EXPERIMENT 8
NMOS Differential Amplifier

A. Background

A differentila amplifer designed using NMOS transistors is shown below in Fig. 8.1. The biasing is provided through the resistor R_O.

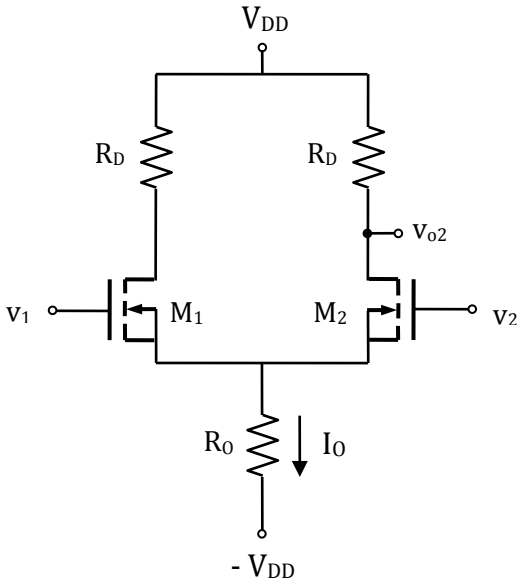

Fig. 8. 1. NMOS DC Circuit

The transistors M_1 and M_2 are assumed matched with idetical parameteter. The currents I_{D1} and I_{D2} are equal and

$$I_{D1} = I_{D2} = I_O/2$$

Defining two new signal v_{cm} and v_{dm} as:

$$v_{cm} = \frac{v_1+v_2}{2}$$

and

$$v_{dm} = v_1 - v_2$$

The inputs v_1 and v_2 may be exressed as:

$$v_1 = v_{cm} + \frac{v_{dm}}{2}$$

and

$$v_2 = v_{cm} - \frac{v_{dm}}{2}$$

Using superposition the output is expressed as:

$$v_{02} = A_{cm2}\, v_{cm} - A_{dm2}\, v_{dm}$$

where

$$A_{cm2} = \frac{-g_m R_D}{1+2g_m R_o} \text{ and } A_{dm2} = \frac{g_m R_D}{2}$$

The common mode ratio is defined as:

$$CMRR = \frac{A_{dm2}}{A_{cm2}}$$

Or in dB

$$CMRR_{dB} = 20\, log\left(\frac{A_{dm2}}{A_{cm2}}\right)$$

B. Preliminary Work

a) Consider the NMOS differrential amplifier given in Fig. 8.2. Assume V_{DD} = 12 V. Determine the value of R_o to set the current I_O = 1 mA, using the transistor parameters obtained in Experiment 2.

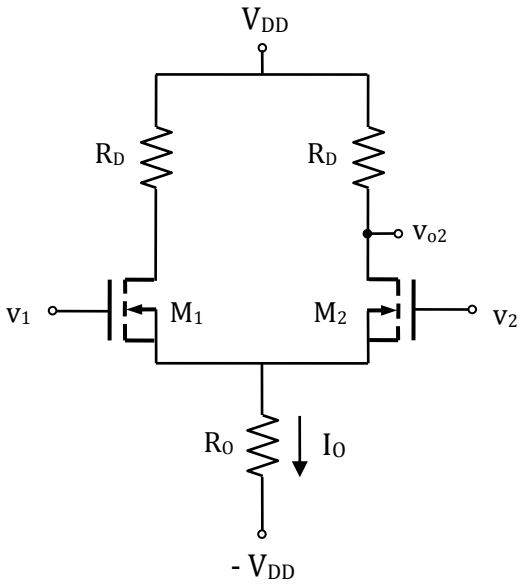

Fig. 8. 2. NMOS Differential Amplifier

b) Determine the value of R_D to set V_{DSQ} = 8 V.

C. Experimental Work

1. Set up the circuit given in Fig. 8.3. with V_{DD}= 12 V, R_o= 10 kΩ, R_D = 3.9 kΩ.

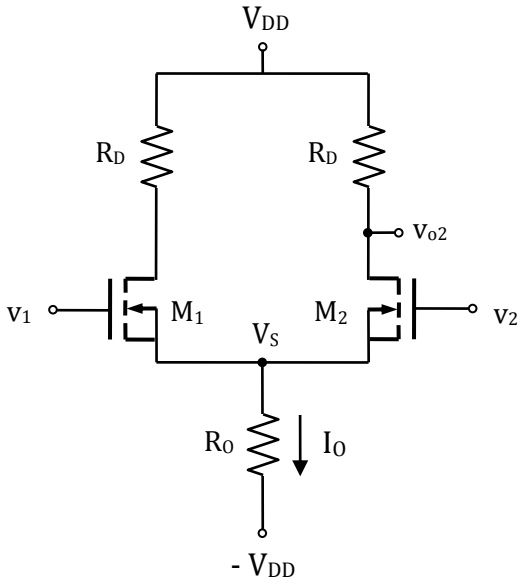

Fig. 8. 3. NMOS Differential Amplifier

2. Set $v_1 = v_2 = 0$. Measure the voltage V_S and the current I_O. Also measure V_{DSQ}.
3. Make necessary modifications to set the current $I_O \cong 1$ mA and $V_{DSQ} \cong 8$ V.
4. Now aplly a sinusiodal input $v_1 = v_2 = V_P \sin \omega_0 t$ at f_0 = 1 kHz. Determine A_{cm2}.
5. Aplly $v_1 = V_P \sin \omega_0 t$ at f_0 = 1 kHz and $v_2 = 0$. Determine A_{dm2}.
6. Caldulate CMRR.