File: E:/courses/spring2006/303/hmwrk5.doc RWN 03/28/06c - 04/10/06

Homework Set 5 due Monday ~~April 10, 2006~~ April 17, 2006

1. [50 points]

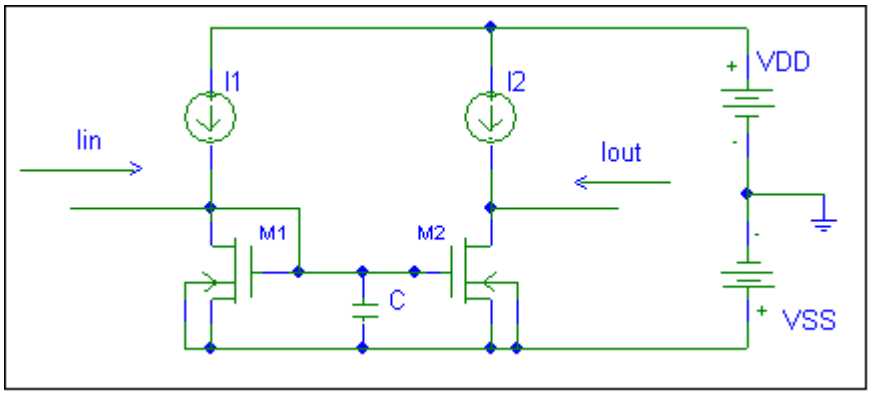
   A) Design three ring oscillators, one each for 3, 5, 7 sections of inverters. Use the 1.2u level 3 AMI (MOSIS) transistors. For this set the minimum W and L to 7u and adjust the inverter sections so that zero input gives zero output [use VDD=-VSS=5V]. Compare their frequencies of oscillation and their waveforms. Compare your results with those given on page 1027 of the text and discuss differences (including frequency calculations vs simulated).

   B) Repeat by inserting a 1NanoFarad load capacitor (to ground) for each inverter.

2. [50 points]

   The following circuit is proposed in the literature [reference below, p, 411, Fig. 4] to be a current-mode low pass filter with transfer function

$$\frac{i_{out}(s)}{i_{in}(s)} = \frac{1}{(\frac{C}{g_m})*s+1}$$



   A) Show that this is the case by expanding about the bias point set by the two DC current sources. In so doing give g_m in terms of circuit parameters. What is the assumed M1 versus M2 ratios of W/L?

   B) Cascade two of these and give the resulting transfer function in the form

$$\frac{i_{out}(s)}{i_{in}(s)} = \frac{k}{s^2+[\frac{\omega_o}{Q}]s+\omega_o^2}$$

   Evaluate Q and ω_o in terms of C1, C2, gm1, gm2 (the two stage parameters) and in so doing show that this cascade can not realize any degree two low-pass filter; give the possible Q which can be obtained.

   C) Introduce feedback into the cascade of B) and show how any low pass filter can be obtained to within a gain constant. How can k>1 and k<-1 be obtained?

Reference: M. Siripruchyanum, "A Low-Voltage, Low-Power Current-mode Automatic Gain Control (AGC) for Battery-Powered Equipment," Proceedings of the Third IEEE International Workshop on Electronic Design, Test & Applications, Kuala Lumpur, January 2006, pp. 410 – 413.