

ENEE 610
Homework Problems for Grading, Set 1 (100 points)
Due at class W 09/13/06
PSpice for Relaxation Oscillations and CMOS inductor

1.(50 points)

The following circuit appears as Fig. 1 in the reference [1.1, p. 687] along with the accompanying equations when $C_2=0$.

- a) Rewrite the equations when $C_2>0$.
- b) Set up your rewritten equations in PSpice. For $u_0\text{sign}(z(t))$ use an Evalue component with gain $V_{dd}*\tanh(Z*z(t))$ with Z very large, say one to ten million [here V_{dd} is like the + bias on a comparator with its - bias at $-V_{dd}$]. Choose $C_1=1\mu\text{F}$ and $R_1=1\text{K}\Omega$, $R_2=R_3=10R_1$, $V_{dd}=5\text{v}$ and C_2 as a parameter (investigate cases with C_2 small, 1pF , and comparable to C_1).
- c) Submit your PSpice circuit showing on it as much information as possible along with typical Probe results illustrating the relaxation oscillation.

Reference:

[1.1] A. Brambilla, P. Maffezzoni, and G. S. Gajani, "Computation of Period Sensitivity Functions for the Simulation of Phase Noise in Oscillators," IEEE Transactions on Circuits and Systems - I, Vol. 52, No. 4, April 2005, pp. 681-694.

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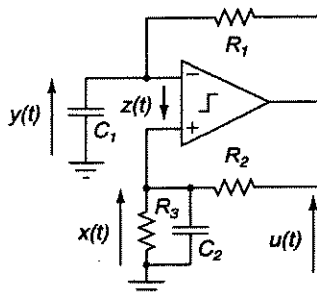


Fig. 1. Schematic of a relaxation oscillator. The comparator is assumed to be ideal.

Consider the relaxation oscillator circuit shown in Fig. 1. We suppose that the value of C_2 is arbitrarily close to 0, so that it can be neglected, and that the comparator is ideal [10], [23]. The dynamics of the relaxation oscillator is modeled by

$$\begin{cases} \frac{dy}{dt}(t) = -\frac{1}{C_1 R_1} y(t) + \frac{1}{C_1 R_1} u(t) \\ u(t) = u_0 \text{sign}(z(t)) \\ z(t) = \frac{R_3}{R_2 + R_3} u(t) - y(t). \end{cases} \quad (41)$$

2. (50) points

The following circuit appears as a CMOS active inductor in reference [2.1, p. IV-149].

- Draw the small signal equivalent circuit for this including C_{gs} , C_{gd} , g_m and g_o of the transistors.
- From the equivalent circuit find the input impedance, $z(s)$, in terms of literal C's and g's.
- Using MPMOSIS transistors with $I_{b1}=I_{b2}=1\text{ma}$, $W=L=10\mu$, evaluate all the values in the equivalent circuit.
- Run an AC analysis using PSpice for the full circuit with the transistors of c) and discuss the nature of this as an "active inductor."

Reference:

[2.1] Y. Wu, M. Ismail, and H. Ollson, "A Novel CMOS Fully Differential Inductorless Bandpass Filter," Proceedings of the IEEE International Symposium on Circuits and Systems (ISCAS), Geneva, May 2000, pp. IV-149 - IV-152.

