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 #1 dat file, sfs592.dat on p. 178 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.

2. Consider the impulse.asm file on p. 181 of the textbook. Explain what would happen if lines 5-7 were replaced with the following

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

line 11 was replaced with

```
move #IMP_PERIOD,b
```

and line 18 was replaced with

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

3. In obtaining the LMS algorithm from the steepest-descent algorithm, we used instantaneous estimates of the autocorrelation matrix, **R** and the cross-correlation vector, **p**. Why was this necessary?

4. The Hilbert filter in Fig. 6.7 p. 197 may be responsible for poor ANC performance when the reference tone has a very low frequency or a frequency close to the Nyquist frequency. Why?

Write a code for the following *non-real-time* programming tasks (Questions 5 – 7). The first is done as an example.

5. 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)
```

6. Compute the power in the array `xvec`

$$P = \frac{1}{N} \sum_{n=1}^{N} xvec(n)^2$$

by completing the following code.

```
N     equ 8        ;define number of samples in xvec

      org y:$0
xvec  dc    0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8    ;samples in xvec

      org p:$100
      move  ?,?                    ;point to x_vec
      clr   ?     ?,x0             ;clr ?, get xvec(1)
      rep   #?
      mac   ?,?,?       ?:(r0)+,x0  ;accumulate xvec^2, get next xvec
      asr   ?,?,?                  ;divide by N, estimate in accumulator a
```

7. Compute the following linear combination of vectors

$$\begin{aligned}\mathbf{y} &= \mathbf{h} + \mu\mathbf{x} \\ &= \begin{bmatrix}0.8\\0.4\end{bmatrix} + 0.5\begin{bmatrix}0.2\\0.1\end{bmatrix} \\ &= \begin{bmatrix}y_1\\y_2\end{bmatrix}\end{aligned}$$

using the following code:

```
mu    equ   0.5               ;define mu

      org x:$0
h_vec ds    2                 ;malloc for h_vec
      org x:h_vec
      dc 0.8,0.4              ;load values for h_vec

      org y:$0
x_vec ds    2                 ;malloc for x_vec
      org y:x_vec
      dc 0.2,0.1              ;load values for x_vec

y_vec ds    2                 ;malloc for y_vec

      org p:$100
      move #h_vec,r0
      move #x_vec,r4
      move #y_vec,r5
```

EE592 Only

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

Write a code for the following programming tasks (Questions 8 - 9), 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.

8. 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
```

9. 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: