EEL204 - Analog Integrated Circuits - Major

Indian Institute of Technology Delhi

Time: 2 hour; Total marks: 40

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) Draw the circuit architecture for an all NMOS differential input to single ended output differential amplifier. You can use ideal current sources for biasing purposes. (2 marks)

(b) In the circuit shown in figure 1 determine

i) The minimum supply voltage (V_{DD}) required for the circuit operation. (2 marks)

ii) The input common mode range. (2 marks)

(c) Determine the small signal voltage gain of the circuit shown in figure 2. (2 marks)

Q2. (a) For the circuit shown in figure 3,

(i) Determine the nature of biasing used for the output amplifier. If the aspect ratio of M_{1P} and M_{1N} is scaled down, how will the quiescent current in M_{2P} and M_{2N} change? (2 mark)

(ii) Determine the range of input voltage v_{in} to keep M_{1P} and M_{1N} in saturation. (2 mark)

(b) A student has learnt in theory that changing the common mode voltage of a differential amplifier with differential input single ended output (differential amplifier with current mirror load) does not change the output voltage. However while experimenting he finds that the output is changing with changes in the common mode voltage. Help the student with explanations as to what all could be the reason behind what he is observing. (2 marks)

(c) For a MOSFET based differential amplifier with differential input differential output plot the transfer characteristics (V_{od} versus V_{id}). Suggest ways to increase the linear range of the plot. (2 marks)

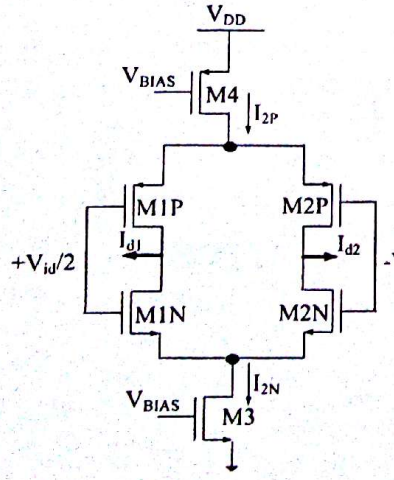

Figure 1: amplifier

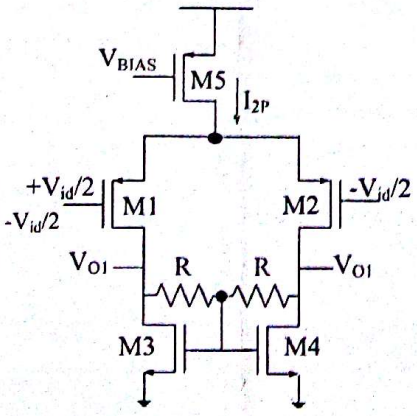

Figure 2: amplifier

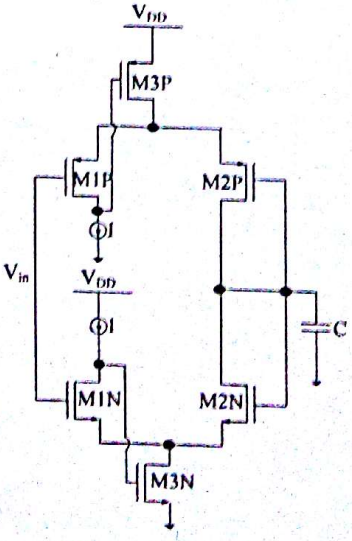

Figure 3: amplifier

Q3. (a) For the circuit shown in figure 4,

(i) Find the relationship between the quiescent current (I_q) and the reference current I. [Hint: 1:h means transistor M2 is h times larger than transistor M1] (2 marks)

(ii) Find the system transconductance G_m. (2 marks)

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(iii) Determine the biasing nature (class) of the amplifier and explain it. (2 marks)
(iv) For the circuit shown in figure 5, determine i_{out}. (2 marks)

Q4. (a) What should be the value of R_C in circuit 6. Given ln(1000)=7. (2 marks)
(b) Determine the output impedance in the circuit shown in figure 7. (2 marks)
(c) In the circuit shown in figure 8, determine the small signal output impedance and the minimum input and output voltages for the current mirror to work. Explain the working of the circuit, start by increasing i_{IN}. (4 marks)

(b)

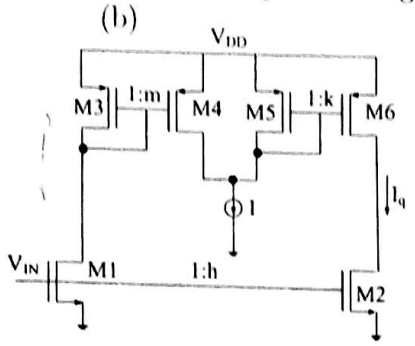

Figure 4: transistors

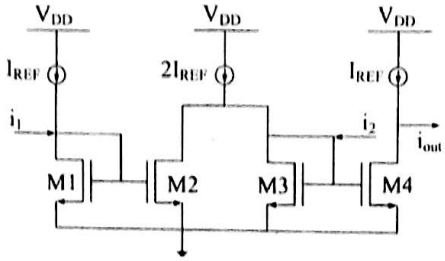

Figure 5: amplifier

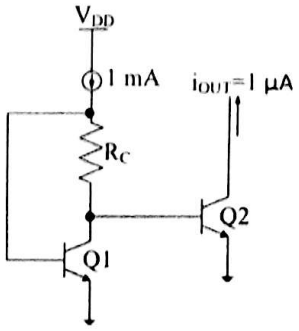

Figure 6: amplifier

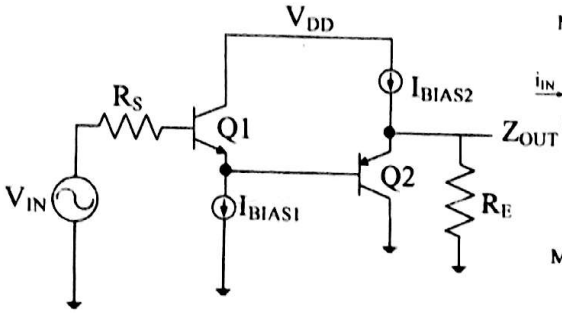

Figure 7: amplifier

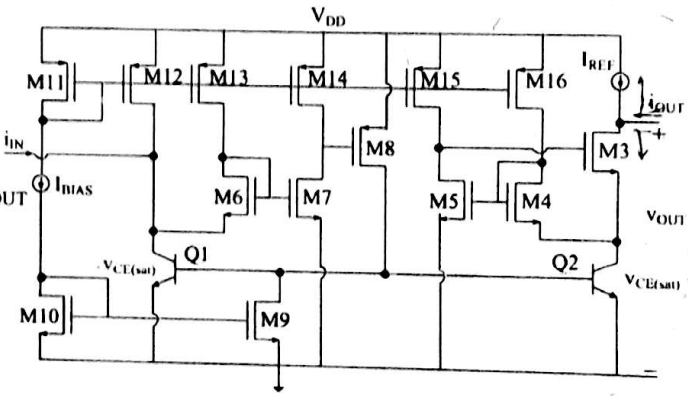

Figure 8: amplifier

Q5. (a) Compare simple, cascode, wide swing cascode, regulated cascode, self-biased cascode and wilson current mirrors for accuracy, input impedance, output impedance, minimum input voltage and minimum output voltage. (3 marks)
(b) 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)

(b) Frame your own question worth 2 marks related to either differential amplifier, single stage amplifier or biasing circuits. Direct example questions from any textbook and multiple choice questions will not be evaluated. Numerical based questions will not get you good marks.(2 marks)

Note: Schedule for showing Major answer scripts
Group 1: May 09, 2014, 1500-1700.
Group 2 and 3: May 10, 2014, 1100-1300
Group 4 and 5: May 11, 2014, 1030-1300.

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