EEL204 - Analog Integrated Circuits - Minor 2

Indian Institute of Technology Delhi

Time: 1 hour; Total marks: 15

Instructions

- Read the questions carefully. If the question is wrong state what is wrong and if any circuit parameter or device state is not mentioned, assume as per your convenience. Don't ask for any clarification, there is nothing to clarify!!.
- Be concise, write no more than couple of sentences for every question.

Q1. (a) Determine the small signal voltage gain and output impedance of the circuit shown in figure 1 and 2 respectively. (2 marks)

(b) State the maximum Z_{OUT} for the circuit shown in figure 3. Also explain why degenerating transistor Q_2 will not help in doubling the output impedance. (1 marks)

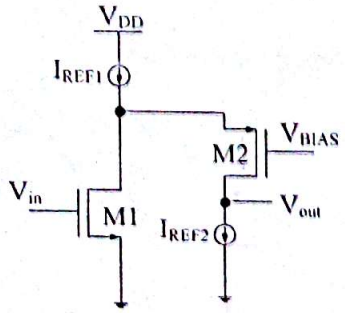

Figure 1: amplifier

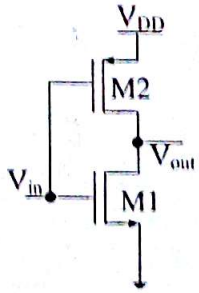

Figure 2: amplifier

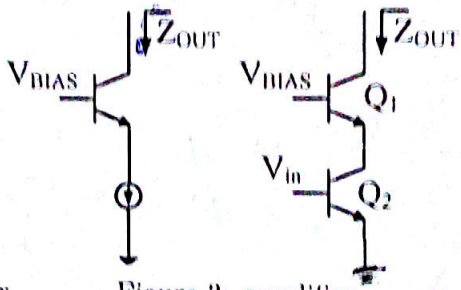

Figure 3: amplifier

Q2. (a) A student wants to design a voltage buffer to provide a better isolation between input and output of an amplifier. He is not sure whether to design the buffer using MOSFET or a BJT. What will you suggest to the student and why? (1.5 marks)

(b) Determine the output impedance of the circuit shown in figure 4. (1.5 marks)

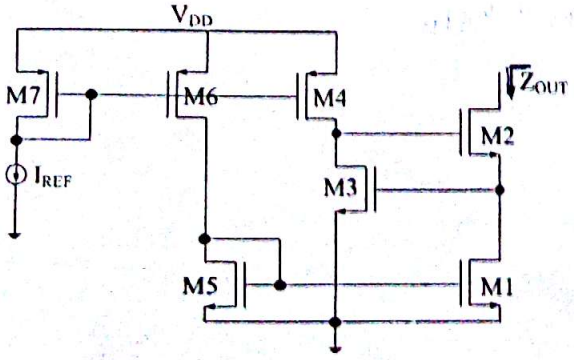

Figure 4: transistors

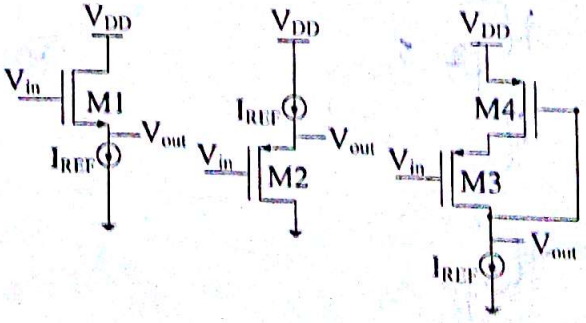

Figure 5: amplifier

Q3. (a) Comment on the maximum current that can be sourced and sinked by the circuits shown in figure 5. (1 marks)

(b) Plot the drain-to-source voltage (V_{DS}) versus output current (I_{OUT}) and output voltage (V_{OUT}) versus input voltage (V_{IN}) for a single MOSFET and a cascode amplifier. Explain in brief the differences observed in the two plots between single MOSFET and cascode. (1 marks)

(c) Determine the small signal voltage gain of the circuit shown in figure 6. (1 mark)

Q4. (a) In the circuits shown in figure 7, estimate V_G in terms of threshold voltage (V_{TH}), overdrive voltage (V_{OV}) and source voltage (V_S). Further if the gate voltage changes by ΔV, estimate the incremental change in the drain current of the transistors in the three configurations. (2 marks)

(b) As the load resistor R_L increases in a cascode amplifier, how does V_{DS1}, V_{DS2} and I_{DS1} change. M1 is the common source amplifier and M2 is the common gate amplifier in the cascode configuration. (1 marks)

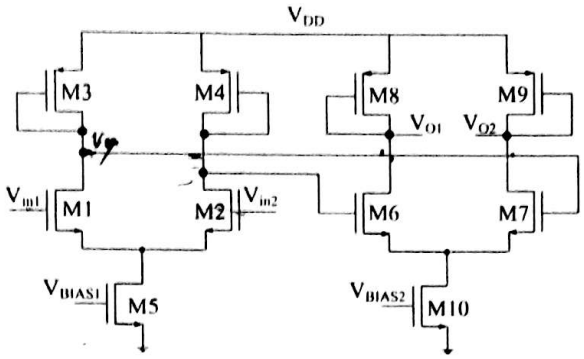

Figure 6: amplifier

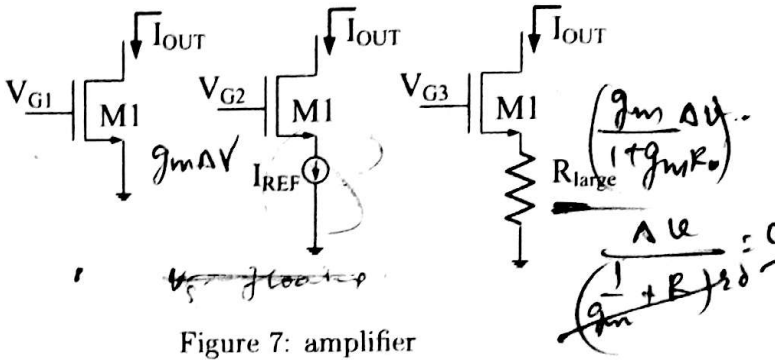

Figure 7: amplifier

Q5. (a) Frame your own question worth 3 marks, justify why it should be graded for 3 marks and write the answer. Direct example questions from any textbook and multiple choice questions will not be evaluated. Numerical based questions will not get you good marks.(3 marks)

$V_{OV} = V_{GS} - V_{TH}$

$V_{OV} \approx V_G - V_S - V_{TH}$

$V_G = V_{OV} + V_S + V_{TH}$

$V_G = V_{OV} + V_{TH}$.

$\tau_D =$

$\left(\frac{-1/g_m v_{in}}{2r_o + 1/g_m}\right)$

$\left(\frac{-g_m r_o}{1+2g_m r_o}\right)$

$\frac{1}{1/g_m}\left\{\frac{1}{(1+g_m r_o)}\right.$

$r_o\left\{\right.$

$v_1 = \frac{-v_{in1}}{1+g_m r_o}$

$v_2 = \frac{-v_{in2}}{1+2g_m r_o}$

$V_{O1} =$