NAME: _____ GRADE: _____

EE442 / EE592 Real-Time Digital Signal Processing
Quiz #3
Allowed: Textbook, Notes, and Calculator

Each question is worth 10 points unless otherwise noted.

1. Consider the project #2 dat file, wavesyn.dat on p. 238 of the textbook. Determine the value which will be preloaded into the following addresses in memory. You do not need to convert numbers to fixed-point fractional form.

(a) `x:NOTESI`

(b) `y:NOTESF`

(c) `x:NOTESI+1`

(d) `x:NOTESI+2`

2. Consider the project #1 dat file, sfs592.dat on p. 175 of the textbook. On line 97, memory is allocated for a circular queue used to store filter states for comb filter 1 (CF1). The comment for the line gives the number of words in the queue and the starting address. Show with your calculations, how one arrives at the numbers in the comment.

3. Consider the impulse.asm file on p. 179 of the textbook. Explain what would happen if lines 5-7 were replaced with the following

```
move x:IMP_COUNT,b
dec b
```

line 13 was replaced with

```
move #IMP_PERIOD,b
```

and line 20 was replaced with

```
move b,x:IMP_COUNT
```

Write a code for the following *non-real-time* programming tasks (Questions 4 – 5). The first is done as an example.

4. Compute the following inner product

$$\mathbf{y} = \mathbf{h}^T\mathbf{x}$$
$$= \begin{bmatrix} 0.4 & 0.3 \end{bmatrix} \begin{bmatrix} 0.2 \\ 0.1 \end{bmatrix}$$

Solution:

```
move #0.4,x0
mpy #0.2,x0,a      ;a = 0.4*0.2
move #0.3,x0
mac #0.1,x0,a      ;a = 0.4*0.2 + 0.3*0.1 (ANSWER IN A)
```

5. Using the following arrays which have been allocated and loaded into memory

```
      org x:$0
H_mat ds 4
      org x:H_mat
dc 0.6, 0.5, 0.4, 0.3

      org y:$0
x_vec ds 2
      org y:x_vec
      dc 0.2, 0.1

y_vec ds 2
```

compute the matrix multiply

$$\mathbf{y} = \mathbf{H}\mathbf{x}$$
$$= \begin{bmatrix} 0.6 & 0.5 \\ 0.4 & 0.3 \end{bmatrix} \begin{bmatrix} 0.2 \\ 0.1 \end{bmatrix}$$
$$= \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$$

Be sure that the resulting answers y1, y2 are stored at address y_vec, y_vec+1 respectively.

Write a code for the following programming tasks (Questions 6 - 8), assuming the Modified Pass Pack beginning on p. 321 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.

6. 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 75 with the following line:

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

7. Write a code which implements the following difference equation:

$$a[n] = \hat{a}g + (1-g)a[n-1]$$

where $\hat{a} = 0.9$, $g = 0.1$, and $a[0] = 0$. The value $a[n]$ should be computed once per sample period, i.e. in real-time.

Solution:

8. Write a code which stores the most recent 8 samples from the left channel and outputs the following:

$$y[n] = \frac{1}{8}\sum_{k=0}^{7} x[n-k]$$

Solution:

EE592 Only

EE442 students: if time permits, you may wish to try these problems, however, no additional points will be earned.

9. The code for sinusoid synthesis with integer delta is given on p. 218 and includes the files PASS_SIN.DAT, PASS_SIN.ASM, PROGINIT.ASM, SINGENID.ASM, and PROCESTER.ASM. Write a new sinusoid subroutine stored in SINGENID.ASM such that the last two lines of your *new* subroutine read

```
move y:(r4+n4),x0
rts
```

With this modification, you will need to add lines of code to the sinusoid subroutine that calculate the correct value of n4 each sample period. In addition, you may need to modify PROGINIT.ASM.