Midterm Examination # 2

Electronic Circuits I - ECSE-330B
March 27th 2007, 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 50. Partial point distribution is indicated in brackets.

3) Only the Faculty Standard Calculator is permitted.

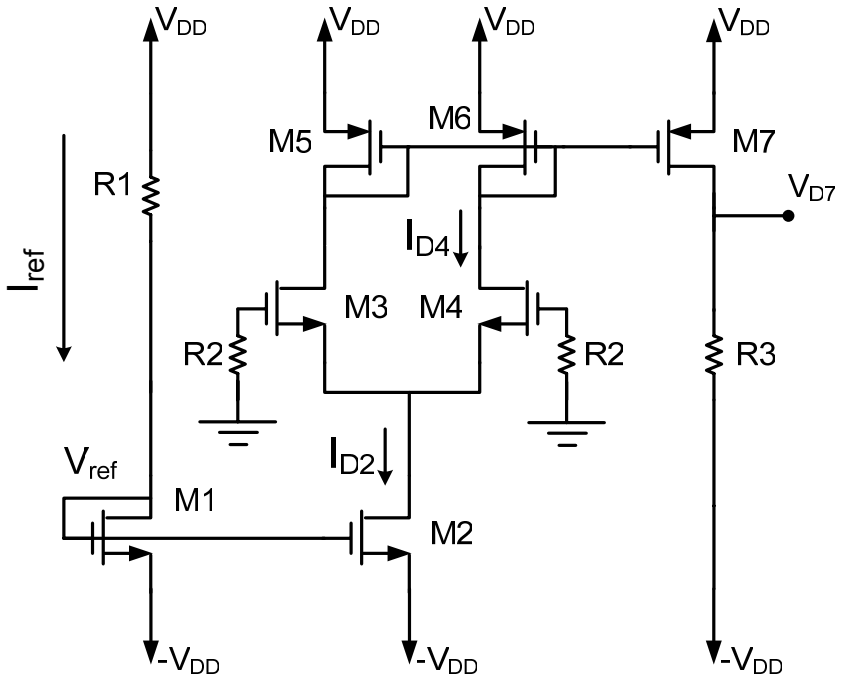
4) Show your work: answers without justification will not receive marks. State any assumption you find necessary to complete your answer.

Last Name	
First Name	
Student Number	

Question	Mark
1	/8
2	/22
3	/9
4	/11
Total	/50

QUESTION 1 *(8 marks)*

In the following circuit:
V_{DD} = 5V, R2 = 10KΩ, R3 = 4KΩ, $\mu_n C_{OX} = \mu_p C_{OX}$ = 100 μA/V^2, $|V_t| = V_{tn} = -V_{tp}$ = 1 V, $(W/L)_1 = (W/L)_3 = (W/L)_4$ = 20, $(W/L)_5 = (W/L)_6$=40 . The channel length modulation and body effect can be ignored. Assume that all transistors are in saturation mode.

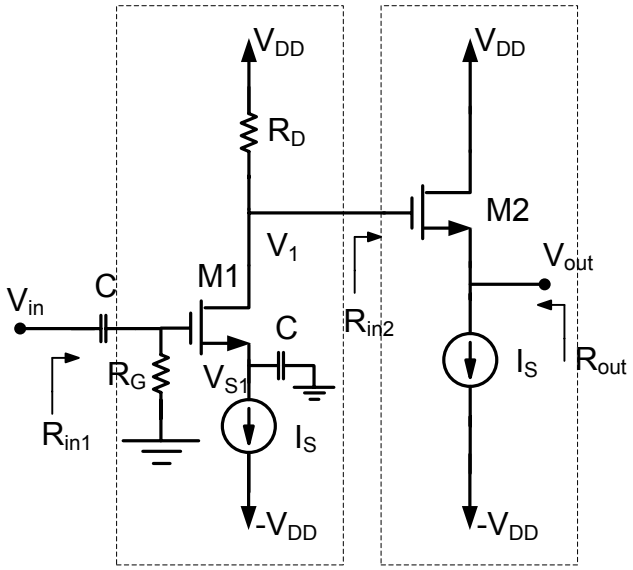


a) Find V_{ref} such that I_{ref}=250 μA. (2 marks)
b) Find R1. (0.5 mark)
c) Find $(W/L)_2$ such that I_{D2}=1 mA. (2 marks)
d) Find I_{D4}. (0.5 mark)
e) Find $(W/L)_7$ if V_{D7} is to be 1V. (3 marks)

QUESTION 2 *(22 marks)*

Consider the two-stage amplifier in Fig.2. Assume V_{DD} = 5 V, R_G = 4 KΩ, R_D = 4 KΩ, $\mu_n C_{OX} = \mu_p C_{OX}$ = 100 μA/V^2, V_{tn} = 1 V, χ=0.2, λ = 0.025 V^{-1}and $(W/L)_1 = (W/L)_2$ = 40. Also assume that I_S=500 μA and that for the small-signal analysis the current sources can be replaced by 100 KΩ resistors. The capacitors are ideal AC short circuits.

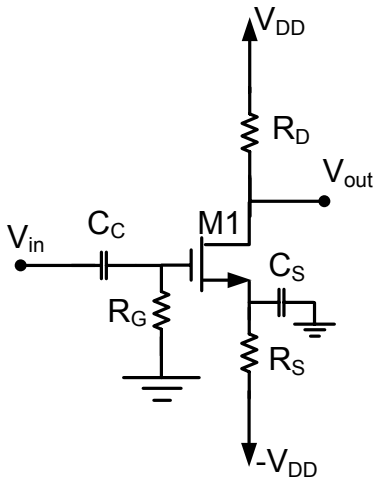
For DC analysis you may ignore CLM and body effect. Consider body effect and CLM for AC analysis.



a) Specify the type of the amplifiers in each stage? (i.e. CS, CG, or CD) (1 mark)
b) Assume that all transistors are in saturation. From the DC analysis find V_{S1}, V_1 and V_{out}. (6 marks)
c) Draw the small-signal equivalent circuit of the entire amplifier. (4 marks)
d) Calculate g_{m1}, r_{o1}, g_{m2}, and r_{o2}. (2 marks)
e) Find R_{in1} and R_{in2}. (1 mark)
f) Derive expressions for the small-signal gains V_1/V_{in} and V_{out}/V_{in} and calculate their values. (6 marks)
g) Calculate the output resistance (R_{out}) of the above amplifier. (2 marks)

QUESTION 3 *(9 marks)*

In the following amplifier ignore body effect but consider CLM.

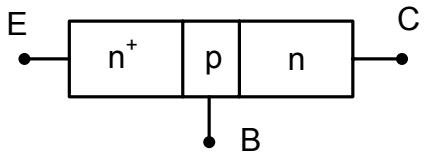


a) Draw the high frequency small-signal equivalent circuit of the amplifier. (3marks)
b) Derive an expression for the mid-band gain. (2 marks)
c) Find the frequency of the pole associated with C_S. (2 marks)
d) Find the frequency of the pole associated with C_C. (2 marks)

QUESTION 4 *(11 marks)*

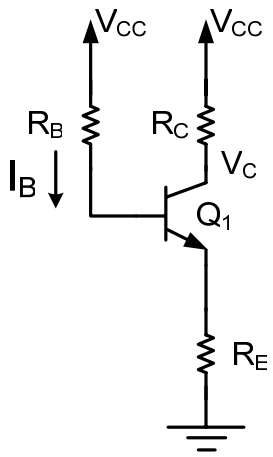
Part I)

- Draw a table naming the different modes of operation of an npn BJT. Specify the state of the BE and BC junctions for each mode. (4 marks)
- Which mode is used in designing amplifiers? Explain the physics of the BJT operation at this mode. (3 marks)



Part II)

In the following BJT circuit V_{CC}=5 V, R_B=200 KΩ, R_E=2.3 KΩ, R_C=1 KΩ, β=100, and V_{BE}(on)=0.7 V.



a) Find the DC values of I_B and V_C. (3 marks)
b) Verify the mode of operation of Q_1. (1 mark)