Department of Electrical Engineering
Indian Institute of Technology, Kanpur

EE 210 **Assignment #6** **Assigned: 12.2.21**

1. An n-channel MOSFET is to be designed to carry a drain current of 100 μA, remaining in the saturation region with the least value of V_{DS} equal to 100 mV, and at this bias point, its output resistance must equal 1 MΩ. Design the values of its W and L, assuming dX_d/dV_{DS} = 10 nm/V. Assume k'_N = 40 μA/V^2, and $\lambda V_{DS} << 1$.

2. Determine the output current I_0 and the output resistance of the bipolar current mirror shown in Fig.1, for V_0 = 1 V, 5 V, and 30 V: i) neglecting any non-idealities, and ii) including all non-idealities. For each case, find the percent change between the ideal and the non-ideal performances. All the transistors have the same emitter-base junction areas. Assume V_A = 130 V and β = 50.

3. Consider the npn ratioed current mirror shown in Fig.2, with V_{CC} = 5 V and R_1 = 1 kΩ. Choose the values of R and R_2, such that the output resistance of the mirror is at least 10 MΩ, and the circuit should operate properly for V_0 all the way down to 0.5 V. What is the output current I_0? Using the calculated value of I_{REF}, determine the value of I_0, for which the simple approximation for the ratioed current mirror would ***just*** break down. What are the corresponding values of R_2, $V_{0(min)}$, and R_0? Neglect base currents and Early effect for the dc analysis of the circuit, and assume V_A = 130 V for ac analysis.

4. Determine the quiescent currents flowing in all the branches of the circuit shown in Fig.3, and calculate the output resistance R_0. Neglect base currents, and assume V_A = 130 V.

5. Determine the output current and the output resistance of the circuit shown in Fig.4. Neglect base currents and assume V_A = 130 V.

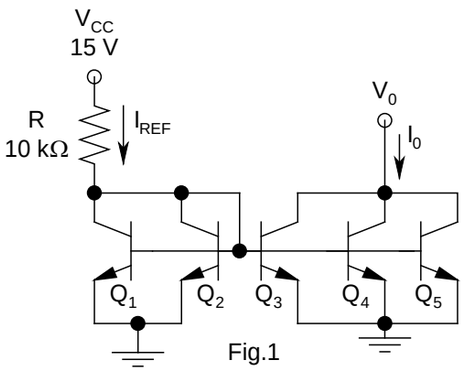

Fig.1

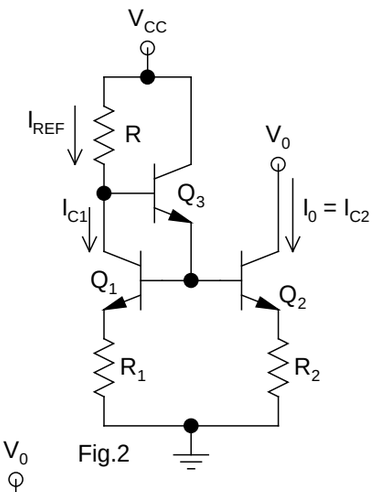

Fig.2

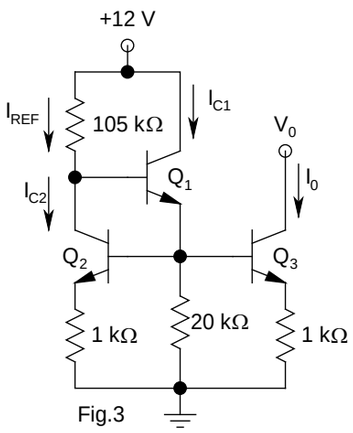

Fig.3

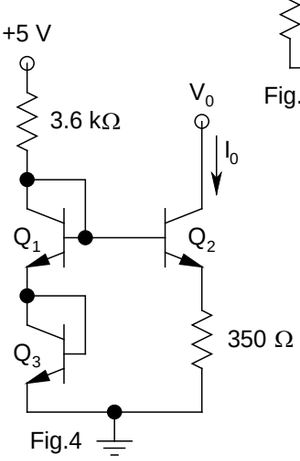

Fig.4