Electronics
EECE2412 — Spring 2013
Exam #2

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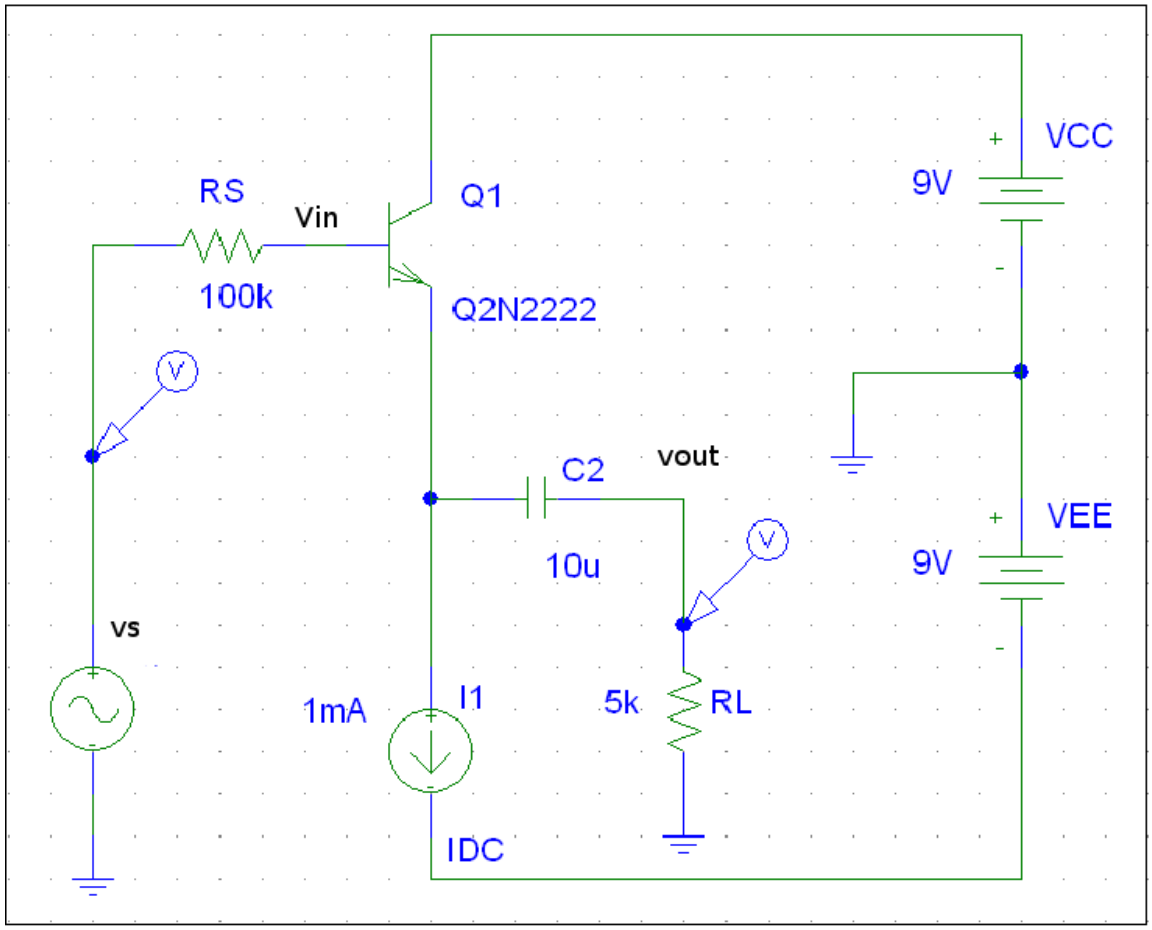
Name: _____ : Row # _____ : Seat # _____

General Rules:

- Write your name, row number, and seat number above. Row #1 is at the front. Seat #1 is to the left as viewed by the students.
- You may make use of one sheet of notes, 8.5–by–11 inches, using both sides of the page.
- You may use a calculator.
- Present your work as clearly as possible. I give partial credit if I can figure out that you know what you are doing. I do not give credit for putting down everything you know and hoping I will find something correct in it.
- Each question has a vertical black bar providing space for your work and a box for numerical answers. Please write your answer to each question clearly. If it happens to be correct, I give you points quickly and move on to the next problem. Please show your work in the space provided, or on extra pages, clearly labeled with the problem number. If the answer is wrong, this will make it easy for me to find ways to give you partial credit.
- Avoid any appearance of academic dishonesty. Do not talk to other students during the exam. Keep phones, computers, and other electronic devices other than calculators secured and out of reach.

1 BJT Amplifier

The following figure shows a BJT amplifier, which we are going to analyze. The transistor has $\beta = 160$, and $V_A = 100$ Volts. *RS* is part of the source. The input and output voltages are at the indicated locations, *vin* and *vout*, respectively.



1.1 Amplifier Type

What type of amplifier is it? _____

What is the typical situation in which this amplifier is used?

_____

_____

1.2 Small–Signal Parameters

What are the small–signal parameters?

$g_m =$ _____

$r_\pi =$ _____

$r_e =$ _____

$R_0 =$ _____

1.3 AC Circuit

Draw the AC circuit, using a T model for the transistor.

1.4 Amplifier Characteristics

What are the AC characteristics of this amplifier?

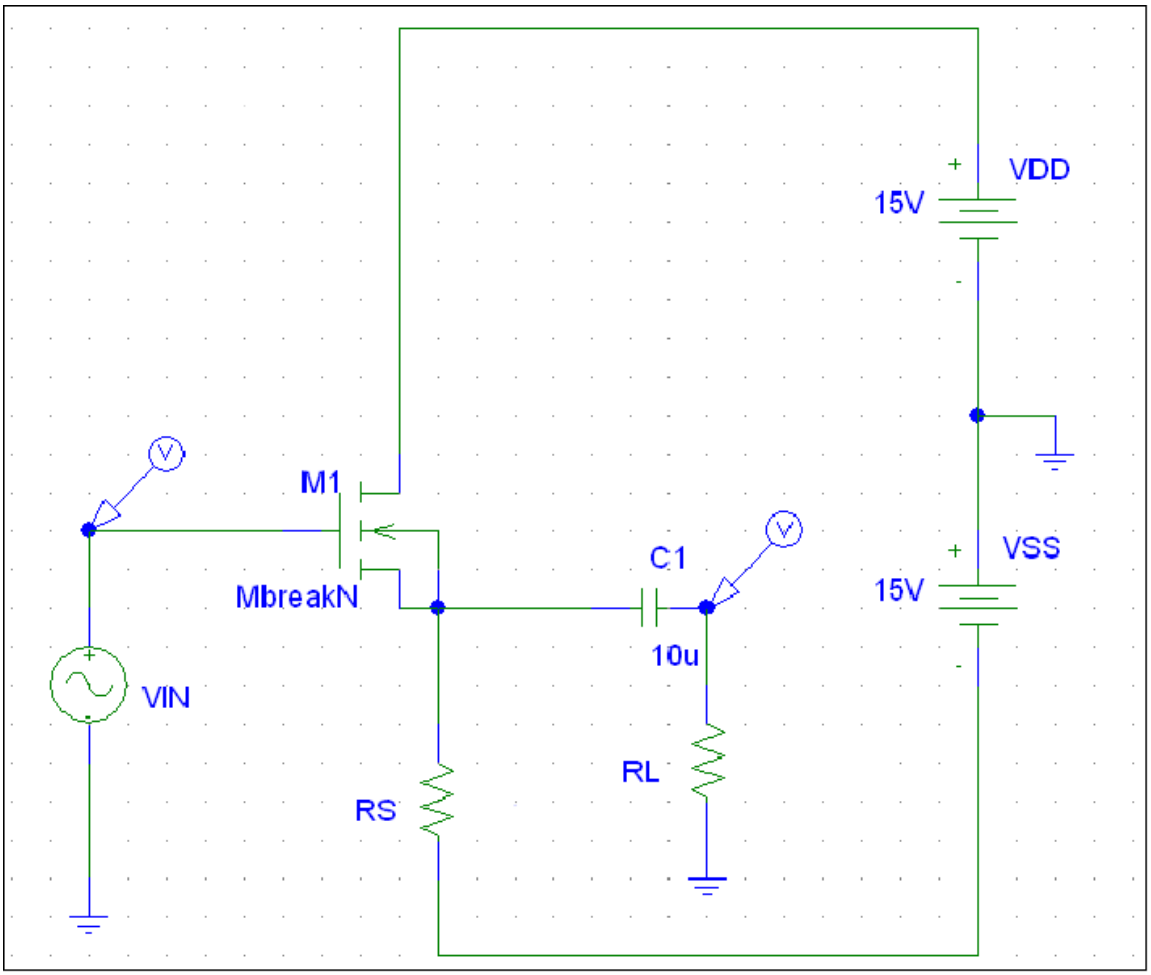
Voltage Gain (With Load) _____

Current Gain _____

Output Resistance _____

2 Discrete FET Amplifier

The following figure shows an amplifier using a discrete FET and a resistor. The transistor has a drain current of 250 μAmp when $V_{GS} = 5$ Volts, and the threshold voltage is zero. The Early Voltage is $V_A = 70$ Volts.



What type of amplifier is it? _____

What is the typical situation in which this amplifier is used?

_____

_____

_____

2.1 Circuit Design

We want a drain current of 250 μAmperes in this circuit. What resistance do we need for RS?

$R_S =$ _____

2.2 Small–Signal Parameters

What are the small–signal parameters?

$g_m =$ _____

$R_0 =$ _____

2.3 AC Circuit

Draw the AC circuit, using a Pi model for the transistor.

2.4 Amplifier Characteristics

What are the AC characteristics of this amplifier?

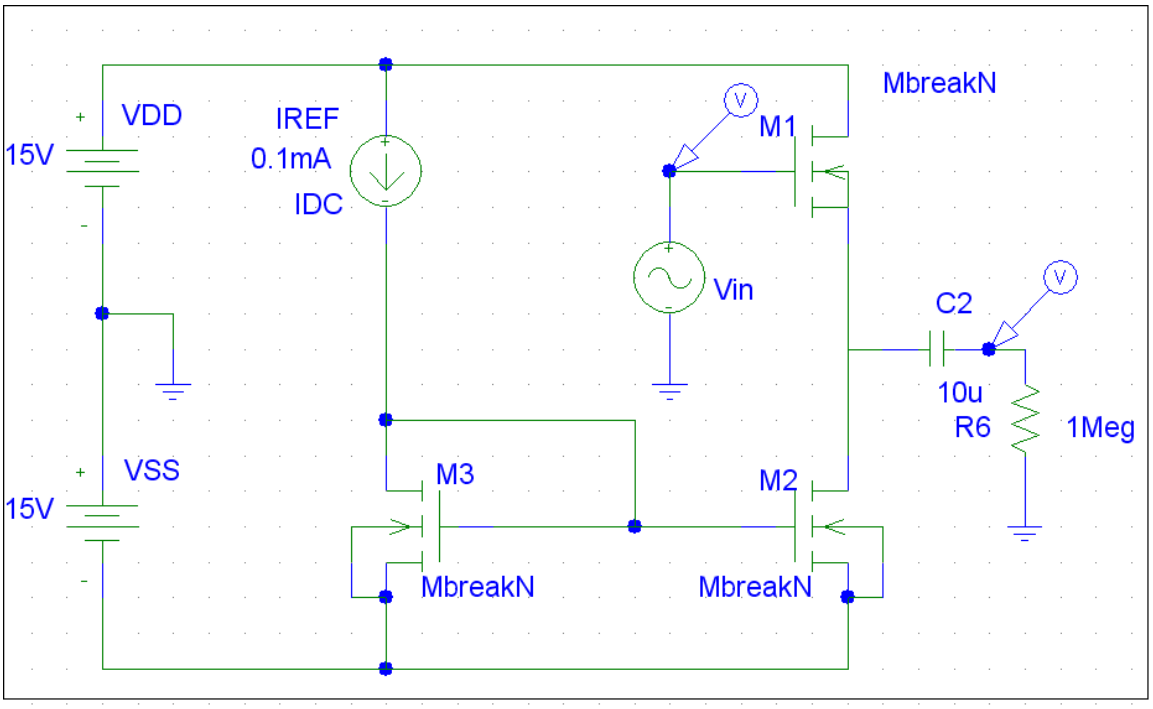
Open–Circuit Gain _____

Input Resistance _____

Output Resistance _____

3 CMOS Amplifier

The figure below shows a CMOS amplifier. The transistors are all the same, and have a drain current of 250 μAmp when $V_{GS} = 5$ Volts, and the threshold voltage is zero (This is the same as in Problem 2). However, in this case, $V_A = 100$ Volts.



3.1 Amplifier Type

What type of amplifier is it? _____

What is the typical situation in which this amplifier is used?

_____

_____

_____

3.2 Transistor Characteristics

What is the constant, $\mu_n C_{ox} W/L$ for this transistor?

3.3 Small–Signal Parameters

What are the small–signal parameters?

$g_m =$ _____

$R_0 =$ _____

3.4 AC Circuit

Draw the AC circuit, using a Pi model for the transistor.

3.5 Amplifier Characteristics

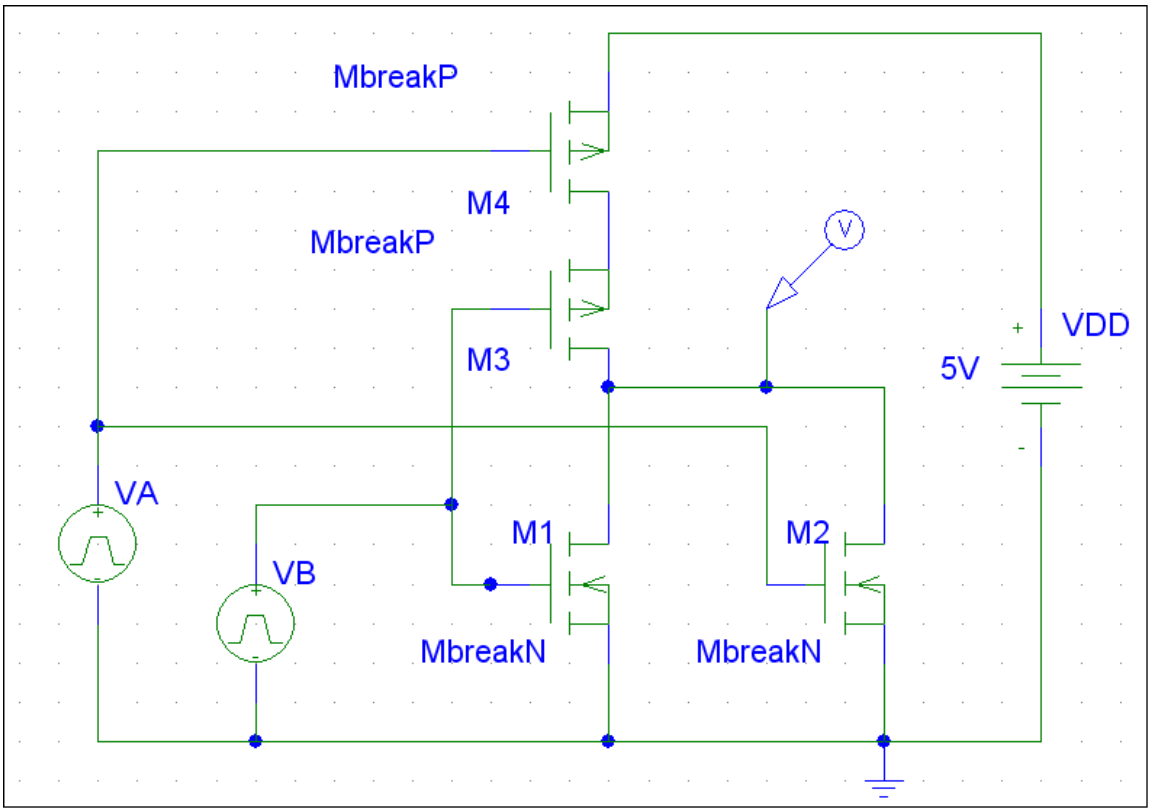
What are the AC characteristics of this amplifier?

Open–Circuit Gain _____

Input Resistance _____

4 CMOS Logic

The following figure shows a CMOS digital logic circuit. As usual, +5 Volts represents "true," and zero represents "false." There are two inputs, VA and VB, and one output, V_{out} at the voltage probe shown in the figure.



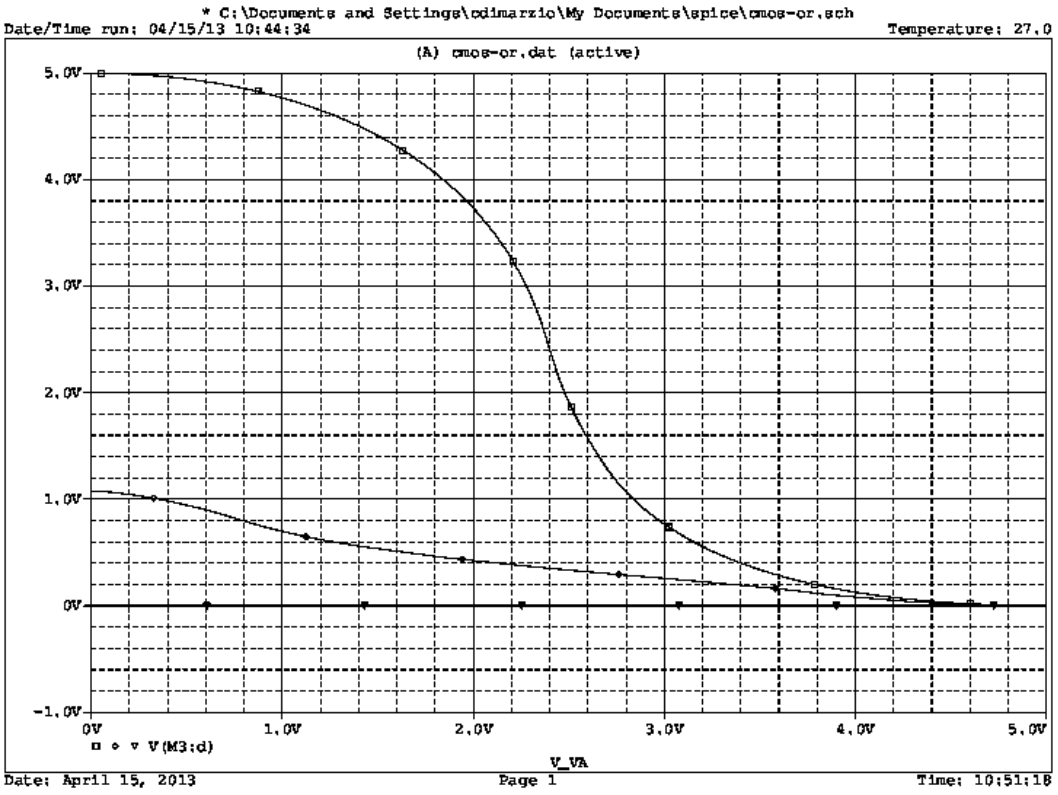
4.1 Truth Table

Construct the truth table for this circuit, for all possible combinations of inputs VA and VB being "true" or "false."

What is the function of this circuit?

4.2 Output Voltages

The following figure shows output voltage as a function of input voltage, VA. In the figure, the bottom curve (along the $V_{out} = 0$ axis) is for $VB = 5$, the next curve is for $VB = 2.5$ Volts and the top curve is for $VB = 0$ Volts. Explain these curves in terms of what you know about FETs.



4.3 Current

Draw a plot of the current, i_D as a function of VA for $VB = 5$ Volts. You don't need to provide a correct current axis, because I have not given you the transistor parameters.

4.4 Alternative Output

With the addition of two transistors at the output, you can convert this to either an "AND" or "OR" gate. Which one? Draw the additional circuit.

"AND" or "OR?" _____