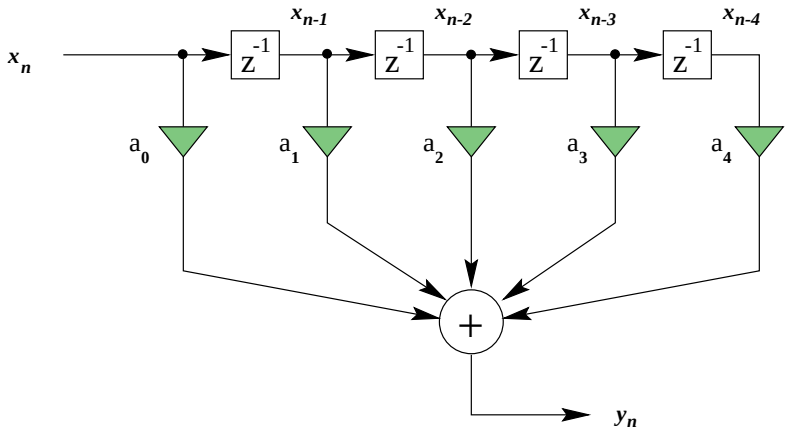
ECE 371 Project #1

DUE: October 31

The N-th order finite impulse response (FIR) digital filter has the transfer function

$$H(z) = \sum_{k=0}^{N-1} a_k z^{-k}$$

where the a_k's are constants. In the frequency domain $z = \exp(j\omega)$ whereas in the time domain z^{-k} denotes a time delay of k clock periods. We are interested in implementing a FIR filter with $N = 4$ (i.e., a 4th-order filter). Our concern is with the time domain implementation. The filter block diagram is shown in the figure below.



The input to this filter is a sequence $\{x_0\ x_1\ x_2\ \ldots\}$ which results in an output response $\{y_0\ y_1\ y_2\ \ldots\}$ where

$$\begin{aligned}
y_0 &= a_0x_0 \\
y_1 &= a_0x_1 + a_1x_0 \\
y_2 &= a_0x_2 + a_1x_1 + a_2x_0 \\
y_3 &= a_0x_3 + a_1x_2 + a_2x_1 + a_3x_0 \\
y_4 &= a_0x_4 + a_1x_3 + a_2x_2 + a_3x_1 + a_4x_0 \\
y_5 &= a_0x_5 + a_1x_4 + a_2x_3 + a_3x_2 + a_4x_1 \\
&\vdots \\
y_k &= a_0x_k + a_1x_{k-1} + a_2x_{k-2} + a_3x_{k-3} + a_4x_{k-4}
\end{aligned}$$

In this project you are to create an assembly language program that implements a 4th-order FIR in the time domain with $a_0 = a_4 = -0.100$, $a_1 = a_3 = 0.303$, and $a_2 = 0.600$.

Run your program on the ARM simulator and record $\{y_0\ y_1\ \ldots\}$ for the input sequence

$$\{x_k\} = \{\ 0x0,\ 0x1c,\ 0x2222,\ 0x5aac,\ 0x3,\ 0x9876,\ 0x230d,\ 0xe285\ \}.$$

NOTES:

1. All a_k's are implemented using 12-bit integer scaling (with an integer ceiling).
2. Each x_k is to be represented as a half word
3. Use the DCW pseudo-op to define the input sequence.
4. There are two ways to store the y_k values: store them in memory and then read them at the end using the debugger, or set a breakpoint to stop the program every time a new y_k is computed.
5. Be sure to include the following in your program in ensure the simulator terminates properly:

```
STOP
        MOV   R0, #0x18       ;  EXIT routine
        LDR   R1, =0x20026
        SWI   0x123456
```

6. Your project report should contain
   - A brief description of the problem
   - a printout of the *.lst file
   - a list of y_k for $k = 0, 1, \ldots, 7$
7. Your project report must be typed and any block diagrams or schematics drawn with some sort of graphics software—no hand drawings!