Jonathan W. Valvano First:_____ Last:_____
November 19, 2010, 2:00pm-2:50pm. Open book, open notes, calculator (no laptops, phones, devices with screens larger than a TI-89 calculator, devices with wireless communication). You have 50 minutes, so please allocate your time accordingly. ***Please read the entire quiz before starting***.

(10) Question 1. A C macro is defined using the **`#define`** construct. For example,

```
#define BIT3_MASK 8
```

A macro with one parameter is defined like this

```
#define bit(x) (1<<(x))
```

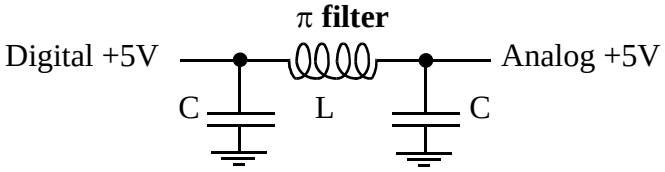
A macro with two parameters is defined like this

```
#define TwoBit(x,y) ((1<<(x))|(1<<(y))
```

Write a C macro that will clear one bit in an I/O port. The following are examples of how your macro will be used.

```
BIT_CLEAR(PTT,7);     // clears PTT bit 7
BIT_CLEAR(PTH,3);     // clears PTH bit 3
```

(5) Question 2. The pi filter can be used in mixed analog-digital designs:



Pick the best answer

A) The capacitor stores charge, so that when an IC needs current it can be delivered from the capacitor.

B) A pi filter (CLC) can be used to separate digital noise from analog circuits. It works by preventing high frequency current spikes on the digital circuits from causing voltage spikes on the analog circuits.

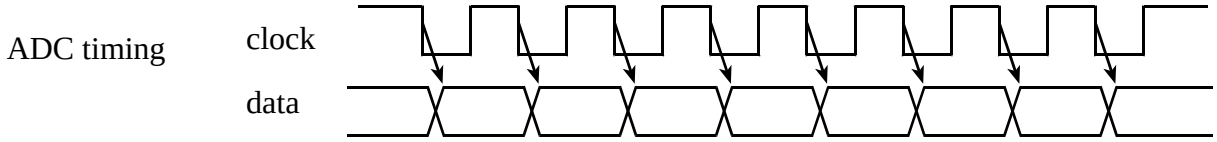
C) For DC voltages, the capacitor acts like an open circuit and the inductor like a short circuit.

D) For high frequency AC voltages, the capacitor acts like a short circuit and the inductor like an open circuit.

E) All of the above are true.

Put your answer in the box.

(5) Question 3. The ADC serial data output, shown in the figure below, is connected to the SPI MISO, serial data input. The 9S12 is the master and the ADC is the slave. The ADC clock input, connected to the SPI clock output, is normally high (when idle the clock is 1). After a conversion, the ADC shifts its new data out on the falling edge of the clock. What values of **CPOL**, **CPHA** should be used?



To what mode should SPI be initialized?

A) CPOL = 0; CPHA = 0
B) CPOL = 1; CPHA = 0
C) CPOL = 0; CPHA = 1
D) CPOL = 1; CPHA = 1

Put your answer in the box.

(35) Question 4. There are two positive-logic switches interfaced to PT1 and PT0. There are two positive-logic LEDs interfaced to PP1 and PP0. You may assume the switches do not bounce. The order in which the switches are touched is irrelevant. LED1 (PP1) should turn on (and stay on forever) if Switch 1 (PT1) goes from touched to released before Switch 0 (PT0) goes from touched to released. LED0 (PP0) should turn on (and stay on forever) if Switch 0 (PT0) goes from touched to released before Switch 1 (PT1) goes from touched to released. Only the first touch and release matters, subsequent touching and releasing should be ignored. If the first time the switches go from touched to released occurs such that both switches are released at the same time, turn on (and leave on) both LEDs. There was a race condition in the FSM solution we developed in Quiz 1. In this solution, we will solve the problem using input capture interrupts on both PT1 and PT0. There are six cases to consider

0) Neither switch is touched and released, so the LEDs should remain off forever;
1) The first PT1 falling edge occurs at least one full instruction before the first PT0 falling edge, so make LED1 on forever;
2) The first PT0 falling edge occurs at least one full instruction before the first PT1 falling edge, so make LED0 on forever;
3) The first PT1 falling edge occurs during the same instruction as the first PT0 falling edge, but PT1 occurs at least 42ns before PT0, so make LED1 on forever;
4) The first PT0 falling edge occurs during the same instruction as the first PT1 falling edge, but PT0 occurs at least 42ns before PT1, so make LED0 on forever;
5) The first PT0 falling edge occurs during the same E clock cycle as the first PT1 falling edge, so make both LEDs on forever;

A good grade will handle cases 0,1,2; a perfect score handles all six cases

Part a) Show the initialization ritual, including direction registers, input capture, LEDs off, arm and enable. Assume the PLL is active, so the E clock is 24 MHz. Include the interrupt enable.

Part b) Show the PT0 input capture0 ISR.

Part c) Show the PT1 input capture1 ISR.

(20) Question 5. A signed fixed-point system has a range of values from -99.99 to +99.99 with a resolution of 10^{-2} cm. Note: 10^{-2} equals 0.01.

Part a) With which of the following data types should the software variables be allocated? The software variable contains the integer part of the fixed-point number. When more than one answer is possible choose the most space efficient type.

A) `unsigned char`	D) `char`	G) `fixed`
B) `unsigned short`	E) `short`	H) `unsigned fixed`
C) `unsigned long`	F) `long`	I) `double`

Put your answer in the box.

Part b) Assume the variable **`Position`** contains the integer part of the number as defined in part a). Write software that multiplies the position by 0.5.

Part c) Again, assume the variable **`Position`** contains the integer part of the number as defined in part a). Write software that adds 4 cm to the position.

(5) Question 6. A ceramic capacitor has the numbers 123 printed on it.

Part a) Is it polarized or nonpolarized?

Part b) What value is it?

(20) Question 7. Design an analog circuit with the following transfer function $V_{out} = 10*(V_{in}-1)$. The input is a single voltage (not differential). The input range is 1 to 1.5V and the output range is 0 to 5V. Use an analog reference and one rail to rail op amp (not an instrumentation amp). Show your work and label all chip numbers and resistor values. You do not have to show pin numbers.