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Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2019					

ENG471 – Analogue Devices	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

- Exam has five questions.
- Answer all questions of the exam.
- Exam has 80 marks.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book 1 x Scrap Paper

THIS EXAMINATION PAPER AND SUPPLIED MATERIALS ARE NOT PERMITTED TO BE REMOVED FROM ANY EXAMINATION VENUE IN ANY CIRCUMSTANCE. THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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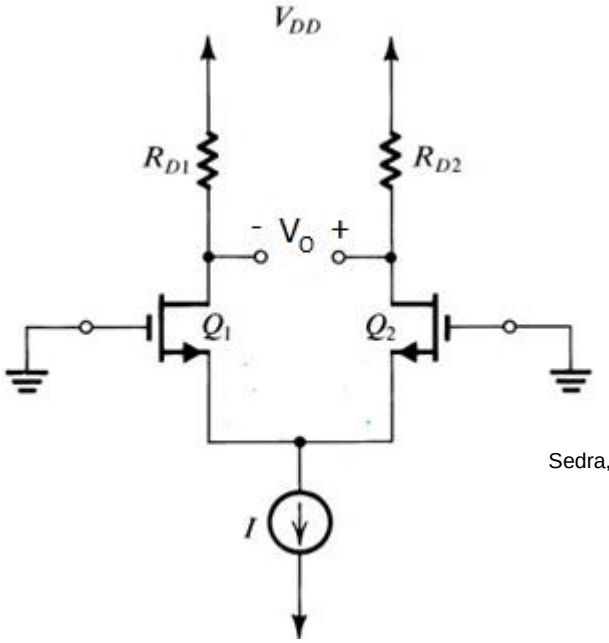
Question 1 (10 marks)

For the MOSFET-Based differential amplifier shown in Figure 1, transistors Q_1 and Q_2 are mismatched due to their k'_n parameters, which are defined as follows:

For Q_1: $(k'_n)_1 = k'_n + \frac{\Delta k'_n}{2}$

For Q_2: $(k'_n)_2 = k'_n - \frac{\Delta k'_n}{2}$

Derive an expression for the offset voltage applied at the input of the amplifier to remove effect of this mismatch.



Sedra,6th edition,ISBN:9780199738519

Figure 1.

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Question 2 (17 marks)

For the circuit shown in Figure 2, answer the following questions:

a) Determine the DC current values of I_{ref} and I_Q. (6 marks)
b) Determine the Differential-mode gain of the amplifier. (11 marks)

Assume:

$|V_t|$=2V and λ=0.01 V^{-1} (for all transistors).

For M1: $K'_n(W/L)$=50 µA/V^2.

For M6: $K'_n(W/L)$=250 µA/V^2.

For M4 and M7: $K'_n(W/L)$=150 µA/V^2.

For M5 and M8: $K'_n(W/L)$=200 µA/V^2.

For M2 and M3=100 µA/V^2.

R_1=100 KΩ.

V_{DD}=V_{SS}=10 V.

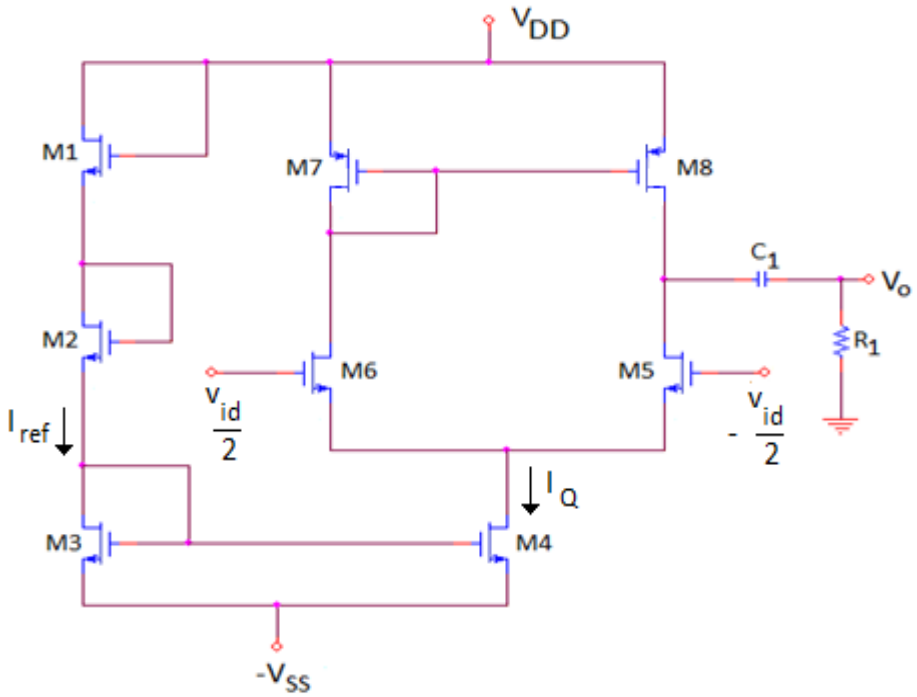

Figure 2.

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Question 3 (15 marks)

Apply the open-circuit time constant method and derive an expression for the upper 3dB frequency f_H of the circuit shown in Figure 3. Consider the Early effect of transistors in your solution.

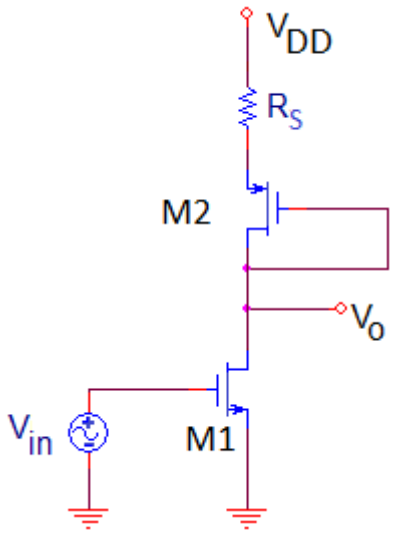

Figure 3.

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Question 4 (23 marks)

For the shunt-shunt feedback based amplifier shown in Figure 4, answer the following questions:

a) Determine DC Collector current value of the transistor. (4 marks)
b) Determine the transresistance gain (V_o/i_i) of the amplifier. (9 marks)
c) Determine the voltage gain (v_o/v_{sig}) of the amplifier. (3 marks)
d) Determine the input resistance (R_{in}) of the amplifier. (4 marks)
e) Determine the output resistance (R_{out}) of the amplifier. (3 marks)
Assume β (or h_{FE})=100, V_A=50 V.

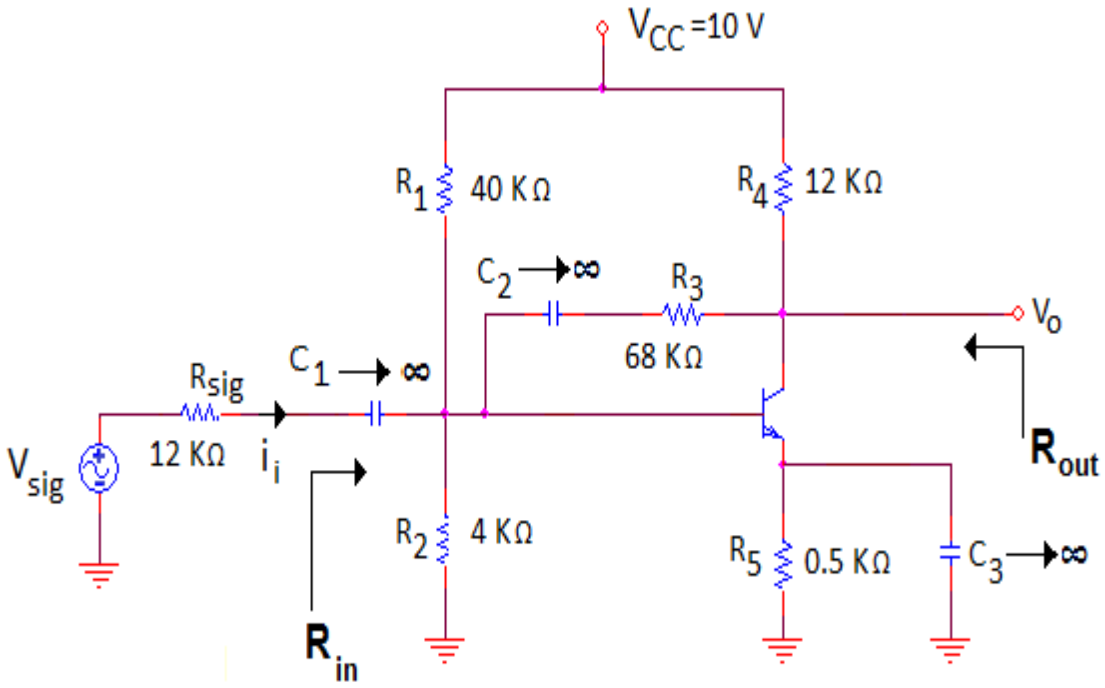

Figure 4.

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Question 5 (15 marks)

For the circuit shown in Figure 5, determine the below parameters to provide the maximum symmetrical swing for the output voltage.

a) The voltage V_{BIAS1}. (2 marks)
b) The voltage V_{BIAS2}. (3 marks)
c) $(\frac{W}{L})$ of transistor M_1 based on $(\frac{W}{L})$ of M_2 and M_3. (10 marks)

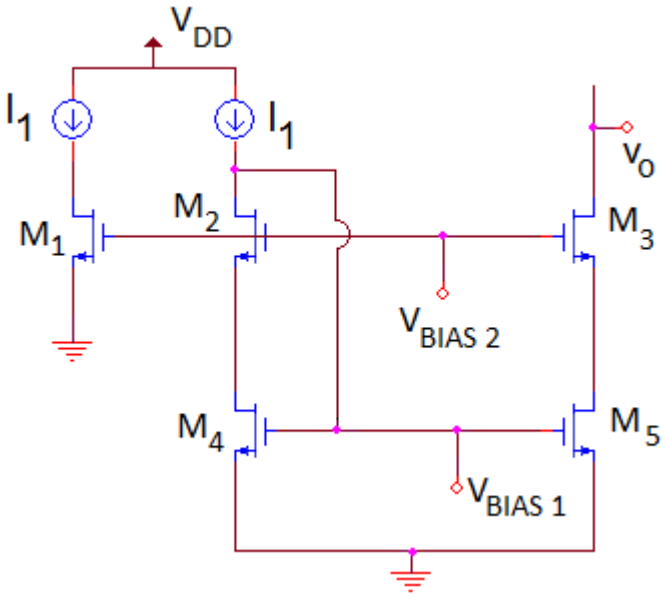

Figure 5.

Assume

$|V_t|$=0.7 V for M_1, M_4 and M_5

$|V_t|$=0.8 V for M_2 and M_3

$|V_{OV}|$=0.2 V for M_2, M_3, M_4 and M_5

k'_n values of all transistors are the same.

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