Chapter 1 Introduction to ADCs and DACs

1.1. Determine the number of quantization levels needed if one wanted to make a digital thermometer that was capable of measuring temperatures to within 0.1 °C accuracy over a range from -50 °C to 150 °C. What resolution of ADC would be required?

1.2. A digitally programmable signal generator uses a 14-bit DAC with a 10-volt reference to generate a DC output voltage. What is the smallest incremental change at the output that can occur? What is the DAC's full-scale value?

1.3. Determine the maximum DNL (in LSBs) for a 3-bit DAC. What is the ideal resolution of this DAC?

Digital Input	Voltage Output
000	0 V
001	0.625 V
010	1.5625 V
011	2.0 V
100	2.5 V
101	3.125 V
110	3.4375 V
111	4.375 V

1.4. Repeat the problem above to calculate INLs (in LSBs).

1.5. For a 4-bit SAR ADC, VREF for the DAC is 10 V, Vin at a moment is 6V. Show all the states of the ADC’s output in a state diagram.

1.6. Hand-draw the register-level schematic of a 4-bit SAR register and explain the operation procedure.

1.7. Design a master-slave DFF with set and reset functions in LTSpice. (use the 1um technology). The 'models.txt' file can be found on the course website.

1.8. (a) Use Superposition and Thevenin's equivalent circuit theory to verify the LSB of the following R-2R DAC is $VDD/2^N$. (b) If the digital input is 10101, find the analog output use Superposition and Thevenin's equivalent circuit theory.