Sheet 2
DAC and ADC

Problem (1)

Design a 3-bit DAC with a step-size of 1 V assuming a logic system where 5V is the logic high. What would be the output voltage range for this DAC?

Problem (2)

a) How many resistors would be required for a 16-bit Flash ADC?
b) How many comparators would be required?

Problem (3)

Design a 2-bit Flash ADC for an input voltage range of 5V. You can leave the encoder as a block.

Problem (4)

An 8 bit DAC has a reference of 5.12 V.

a) What is the voltage step size (1 LSB)?
b) The digital input is 0100 1000. What is the analog output? (Assume it is a "perfect" DAC.)

Problem (5)

a) A 12 bit ADC has a "full scale" voltage of 10.24 V. What is the resolution of the ADC (in terms of voltage not bits)?
b) The above ADC has a voltage of 2.000 V applied to the input. What is the digital output?

Problem (6)

a) You want to digitize a signal that has frequency components up to 15 kHz, i.e. from 0 Hz to 15 kHz. What is the minimum sampling rate?
b) What is the maximum conversion time the converter can have in order to digitize this signal, i.e. satisfy the Nyquist sampling theorem.
c) The above signal has a dynamic range (voltage) of 2,000 (66 dB), i.e. you want to measure it to 1 part in 2000. What minimum resolution (in terms of bits) does an ADC need in order to handle this dynamic range?
d) What minimum resolution (in bits) is needed if the dynamic range is 80 dB, i.e. 1 part in 10,000? Will a 14 bit ADC be able to do this?

Problem (7)

Given a 14-bit ADC, determine the number of comparators required for the flash technique, and the number of comparisons required if successive approximation technique is used.

Problem (8)

a) A single 16-bit ADC with sampling rate of 10 kHz is connected to a PC. Determine the data rate in bytes per second.
b) If the PC has 350 k bytes of RAM available for data storage, how much time does this represent?

Problem (9)

A 12-bit 2 μs DAC is used as part of a discrete successive approximation ADC. Assuming that logic delays and signal settling times are negligible, determine the minimum time allowable between sample points, and the maximum input signal frequency without aliasing.

Problem (10)

An 8-bit ADC produces a full scale output of 11111111 with a 2V input signal. Determine the output word given the following inputs: 100 mV, 10μV, 0V, 1.259V (Assume that this converter rounds to the nearest output value and is unipolar).

Problem (11)

Determine the maximum conversion time for an 8-bit ADC using flash, successive approximation, and staircase techniques respectively.

Problem (12)

Predict how the operation of this "flash" analog-to-digital converter (ADC) circuit will be affected as a result of the following faults. Consider each fault independently (i.e. one at a time, no multiple faults):

a) Resistor R_{16} fails open:
b) Resistor R_1 fails open:
c) Comparator U_{13} output fails low:
d) Solder bridge (short) across resistor R_{14}:

For each of these conditions, explain *why* the resulting effects will occur.