

EE442 / EE592 Real-Time Digital Signal Processing
Quiz #2

Allowed: *Course Textbook*, Calculators

1. Suppose the impulse response of a digital filter is given by

$$h(n) = 0.25\delta(n) + 0.25\delta(n-1) + 0.25\delta(n-2) + 0.25\delta(n-3)$$

and the input is given by

$$x(n) = \delta(n) + 2\delta(n-1) + 3\delta(n-2).$$

Compute the filter output

$$y(n) = h * x \equiv \sum_k h(k)x(n-k).$$

2. Consider the DO (text p. 104, FM p. 13-56) and REP (text p. 102, FM p. 13-160) instructions. Why doesn't the REP instruction require the Loop Address (LA) register as does the DO instruction?

3. Suppose we have two values in registers x0 and y0. Write a code which will perform the following steps:

```
if x0 < y0
    x0 = x0 * 2
else
    x0 = x0 / 2
end
```

Write a code for the following programming tasks (Questions 4 - 6), assuming the Modified Pass Pack beginning on p. 317 of the text. Identify by file name (**pass.asm**, **pass.dat**, **proginit.asm**, and **procster.asm**) and line number where you would place your instructions. The first programming task is done as an example.

4. Write a code which multiplies the right channel by $g = 0.7$.

Solution:

In **pass.dat** insert after line 10 the following line:

```
g    equ    0.7
```

In **procster.asm** replace the NOP the following line:

```
    mpyr    #g,x0,a    ;multiply right sample by g and round
```

In **pass.asm** replace line 74 with the following line:

```
    move    a,x:TX_BUFF_BASE    ;transmit right sample
```

5. Suppose we add the following lines to **pass.dat**:

```
line 11: N        equ    1000
line 11: Nby2     equ    N/2
line 78: QUEUE    dsm    N
```

Write a code which resides in **proginit.asm** which points r2 to the QUEUE, sets the modifier register for circular addressing, sets the offset register to N/2, and clears the QUEUE out prior to entering the main event loop (loop_1).

6. Using your code from the previous problem, write a code which resides in **procster.asm** and creates a simple tapped delay line on the right channel

$$y(n) = x(n) + 0.5x(n - N/2) + 0.25x(n - N).$$

Assume that going into your code, r2 points to $x(n - N)$ in the QUEUE (you of course must write code to insure the assumption holds true upon exit for the next iteration of process_stereo).

This page EE592 only

7. (+ 20 points) Consider a difference equation for a 3rd order Butterworth lowpass filter

$$\begin{aligned}y(n) &= b_0x(n) + b_1x(n-1) + b_2x(n-2) + b_3x(n-3) - a_2y(n-2) \\ &= 0.1667x(n) - 0.5x(n-1) + 0.5x(n-2) - 0.1667x(n-3) - 0.3333y(n-2)\end{aligned}$$

- (a) Draw a Direct Form (DF) I realization of the difference equation.
- (b) Draw a DF II realization of the difference equation.
- (c) Write the state equations for the DF II realization.