Nanyang Technological University
School of Electrical & Electronic Engineering
EE2002 Analog Electronics – Tutorial 11

1. (a) Derive the output resistance R_o of the cascode current mirror in Figure 1. State your assumptions for the circuit to operate with high output resistance.
   (Ans: $g_{m3}r_{o3}r_{o2}$)
   (b) What is the lowest voltage limit at the drain of M_3 if all the transistors are in the saturation region.
   (Ans: $V_{TN} + 2\sqrt{\frac{2I_{REF}}{K_n}}$)

   (c) If I_{REF} = 17.5μA, V_{DD} = 5V, K_n = 75μA/V^2, V_{TN} = 0.75V, and λ = 0.0125V^{-1}. Find R_o if the drain voltage of M_3 is connected to V_{DD}. Calculate also the minimum voltage at the drain of M_3 for all transistors to remain in the saturation region of operation.
   (Ans: *1.16 GΩ., 2.12 V*)

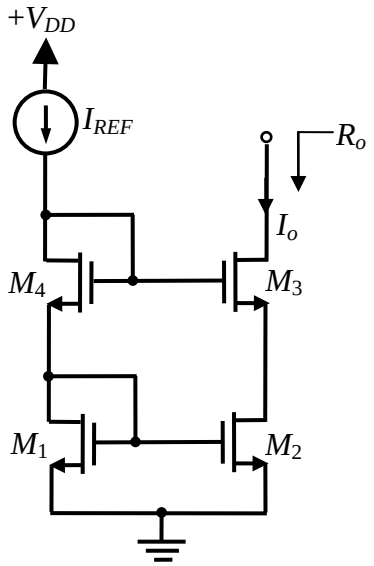

Figure 1

2. An amplifier has a transfer function:

$$T(s) = \frac{10^{12}s^2}{(s+10)(s+10^3)(s+10^6)}$$

   Sketch the Bode magnitude plot for the gain response. Use the plot to estimate the values for the amplifier gain at 10^3 rad/s and 10^6 rad/s respectively. What should be the actual values of the gain at these frequencies? Determine the bandwidth of the response.
   (Ans: 120 dB, 120 dB, 117 dB, 0.999x10^6 rad/s)