American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics Fall 2011 – 2012

*Due Wednesday November 30, 2011 at 9:00 am*

**Homework 7**

**Problem 1 [52 points]**

a) [32 points] Design the amplifier shown in the figure below to achieve a small-signal voltage gain *Av = vo/vi* of –10 for *RL* = 39 k, and to have *Rin* = 3 M.

Assume that the Q-point is chosen at *ID* = 0.2 mA and *VDS* = 3 V. Also, assume that *VDD* = 9 V, and that all capacitors are very large (and therefore, the capacitors have zero impedance at the signal frequency, but infinite impedance at DC.)

For the MOSFET, *Vt* = 0.8 V, *k*’(*W*/*L*) = 1.1 mA/V2 and  = 0.12 V-1.

For this amplifier circuit –

The input resistance is given by:

*R*in = *R*1 // *R*2

The small-signal voltage gain is given by:

 where  and *VOV* = *VGS* – *Vt* .



b) Find the largest possible input signal *vi(peak)* that results in:

* 1. Drain current becoming equal to zero [5 points]
  2. MOSFET entering linear: *vDS* becomes equal to *vOV* [5 points]
  3. Distortion: *vgs(peak)* is equal to 0.1×*VOV* [5 points]

What should *vi(peak)* be limited to in order to avoid all the above conditions? [5 points]

**Problem 2 [48 points]**

The MOSFET in the circuit has *V*t = 0.7 V, *k*’(*W*/*L*) = 1.1 mA/V2, and *V*A = 1/ = 22 V.



1. [24 points] Find the values of *R*S, *R*D, and *R*G so that *I*D = 0.4 mA, the largest possible value of *R*D is used while a maximum signal swing at the drain of ± 1.5 V is possible keeping the MOSFET in the saturation region, and the input resistance at the gate is 3 M.
2. [10 points] Find the values of *VDS, VGS, VOV*, *g*m and *r*o for the MOSFET at the bias point.
3. [10 points] If the amplifier input (at the gate) is connected to a source with a 39 k source resistance, and to a load (at the drain) with a resistance of 120 k, find the voltage gain and the power gain from *signal* source to output.
4. [4 points] How can you increase the voltage gain of the amplifier without disrupting the bias conditions?