Midterm Examination # 2

Electronic Circuits I - ECSE-330B
March 31st 2005, 8:35 AM – 9:55 AM
Professor Ramesh Abhari

Pertinent Information:

1) This is a closed-book examination, no notes permitted.

2) This examination consists of 4 questions with total possible points of 32. Partial point distribution is indicated in brackets.

3) Only the Faculty Standard Calculator is permitted.

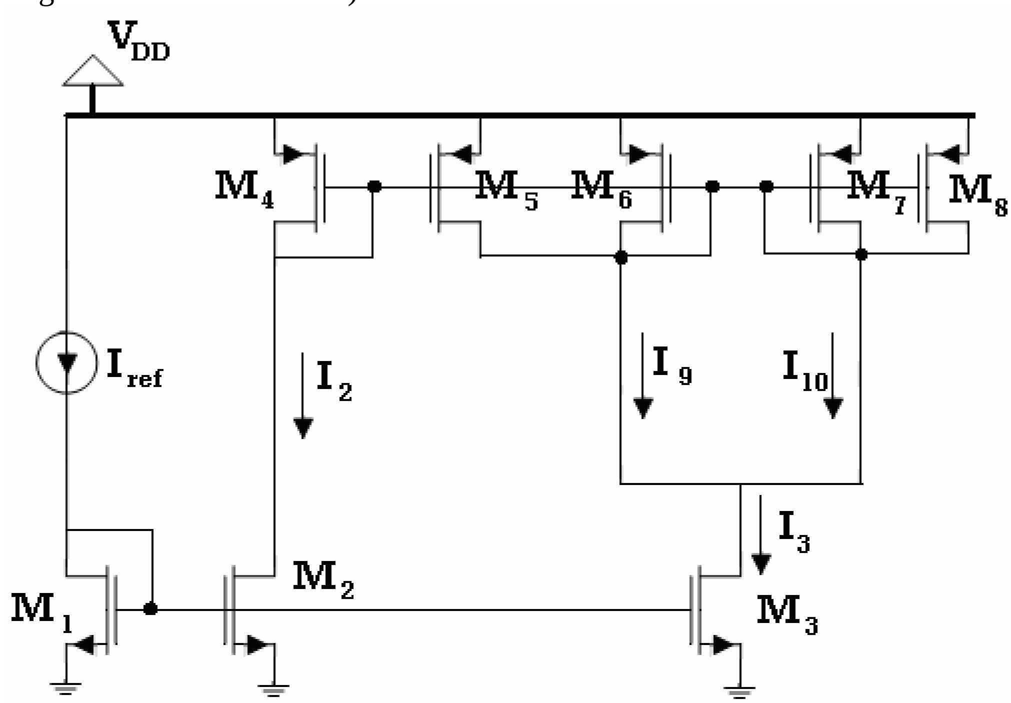
4) Show your work: answers without justification will not receive marks. State any assumption you find necessary to complete your answer.

Last Name	
First Name	
Student Number	

Question	Mark
1	/7
2	/8
3	/9
4	/8
Total	/32

Question #1 (8 Points)

In the following circuit:
$k_p = k_n$,
$V_{t0n} = |V_{t0p}|$,
$\left(\frac{W}{L}\right)_2 = 2\left(\frac{W}{L}\right)_1$,
$\left(\frac{W}{L}\right)_4 = \left(\frac{W}{L}\right)_5 = \left(\frac{W}{L}\right)_6 = \left(\frac{W}{L}\right)_7 = \left(\frac{W}{L}\right)_8 = \left(\frac{W}{L}\right)_1$,
Channel length modulation can be ignored $(\lambda = 0)$. (Assume that all the transistors are operating in the saturation mode)

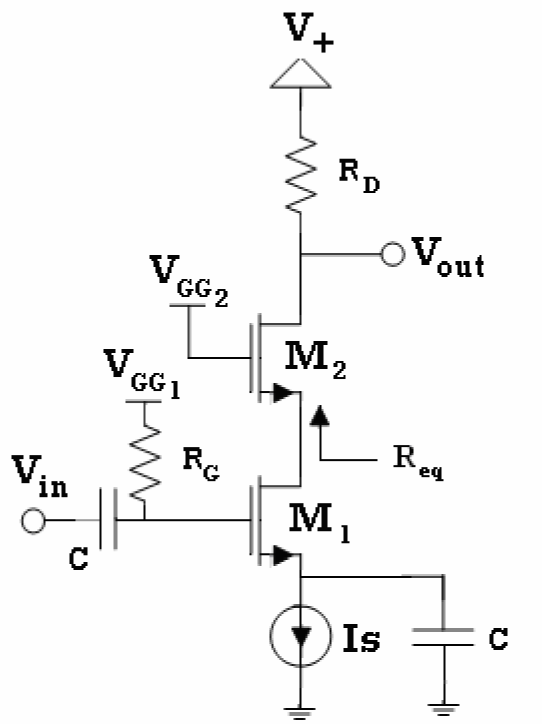


(a) Calculate I_2, I_9, and I_{10} in terms of I_{ref}. (5 pts)

(b) Find I_3 and determine $\left(\frac{W}{L}\right)_3$ in terms of $\left(\frac{W}{L}\right)_1$. (2 pts)

Question #2 (8 Points)

In the following amplifier ignore the body effect and the channel length modulation. V_{GG1} and V_{GG2} are the DC voltage supplies used for biasing the gates of M_1 and M_2.



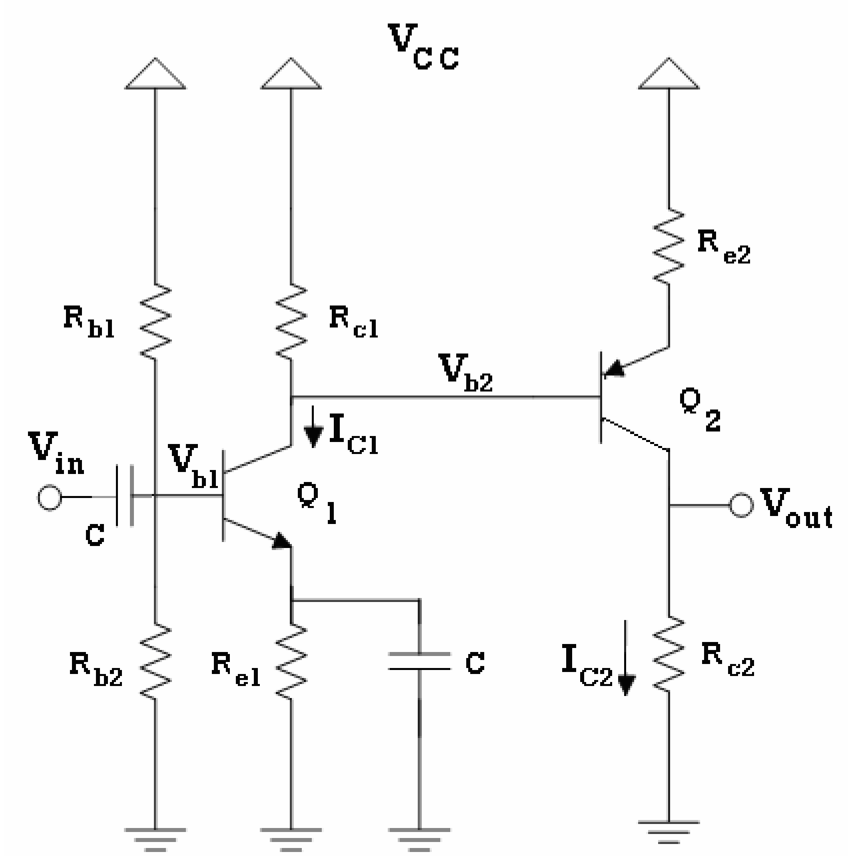
(a) Draw the small signal equivalent circuit. (2 pts)

(b) Derive an expression for the small signal equivalent resistance (R_{eq}) when looking into the source of M_2 (as shown above). (3 pts)

(c) Derive an expression for the small signal voltage gain $A_v = \frac{V_{out}}{V_{in}}$. (3 pts)

Question #3 (9 Points)

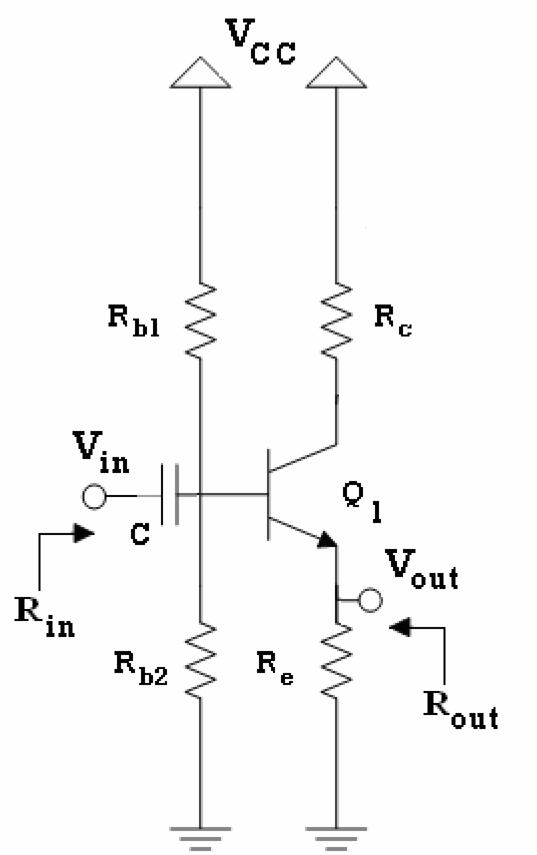
In the following circuit:
$\beta_1 = \beta_2 = 100$, $V_{CC}=10^V$, C is very large, $R_{b1}=70K\,\Omega$, $R_{b2}=30K\,\Omega$, $R_{e1}=2K\,\Omega$, $R_{c1}=4K\Omega$, $R_{c2}=4K\Omega$, and $R_{e2}=3K\Omega$.
The Early effect can be ignored for all transistors.



(a) Calculate I_{C1}, I_{C2}, V_{b1}, and V_{b2} and verify the assumed mode of operation for the transistors. (8 pts)
(b) Determine the maximum value for R_{c2} so that Q_2 operates in the active mode. (1 pt)

Question #4 (8 Points)

In the following amplifier the Early effect can be neglected.



(a) Draw the small signal equivalent circuit. (2 pts)

(b) Derive an expression for the small signal voltage gain A_v . (2 pts)

(c) Derive an expression for the small signal current gain A_{IS} . (2 pts)

(d) Derive expressions for R_{in} and R_{out}. (2 pts)