HW9, Due time: Friday 4/12 in class.

1. Finish the in-class example by hand. A unipolar 4-bit ADC has Vref =15V and transition voltages Vtran ={1.5473 3.1903 4.2564 4.7504 5.2595 5.9200 7.3970 8.0530 9.4930 10.133 11.734 12.524 13.100 13.751 14.914 }. Determine this ADC’s ideal LSB, offset and gain error in units of ideal LSBs, code bin intervals for each code, code bin width for each code, actual LSB, DNL\_k, INL\_k, DNL, and INL. Bonus worth ½ problem: plot the noise free transfer curve of this ADC, with analog input from -1 V to 16V as horizontal axis and digital codes as vertical axis.
2. Write a Matlab function [Vos, Gerror, DNLk, INLk, DNL, INL, mono\_flag] = DAClinearity(Vrefp, Vrefn, Vout). The meanings of the three inputs and 7 outputs are self-explanatory. This function should work for unipolar (Vren=0, Vrefp>0), bipolar (Vrefp = - Vrefn >0), and general shifted range (Vrefp > Vrefn, but signs and values arbitrary). The number of levels is equal to the number of elements in Vout and is not necessarily a power of 2. The input codes are sequential and ranges from 0 to length(Vout)-1. Ideal LSB = (Vrefp-Vrefn)/length(Vout). The “mon\_flag” is string of either ‘monotonic’ or ‘non-monotonic’.
3. Write a Matlab function [Vos, Gerror, DNLk, INLk, DNL, INL, mono\_flag] = ADClinearity(Vrefp, Vrefn, Cout, Vtran). The meanings of the four inputs and 7 outputs are self-explanatory. The values in Vtran is non-decreasing, i.e., Vtran(k+1) >= Vtran(k). Cout is a vector of integers. Two adjacent values are always different, but may not always increase with index. Length(Cout) is one more than length(Vtran). Ideal LSB = (Vrefp-Vrefn)/{max(Cout) – min(Cout) +1}. The “mono\_flag” is string of either ‘monotonic’ or ‘non-monotonic’.
4. (Bonus) Write a Matlab function [DNLk, INLk, DNL, INL, missing\_codes] = ADCRHT(H). The meanings of the first four outputs are self-explanatory. H is a vector containing integers. H(k) is the number of hits for ADC output coke k-1. That is H(1) is the number of hits for code 0. RHT stands for ramp histogram test. A slow, perfectly linear ramp input is applied. The ADC output is sorted by the code and the number of hits for each code is the histogram count. Length(H) equals the # of distinct codes of the ADC. Some hits may be 0 if the corresponding code is missing from the output. The fifth output then should contain a list of all those codes that are missing. If none missing, it is an empty vector.
5. 15.2
6. 15.3
7. 15.6
8. 15.11
9. 15.17
10. 16.16 (bonus)