

PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

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Microelectronic Circuits Exam: Differential Amplifiers

Instructions: Please read each question carefully and answer to the best of your ability. Show your work for partial credit where applicable.

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 amplifiers in integrated circuits?

- A) Higher power consumption
- B) Increased sensitivity to noise
- C) Reduced component count
- D) Improved matching of device parameters due to IC fabrication

Question 2: In a MOS differential amplifier, if the input voltages at the two gate terminals are equal (VCM), what is VCM?

- A) The differential voltage
- B) The common-mode voltage
- C) The drain voltage
- D) The threshold voltage

Question 3: Assuming Q1 and Q2 are perfectly matched in a MOS differential amplifier, and r_o is neglected, what is the Differential Voltage Gain (A_d)?

- A) g_m/R_D
- B) $g_m + R_D$
- C) $g_m * R_D$
- D) R_D/g_m

Question 4: In a MOS differential amplifier where Q1 and Q2 are matched and have a current source I , how is the current divided between the transistors?

- A) All of I flows through Q1.
- B) All of I flows through Q2.
- C) I divides equally, i.e., $I/2$ through each transistor.
- D) The current division depends on the input voltage.

Short Answer Questions (6 points each, 30 points total)

Instructions: Answer each question in 2-3 complete sentences.

Question 5: Explain why differential amplifiers are less sensitive to noise compared to single-ended amplifiers.

Question 6: Describe what is meant by the term "common-mode voltage" in the context of a MOS differential amplifier and its effect.

Question 7: Why is matching between the two sides of a differential amplifier circuit so important for its performance? Explain in terms of IC Fabrication.

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

Instructions: Show your work and clearly state your final answer.

Question 8: A MOS differential amplifier has a drain resistance (R_D) of $10\text{ k}\Omega$ and a transconductance (g_m) of 2 mA/V . Calculate the differential voltage gain (A_d), assuming r_o is negligible.

Question 9: In a MOS differential amplifier, the current source $I = 1\text{ mA}$. If $k_n'(W/L) = 2\text{ mA/V}^2$, determine the overdrive voltage (V_{OV}).

Question 10: Explain how using a current source as a load in a MOS differential amplifier affects the common-mode rejection ratio (CMRR) and why this is beneficial.