COMMONWEALTH OF AUSTRALIA

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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2016

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

INSTRUCTIONS TO CANDIDATES

1. The examination has **5** questions.
2. The exam has 90 marks. Note that questions **ARE NOT** of equal value

   Question 1: 9 marks

   Question 2: 21 marks

   Question 3: 20 marks

   Question 4: 25 marks

   Question 5: 15 marks
3. Read ALL questions carefully

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

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1 (9 marks)

A differential amplifier for which the total emitter bias current is 600 μA uses transistors whose β are specified to lie between 80 and 200.

a) What is the largest possible input bias current? (3 marks)

b) The smallest possible input bias current? (3 marks)

c) The largest possible input offset current? (3 marks)

Question 2 (21 marks)

For the amplifier shown in Figure 1, it is required to have a zero DC volt at the output of the amplifier. Answer the following questions:

a) What are the Q-points (I_D, I_C, $|V_{CE}|$ and $|V_{DS}|$) of transistors? (6 marks)

b) What is the value of R_C? (2 marks)

c) Determine the input resistance of the amplifier (R_{in}). (3 marks)

d) Determine the output resistance of amplifier (R_{out}). (3 marks)

e) Determine the differential –mode voltage gain. (7 marks)

Note that DC value for the input voltages of the amplifier is zero.

Assume: $V_{CC}=V_{EE}=5$ V, $R_L=1.5$ KΩ

$I_1=150$ µA, $I_2=300$ µA, $I_3=1.0$ mA

Transistors' specifications:

MOSFETs: $k'_n(W/L)= 2.0$ mA/V^2, $V_t=1$V

BJT: $\beta=50$, $V_{BE}=0.7$ V, $V_T=25$ mV.

For all transistors: $\lambda=0.02$.

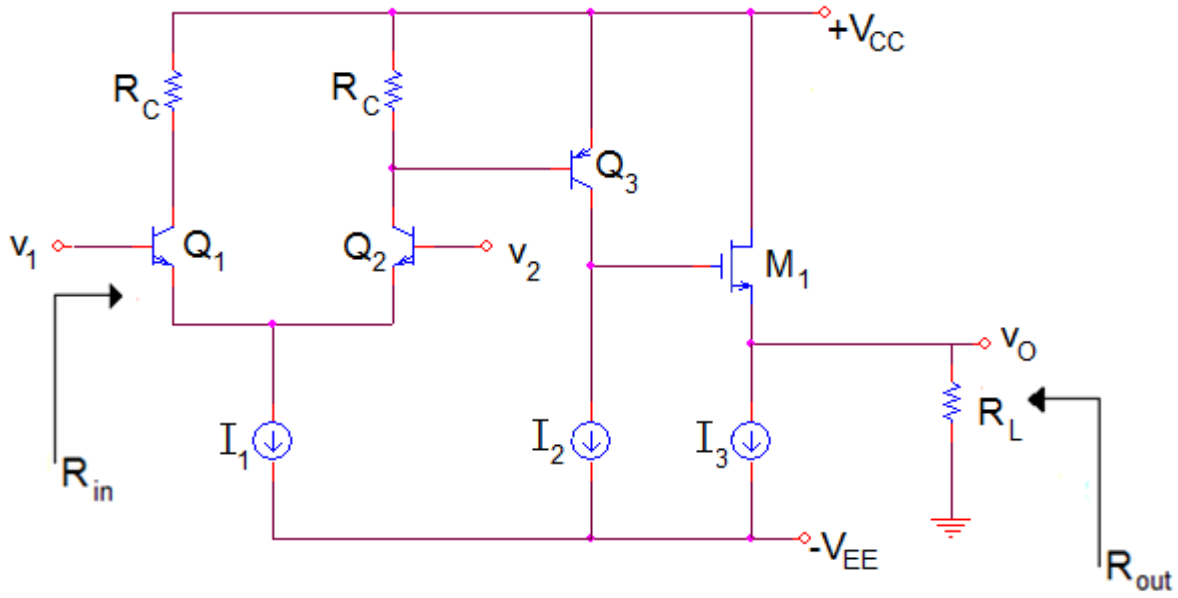

Figure 1.

Question 3 (20 marks)

For the circuit shown in Figure 2, its high frequency analysis is required. Apply the open-circuit time constant technique and determine frequency of poles obtained from capacitors of transistor M1.

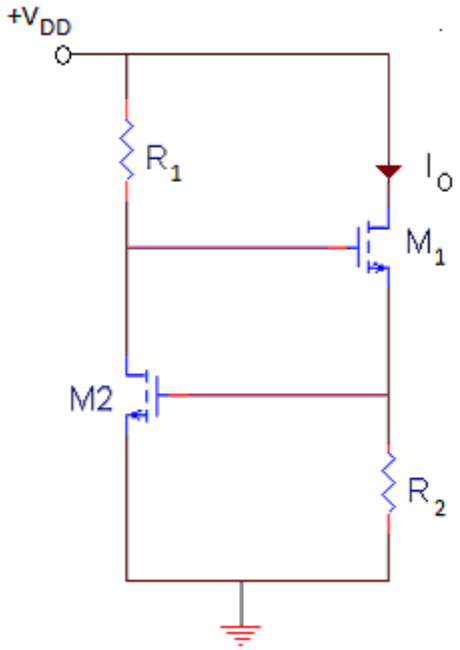

Figure 2.

Question 4 (25 marks)

For the circuit shown in Figure 3, answer the following questions:

a) With an accurate analysis, determine collector currents of each transistor. (3 marks)

b) Determine the feedback type and its important parameters. (5 marks)

c) Determine the input resistance of the amplifier (R_{in}). (4 marks)

d) Determine the output resistance of the amplifier (R_{out}). (5 marks)

e) Determine the voltage gain (v_o/v_{sig}). (8 marks)

Assume β=50 and V_A=50 V.

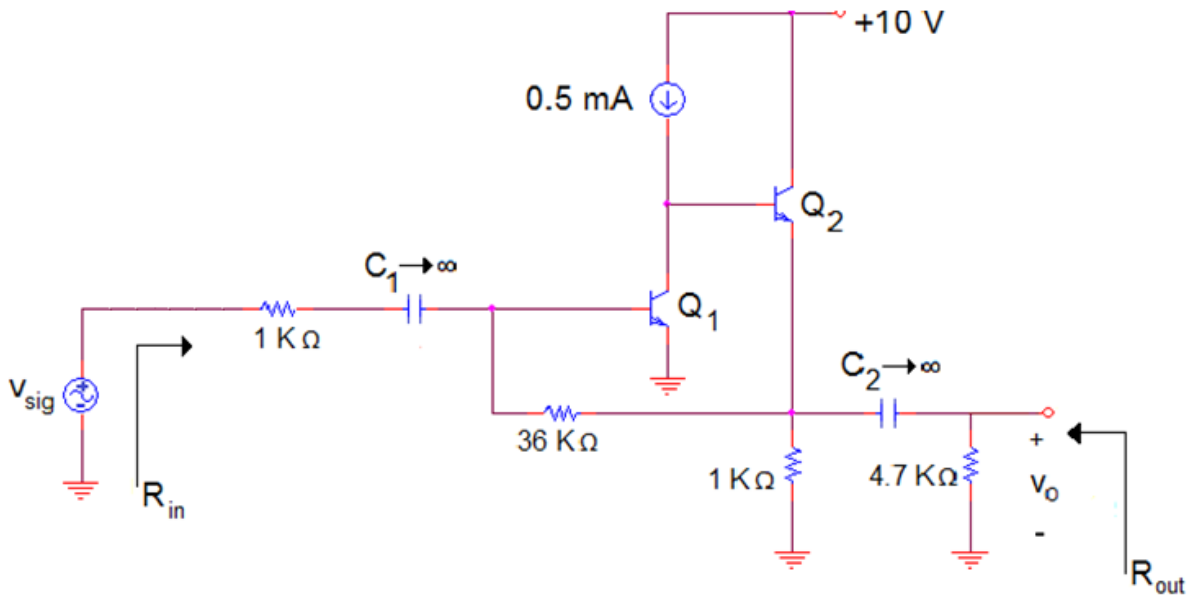

Figure 3.

Question 5 (15 marks)

It is required to design the folded-cascode circuit of Figure 4 to provide gain of 80 dB and a unity gain frequency of 10 MHz when C_L=10 pF. Design for I_B=I, and operate all devices at the same $|V_{OV}|$. Utilize transistors with 1-µm channel length for which $|V_A|$ is specified to be 20 V.

a) Find the required overdrive voltages and bias currents. (8 marks)

b) What is the slew rate of the circuit? (2 marks)

c) Determine the width of each transistor. (5 marks)

Assume transistors have the following specifications:

k'_n=2.5 k'_p=200 µA/V^2

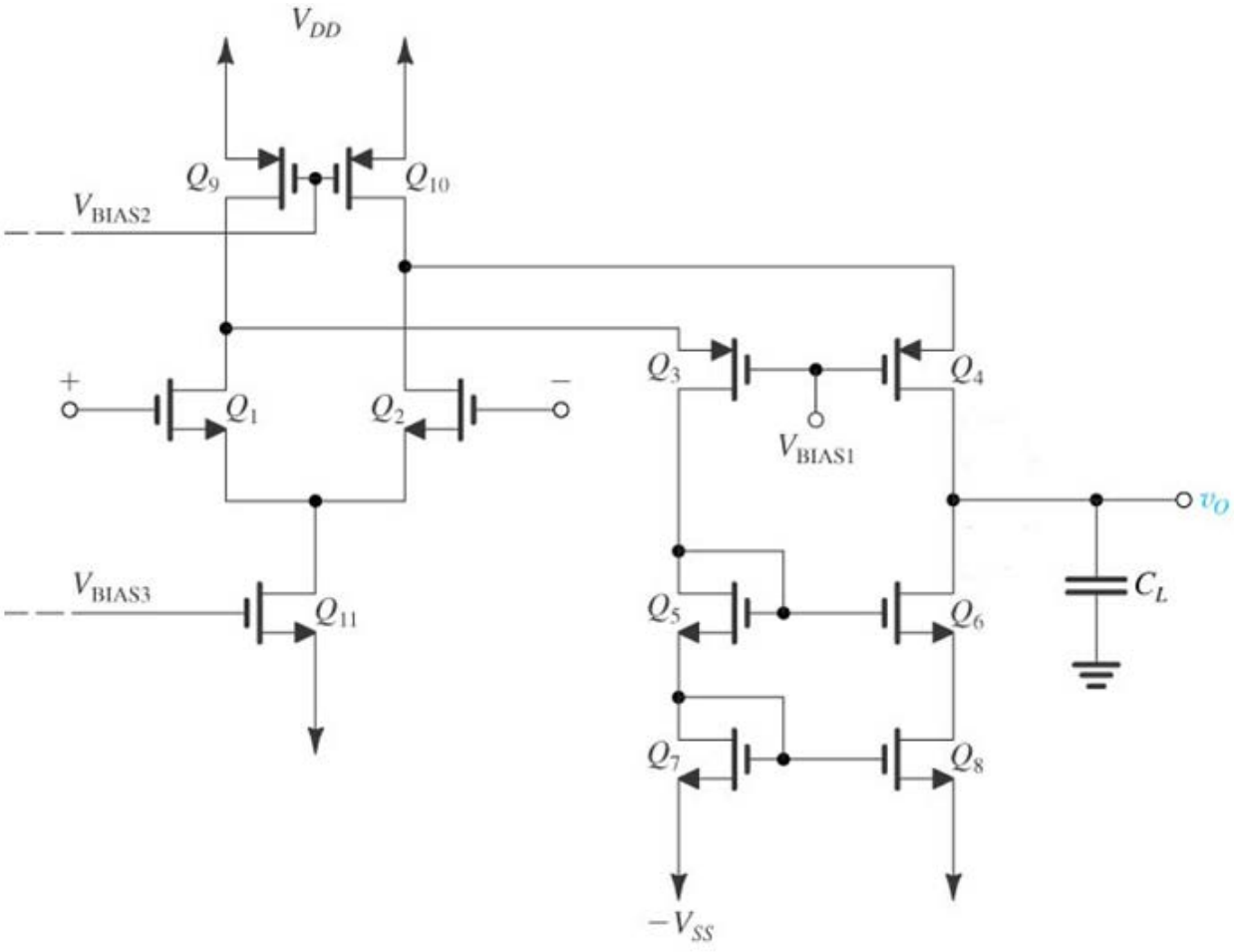

Figure 4.