PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

Microelectronic Circuits - Differential Amplifiers Exam
Instructions: Please answer all questions to the best of your ability. Show your work for problem-solving questions to receive partial credit.

Section 1: Multiple Choice Questions (4 points each, 40 points total)

Instructions: Choose the best answer for each question.

Question 1: What is a primary advantage of using differential amplifier configurations in circuit design?
A) Increased sensitivity to noise
B) Reduced component count
C) Reduced sensitivity to noise
D) Higher power consumption

Question 2: In a perfectly matched MOS differential amplifier with equal common-mode input voltage (VCM) applied to both gates, how is the current I typically divided between the two transistors (Q1 and Q2)?
A) All current flows through Q1.
B) All current flows through Q2.
C) The current is divided equally: ■■1 = ■■2 = I/2
D) The current division is unpredictable.

Question 3: The differential voltage gain (Ad) of a MOS differential amplifier is given by which formula (neglecting ro)?
A) Ad = 1 / (gm*RD)
B) Ad = gm / RD
C) Ad = gm * RD
D) Ad = RD / gm

Question 4: What is a key reason why differential amplifiers are well-suited for IC (Integrated Circuit) applications?
A) They require fewer components than other amplifier types.
B) IC fabrication allows for highly matched devices, and their parameters track well together across changes in temperature and voltage
C) They have inherently low power consumption.
D) They are less sensitive to variations in component values.

Section 2: Short Answer Questions (6 points each, 30 points total)

Instructions: Answer each question in 2-3 sentences.

Question 5: Explain why the input stage of an operational amplifier (Op Amp) is often a differential amplifier.

Question 6: Describe the condition in which the MOSFETs in a differential amplifier should operate for proper amplification.

Question 7: In the context of MOS differential amplifiers, what does the term "common-mode voltage (VCM)" refer to, and how is it applied?

Section 3: Problem-Solving Questions (10 points each, 30 points total)

Instructions: Show all work for full credit.

Question 8: A MOS differential amplifier has a differential voltage gain (Ad) of 25 and a drain resistance (RD) of 5 kΩ. Calculate the transconductance (gm) of the transistors. (Assume ro is negligible).

Question 9: In a MOS differential amplifier with a current source I, if I = 200 μA, and the transistors Q1 and Q2 are perfectly matched, what are the drain currents (i_D1 and i_D2) of each transistor?

Question 10: Briefly explain how the common-mode voltage affects the bias of the differential amplifier circuit. How can we change the common-mode voltage?