Exam 1

Date: March 1, 2019

UT EID: _____

Printed Name: _____
Last, First

Your signature is your promise that you have not cheated and will not cheat on this exam, nor will you help others to cheat on this exam:

Signature:

Instructions:

- Closed book and closed notes. No books, no papers, no data sheets (other than the last two pages of this Exam)
- No devices other than pencil, pen, eraser (no calculators, no electronic devices), please turn cell phones off.
- Please be sure that your answers to all questions (and all supporting work that is required) are contained in the space (boxes) provided. **Do Not write answers on back of pages as we will not be scanning the back of your exam sheets.**
- You have 75 minutes, so allocate your time accordingly.
- Unless otherwise stated, make all I/O accesses friendly and all subroutines AAPCS compliant
- Please read the entire exam before starting.

Problem 1	10	
Problem 2	15	
Problem 3	10	
Problem 4	20	
Problem 5	10	
Problem 6	15	
Problem 7	20	
Total	100	

(2) ***Problem 1a.*** The intent of the function `Fun1` is to call another function `Output` with the values from 1 to 100. There is one bug. Fix the bug in the code by adding, changing or removing as necessary.

```
void Fun1(void){
    uint16_t i = 1;
    while (i<=100)
       Output(i);
       i = i+1;
}
```

(2) ***Problem 1b.*** The input is a 32-bit signed value in R0, and the return value, also 32-bit signed, is in R0. The intent of the function Fun2 is to return 1024*input+25. Choose the best answer that describes this function.

```
Fun2  LSL R0,R0,#10
      ADD R0,R0,#25
      BX  LR
```

A) This function is not AAPCS compliant.
B) There is a bug, should have used ASR.
C) There is a possibility for overflow.
D) There is a bug, should have used ADDS.
E) There is nothing wrong, it always works.

(2) ***Problem 1c.*** What is the value of `Diff` when the following function is executed?

```
uint8_t Data[4] = {1,2,4,8};
uint8_t Diff;
void Fun3(void){
   Diff = Data[1] - Data[2];
}
```

(2) ***Problem 1d.*** Which equation describes the **power** dissipated in a resistor?

A) $P = V/I$
B) $P = V^2 * R$
C) $P = I^2 * R$
D) $P = V/R^2$
E) None of the above

(2) ***Problem 1e.*** What is the value in the variable z after executing this C code?

```
uint16_t x = 0x1234;
uint16_t y = 0xEDCB;
uint16_t z = x&&y;
```

(15) ***Problem 2.*** Consider the following C function that finds the integer part of the square-root of a number (num). Convert the C code to assembly code so that it implements the same functionality in each box.

`uint16_t root;` `uint32_t sqr;`	`AREA  DATA, ALIGN=2`
`const uint32_t num=1000;`	`AREA  |.text|, CODE, READONLY, ALIGN=2`

`void Func(){`
`  root = 1;`
`  sqr = 1;`	

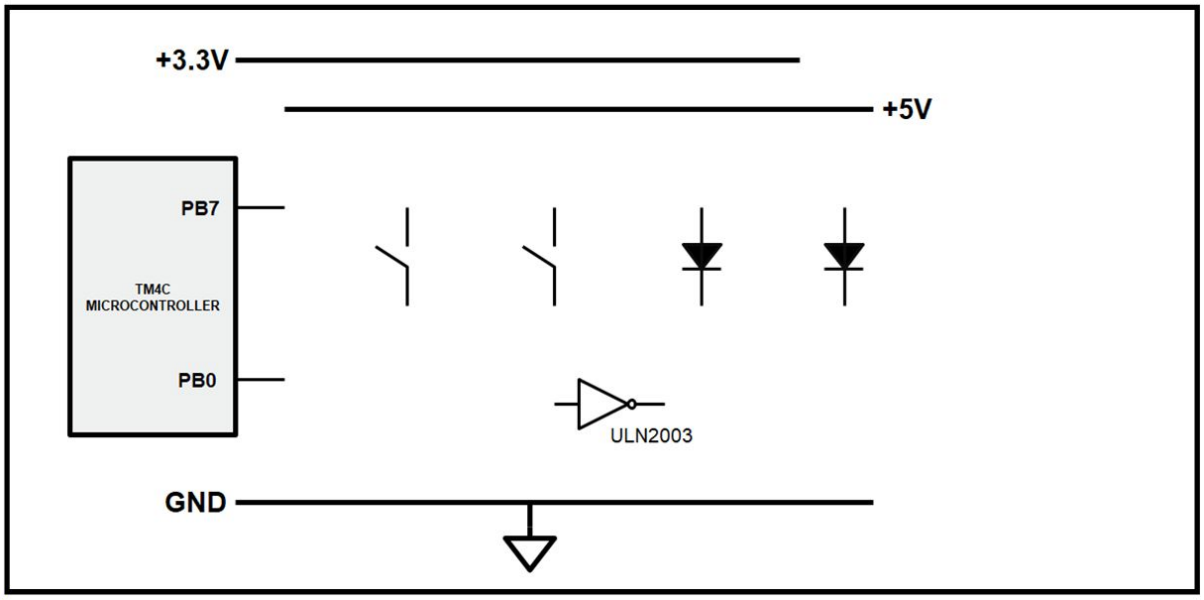
`  while (sqr <= num){`
`    root++;`
`    sqr = root*root;`
`  }`	

`  root--;` `}`	

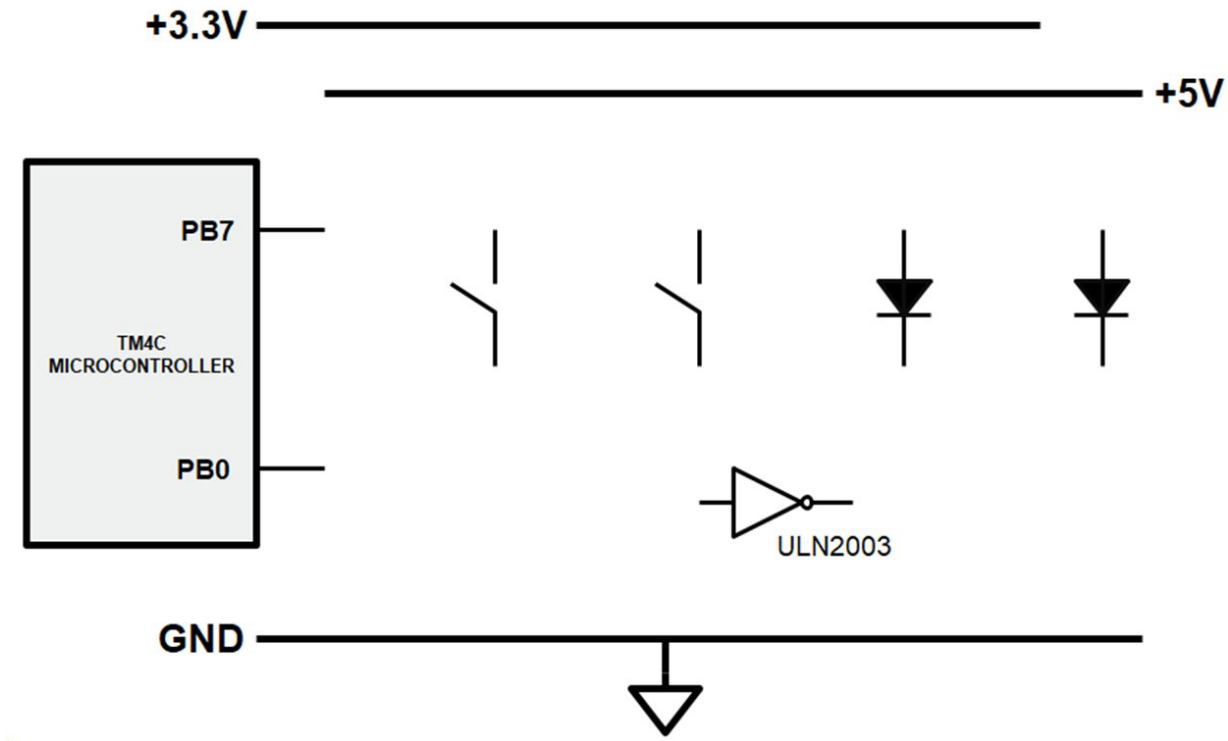
(10) ***Problem 3.*** Consider the following assembly function that performs input/output on Port B. You may assume Port B has been initialized so PB0-3 are inputs, and PB4 is an output. Convert the assembly function to C code so that it implements the same functionality.

```
OneOne
      LDR R1,=GPIO_PORTB_DATA_R
      LDR R0,[R1]
      AND R0,R0,#0x0F
      CMP R0,#0x01
      BEQ One
      CMP R0,#0x02
      BEQ One
      CMP R0,#0x04
      BEQ One
      CMP R0,#0x08
      BEQ One
      MOV R0,#0x0
      B   Done
One   MOV R0,#10
Done  STR R0,[R1]
      BX LR
```

(10) ***Problem 4a***: Using only ONE 10 kΩ resistor, interface both switches to the microcontroller Port B, bit 0 such that the input voltage is LOW when both switches are closed and HIGH otherwise. The microcontroller is powered by 3.3V. Show your circuit below.



(10) ***Problem 4b*****:** Using only ONE resistor, interface both LEDs to the microcontroller Port B, bit 7 using positive logic. The LEDs are either both ON or both OFF at the same time. The operating point for each LED is 50mA at 2.5V. Assume both LEDs are identical. The microcontroller's output high/low voltages are 3.3V and 0V, respectively. The V_{OL} for the ULN2003 driver is 0.3V. You have +5V, +3.3V, and GND to which you can connect your components. Design your circuit such that the power dissipated in the resistor is less than 125mW (1/8W). Show your circuit below, compute the resistor value needed for the above operating point, and determine the power dissipated in the resistor when the LED is on. Show your calculations



Resistor Calculations
Power Calculations

(10) ***Problem 5***: The objective of this question is to design a system that creates an orange light using the three-color LED of the LaunchPad. If you output a 0,0,1 to PF3,PF2,PF1, the LED will be red. If you output 1,0,1 to PF3,PF2,PF1, the LED will be yellow. To make your eyes think you see orange you can alternate red with yellow.

Address	7	6	5	4	3	2	1	0	Name
$400F.E608			GPIOF	GPIOE	GPIOD	GPIOC	GPIOB	GPIOA	SYSCTL_RCGCGPIO_R
$4002.53FC				DATA	DATA	DATA	DATA	DATA	GPIO_PORTF_DATA_R
$4002.5400				DIR	DIR	DIR	DIR	DIR	GPIO_PORTF_DIR_R
$4002.551C				DEN	DEN	DEN	DEN	DEN	GPIO_PORTF_DEN_R

```
#define SYSCTL_RCGCGPIO_R  (*((volatile uint32_t *)0x400FE608))
#define GPIO_PORTF_DATA_R  (*((volatile uint32_t *)0x400253FC))
#define GPIO_PORTF_DIR_R   (*((volatile uint32_t *)0x40025400))
#define GPIO_PORTF_DEN_R   (*((volatile uint32_t *)0x4002551C))
```

(5) Part a) Show the initialization function that configures PF3,PF2,PF1 as outputs. You must write friendly code. Since you are not using PF0, you need not unlock anything. You must solve this in C.

```
void Orange_Init(void){









}
```

(5) Part b) Show the main program that calls the initialization function in part a), and executes an infinite loop that creates the orange light. You must write friendly code. You must solve this in C.

```
int main(void){









}
```

(15) ***Problem 6***: Assume the value of the Stack pointer (SP) is `0x20000FFC`. Consider, the following code sequence starts execution at label `CallR`. The initial stack contents are given on the right. When drawing the stack contents, you need only to show numbers on the stack that represents valid data.

```
CallE
     PUSH {R4,R1}     <--- A
     LSR  R4,R0,R1
     SUB  R1,R4
     LSL  R0,R1,R4
     POP  {R4,R1}
     BX   LR
. . .
CallR               <--- Start here
      POP  {R1,R0}
      MOV  R4,#16
      BL   CallE
      ADD  R0,R4
      SUB  R1,#1
      BL   CallE
      . . .          <--- B
```

	0x20000FF4	**64**
	0x20000FF8	**6**
SP-->	**0x20000FFC**	**32**
	0x20001000	**5**
	0x20001004	**16**
	0x20001008	**4**
	0x2000100C	**8**

(8) **Part a)** Give the state of the stack (SP and contents) *after* the first time the `PUSH` instruction marked **A** is executed. Each box is 32 bits.

0x20000FF4	
0x20000FF8	
0x20000FFC	
0x20001000	
0x20001004	
0x20001008	
0x2000100C	

SP: _____

(7) **Part b)** Give the state of the stack (SP and contents) while executing the instruction marked **B**, and the values stored in R0, R1, and R4.

0x20000FF4	
0x20000FF8	
0x20000FFC	
0x20001000	
0x20001004	
0x20001008	
0x2000100C	

SP: _____

R0: _____

R1: _____

R4: _____

(20) ***Problem 7***: You will write two *assembly* functions. The function **`Generate`** is given a 31-bit value in R0 with bit 31 initially 0. If the number of bits that are set (set means the bit is a 1) in R0 is odd, then the function will set bit 31 to 1. If the number of bits that are set in `R0` is even, then the function will NOT set bit 31. In this way, the return value in `R0` contains the original 31 data bits, plus one more bit, such that the entire register now has an even number of bits that are 1. For example, if the input value is `0x0000E000` (there are an odd number of bits that are 1), it returns `R0=0x8000E000`. For example, if the input value is `0x6018C003` (there are an even number of bits that are 1), it returns `R0=0x6018C003` unchanged. The second function **`Check`** is given a 32-bit input in `R0`, and returns a true (`R0=1`), if there are an even number of bits that are set in the input. **`Check`** returns a false (`R0=0`), if there are an odd number of bits that are set in the input. One function may call the other if you wish. Your functions must be AAPCS-compliant.

`Generate`	**`Check`**