Midterm Examination # 2

Electronic Circuits I - ECSE-330B

March 25th 2004, 8:35 AM – 9:55 AM

Professor Ramesh Abhari

Pertinent Information:

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

2) Answers should be written in pen.

3) This examination consists of 4 questions with total possible points of 36. Partial point distribution is indicated in brackets.

4) Only the Faculty Standard Calculator is permitted.

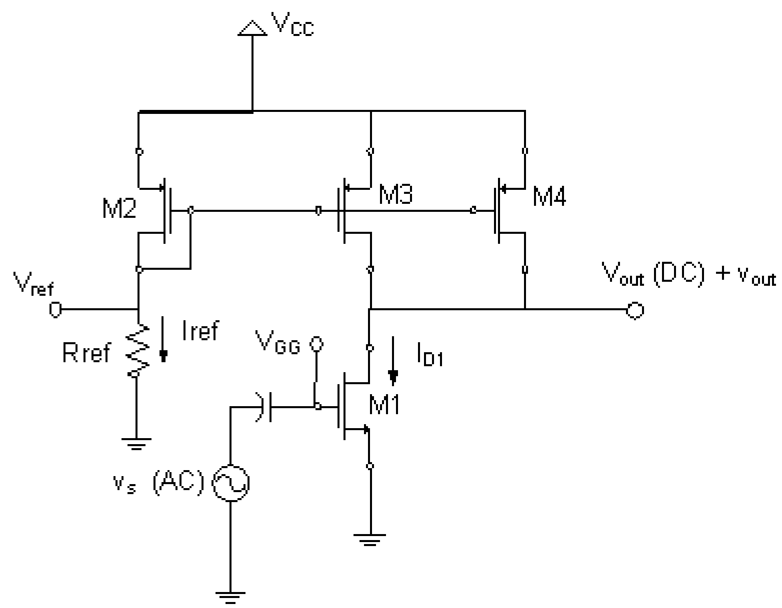
5) Show your work: answers without justification will not receive marks. State any assumption you find necessary to complete your answer.

Last Name	
First Name	
Student Number	

Question	Mark
1	/7
2	/10
3	/7
4	/12
Total	/36

Question #1 (7 pts)

In the following circuit, in all transistors $V_{tn} = -V_{tp} = 1V$.
$k_p'W_2/L_2 = k_n'W_1//L_1 = 200\mu A/V^2$, and $W_3/L_3 = W_4/L_4 = 10W_2/L_2$. k_p' is the same in all PMOS transistors.
Vcc = 5 V and Vref = Vout (DC) = 3V.



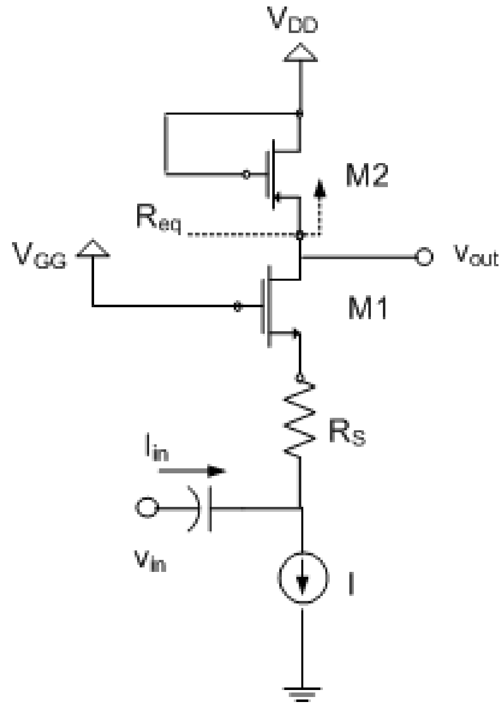
a) Ignore the channel length-modulation and find Iref, Rref, and I_{D1}? (3 pts)

b) Assume $|\lambda| = 0.05V^{-1}$ for all of the transistors. Replace the current mirror with an appropriate output resistance and draw the small-signal model for the amplifier circuit. Be sure to calculate the small-signal parameters. (3 pts)

c) Calculate the gain v_{out}/v_s. (1 pts)

Question #2 (10 Points)
In the following circuit, neglect the channel length modulation for both M1 and M2 and consider the DC

current source ideal.



a) Find the Req as indicated in the above diagram. (2 pts)

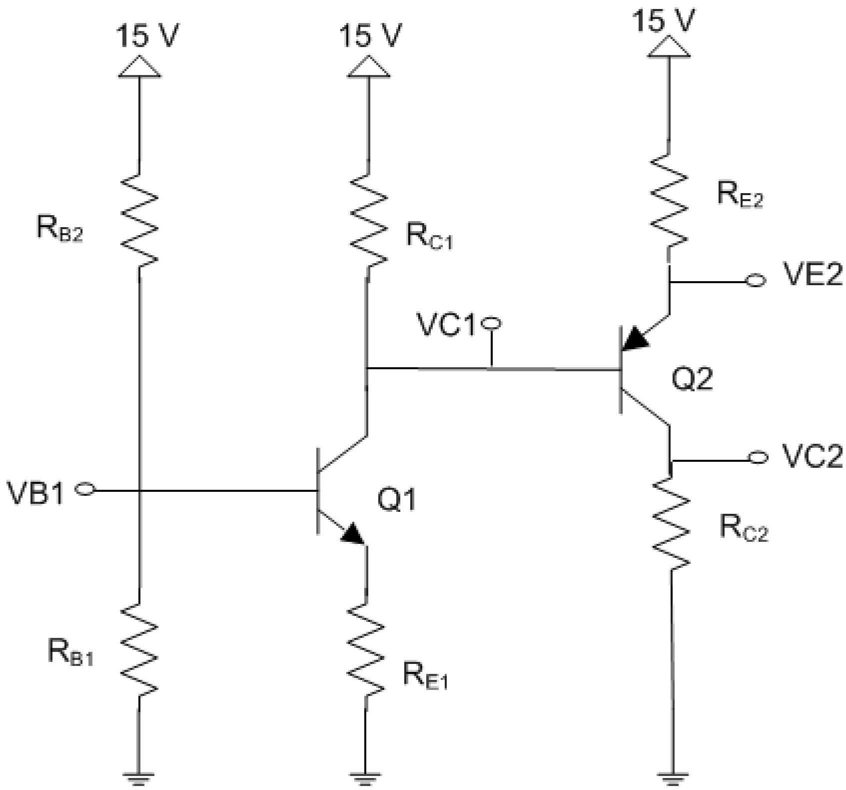
b) Replace M2 with the equivalent resistance found in part (a). Draw the small signal model for this circuit and include the Body Effect for M1 in your model. (3 pts)

c) Based on the model found in part (b), find an expression for the voltage gain (V_{out}/V_{in}). (5 pts)

Question #3 (7 Points)

Consider the following circuit. Both NPN and PNP transistors have $\beta = 100$ and $V_{BE} = V_{EB} = 0.7V$.

R_{B2} = 200 KΩ, R_{B1}= 100 KΩ, R_{C1}= 10 KΩ, R_{E1}= 10 KΩ and R_{E2}= 1 KΩ.

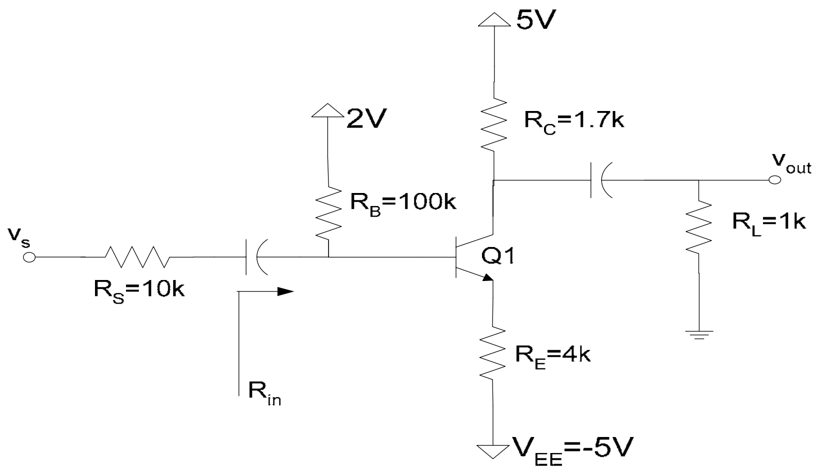


a) Assume the active mode operation for both transistors. If R_{C2} is 1 KΩ, find VB1, VC1, VE2 and VC2. (6 pts)

b) If V_{ECsat} = 0.3V and V_{EB}= 0.7 V, what is the maximum value for R_{C2} in order to keep Q2 operating in the active mode. (1 pt)

Question #4 (12 Points)

Consider the following common-emitter amplifier circuit. The signal source has a resistance of 10kΩ as shown in the figure, and a 1kΩ load R_L is attached at the output. Capacitors are infinite-valued, and transistor β=100.



Figure

a) Solve for the DC value of the emitter current I_E and the collector voltage V_C. (3 pts)

b) Draw the small-signal model and find an expression for the input resistance R_{in} seen by the signal source and calculate it based on your answers from part (a). Ignore the Early Effect. (4 pts)

c) Find an expression for the overall voltage gain $A_V = v_{out}/v_s$ and calculate it using answers from parts (a) and (b). (2 pts)

d) Consider what happens if the negative power supply has a voltage ripple noise which is not uncommon. You may treat such a ripple as a small-signal source v_{ee} at the negative power supply. This signal has no source resistance. Find an expression for the voltage gain v_{out}/v_{ee} (do not calculate it). Ignore the Early Effect. (3 pts)