File: G/coursesS19/303/303S19Midtrm_supplement.doc RWN 04/10/19

ENEE 303 Spring 2019 – Midterm Exam Supplement – take home.

Due in class Thursday April 18, 2019

Open book open notes. Your signature insures that the work submitted is solely your own. Good luck

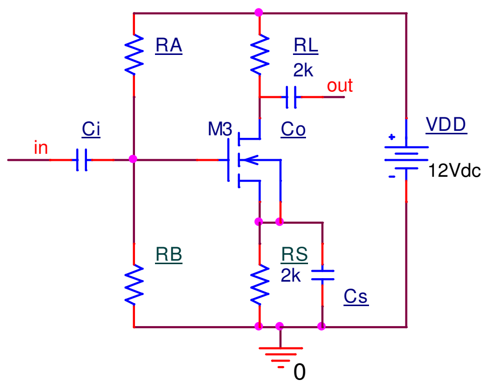
1. (40 points, 20 min; NMOS bias & gain)

Assume $KP=0{,}02mA/V^2$ [for $k=(KP/2)(W/L)$], VTO=1V, **λ=0.01**, for the following NMOS amplifier. Also assume RL=RS=2kOhm and RA = RB

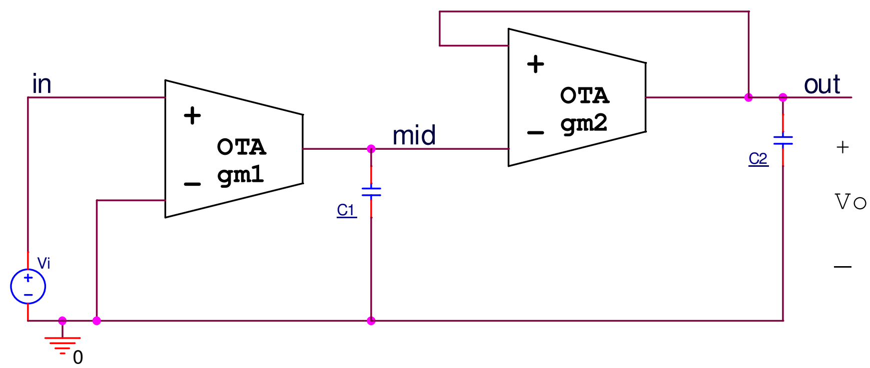
a. For I_D=1mA find W/L and with it the Q point (bias) values for V_{GS} and V_{DS} and check that the transistor is in saturation.

b. Determine gm and go.

c. Draw the mid-band gain small signal equivalent circuit and give the mid-band voltage gain $Av = v_{out}/v_{in}$ (where voltages are measured with respect to ground and the capacitors are assumed shorts) [include RA & RB].



2. (30 points, 10 min; OTA circuit gain and ODE)



a) For this circuit give the voltage transfer function $A_v(s)$ and give the poles and zeros.

b) Give the differential equation relating $v_o(t)$ to $v_i(t)$

3. (30 points 10 minutes; Small signal parameters)

The FIN-FET is a new transistor being considered for quantum systems. An N-type FIN-FET with n fins has the same circuit symbol and is like an NMOS (with no gate current and bulk tied to source) but has the n-power law (n=number of fins, any positive real $n \geq 1$ but normally an integer).

Off: $i_D=0$ for $v_{GS}-Vth<0$

And for $v_{GS}-Vth \geq 0$

Saturation: $i_D=k(v_{GS}-Vth)^{(n)}(1+\lambda v_{DS})$ for $v_{DS} \geq (v_{GS}-Vth)$

Triode: $i_D=k([2(v_{GS}-Vth)^{(n/2)}(v_{DS}^{(n/2)})]-v_{DS}^{(n)})(1+\lambda v_{DS})$ for $v_{DS} \leq (v_{GS}-Vth)$

a) Show that there is a number of fins, n, for which the FIN-FET behaves like an NMOS transistor

b) For a FIN-FET with n=4 fins and k=1nanoA/V^4, VGS=1.1, Vth=0.1V, λ=0.01, VDS=0.1V, give its gm and go and draw the low frequency equivalent circuit.