Jonathan W. Valvano First:_____ Last:_____
July 31, 2000, 2:30-3:45pm

This is an open book, open notes exam. You must put your answers on these pages only, but you can use the back. You have 75 minutes, so please allocate your time accordingly. ***Please read the entire quiz before starting.***

(25) Question 1. Finish the implementation of the following IIR digital filter.

y(n) = 0.625•x(n)+0.25•x(n-1)+0.125•x(n-2)+0.0625•y(n-2)

The unsigned ***8-bit*** input data (from `A2D(0)`) is bounded between 0 and 255. Since the filter gain is less than one, the y(n) values are also bounded between 0 and 255. No floating-point calculations are allowed. For full credit you must implement the filter without approximation. Be careful to specify whether you use 16 or 32-bit integer math.

```
unsigned char x[3],y[3]; // 8-bit unsigned numbers, 0 to 255
#define C5F  0x20
#pragma interrupt_handler TC5Handler()
void TC5Handler(void){
   TFLG1=C5F;         // ack interrupt
   TC5=TC5+8333;      // fs=240Hz
  // add code here to shift the MACQ









   x[0] = A2D(0);        // new 8-bit data, 0 to 255
// add code here to execute the filter









}
```

(30) Question 2. Consider a pressure data acquisition system. The pressure range is -5 to 5 psi (pounds per square inch). The frequencies of interest are 0 to 25 Hz. The transducer is a resistance bridge that produces a differential voltage output. The linear transducer has a sensitivity of 50 mV/psi. A zero pressure translates to a zero bridge output. The transducer output impedance is 5 kΩ. A 12-bit signed ADC will be used to convert analog voltage (-5 to +5V range) into digital samples (-2048 to +2047 range). Accuracy is more important than low cost. DO NOT BUILD THE ANALOG CIRCUIT.

(5) Part a) What is the maximum allowable noise of the analog electronics referred to the ADC input?

(5) Part b) Assuming the noise is less than the value stated in part a), what pressure resolution do you expect for the system in psi?

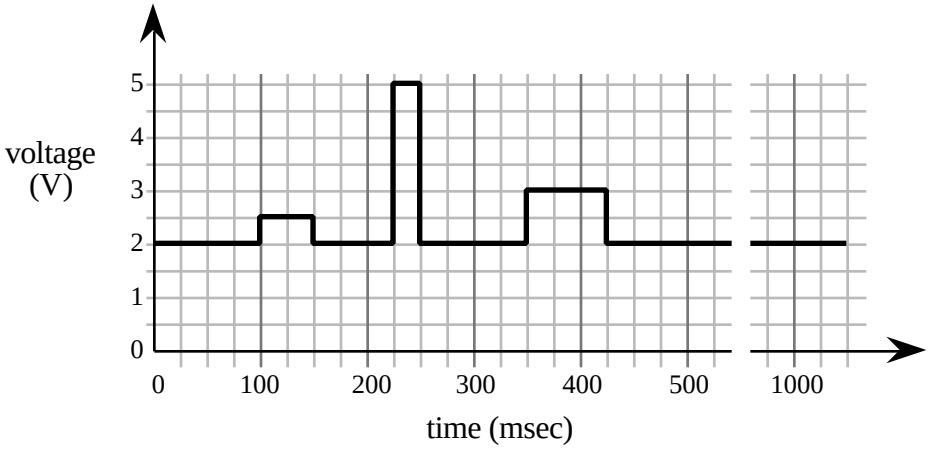
(5) Part c) What sampling rate would you choose? Why?

(5) Part d) What input impedance of the analog amplifier do you need? Show your work.

(5) Part e) What gain would you choose?

(5) Part f) Since the resistance bridge produces a differential output, a differential amplifier is needed. Which of the three differential amplifiers from Chapter 11 of the book would you choose? In particular, your choices are single op amp, instrumentation amp made with three op amps, or integrated instrumentation amp (e.g., AD620).

(35) Question 3. You will design a signal generator that produces the following periodic waveform. This pattern will repeat every 1-second. Your software will run in the background using periodic interrupts. You may call any C function from the book without copying the code, simply use the same function name and reference the page number of the book.



(10) Part a) Show the analog hardware needed. You may use any device from the book (e.g., DAC8043 in Figure 7.44 on page 405, and Figure 11.76 on page 632), but not the MAX548/549 from lab. Show all connections to power supply voltages. Show the connections to the 6812. Specify the type and tolerances of all resistors and capacitors. If you use the DAC8043, you will need to add additional circuits to make the range 0 to +5V.

(5) Part b) Show the data structure that holds the waveform shape. Make it reside in nonvolatile EEPROM.

(10) Part c) Show the ritual that initializes the system. Once initialized, the waveform will be generated in the background via a periodic interrupt.

(10) Part d) Show the interrupting software that produces the waveform.

(10) Question 4. Look up each assembly instruction. Very briefly state what it does and how it might be used in an embedded system. Don't worry about the details, just the general idea.
Part a) `emac`

Part b) `mem`

Part c) `callf`

Part d) `rti`

Part e) `etbl`