Laboratory Six MOSFET

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Introduction

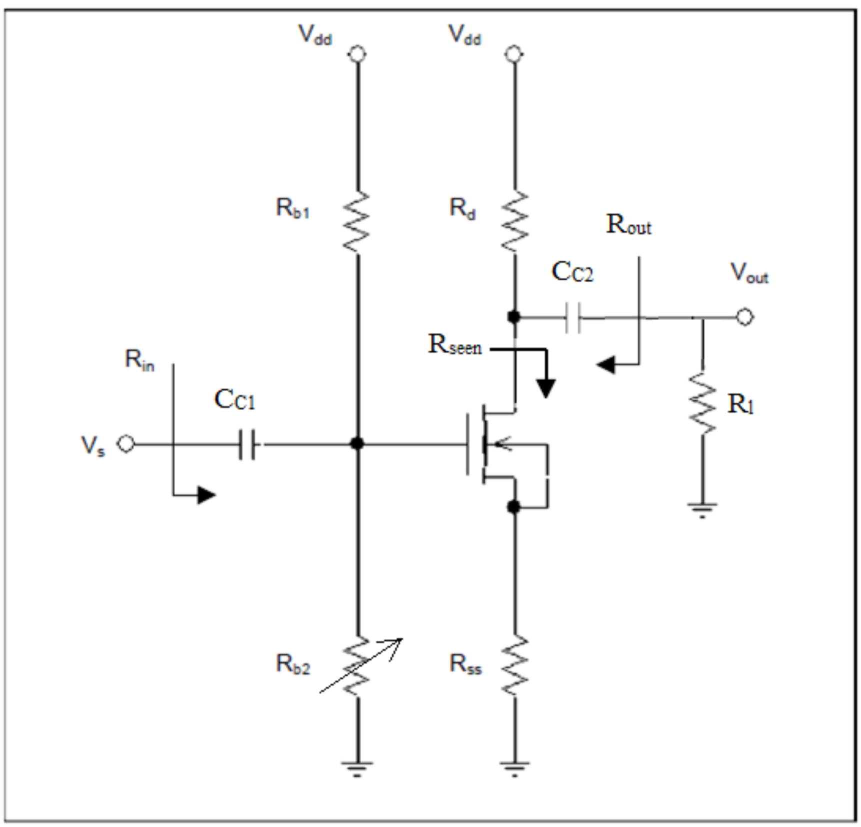
MOSFETs is a type of transistor used for amplifying or switching electronic signals. Additionally, small signal analysis is done to have a guess of the transistor's behavior and to calculate the gain on the simple transistor amplifiers. Two amplifiers were built, common-source and common-drain amplifiers. Small signals resulting from large signals input and load influences were analyzed as well.

Exercise 1

Procedure

On Exercise 1, the following circuit was built. The gain was calculated for Id = 1mA and the input signal to the circuit was a sinusoidal signal of 50 mV with 10 kHz. Vdd = 5V.

Data



Circuit Schematic

	R_D (Ω)	R_{SS} (Ω)	R_{B1} (Ω)	R_{B2} (Ω)	C_{C1} (μF)	C_{C2} (μF)
Values	1487	501	21620	25060	5 μF	5 μF

Questions
The gain is larger than the one from the calculations and SPICE simulations because we used a simplified model for the hand analysis.

Discussion
From the actual circuit, the Vin = 130 mV peak-to-peak voltage and a Vout = 480 mV. As a result, the gain is 3.63.

Exercise 2

Procedure
On Exercise 2, the gain from Exercise 1 was doubled. The theoretical equation for gain used is:

$$A_V = -\frac{gm\ Rd}{1+gm\ Rss}$$

Discussion
By analyzing the equation, Rd should be incremented or Rss should be decreased. In order to obtain a gain twice the value from Exercise 1, 7.18, we will make Rss = 110 Ω to obtain a Vout of 934 mV.

Exercise 3

Procedure.
On Exercise 3, we would use circuit from Exercise 1. The gain was calculated using when different values for resistances were used. 100 kΩ, 10 kΩ, 1kΩ, and 100 Ω.

Data

Theory Value for R (Ω)	**Real Value for R (Ω)**	**Gain**
100k	98.67k	3.44
10k	9.89k	3.44
1k	995	1.29
100	99.3	0.5

Questions
The results of this analysis match with the results of pre-lab Exercise 4, therefore they confirm our expectations.

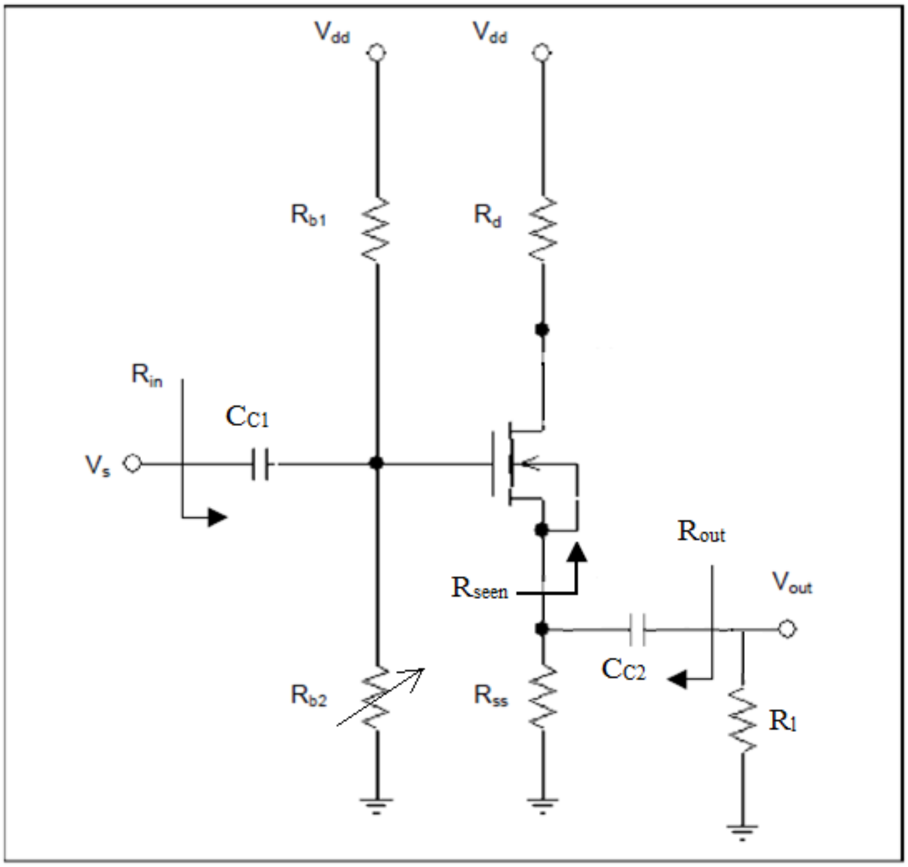
Discussion
The gain gets influenced as the value of R_L gets closer to the value of R_D. As R_D decreases, the resistance goes to zero. As a result, the gain dropped.

Exercise 4

Procedure

On Exercise 4, the following circuit was built. The gain was calculated for Id = 1mA and the input signal to the circuit was a sinusoidal signal of 50 mV with 10 kHz. Vdd = 5V.

Data



	R_D (Ω)	R_{SS} (Ω)	R_{B1} (Ω)	R_{B2} (Ω)	C_{C1} (μF)	C_{C2} (μF)
Values	1487	501	21620	27100	5 μF	5 μF

Questions

The result, in this case the gain, yields to what expected from the circuit.

Discussion

In this exercise Vs = 130 mV peak-to-peak and Vout = 142 mV. As a result, gain is equal to 1.09.

Exercise 5

Procedure

On Exercise 5, the load resistance was increased from 100 Ω to 100 kΩ. As resistance was increased, the gain increased because the resistance becomes closer to become an open circuit. Therefore, it affects the gain less.

Data

Theory Value for R (Ω)	Real Value for R (Ω)	Gain
100k	98.67k	1.016
10k	9.89k	1.048
1k	995	1.033
100	99.3	0.613

Questions

The result yields to what expected from the circuit.

Discussion

For R_L smaller than R_{SS} the gain drops because it is directly proportional to $R_{SS} \mid\mid R_L$. In the common-drain gain equation, R_{SS} is replaced by R_L and $g_m R_L$ decreases smaller than 1. As a result, the gain drops.

$$A_V = \frac{gm\ Rss}{1 + gm\ Rss}$$

Conclusion

The results clearly agree with the objective of the lab that is analyze amplifiers and its concepts. In general, the results obtained from the laboratory experiments yield to the results from the hand calculations and the SPICE simulations because the common-drain and common-source amplifiers behaviors can be considered successful according to the experiments.