| 15-348 Embedded Systems: Sample Exam 2 |

Name: _____

Andrew ID: _____

Question:	1	2	3	4	5	Total
Points:	15	16	32	20	17	100
Score:						

□15 1. (a) Write C or assembly code that creates this output on PF2 using periodic timer interrupts. Assume the bus clock is 5 MHz. The pattern of high for 1 milli seconds and low for 3 milli seconds (±10%) should repeat over and over.
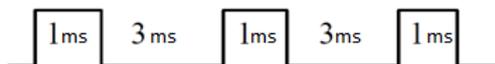

```c
void init(){
    // ASSUME THAT CODE THAT INITIALIZES PORT F2 TO BE OUTPUT IS ALREADY HERE
    ...
    // Periodic, countdown timer
    TIMER0_TAMR_R = 0x00000002;
    // ASSUME CODE IS HERE TO INITIALIZE TIMER0A INTERRUPT HANDLED BY timer0Handler
    ...
    // load register value for a 16 bit countdown timer

    TIMER0_TAILR_R =  _____;// FILL THIS VALUE

    // set port PF2 high to start the first pulse. We should interrupt after 1 ms
    GPIO_PORTF_DATA_R = 0x04;

}
void main()
{
   init();
       while (1){}
}



/* declare any global variables here */


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void timer0Handler(void){
       /* local variables and your code goes here */










}
```

2. In the interfacing methods lecture, we looked at the following ways of interfacing with external hardware:

   (a) Blind Cycle Counting

   (b) Polling

   (c) Interrupts

   (d) Direct Memory Access

For the following scenarios, which of the above methods closely describes these scenarios – explain your answers:

<div style="margin-left:1em">4</div>

(a) I am baking a cake while making this exam. The cake is in the oven. I write some text for a question and check if the cake is done. I come back and write some more and then check again until the cake is done. (It takes much longer to write the exam than to bake a cake).

<div style="margin-left:1em">4</div>

(b) I click the print button and get back to doing other work. After 10 minutes, I get a notification indicating that the exams are printed. I finish what I was doing and go to collect the exams.

<div style="margin-left:1em">4</div>

(c) During the exam, you look at the clock after attempting each question to see if time is up.

<div style="margin-left:1em">4</div>

(d) The exam is 80 minutes long. I asked you to put your exams on the instructor table once you are done. After exactly 80 minutes, I collect all the exams that are on my table to go back to my office.

3. Answer the following questions and BRIEFLY explain your answers

15 (a) You wish to design a system that measures the period of a digital signal. Range of periods is 1 to 2 ms, and the desired resolution is 10us. Which interrupt mechanisms can you use and why? Mark all answers that apply and explain:

  (a) Output compare with a fixed period

  (b) Output compare with a variable period

  (c) Input capture on the both the rising and falling edges of the digital signal

  (d) Input capture on the rising edge of the digital signal

  (e) PWM interrupt

5 (b) You are attempting to capture a sinusoidal sound with a frequency of 7.5 kHz and a range of 0-2 Volts. The ADC is set to 125k samples/sec. Using the 12-bit ADC and periodic interrupts, you have programmed the SysTick to interrupt at a frequency of 20 kHz. During the SysTick ISR you collect one ADC sample. Is it possible to recreate the original signal from the captured samples? If your answer is YES, explain how. If your answer is NO, explain why not?

12 (c) You need to produce a 10-bit analog signal at 10Hz. Which interrupt mechanism can you use? Mark ONLY the answers that apply and explain why and what does the ISR need to do?

(a) Periodic timer running at 10Hz.

(b) Output compare with a variable period.

(c) Input capture on the both the rising and falling edges of the digital signal

(d) PWM interrupt

12   4. (a) In modern cars, the cruise control is a common feature that uses an actuator to maintain a set speed without using the accelerator. Suppose you are designing a feedback control system for a vehicle cruise control. Which of the following performance features relate to the driver safety? Mark ONLY the answers that apply and explain why

    (a) Rise Time

    (b) Percent Overshoot
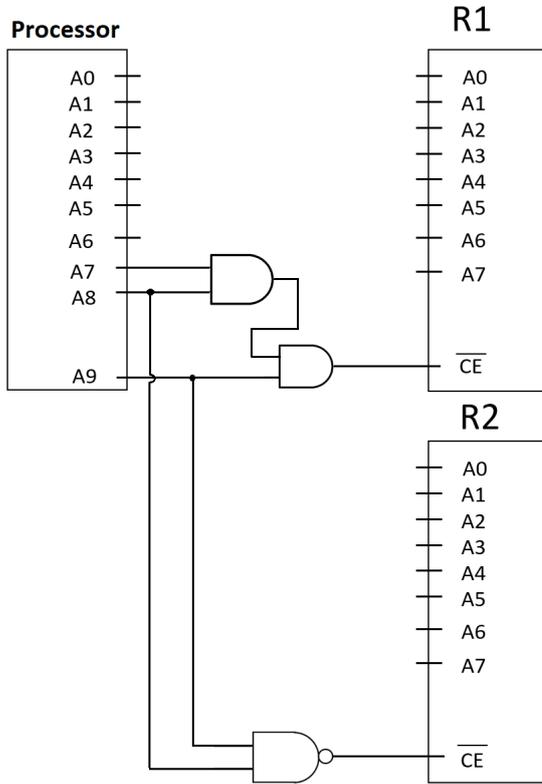
    (c) Settling Time

    (d) Steady State Error

8   (b) Explain why some variations of PID such as P-controllers, and PI-controllers do work in many cases while pure derivative control and pure integral control don't. Use the above example, or any other example, to illustrate your argument.

5. We have a small micro-processor similar to the 6502 we have been using in the hardware labs. This processor has 10 address lines A0-A9. We would like to interface two RAM modules (R1 and R2) with this controller. Each RAM module has 8 address lines (A0-A7) and can store 256 Bytes of memory. We configure the processor, such that address lines A0-A7 are connected to address pins A0-A7 on R1 and R2. You can assume that data pins on the processor and the two RAMs are also connected to each other.

(a) Consider the connection to the CE (Chip Enable - active low) pin on R1 and R2 as shown below. Address lines and data pins are connected as described above (connections are omitted for readability). Based on this configuration, answer the following questions:

Processor

Processor	R1
A0	A0
A1	A1
A2	A2
A3	A3
A4	A4
A5	A5
A6	A6
A7	A7
A8	
A9	$\overline{CE}$

(A7 and A8 feed an AND gate; its output and A9 feed a second AND gate whose output drives R1 $\overline{CE}$)

R2

R2
A0
A1
A2
A3
A4
A5
A6
A7
$\overline{CE}$

(A8 and A9 feed a NAND gate whose output drives R2 $\overline{CE}$)

(a) Based on the above configuration, what range of addresses on the processor map to RAM modules R1 and R2?

(b) How much total memory is available to the processor?

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(b) Now lets assume that we have the following configuration for Chip Enable (CE) instead. Do you see any problems with this setup? Please explain briefly.