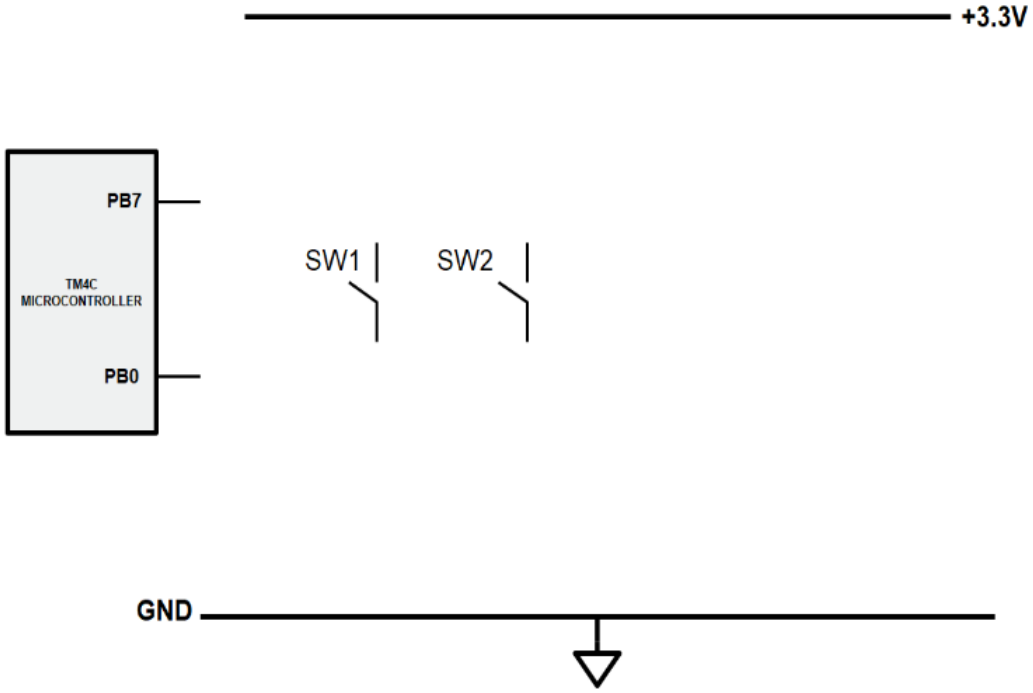
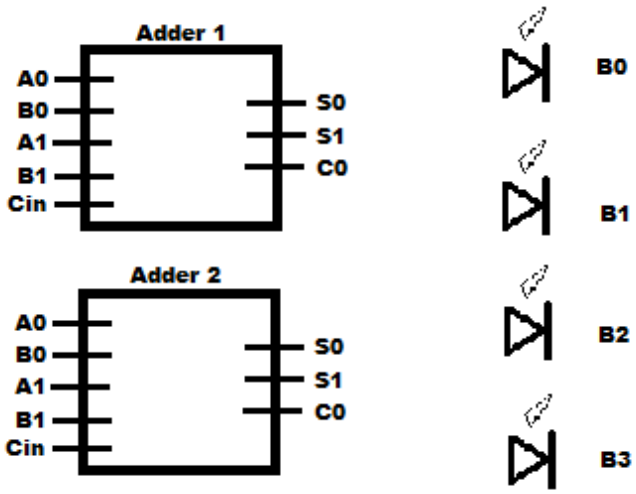
15-348 Embedded Systems: Sample Exam 1

Question:	1	2	3	4	5	6	Total
Points:	16	20	34	20	10	25	125
Score:							

8 1. (a) You have two 10k resistors and your goal is to interface both switches to the microcontroller Port B, bit 7, such that the input voltage is HIGH when either switch is closed and LOW otherwise. The microcontroller is powered by 3.3V. Show your circuit below.



8 (b) Consider the following image that has two 2-bit adders. Combine the two bit adders to make a 4-bit adder. You can assume that the lower 2 bits of each input are applied to input of Adder 1 and the upper two bits of each input are connected to Adder 2. The output should be displayed on the 4 LEDs on the right, with the least significant bit shown by B0.



(a)

A1 A0
+ B1 B0
+ Cin

(b) Functionality of a 2-bit adder

8 2. (a) You have a 16 bit timer and a 45MHz clock. The timer counter decrements every clock cycle and interrupts the controller once it decrements down to 0. What value should we set in the counter for it to interrupt after 0.5ms?

7 (b) We use the timer described in the previous task and load it with 0xFFFF every time it interrupts and then we count interrupts to keep track of seconds. How many interrupts would we need to count for 1 second? You can round up or down but explain your answer.

5 (c) If you use the number of interrupts you wrote for part B, what would be the amount of error after 1000 seconds?

15 3. (a) For the assembly code given below, indicate the value of each register shown after the instruction as well as the values for N and Z bits. Assume that there are the following four variables: `var1` at address location 0x2000000 and has initial value of 1; `var2` at address location 0x2000004 and has initial value of 2; `var3` at address location 0x2000008 and has initial value of 3; `var4` at address location 0x200000C and has initial value of 4.

```
exam1

    MOV     R1,#0x200       ;R1=_____, N=____, Z=_____

    LSL     R1,#20          ;R1=_____, N=____, Z=_____

    ORR     R1,#0x4         ;R1=_____, N=____, Z=_____

    LDR     R2,[R1,#4]      ;R2=_____, N=____, Z=_____

    MOVS    R0,#-4          ;R0=_____, N=____, Z=_____

    SUB     R2,R2           ;R2=_____, N=____, Z=_____

    BLT     skip1

    MOVS    R0,#-1          ;R0=_____, N=____, Z=_____
    B       skip2

skip1
    ADDS    R1,R0           ;R1=_____, N=____, Z=_____

    STR R0,[R1]

    BX  LR
skip2
    STR R2, [R1]

    BX LR
```

4 (b) After the above code executes, what are the values of the following variables

```
var1 = ____________________________________

var2 = ____________________________________

var3 = ____________________________________

var4 = ____________________________________
```

15 (c) Write assembly code below, that implements the following C function. Create var1, var2, and var3 as global 32-bit variables.

```
void min()
{
      if(var1 < var2)
         var3 = var1;
      else
         var3 = var2;
      return;
}
```

4. Suppose we input the periodic sequence "0101010101..." into a finite state machine. For each of the infinite sequences below, construct a state machine (specify the state diagram and the initial state) that will yield the sequence as output. You can choose to construct either a Mealy or a Moore state machine.

10 (a) abababababab ...

10 (b) aaaaababababababab ...

10 5. Design a Moore state machine which receives a 2-bit number as input X and produces a 1-bit output Y. The output Y becomes 1 when the cumulative sum of the input numbers becomes multiple of 3. When the cumulative sum is not multiple of 3, the output Y should be 0. You can assume that in the initial state the cumulative sum is zero. For instance, the input:

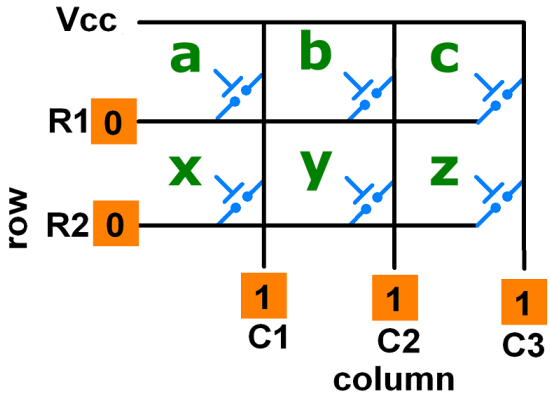
```
01, 01, 10, 00, 10, 11
```

produces the following output:

```
0, 0, 0, 0, 1, 1
```

Draw the state diagram of the Moore state machine.

6. You are asked to build a 6-key keypad with the TM4C LaunchPad using only 5 GPIOs rather than 6. The circuit of the keypad is as follows:



You can assume that the circuit works as follows: when `R1` is LOW and button 'a' is pressed, `C1` will be LOW, when `R2` is LOW and button 'y' is pressed, `C2` will be LOW, ...

10 (a) Write the function `setupPorts()` that configures the ports. You can choose any number of GPIO ports. You should indicate how the GPIO ports map to the pins of the keypad: R1, R2, C1, C2, C3.

```
void setupPorts(void)
{
    /** your code here **/




}
```

15 (b) Complete the main function such that each letter is printed through the serial port every time the corresponding key is pressed. You don't need to implement debouncing. The letter should be printed one time for each press and release. You can assume that all other functions are correctly implemented. If needed, add comments to explain your approach.

```
int main(void)
{
    PLLInit();
    SystickInit();
    SetupSerial();
    SetupPorts();
    /** your code here **/









}
```