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November 6, 2002, 12:00 to 12:50 pm

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.***

(25) Question 1. Design an analog amplifier with the following relationship

$$V_{out} = 100 \bullet (V_1 - V_2) + 2.5$$

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.

(25) Question 2. Consider a problem of running two foreground threads using a preemptive scheduler with semaphore synchronization (like Lab 17.) There are three shared 8-bit global variables:

```
unsigned char In1,In2,Out;
```

First, he `client` thread should create two pieces of data and store them in `In1` and `In2`. Once new data is available in `In1` and `In2`, the `server` thread should calculate the maximum of these two numbers and place the result in `Out`. Once new calculation is complete and the result is available in `Out`, the `client` thread should output the result. The basic shell of this operation is given. Define one or more semaphores, then add calls to the following three functions in order to properly synchronize the interactions between `client` and `server`.

```
int OS_InitSemaphore(Sema4Type *semaPt, short value);
void OS_Wait(Sema4Type *semaPt);
void OS_Signal(Sema4Type *semaPt);
```

You will define one or more semaphores and calls to the semaphore functions, otherwise no other changes are allowed. For each semaphore you add, explain what it means to be 0, 1 etc. Assume `client` is run first.

```
void client(void){
  DDRA=DDRB=0; // Ports A, B are input
  DDRC=0xFF;   // Port C is an output
  while(1){
    In1=PORTA; // read first input
    In2=PORTB; // read second input
    PORTC=Out; // output the result
  }
}
```

```
void server(void){
  while(1){
    if(In1>=In2){
      Out = In1; // In1 is larger
    }
    else{
      Out = In2; // In2 is larger
    }
  }
}
```

(25) Question 3. You have a 10-bit 0 to +5V digital to analog converter (DAC) and use it to create an analog output wave. The maximum slope (slew rate) of the desired wave is 100V/s, and the output rate is 1000 samples/sec. This means a periodic interrupt will output a new value to the DAC every 1 ms. What is the expected maximum error (i.e., difference between the desired wave and the actual analog output)?

(25) Question 4. A transducer has the following quadratic relationship

$$T = 0.0083*R^2 - 12.465*R + 6632$$

where T is the temperature and R is the resistance. Write a C function using fixed-point math (integer calculations) that takes R as an input and gives T as an output. DO NOT IMPLEMENT TABLE-LOOKUP WITH LINEAR INTERPOLATION. Implement the quadratic equation directly. The domain of R is 200 to 640, and the range of T is 2000 to 4500.