AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)
FACULTY OF SCIENCE & TECHNOLOGY
ELECTRONIC DEVICES LAB

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Section:U

LAB REPORT OEL:

Performance analysis of a common source (CS) E-MOSFET amplifier circuit by varying the loads and justification of the analysis with respect to simulated and experimental data (followed by the given constraints).

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Title:

Performance analysis of a common source (CS) E-MOSFET amplifier circuit by varying the loads and justification of the analysis with respect to simulated and experimental data (followed by the given constraints).

Objective:

Design a common source E-MOSFET amplifier circuit and analyze the gain with varying the loads. Finally, a complete analysis will be expected with respect to experimental and simulated data.

Literature review:

MOSFET devices belong to the group of Insulated Gate Field Effect Transistor (IGFETs). MOSETs like all other IGFETs has three terminals, which are called Gate (G), Source (S), and Drain (D). In PMOS, the body terminal is held at the most positive voltage in the circuit and in NMOS, it is held at the most negative voltage in the circuit.

There are four types of MOSFETs: enhancement n-type MOSFET, enhancement p-type MOSFET, depletion n-type MOSFET, and depletion p-type MOSFET. If the channel between the drain and the source is an induced channel, the transistor is called enhancement transistor. Throughout the handout, we will concentrate on analyzing the enhancement type MOSFET. If we put the drain and source on ground potential and apply a positive voltage to the gate, the free holes (positive charges) are repelled from the region of the substrate under the gate (channel region) due to the positive voltage applied to the gate. The holes are pushed away downwards into the substrate leaving behind a depletion region. At the same time, the positive gate voltage attracts electrons into the channel region. When the concentration of electrons near the surface of the substrate under the gate is higher than the concentration of holes, an n region is created, connecting the source and the drain regions. In the case of an enhancement type NMOS transistor the threshold voltage is positive, whereas an enhancement type PMOS transistor has a negative threshold voltage. So, in order for the current to flow from drain to source, the condition that should be satisfied is $V_G > V_{th}$, where V_G is the gate voltage and V_{th} is the minimum voltage required to form a

channel between drain and source so that carriers can ow through the channel. By changing the applied gate voltage, we can modulate the conductance of the channel.
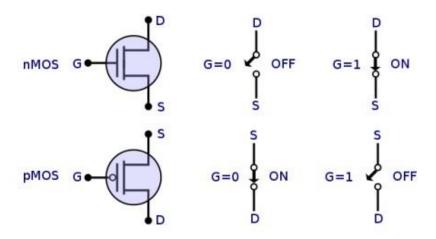

Figure: Symbols for enhancement NMOS and PMOS transistors

Apparatus:

Apparatus	Quantity
MOSFET	1
Trainer board	1
Resistors	8
Oscilloscope	1
Multimeter	1
Signal Generator	1
Capacitors	1
DC Power Supply	1

Experimental data table:

Table 1

V_{DD}	V_D	$V_{DD}-V_D$	$I_D = (V_{DD}-V_D) / R_D$	V_{DS}
10 V	95.7 mV	9.91 V	6.67 mA	9.98 V

Table 2

Load resistor	Input voltage	Output voltage	Gain
1k	400 mV	3.9 mV	00.00975
4.7k	420 mV	10.1 mV	0.024
10k	420 mV	9.4 mV	0.022
100k	420 mV	13.1 mV	0.031
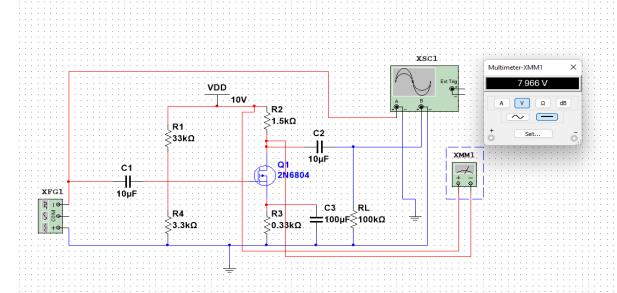
Simulated data table:
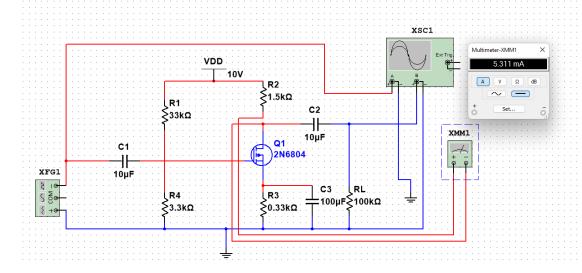
Table 3
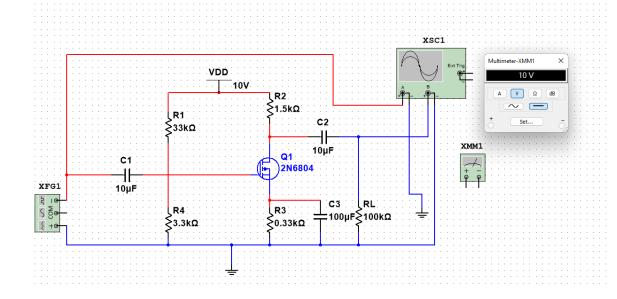
V$_{DD}$	V$_D$	V$_{DD}$-V$_D$	I$_D$ = (V$_{DD}$-V$_D$) / R$_D$	V$_{DS}$
10V	7.966 V	2.004	5.311 mA	10 V

Table 4
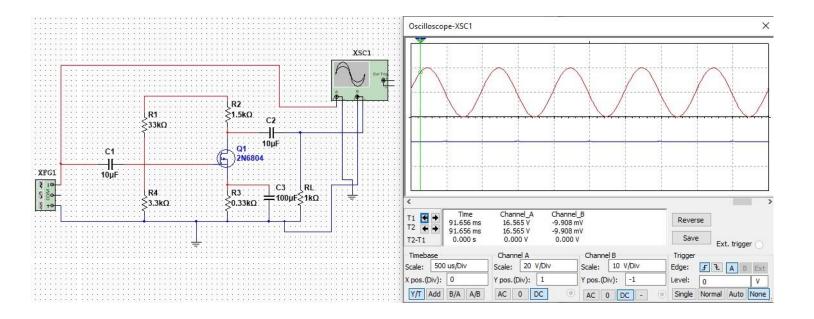
Load resistor	Input voltage	Output voltage	Gain
1k	16.6V	9.91mV	0.597
4.7k	16.7V	43.7mV	2.62
10k	16.03V	95.2mV	5.94
100k	16.2V	258.9mV	15.98

Circuit 1:

XSC1

Multimeter-XMM1   ×
7.966 V
A | V | Ω | dB
Set...
+   −

VDD 10V
R2 1.5kΩ
R1 33kΩ
C2 10µF
C1 10µF
Q1 2N6804
XFG1
R4 3.3kΩ
R3 0.33kΩ
C3 100µF
RL 100kΩ
XMM1

Circuit 2:

XSC1

Multimeter-XMM1   ×
5.311 mA
A | V | Ω | dB
Set...
+   −

VDD 10V
R2 1.5kΩ
R1 33kΩ
C2 10µF
C1 10µF
Q1 2N6804
XFG1
R4 3.3kΩ
R3 0.33kΩ
C3 100µF
RL 100kΩ
XMM1

Circuit 3:

XSC1

Multimeter-XMM1   ×
10 V
A | V | Ω | dB
Set...
+   −

VDD 10V
R2 1.5kΩ
R1 33kΩ
C2 10µF
C1 10µF
Q1 2N6804
XFG1
R4 3.3kΩ
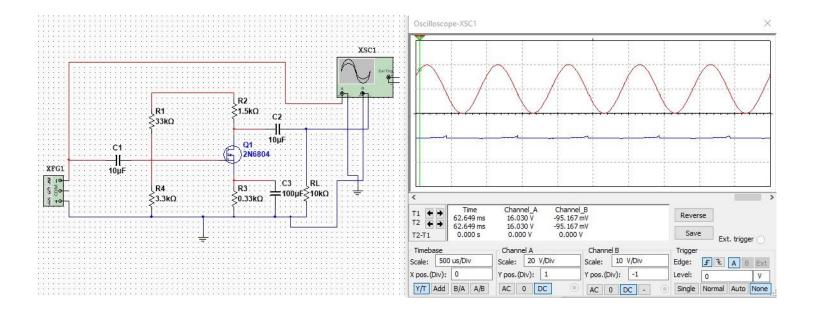R3 0.33kΩ
C3 100µF
RL 100kΩ
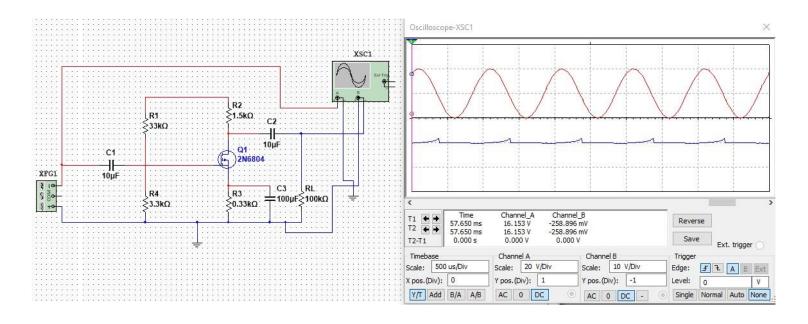XMM1

For load resistance 1 kilo ohm:
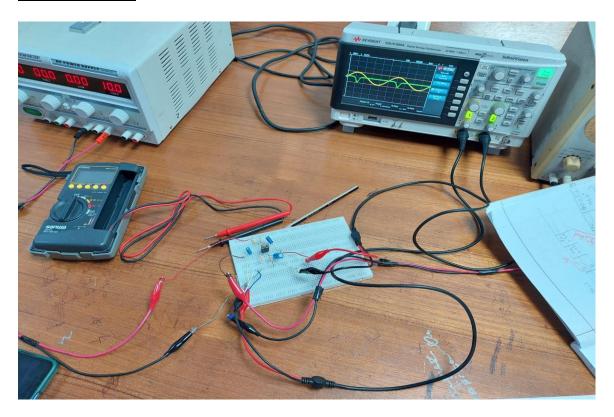

For load resistance 4.7 kilo ohm:
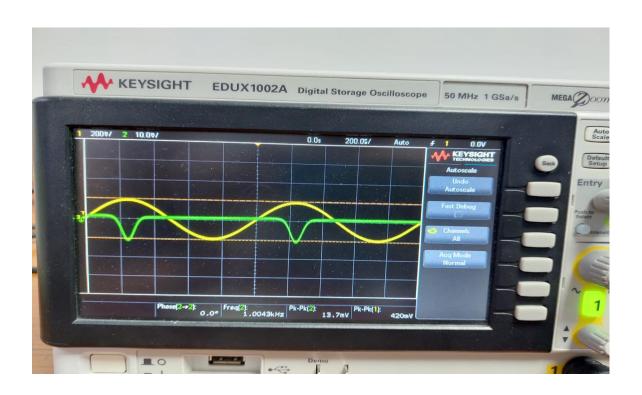
For load resistance 10 kilo ohm:

For load resistance 100 kilo ohm:

Practical images:

Discussion:

In this experiment the concept of E-MOSFET common source small signal amplifier was illustratedand the characteristics and applications were discussed. After that the circuit was implemented on the trainer board to determine the voltage gain, input and output voltages by using DC and AC analysis and to investigate the input and output waveforms of CS amplifier circuit. While AC analysis we faced some difficulties in calibrating the oscilloscope but with the help of our lab assistant instructor the issue was fixed. Both of the table was filled up carefully. Then with the help of NI Multisim software the implemented circuit was simulated and compared with themeasured value. Some differences were noticed but they are negligible. These negligible errorsmight be occurred due to unstable power sources used in the lab or fluctuation of Oscilloscope.Since there is no big difference between measured value and simulated value, it can be said thatthe main objectives for this experiment is accomplished.

References:

[1] Electronics Tutorials, "MOSFET Amplifier Circuit using an Enhancement MOSFET", https://www.electronics-tutorials.ws/amplifier/mosfet-amplifier.html

[2] Libretexts, "MOSFET Common Source A mplifiers", https://eng.libretexts.org/Bookshelves/Electrical_Engineering/Electronics/Book%3A_Semiconductor_Devices_-_Theory_and_Application_(Fiore)/13%3A_MOSFET_Small_Signal_Amplifiers/13.2%3A_M OSFET_Common_Source_Amplifiers

[3] American International University Bangladesh AIUB Electronic Device Lab Manual.

[4] Electronics Tutorials: Amplifier Distortion in Transistor Amplifiers (electronics-tutorials.ws)