EE 230 NAME ______________________

Final Exam

Fall 2006

Instructions: There are 8 short questions and 8 problems. The points allocated to each of the questions are as indicated. The problems are all equally weighted with an assigned weight of 10 points each. All work should be included on the exam itself. Attach additional sheets only if you run out of space on a problem. Students may bring 6 pages of notes to the exam. Calculators are permitted but can not be shared.

Questions:

1. (2pts) What parameter of the operational amplifier specifies the maximum rate of change of the output voltage?

2. (2pts) Where are the poles of a circuit located if the circuit is to perform as a sinusoidal oscillator?

3. (2pts) What parameter of a MOS transistor plays the dominant role in determining the small-signal output conductance?

4. (2pts) If the + and – terminals of an op amp used in a basic noninverting feedback amplifier are interchanged, the resulting circuit will perform as a comparator with hysteresis. Sketch the transfer characteristics of this comparator.

.

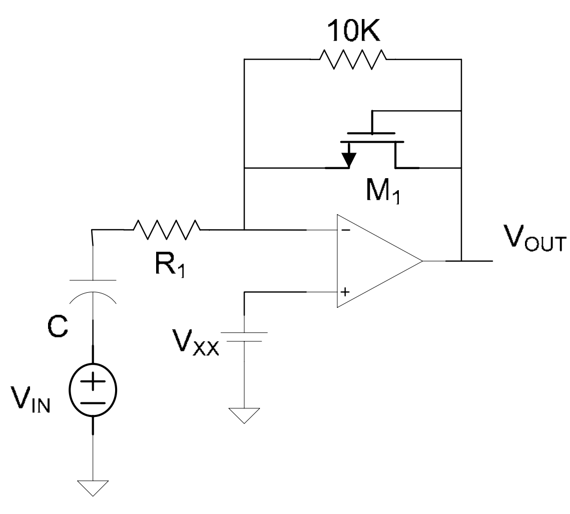
5. (2pts) Consider a signal $f(t)=A_1\sin(500t)+A_2\sin(1000t)+A_3\cos(2000t)$ where A_1, A_2 and A_3 are slowly varying variables. What is the minimum rate that this signal must be sampled at to have sufficient information in the samples to recover the signal?

6. (2pts) What is the ideal input impedance for the β network of a feedback amplifier if the feedback amplifier is a transresistance amplifier?

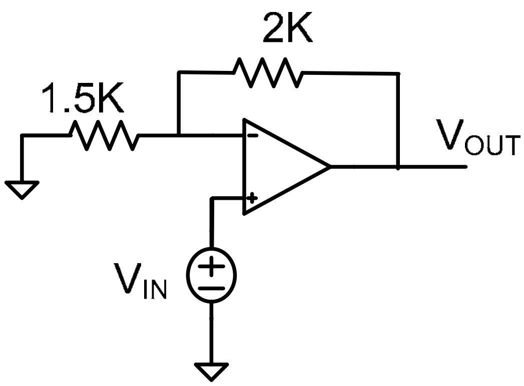
7. (2pts) There are several substantial benefits derived from using the feedback concept. Give two of the more significant benefits.

8. (2pts) The input port of an ideal operational amplifier is often termed a Null Port. What are the key properties of a Null Port?

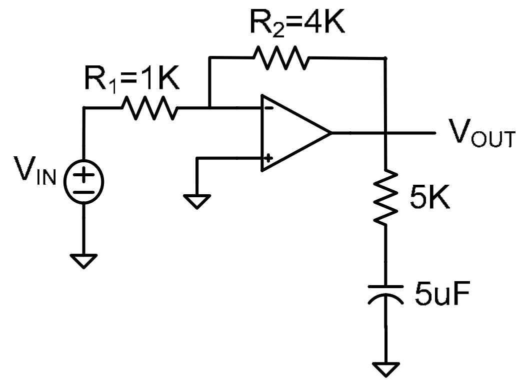
9. (4pts) Draw the small-signal equivalent circuit. Assume the MOSFET is operating in the saturation region, C is small, and that V_{IN} is a small-signal source.



Problem 1 Determine the 3dB bandwidth of the following circuits. Assume the GB of the op amps is 2MHz.



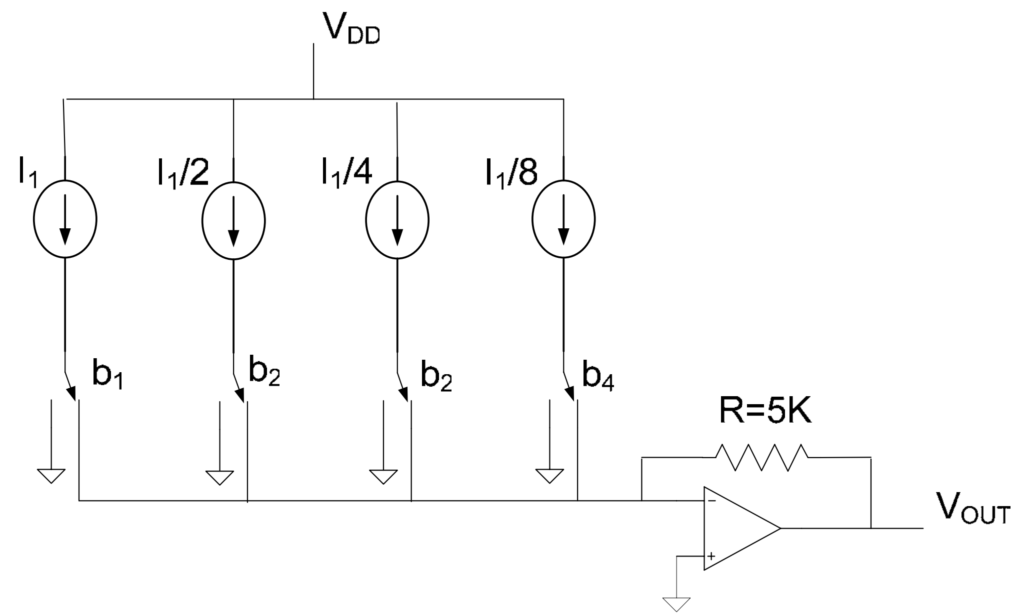
(a)



(b)

Problem 2 A current-steering DAC is shown. Assume the current source I_1 is 1mA and that the switches are controlled by the Boolean variables b_1, b_2, b_3, and b_4 and are in the right position when the corresponding Boolean variable is a "1".

a) What is the resolution of the DAC
b) What is an LSB of the output voltage?
c) Plot the transfer characteristics of this DAC explicitly showing all output voltage levels
d) What will be V_{OUT} if V_{IN}=**[0 1 0 1]** ?



Problem 3 A periodic signal was applied to a DAC and the output was sampled 2048 times at 1msec spacings over precisely 7 periods of the output. A DFT using the FFT was used to obtain the DFT of the sequence. The magnitude of the first 25 terms of the DFT, expressed in DB, are given in the table below. All remaining terms were smaller than -95dB.

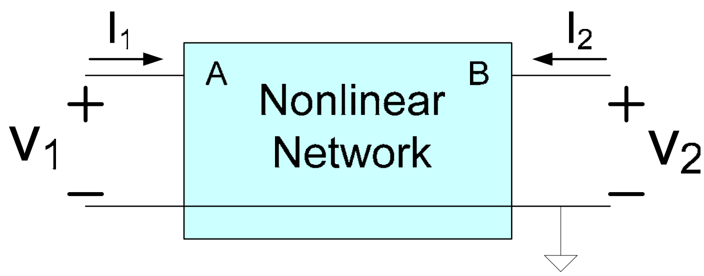
a) What is the magnitude of the signal?
b) What is the SFDR?
c) What is the THD?

Index No.	DFT (dB)	Index No.	DFT (dB)
1	-97.2	14	-99.2
2	-98.4	15	-18.0
3	-96.3	16	-95.6
4	-99.2	17	-97.4
5	-97.4	18	-97.2
6	-95.6	19	-98.2
7	-97.4	20	-99.4
8	3.0	21	-98.8
9	-98.2	22	-37.0
10	-99.4	23	-95.6
11	-98.8	24	-96.3
12	-98.8	25	-99.2
13	-96.3	26	-97.4

Problem 4 Assume the Nonlinear Network shown is characterized by the equations

$$I_1 = 2\sin\left(V_1\frac{\pi}{2}\right)V_2$$

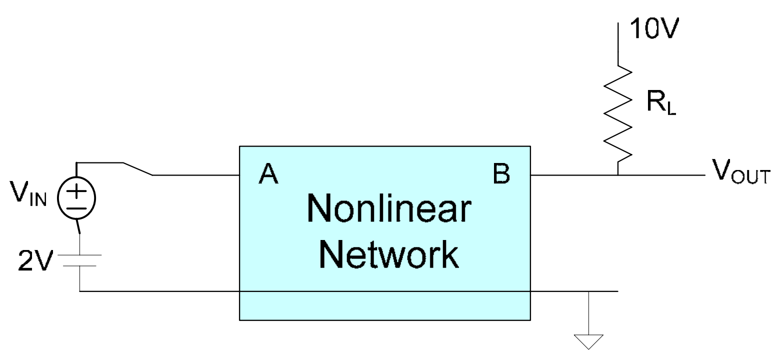
$$I_2 = \frac{V_1^3 V_2}{10}$$



a) Determine a small signal model for the device at the Q-point defined by the V_{1Q}=2V, V_{2Q}=0.25V

b) Draw a small-signal equivalent circuit

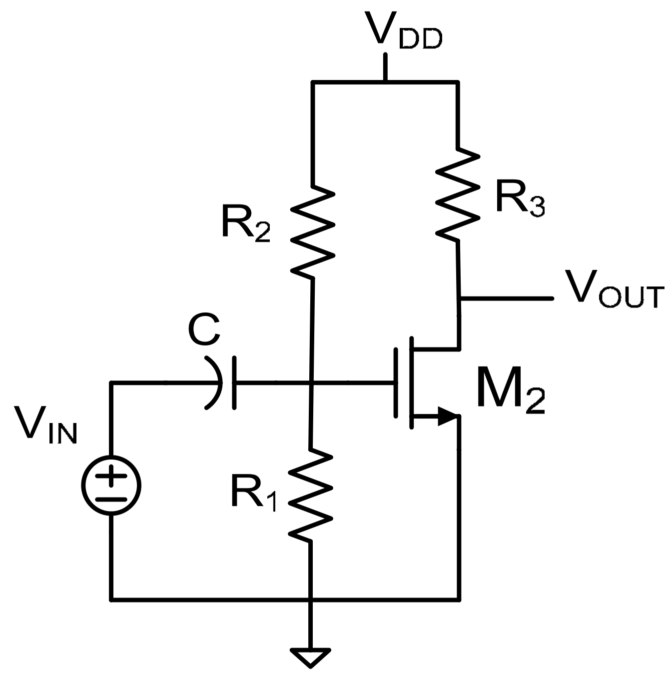
c) If this nonlinear network is connected in the circuit shown below, determine a parametric expression for the small-signal voltage gain in terms of the small-signal model parameters



(Provide Solutions on the Following Page)

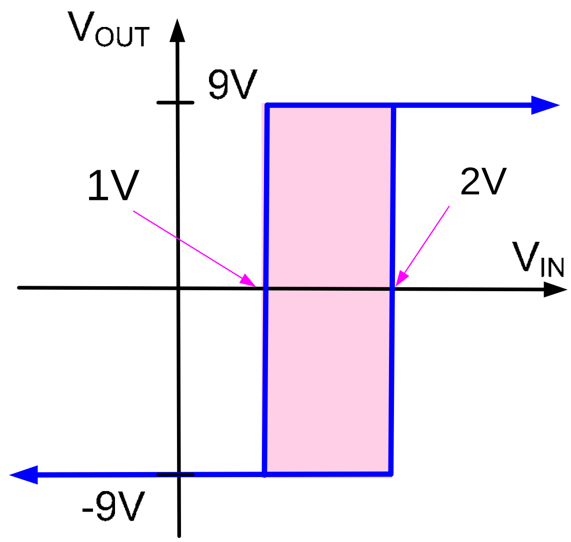
Solution for Problem 2 goes here

Problem 5 Assume the transistor is characterized by model parameters $\mu C_{OX}\frac{W}{L}=50\mu A/V^2$ and $V_T=1V$. Assume V_{IN} is a small-signal input given by $V_{IN}=.0.2\sin 10000t$, C is a small capacitor of value 100pF, $R_1=100K$, $R_2=200K$, $R_3=10K$ and $V_{DD}=15V$.



a) Determine the quiescent output voltage
b) Obtain a small-signal model for M_2 at the operating point determined by this circuit
c) Draw a small-signal equivalent circuit for the whole circuit.
d) Determine the sinusoidal steady-state output voltage.

Problem 6   Design a comparator that has the following transfer characteristics. You have available resistors, dc power supplies, and op amps for your design.

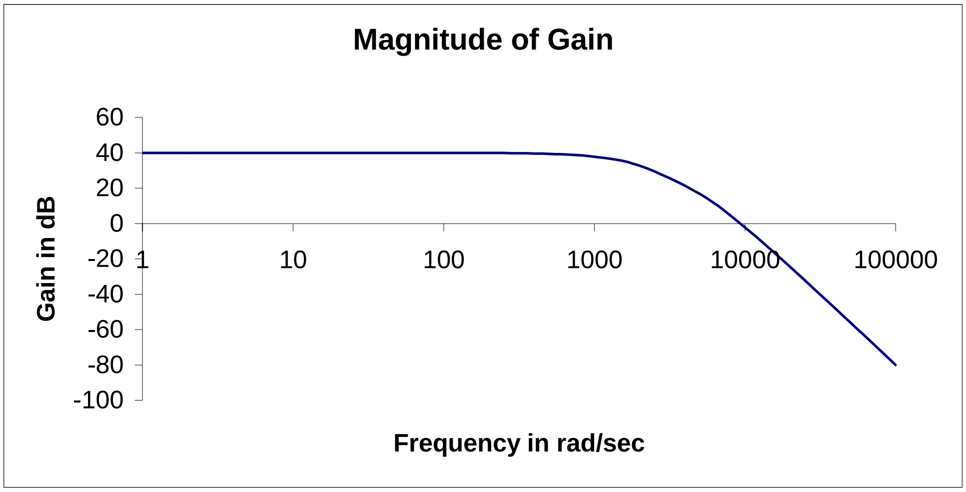


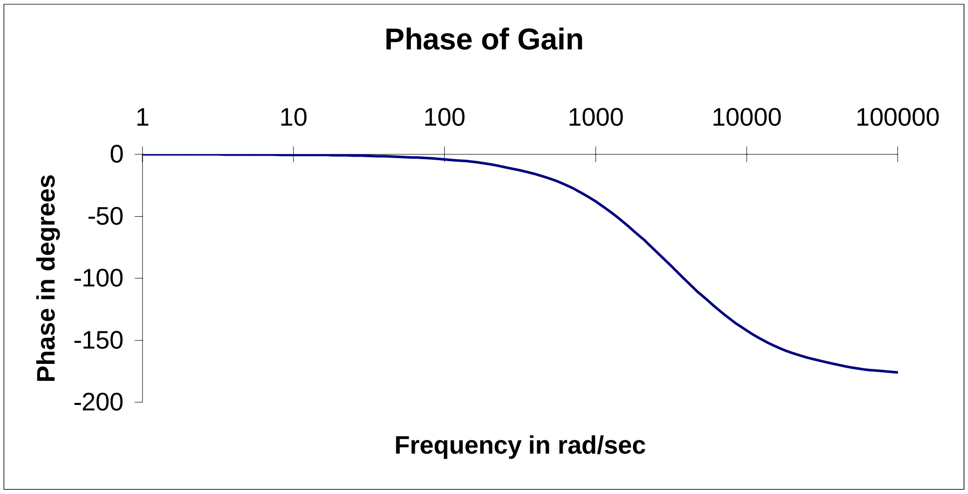
Problem 7 An amplifier that has a gain that has the transfer magnitude and phases shown. where the horizontal axis is in rad/sec.

a) Determine the half-power frequency of the amplifier

b) Determine the dc gain of the amplifier

c) Determine the steady-state response if the input is $V_{IN}=0.4\sin(4000t+30^{o})$





Problem 8 Obtain an expression for the output voltage for the following circuits. Assume the op amps and the diodes are ideal.