Experiment 5

MOS differential amplifier

Hardware Exercise

Objectives:

To characterize an NMOS current mirror circuit and a CMOS differential input to single ended output amplifier.

Equipment/Components Required:

1. MOSFET IC – CD 4007
2. Resistors of suitable values
3. Capacitors – 2.2 µF
4. Regulated power supply – 10V
5. Arbitrary Function Generator
6. Digital Storage Oscilloscope

NMOS current mirror
Steps:

1. Connect the circuit of an NMOS current mirror as shown in Figure 1 on a breadboard using CD4007 IC for the MOSFETS.
2. Adjust the 15 kΩ potentiometer till the output current I_{DS} is 1 mA.
3. Now, remove the 22 kΩ resistor and replace it with a 20 kΩ potentiometer.
4. By adjusting the 20 kΩ potentiometer, measure I_{DS} for different values of V_{DS} and tabulate your results.

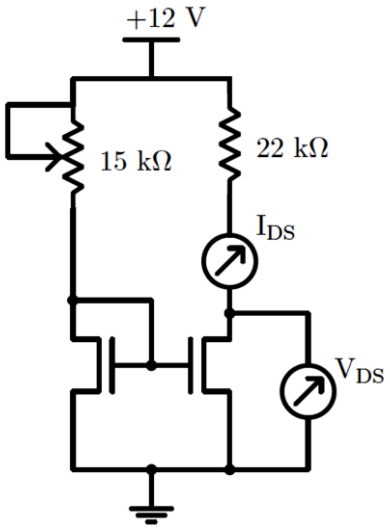

Figure 1: NMOS current mirror circuit

5. Tabulate your observations as follows:

V_{DS}	I_{DS}

6. Plot the output characteristics of the current mirror and compute the output impedance (r_{DS}) and channel length modulation parameter (λ)

CMOS differential amplifier
Steps:

1. Connect the circuit of a CMOS differential amplifier as Figure 2 on a breadboard using CD4007 IC for the MOSFETS. Use the current mirror set to provide 1 mA as in the previous sub-experiment.
2. Calculate the values of R_1 and C_i for a lower cut-off frequency <30 Hz. (Recall similar calculations you had done in earlier experiments).
3. Use the function generator to provide an input of 100 mV at 1 kHz and using the oscilloscope, measure the gain of the amplifier.

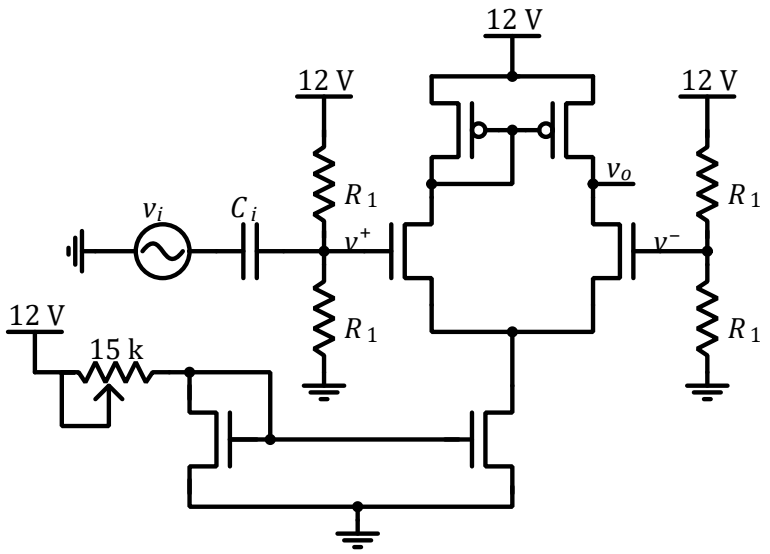

Figure 2: CMOS differential amplifier.

4. Now modify the circuit to include a feedback as shown in Figure 3.

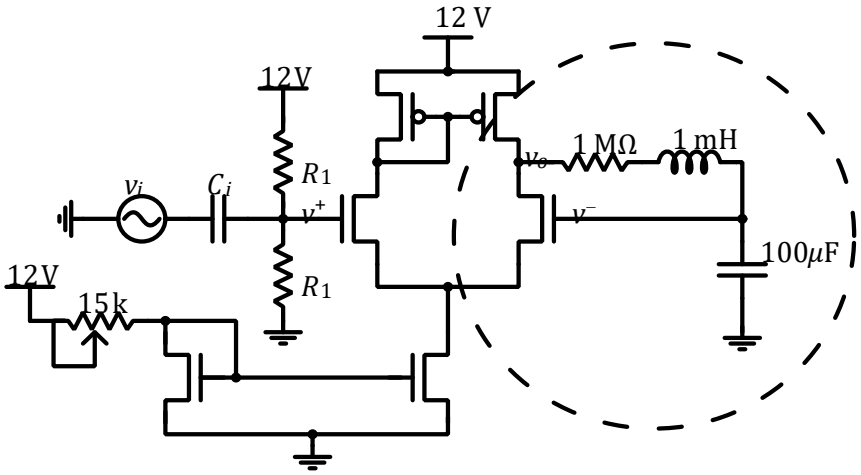

Figure 3: CMOS differential amplifier.

5. Use the function generator to provide an input of 30 mV at 1 kHz and using the oscilloscope, measure the gain of the amplifier.

6. Comment on your observations about the gain in the two configurations.

7. Measure the frequency response of the amplifier by varying the frequency from 10 Hz to 100 MHz and plot your results.

Freq.	V_i ($V_{p\text{-}p}$ V)	V_o ($V_{p\text{-}p}$ V)	Phase diff.	Freq.	V_i ($V_{p\text{-}p}$ V)	V_o ($V_{p\text{-}p}$ V)	Phase diff.