American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics Fall 2011 – 2012

*Due Wednesday November 16, 2011 at 9:00 am*

**Homework 6**

**Problem 1. [25 points]**

1. [5 points] The mobility of electrons in the channel of an NMOS device is 1000 cm2/V.sec. Find the transconductance parameter *k*’n for this MOSFET if its oxide thickness is 7 nm.   
   The permittivity of the oxide (SiO2) is **ox =3.9**0 = 3.453×10–11 F/m.
2. [10 points] The threshold voltage *V*t0 for this NMOS transistor is 0.55 V. Find the required dimensions of the gate of the NMOS transistor (*W* and *L*) to get a drain current of 1 mA when the MOSFET is biased at (*V*GS = 3 V, *V*DS = 3 V). Minimize the area of the gate, but keep the minimum dimension (*L* or *W*) at 0.32 m.
3. [10 points] The drain current of this NMOS transistor is *I*D1 at (*V*GS = 3 V, *V*DS = 3 V). When *V*DS becomes 2.5 V while keeping other voltages constant, the current decreases by 3% to   
   0.97 *I*D1. Find the values of *V*A and *V*A’ for this transistor.

**Problem 2. [35 points]**

The circuit shown below is a *voltage-controlled attenuator*. Assume *V*GG = 2.5 V, *R* = 4.7 k,   
and for the MOSFET: *V*t = 0.55 V, *k*’(*W*/*L*) = 0.4 mA/V2.

1. [10 points] For what range of output voltages does the MOSFET behave as a (voltage-controlled) resistor? Assume that the square term is negligible when it is less than 3% of the linear term in the MOSFET current equation.
2. [15 points] Find the value of *V*OV = *V*GS – *V*t for the MOSFET and the value of its conductance *g*DS and resistance *r*DS when *v*O satisfies the condition of part (a).
3. [10 points] When the circuit satisfies the condition of part (a), plot the attenuation factor (*v*o/*v*s) as a function of *V*GG, for *V*GG in the range 0 V – 5 V.



**Problem 3. [40 points]**

Two identical enhancement MOSFETs with *k*’n(*W*/*L*) = 450 A/V2, *V*t = 0.55 V, and *VA*= 9 V   
are connected as shown below.   
The MOSFET drain current is 145 A. Assume that *V*DD = 12 V.

1. [10 points] Find the value of *V*GS for the lower MOSFET. In what region is this MOSFET operating?
2. [10 points] Find the voltage at the gate of the upper MOSFET. In what region is this MOSFET operating?
3. [10 points] Find the resistance *R*1 when *R*2 = 120 k.
4. [10 points] Find the power dissipated by the supply VDD.

