

PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

Microelectronic Circuits Exam: Differential Amplifiers

Instructions: Please answer all questions to the best of your ability. Show your work for partial credit on problem-solving questions.

Section 1: Multiple Choice (40 points total, 10 points each)

Instructions: Choose the best answer for each question.

Question 1: What is a primary advantage of using differential amplifiers in integrated circuits?

- A) Lower cost due to fewer components
- B) Reduced sensitivity to noise and interference
- C) Higher power consumption
- D) Simpler biasing requirements

Question 2: In a perfectly matched MOS differential amplifier, with equal voltages applied to both gate terminals (V_{CM}), how is the current I divided between the two transistors (Q_1 and Q_2)?

- A) All the current flows through Q_1
- B) All the current flows through Q_2
- C) The current is divided equally: $i_{D1} = i_{D2} = I/2$
- D) The current division depends on the value of V_{CM}

Question 3: Assuming r_o is negligible, what is the differential voltage gain (A_d) of a MOS differential amplifier?

- A) $A_d = g_m/R_D$
- B) $A_d = g_m + R_D$
- C) $A_d = g_m R_D$
- D) $A_d = R_D/g_m$

Question 4: What is the benefit of the differential amplifier configuration that allows the amplifier and couple amplifier stages together without the need of what component?

- A) Resistors
- B) Capacitors
- C) Inductors
- D) Diodes

Section 2: Short Answer (30 points total, 15 points each)

Instructions: Answer each question in 2-3 sentences.

Question 5: Explain why differential amplifiers are particularly well-suited for implementation in Integrated Circuits (ICs).

Question 6: In the context of a MOS differential amplifier, what does the term "Common-Mode Voltage (VCM)" refer to, and how does it relate to the gate voltages of the transistors?

Section 3: Problem-Solving (30 points total, 15 points each)

Instructions: Show all work for full credit.

Question 7: A MOS differential amplifier has a transconductance (g_m) of 2 mS and a drain resistance (R_D) of 10 k Ω . Assuming r_o is negligible, calculate the differential voltage gain (A_d).

Question 8: In a MOS differential amplifier, the current source I is 1mA. The transistors are matched. What is the drain current in each transistor?