Analog Circuit Design (ACD) – ECE520

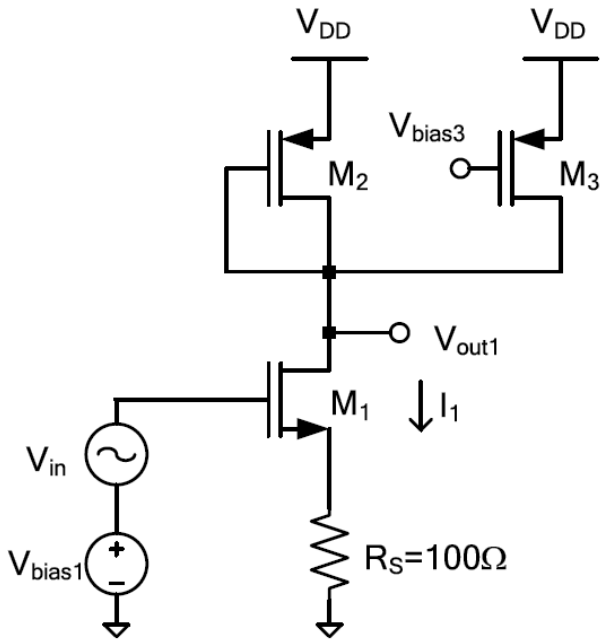
Home Assignment - 4

Total Marks: 10 Submission Deadline: 21.10.2013

Instructions:

- **Answer all the questions.**
- **Please adhere to institute's plagiarism policy.**
- **Submit before 5:00pm on the submission day. No late submission allowed.**

Q1. [3 marks] In the following circuit assume that all transistors are operating in the saturation region. Also, assume that $\lambda = \Upsilon = 0$, V_{DD}=1.8V, V_{bias3}=1.15V, V_{TN} = 0.4V and V_{TP} = -0.4V, $\mu_n C_{ox}$=800 $\mu A/V^2$, $(W/L)_1 = 40$, $\mu_p C_{ox}$=400 $\mu A/V^2$, $(W/L)_2 = 40$, $(W/L)_3 = 40$, and R_S=100Ω.



a) Find V_{bias1} such that the bias current of M_1 is I_1=1mA.

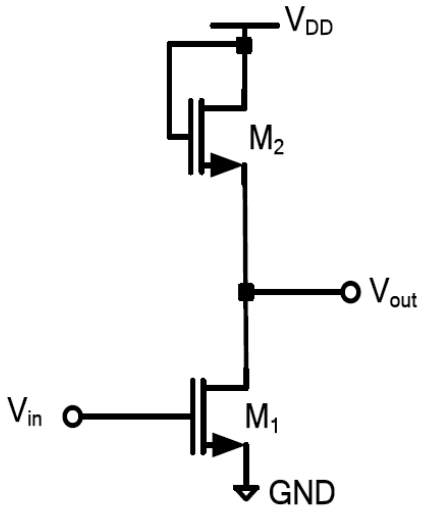
b) Calculate the small-signal voltage gain $A_{V1}=V_{out1}/V_{in}$.

c) Calculate the small-signal output impedance seen at the output node V_{out1}.

Q2. [4 marks] Design a common-source amplifier with a diode-connected load based on the schematic shown below with the following design specifications:

- Transistor M_1 is in saturation
- The minimum possible output voltage to keep M_1 in saturation is 0.2V
- Total power consumption of the amplifier is 3mW
- Both transistors have L=0.5µm and for transistor M_2 we have W_2=1 µm

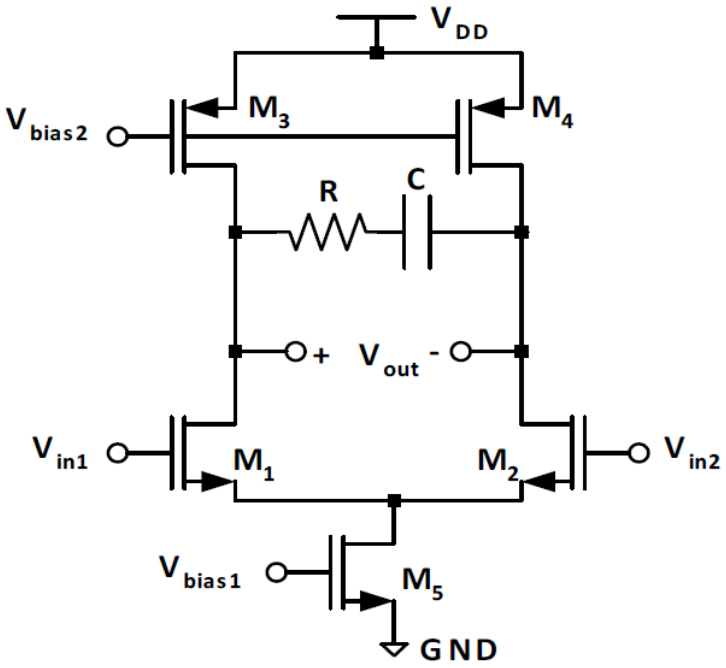
The technology parameters are: λ(NMOS) = 0, ϒ = 0, VDD=3V, VTN = 0.5V, $\mu_n C_{ox}$=1 mA/V2



Find the following values:

a) DC level of the input
b) DC level of the output
c) width (W1) of transistor M1
d) small-signal gain
e) Maximum output signal swing for a symmetric output signal.

Q3. [3 marks] In the following circuit assume transistors M_1 and M_2, and transistors M_3 and M_4 are identical and ϒ = 0: and λ ≠ 0:



a) Find the expression for the small-signal differential voltage gain [$V_{out}/(V_{in1}-V_{in2})$] of the circuit.
b) What is the gain of the circuit at very low frequencies?
c) What is the gain of the circuit at very high frequencies?