Problem Set 1

January 22, 2015

1

1.1

(3 points) Figure 1a is the transfer characteristic of an amplifier. If it has an input referred noise density of $NkT\Delta f$ (in units of V/Hz$^{0.5}$), what is its dynamic range? Assume it is a first-order system with a bandwidth of ω.

1.2

(3 points) Figure 1b is the transfer characteristic of an ADC. What is it's dynamic range?

1.3

(4 points) If the amplifier's output is connected to the ADCs input, what is the dynamic range of the composite system? Assume that $\sqrt{NkT\omega} = V_{i,sw}/20$.

2

2.1

(3 points) Find the half-power bandwidth of each of the structures in Figure 2 if a signal is injected at node x and the output is measured at node y.

2.2

(3 points) If a digital system were sampling node y, what would the throughput of the digital system need to be for real time processing of the samples without any loss of information? Assume the signal is "band-limited" by the bandwidth you found in the first part of this problem.

2.3

(4 points) For each circuit, find the total noise at node y if a noise voltage source of value $v_n^2 = NkT\Delta f$ is attached between node x and ground. Treat the resistors in circuits i and iii as "noisy" and treat the resistor in circuit ii as ideal.

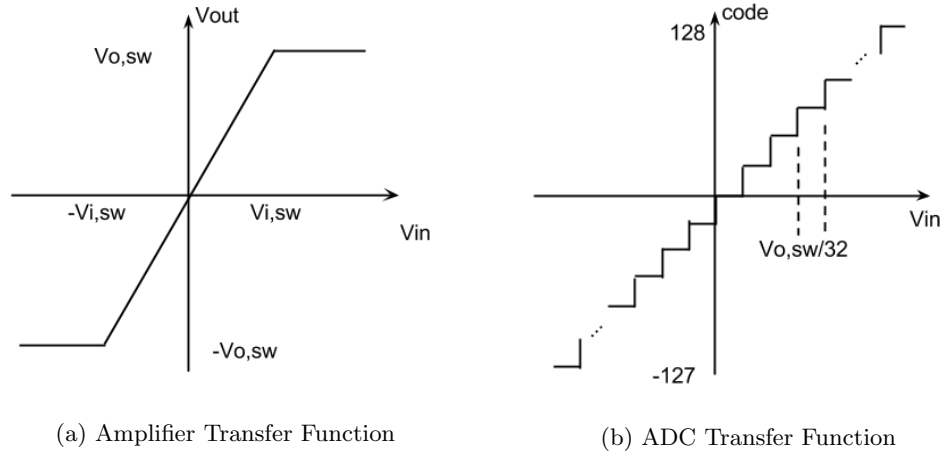(a) Amplifier Transfer Function   (b) ADC Transfer Function
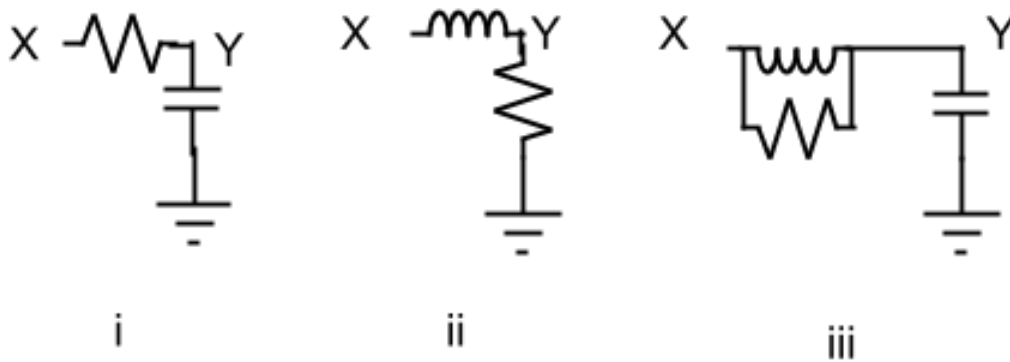
Figure 1: Transfer functions for dynamic range calculation

Figure 2: Noise and Bandwidth Circuits.