Name: _____

EECS 452. Digital Signal Processing Design Laboratory

Final Examination — April 7, 1999

This examination closed book and notes and is given under the honor code. Please write out and sign the honor code.

1. (**10 pts)**
   a. Describe the memory present on the DSP56303 chip and describe where it lies in address space.
   b. Describe the memory present on the TI C50 chip describe where it lies in address space.
2. (**10 pts)** There are three sets of registers associated with indexed addressing in the DSP56303. These are the Rn, Nn, and Mn registers where n is an integer ranging from 0 through 7. Describe the function of each set of registers.
3. (**10 pts)** The following two code segments implement FIR filters. The first code segment is from Homework 3 and is for use on the TI C50. The second code segment is from Lab 2 and is for use on the DSP56303.

   C50 FIR code

```
MAR     *,AR1
ZAP
LAR     AR1,#(STATE+ORDER)
REPT    #(ORDER-1)
MACD    COEFF,*-
APAC
SACH    STATE,SCALE
```

DSP56303 code

```
 ; Clear accumulator, save sample, get first coeff

        clr     a   x0,x:(r0)+ y:(r4)+,y0

; Do all but the last tap, and then finish off with rounding

        rep     #NTAPS-1
        mac     x0,y0,a x:(r0)+,x0  y:(r4)+,y0
        macr    x0,y0,a (r0)-     ; back up r0 by one to shift inputs
        move    a,x:DA_DATA       ; Put value in left channel tx.
```

a. The TI code can perform simultaneous memory access of both FIR state values and FIR coefficients when executing the above code. Describe how this is done. Note any particular limitations that will restrict doing the simultaneous transfers.

b. The DSP56303 performs simultaneous transfers of FIR state values and FIR coefficients when executing the above code. Describe how this is done. Discuss when this will and will not be possible.

4. (**6 pts)** The displays in shown in Figure 1 were generated using lab5.cld. Which are:

   · a linear magnitude plot
   · a logarithmic plot
   · an unwindowed log plot
   · a windowed log plots
   · a Hamming windowed log plot
   · a Chebyshev windowed log plot

   The questions are written in the singular however there may be more than one response.

5. (**5 pts)** What is a *critical section* and why would such exist?

6. (**1 pt)** Which set of DSP56303 registers should *always* be treated as a pair and essentially loaded simultaneously with values.

   a: R0 and R1
   b: R0 and N0
   c: R0 and M0

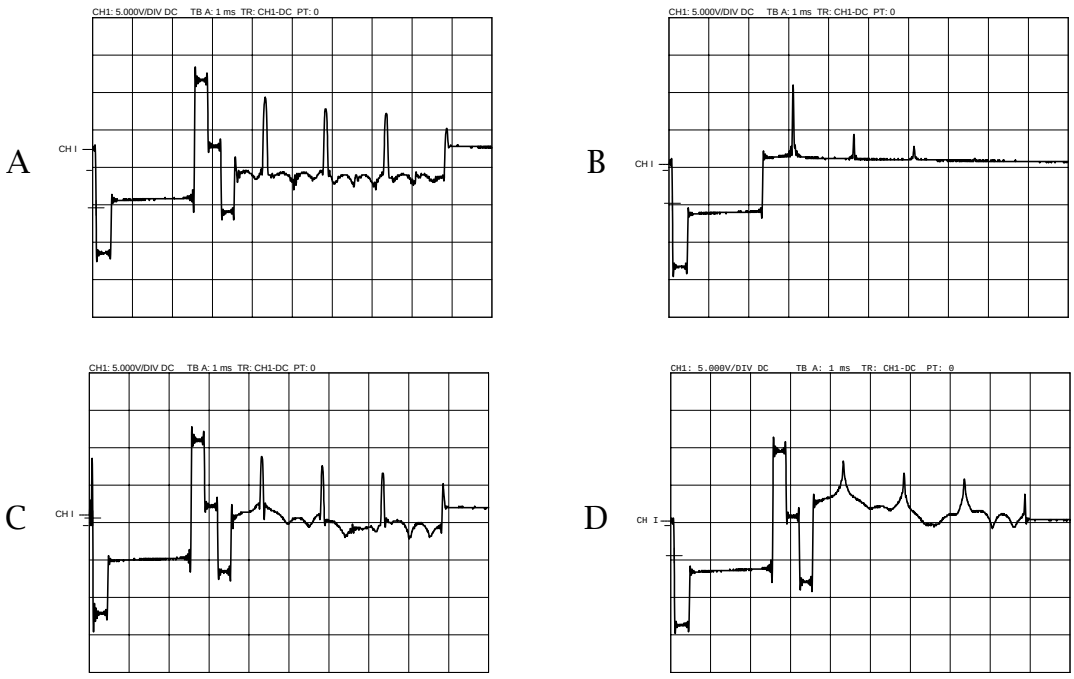

Figure 1: Lab 5 displays.

d: N0 and M0

7. (**1 pt)** How is the order of an FIR filter related to the number of delay stages used in implementing the filter?

8. (**1 pt each)** True or False

___ On the DSP56303 placing $000000 into N0 turns on bit reverse addressing mode.

___ On the C50 using the **MACD** instruction an additional memory location should be reserved immediately following the section of memory used to hold the state of an FIR filter.

___ The maximum error in a minimum mean square polynomial approximation is generally larger than in an equiripple polynomial approximation of the same order.

___ A pipelined computer architecture presents special timing problems when operating under interrupts.

___ A key feature of a DSP computer is possession of a multiply and add instruction.

___ Programs written in C execute more efficiently on a DSP than do programs written in assembly language.

___ There are no special concerns when sending short pulse like waveforms to a D/A converter designed to have an ideal *brickwall* filter response.

___ Direct Form II filters are more likely to experience overflow problems when updating the filter state that Transposed Direct Form II filters.

___ Care has to be exercised when designing FIR filters to minimize the possibility of limit cycles.

___ For similar filter transfer functions IIR filters require less memory than do FIR filters.

___ Both the TI and Motorola DSP devices use serial interfaces to connect to peripherals because of ease of implementation and cost efficiency.

___ Sigma-Delta A/D generally cost more than successive approximation A/D converters and have more difficulty with nonlinearities.

___ The Motorola EVMs uses a 16-bit Sigma-Delta A/D converters.

___ In the DSP56303 saturated memory transfers should be avoided when implementing IIR filters.

___ The C50 provides 8 address registers but only two at a time can be in active use via the $*$ operator.

___ The programming language C contains special support for implementing fixed point arithmetic where the location of the binary point is just to the right of the sign bit.

___ DSP processors have no application in controlling the performance of electric motors.

___ The multithread programming approach is useful in making it possible for other tasks to use the time it takes a given task to wait for input/output operations to complete.

___ Numerical approximations are not useful in reducing execution time. For example, when taking the square root.

___ Doing simulation studies using MATLAB or some other high level language prior to implementing a DSP algorithm is rarely useful.

___ Debuggers such as were used in the laboratory experiments are ideally suited for tracing down problems in real time programs.

___ It is often possible to make a trade between program size (code and/or data requirements) and execution time.

___ Move memory not pointers.

___ Team efforts require too much interaction and are thus to be avoided in order to increase efficiency.

9. (**1 pt)** Choose one. The largest market for DSP today is

   a: communications
   b: energy efficient motor control
   c: image compression
   d: voice recognition

10. (**1 pt**) Choose one. The dominant (> 45% market share) DSP manufacturer is

    a: Intel
    b: Motorola
    d: Texas Instruments
    d: Lucent Technologies
    e: Analog Devices
    f: IBM

11. (**5 pts)** Explain why even the "unwindowed" waveforms in lab 5 have, in essence, been windowed. What does this do to the spectrum of the waveform compared to the ideal Fourier transform of that waveform.

12. (**5 pts)** Consider the system shown in Figure 2. Q is a quantizer such that

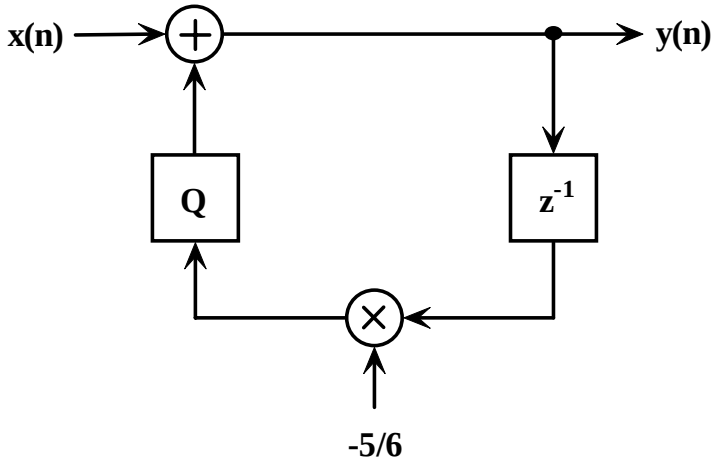

Figure 2:

$Q(x)$ rounds $|x|$ to the next larger value if the fractional part is ≥ 0.5 and truncates otherwise. Levels are represented in two's complement form using five bit words. The left most bit is the sign bit. For example, $[11100] = -1/4$.

a. Write an expression for y(n).

b. What is the range and resolution of the quantized values?

c. Assume $x(0) = 5/16$ and $x(n) = 0, n \neq 0$ (i.e., impulse response). What will be $y(n)$?

d. What *finite length word effect* do you observe?

e. What is the dead band, i.e., what is the range of $y(n)$ after the system has stabilized?

13. (**5 pts**) Consider the following statement: "The Nyquist rate (samples per second) for the waveform $y(t) = \sin(\omega_1 t)\cos(\omega_2 t)$ where $\omega_2 > \omega_1$, is ω_2/π." Is this true? Why or why not?

14. (**9 pts**) Consider the system shown in Figure 3. The D/A converter uses a zero-order hold on its output. Assume f_r equals f_s and $x(t) = 2\cos(2000\pi t)$.

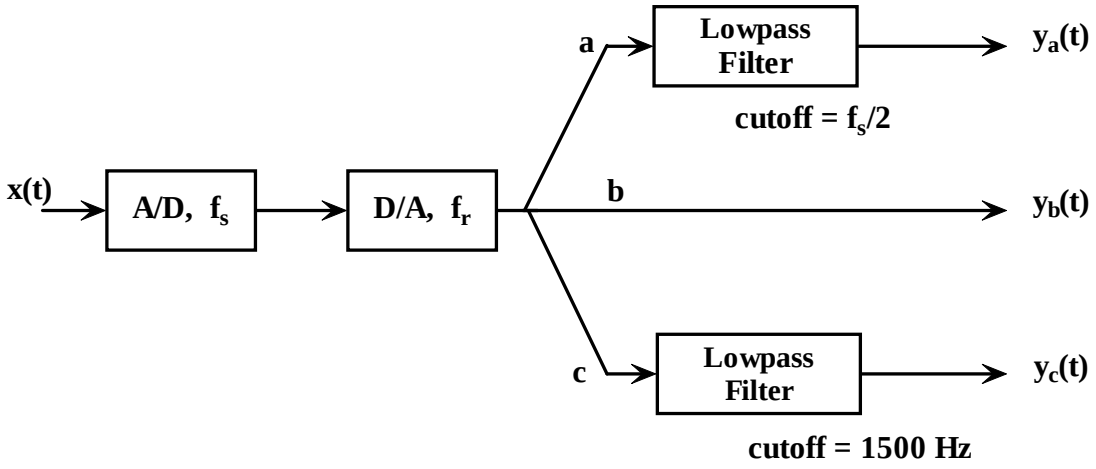

Figure 3:

a. Sketch and label $y_a(t)$ when $f_s = 300$ Hz.

b. Sketch and label $y_b(t)$ when $f_s = 2$ kHz.

c. Sketch and label $y_c(t)$ when $f_s = 1000$ Hz.

15. (**3 pts**) Consider the three IIR implementations shown in Figure 4.

(a) Which is Direct Form I

(b) Which is Direct Form II

(c) Which is Transposed Direct Form II

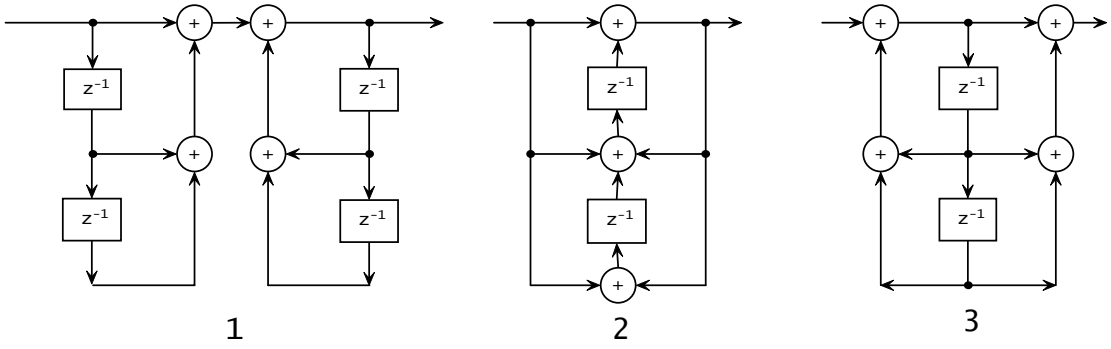

Figure 4:

16. (**15 pts**) For each of the five laboratory exercises list the primary topic and three key concepts that were being demonstrated or taught.

17. (**4 pts**) In lab 5 the displays generated using the D/A converter to plot on the oscilloscope (see Figure 1) exhibited ringing when sharp amplitude transitions were made. What was the cause of this ringing?

18. (**6 pts**) Briefly describe three situations where a lack of ethics can hurt a company financially.