ARIZONA STATE UNIVERSITY
DEPARTMENT OF ELECTRICAL ENGINEERING

EEE 404/591 Spring 2009
Problem Set #5

Assigned: 15 April 2009
Due Date: (Practice only

Reading: Read Chapter 8 of Kuo and Gan.

Announcement: **Exam 2 will be held on Wednesday 29 April 2009** and will cover the reading and problems assigned in homeworks 4 and 5, and the material discussed in class on Fractional Division, TI C55x Architecture, TI C55x Addressing, TI C5xx Data and Program Memory, Time-Frequency Respresentation, Spectrogram, Music Synthesis, DFT, FFT, Windowing and Short-Time Fourier Transform.

PROBLEM 5.1:

(a) Provide a memory-map table showing how the following instructions are stored in the TMS320C5510 32-bit wide data/program memory:

Instruction	Size	Address
MPY	2 bytes	000402h
MOV	2 bytes	000404h
MPYM	3 bytes	000406h

(b) Consider an assembly code segment that calls a subroutine whose first instruction is MPY at byte address 000402h. For this instruction to be executed, indicate the value of the Program Counter and the value placed on the Program-read Address Bus (PAB).

PROBLEM 5.2:
Problem B-8-17 in Kuo & Gan.

PROBLEM 5.3:
Problem B-8-20 in Kuo & Gan.

PROBLEM 5.4:

Consider an audio signal $x(t)$ that is sampled at a sampling rate of 40KHz.

(a) Determine the maximum code size (number of instructions) that can be used to process samples of the audio signal in real-time using the TMS320C5510 at a 200MHz clock rate with 1 instruction per cycle.

(b) If a DFT is performed using a window of 25 msec (i.e., using a block of samples corresponding to 25 msec aquisition time), determine the frequency resolution of the DFT in Hertz (cycles/sec).

(c) Indicate the number of multiplications required if the DFT in part (b) is implemented directly using the DFT equation.

(d) Indicate the number of multiplications required if the DFT in part (b) is implemented using the FFT algorithm.

PROBLEM 5.5:

Consider a discrete-time signal $x(n)$ given by:

$$x(n) = \begin{cases} n+1, & n = 0, 1, 2 \\ 0, & \text{otherwise} \end{cases}$$

(a) Compute the 4-point DFT of $y(n) = x(-n)$.

(b) Let the 4-point DFT of $x(n)$ be computed using a decimation-in-time FFT. Sketch the butterfly-based flow graph of the FFT computation. Carefully label the inputs and outputs of the flow graph.

PROBLEM 5.6:

Consider the following discrete-time signal $x(n)$ that is generated by sampling an analog signal with a sampling frequency of 10KHz:

$$x(n) = \cos\left(\frac{\pi}{4}n\right) + \cos\left(\frac{\pi}{2}n\right).$$

Let $s(n)$ be a segment of $x(n)$ obtained by windowing $x(n)$ using a window $w(n)$ of length L.

(a) Determine and plot the DTFT $S(\omega)$ of $s(n)$ if $w(n)$ is a window given by:

$$w(n) = \begin{cases} 1, & 0 \le n \le 23 \\ 0, & \text{otherwise} \end{cases}$$

Indicate whether or not the frequency components of $x(n)$ can be detected from $S(\omega)$. Justify your answer.

(b) If $w(n)$ is a rectangular window, determine the length of $w(n)$ that would provide the best time-resolution while allowing the frequency components of $x(n)$ to be resolved.

(c) Using the TMS320C5510 at a 200MHz clock rate and assuming 1 instruction per cycle, determine the number of instructions that can be performed during the acquisition time of a segment $s(n)$ of length 20 samples.

(d) Let the segment $s(n)$ be of length $L = 4$. Explain how the 4-point DFT of $s(n)$ can be implemented using a single 2-point FFT and draw a flowgraph illustrating the proposed FFT-based implementation.