Jonathan W. Valvano February 27, 2009, 10:00 to 10:50am

(30) Question 1. A file system using **contiguous allocation** and files are never deleted.

(10) Part a) The key information in this question is that files will never be deleted; therefore there will never be gaps/holes in the disk, like the one shown in the Fall 2006 Quiz 1 Question 3. Because there are no gaps, this file system has no external fragmentation. In the picture there are 243 free blocks, representing 243*32=7776 free bytes that could contain data. We could create one file containing all 7776 bytes.

(5) Part b) The average number is 1 more read, the maximum number is 1 more read. This is because once we have the directory and the relative address within the file, we can calculate which block the data is in.

(5) Part c) Place an 8-bit free block counter in the directory, defining the first available free block. In the picture shown, this counter would equal 13 because blocks 13-255 are free. An empty disk has the counter at 1. If the counter is 0, the disk is full.

(5) Part d) Each directory entry is 4 bytes (1 for name, 1 for first block and 2 for size). There is one byte for free space, so (32-1)/4 = 7 files.

(5) Part e) Because the file size is random and complete blocks are allocated, on average 16 bytes are wasted for each file. Assume you have **n** files each with of random size. Wasted space due to block size is 16**n**. There are 32 bytes in the directory, so total wasted space is 16**n**+32.

(20) Question 2. The sampling rate is 100 Hz. H = (z-1)/(z- ¾)

Part a) This is a high pass filter, blocking DC (f=0). I didn't ask for the specific gain values, but gains are easy to calculate. The gain at 0 Hz needs z = 1,

H(1) = (1-1)/(1- ¾) = 0, gain is 0

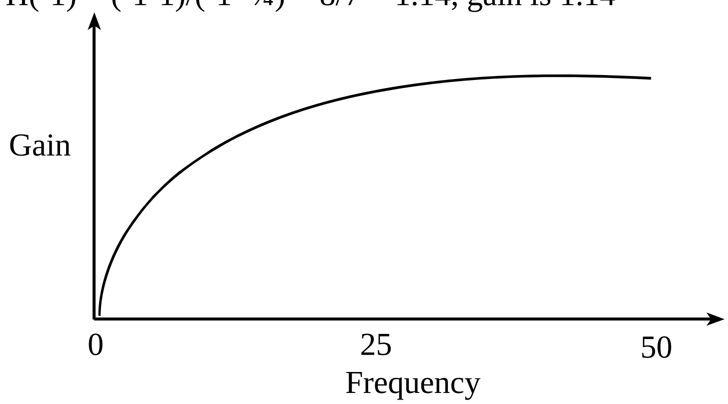
The gain at 25 Hz needs z = j,

H(j) = (j-1)/(j- ¾) = (j-1)*(j+ ¾)/[(j- ¾)/(j+ ¾)] = (-1 - ¼j - ¾)/(-1- 9/16)

= (7/4 + ¼j)/(25/16) = (28 + 4j)/25, gain is [sqrt(28*28+4*4)]/25 =[sqrt(800)]/25 = 1.13

The gain at 50 Hz needs z = -1,

H(-1) = (-1-1)/(-1- ¾) = 8/7 = 1.14, gain is 1.14



Part b) Show the **H(z)** transfer function for this digital filter.

H = (z-1)/(z- ¾) = $\mathbf{(1 - z^{-1})/(1 - \frac{3}{4} z^{-1})}$

I didn't ask for the digital filter, but it would have been easy to derive

$Y/X = (1-z^{-1})/(1- \frac{3}{4} z^{-1})$

$Y(1- \frac{3}{4} z^{-1}) = X (1-z^{-1})$

y(n) - 0.75y(n-1) = x(n)-x(n-1)

y(n) = x(n) - x(n-1) + 0.75y(n-1)

y(n) = (4*x(n) – 4*x(n-1) + 3*y(n-1))/4

(10) Question 3. Show the digital filter equation

$H = (z^2-2)/(z^3+0.5) = (z^{-1}-2z^{-3})/(1+ 0.5z^{-3})$

$Y(1+ 0.5z^{-3}) = X(z^{-1}-2z^{-3})$

$y(n) + 0.5y(n-3) = x(n-1) – 2x(n-3)$

$y(n) = x(n-1) – 2x(n-3) - 0.5y(n-3)$

(15) Question 4. Use an oscilloscope in line-trigger mode; if the noise becomes stationary (triggered to the line), then it is 60 Hz. If the noise does not synchronize to the trigger, then it is not 60 Hz. Measure the noise using a spectrum analyzer; if there are peaks at 60, 120, 180… then it is 60 Hz. If there are no peaks at 60, 120, 180… then it is not 60 Hz.

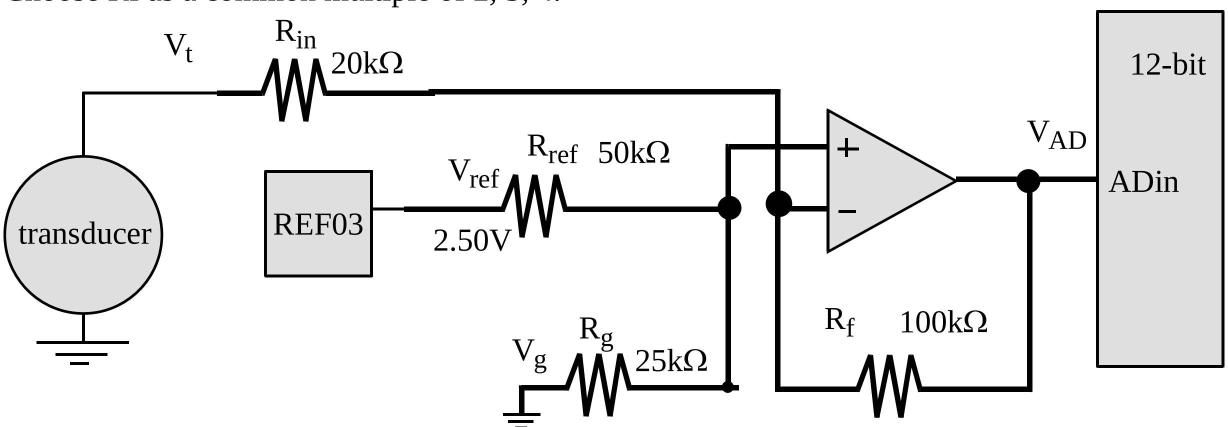
(25) Question 5. The objective is $\mathbf{V_{AD} = 5.0 - 5V_t}$

Part a) Build this interface with one op amp and a REF03 2.50V analog reference

$\mathbf{V_{AD} = 2V_{ref} - 5V_t}$

$\mathbf{V_{AD} = 2V_{ref} - 5V_t + 4V_g}$

Choose Rf as a common multiple of 2, 5, 4.



Part b) The range of $\mathbf{V_t}$ is 1 V; the precision is 4096 alternatives; resolution is 1/4096V = 0.244mV.