Midterm Examination # 2

Electronic Circuits I - ECSE-330B
March 25th 2008, 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.

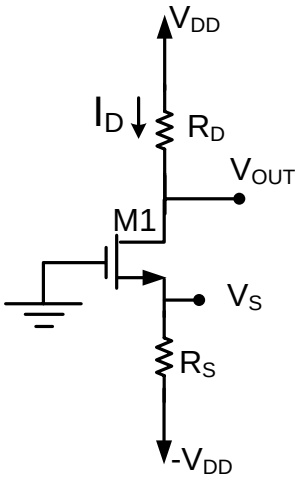
Last Name	
First Name	
Student Number	

Question	Mark
1	/19
2	/8
3	/15
4	/8
Total	/50

QUESTION 1 *(19 marks)*

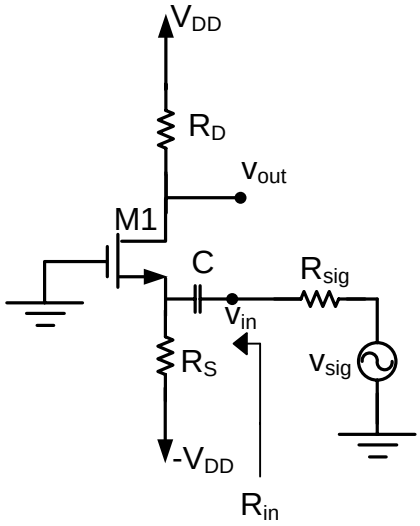
Consider the following circuit. Assume V_{DD} = 5 V, R_D = 4 KΩ, R_S = 3 KΩ, $\mu_n C_{OX}$ = 100 μA/V^2, V_{tn} = 1 V, χ=0.2, λ = 0.025 V^{-1}and $(W/L)_1$= 20.

For <u>DC analysis</u> you may <u>ignore CLM and body effect.</u>



a) From the DC analysis find V_{out}(DC), V_S(DC), and I_D. (3 marks)

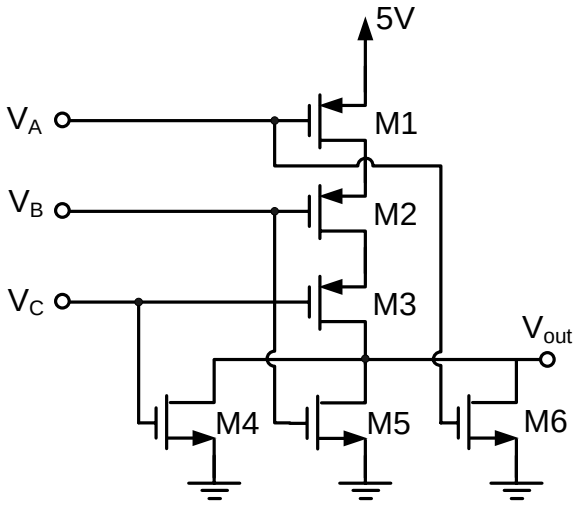
This circuit is now used as an amplifier. Consider R_{sig}=50Ω. The capacitor is ideal AC short circuit. **<u>Consider body effect</u> but <u>ignore CLM</u> for <u>AC analysis</u>.**



b) Specify the type of the amplifier? (i.e. CS, CG, or CD) (1 mark)

c) Draw the small-signal equivalent circuit of the amplifier. (3 marks)
d) Calculate g_m and g_{mb}. (If you haven't solved (a) assume I_D=2 mA). (2 marks)
e) Derive an expression for the small-signal gain V_{out}/V_{in} and calculate its value. (4 marks)
f) Derive an expression for R_{in} and calculate its value. (3 marks)
g) Derive an expression for the small-signal gain V_{out}/V_{sig} and calculate its value. (3 marks)

QUESTION 2 *(8 marks)*



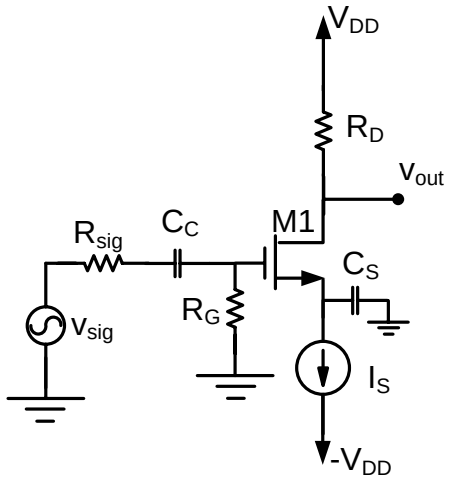
In the digital logic circuit shown above determine the output voltage (V_{out}) for the following input combinations:

a) V_A=0V, V_B=0V, and V_C=0V (4 marks)
b) V_A=0V, V_B=5V, and V_C=0V (4 marks)

For each part clearly indicate the state of all transistors and explain why. Consider the magnitude of the threshold voltage for all transistors is 1.

QUESTION 3 *(15 marks)*

In the following amplifier ignore body effect and CLM.



a) Draw the high frequency small-signal equivalent circuit of the amplifier. The current source is assumed to be ideal. (3 marks)
b) Derive an expression for the mid-band gain. (3 marks)
c) Find the frequency of the pole associated with C_S. (3 marks)
d) Find the frequency of the pole associated with C_C. (3 marks)
e) Find the f_H (high frequency 3-dB corner frequency) assuming that the effect of C_{gd} at the input (gate) of M_1 is a capacitor to ground with a value equal to $C_{eq}=C_{gd}(1+g_mR_D)$. (3 marks)

QUESTION 4 *(8 marks)*

- Specify the state of the BE and BC junctions in the active mode.
- Explain the physics of the BJT operation in the active mode.