Jonathan W. Valvano First:_____ Last:_____
April 10, 2002, 9:00 to 9:50 am

This is an open book, open notes exam. You must put your answers on these pages only. You can use the back. You have 50 minutes, so please allocate your time accordingly. ***Please read the entire quiz before starting.***

(30) Question 1. The following is a simple IIR digital filter.

y(n) = 0.70x(n) -0.65x(n-1) +0.15x(n-2) -0.5y(n-1) +0.25y(n-2)

The unsigned ***8-bit*** input data (from `A2D(0)`) is bounded between 0 and 255. You may assume the filter gain is less than one, so 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. Assume TMSK2 contains its initial value of 0. Specify the `CONSTANT` required for 1000 Hz sampling.

```
unsigned char x[3],y[3];   // 8-bit unsigned numbers, 0 to 255
#pragma interrupt_handler TC5Handler()
#define CONSTANT          // fill in the value here to make fs equal to 1000Hz
void TC5Handler(void){
   TFLG1 = 0x20;           // ack interrupt
   TC5 = TC5+CONSTANT;     // fs=1000Hz
  // 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









}
#pragma abs_address:                          // fill in the vector here
void (*OC5_vector[])() = { TC5Handler};
#pragma end_abs_address
```

(30) Question 2. Design an analog circuit that has the transfer function $\mathbf{V_{out} = 4\ V_1 - 10\ V_2 + 5}$. V_1 and V_2 are analog inputs, and V_{out} is the analog output. You do not need to worry about input or output impedance. Your circuit will operate on a ±12 V supply using REF02 references and OP07 op amp(s). The REF02 creates a +5.00 reference voltage. Full credit will be given to proper solutions using one REF02 and one OP07 op amp. Show the analog circuit. Label all resistor values. You do not need to show the power supply connections for the OP07 and REF02.

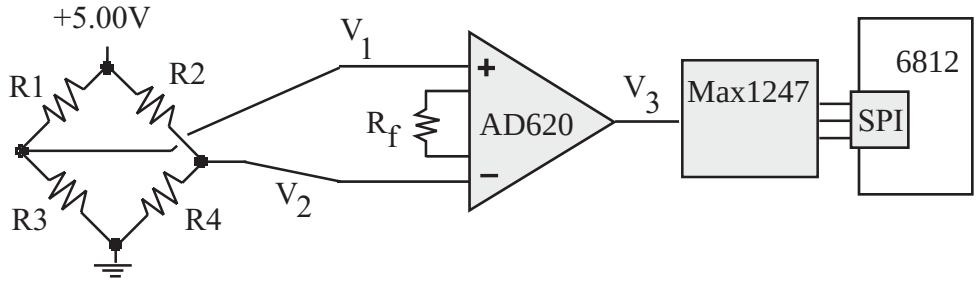
(40) Question 3. In this problem, you will design an instrument to measure weight using the Maxim MAX1247. The range of weight is 0 to 400 lbs. Because you are using a 12-bit ADC and the system is linear, the measurement precision will also be 12 bits. The frequencies of interest are 0 to 1 Hz. The weight is measured with 4 resistive strain gages placed in a bridge, two in compression (100-ΔR), two in expansion (100+ΔR). The sensitivity of each gage is 0.005 Ω/lbs. The change in transducer resistance, ΔR, is linearly related to weight.

(10) Part a) Complete the following table. `Data` is the digital result from the unsigned 12-bit ADC. The system will use the full scale 0 to +2.5V ADC range. Refer to the circuit in part c).

W	ΔR	R1	R2	R3	R4	V1	V2	V1-V2	V3	`Data`
0	0	100	100	100	100				0.00	
200	1	99	101	101	99				1.25	
400	2	98	102	102	98				2.50	
lbs	Ω	Ω	Ω	Ω	Ω	V	V	V	V	

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

(5) Part c) Specify the desired gain for the instrumentation amp.



(5) Part d) Specify the $\mathbf{R_f}$ resistor that implements that gain.

(5) Part e) What is the maximum allowable noise of the analog circuit, referred to its input (at V1, V2)?

(5) Part f) What is the measurement resolution in lbs?

(5) Part g) Floating point is not available. The software will perform many mathematical calculations on the measurement. What number format would you suggest be used to represent the weight? Be as specific as possible.