET transistor. Use the +6 V power supply for \(V_{IN}\), the +25 V supply for \(V_{DD}\), and the HP multimeter to measure \(V_{OUT}\).
2) Set \(V_{DD} = 5\) V. Adjust \(V_{IN}\) from 0 to 5 V while measuring \(V_{OUT}\). Use enough voltage steps that a good plot of the dc transfer characteristic, \(V_{OUT}\) vs. \(V_{IN}\), can be made.
3) Disconnect the power supply from \(V_{IN}\) and replace it with the function generator set to a square wave at frequency of 20 kHz.
4) Connect CHANNEL 1 of the oscilloscope to the input and CHANNEL 2 to the output.
5) Adjust the amplitude and offset of the function generator for an input square wave of 0 to 5 V as measured on the oscilloscope.
6) Measure the rise and fall times of the output waveform.
Data Analysis

Amplifier
1) Compare the measured DC voltages to those obtained via hand calculations.
2) Compute the ac voltage gain of the amplifier at each input level by comparing the input and output $V_{pp}$ measurements. Make a plot of gain vs. input voltage.
3) Compute the temperature variation in voltage gain as a percentage change:

$$\frac{A_v(\text{warm}) - A_v(\text{room temp})}{A_v(\text{room temp})} \times 100\%$$

Inverter
4) Use the measured data to plot the transfer characteristic of the circuit, $V_{OUT}$ vs. $V_{IN}$.
5) Compare the rise and fall times to those in the transistor specification.

LAB REPORT
Your report should be completed in the format requested by the instructor. The lab report should be in standard format and include Data Analysis from above.