Additional end-of-chapter problems for Chapter 27 – Nonlinear Analog Circuits

*CMOS: Circuit Design, Layout, and Simulation*

**A27.1** Show that the positive feedback decision circuit in Fig. 27.4 can have an unintentional hysteresis because of MOSFET mismatches. Further show that this hysteresis can be asymetrical. Use SPICE to verify your hand calculations. Note this is an important concern with using the comparator to regenerate full logic levels (in, for example, a PLL or DLL as seen in Sec. 19.6). Offsets in the positive feedback circuit can result in skew, when asymmetrical hysteresis is present, in digital signals.

**A27.2** Add an offset (say a 50 mV DC voltage source in series with one of the MOSFET’s gates) into the positive feedback portion (not the devices with their gates tied to the clock signal) of the clocked comparator seen in Fig. 27.16. Show, using simulations, that for small differences in the comparator’s input signals, that the comparator functions incorrectly.

**A27.3** Show, using simulations, that the gain of the clocked comparator in Fig. 27.16 can be increased by increasing the lengths of the PMOS and NMOS devices used in the positive feedback latch that have their gates connected to the clock signal.

**A27.4** Design (using the 1 m long-channel process) and simulate the operation of the adaptive voltage follower in Fig. 27.21. Comment on the benefits and drawbacks of using this topology. Use the simulation results to support your comments.

**A27.5** Design (using the 1 m long-channel process) and simulate the operation of the multiplier seen in Fig. 27.28. Comment on the limitations of the allowable input signal swings.

**A27.6** The equations describing the operation of the multiplier circuits seen in Sec. 27.3 where derived using the long-channel square-law equations. Will the multipliers still function correctly if this isn’t the case? Use the 50 nm short-channel process, and simulations, to verify your answers. Will the circuits behave as multipliers if we assume small-signal operation where the only valid equation we have is . Again, using simulations to verify your answers.