Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.776
High Speed Communication Circuits
Spring 2005

Homework #6: Oscillator Phase Noise and Power Amplifiers
Passed Out: April 14, 2005 Due: April 28, 2005

Reading: Chapters 15 and 18 of Thomas H. Lee's *second* edition book (OR Chapters 13 and 17 of Thomas H. Lee's *first* edition book). Note that, in the case of these two chapters, you are much better off using the second edition book if at all possible.

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1. The following problem focuses on analysis of the linearized oscillator model shown in Figure 1. It is assumed, for simplicity, that both of the current noise sources are white, and that the comparator is ideal (i.e., has infinite slope at its transitions, and no internal noise sources).

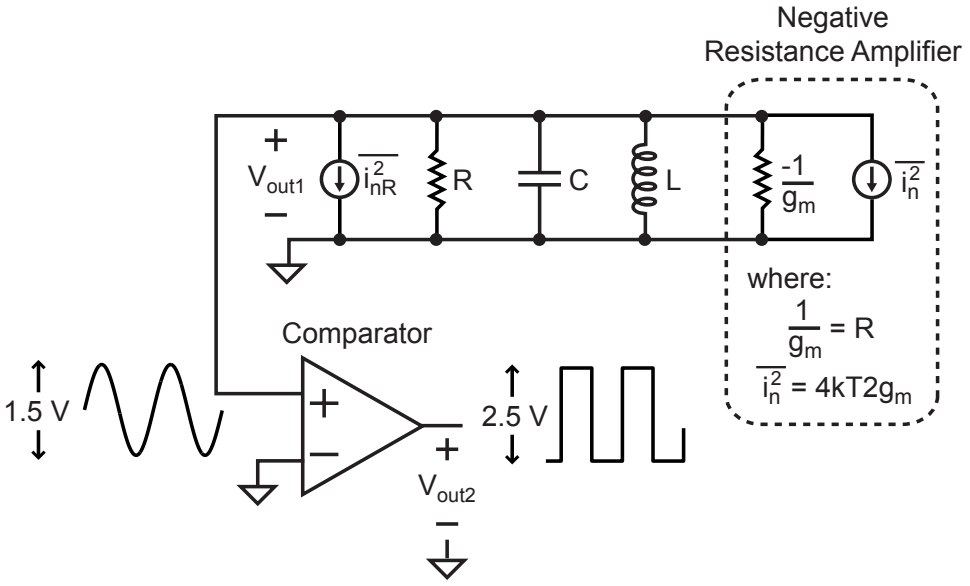

Figure 1: Linearized model of an oscillator feeding into a comparator.

(a) How does the noise of the tank effective resistance, R, compare to that of the amplifier? Do you think this observation will hold over a wide range of LC oscillators?

(b) How does the phase noise of V_{out1} compare to the phase noise of V_{out2}?

(c) Derive an expression for the phase noise spectrum of V_{out1} using Leeson's approach.

(d) Re-derive the expression for the phase noise spectrum of V_{out1} using the LTV (linear, time-varying) analysis method described in Chapter 17 of Thomas Lee's first edition book (Chapter 18 of his second edition book). In your calculation, assume that the oscillation waveform and ISF are sinusoidal and that the noise sources are stationary.

(e) Compare your answers and provide an explicit expression for F, the Leeson fitting parameter, based on its use in Equation 13 of Chapter 17 of the first edition book (Equation 19 of Chapter 18 of the second edition book), for the linearized oscillator model.

2. Problem 3 of Chapter 13 in Thomas Lee's *first* edition book
   OR Problem 3 of Chapter 15 in his *second* edition book.

3. Problem 6 of Chapter 13 in Thomas Lee's *first* edition book
   OR Problem 6 of Chapter 15 in his *second* edition book.

4. Problem 7 of Chapter 13 in Thomas Lee's *first* edition book
   OR Problem 7 of Chapter 15 in his *second* edition book.