EE 2004
2020-2021: Semester B
Assignment 1
Due: Feb. 19, 2021

Instructions:
The .asm and .lst files for the programs required for Questions 1 and 2 should be submitted. The answers for Questions 3 and 4 should be provided in a Microsoft Word file. **The Microsoft Word file and all the requested .asm/.lst files should be zipped as a single zip file for submission.**

Students must submit the assignment through Canvas. Click on the item "Assignment" on the left panel. You should see a row with title "Assignment 1". Click on the "Assignment 1" label and find the "Submit Assignment" label on the right panel. Click on it and upload the requested zip file.

Question 1 (30 marks)

Loop: Summing numbers in a sequence

A sequence is defined by the following recurrence relation:

$Q_n = Q_{n-1} + Q_{n-2} + Q_{n-3}$

with seed value

$Q_0 = 0$, $Q_1 = 0$ and $Q_2 = 1$ where Q_n is the n^{th} number in the sequence.

Write a loop in assembly language that calculates the sum of the series $Q_0 + Q_1 + \ldots\ldots Q_{10}$. Store the sum in the file register with address 0x000. Save your program in a file named `Loop.asm`. Assemble and verify your code using MPLAB. You should submit the `Loop.asm` and `Loop.lst` files.

Question 2 (19 marks)

BCD addition of two multi-byte numbers

Write a program to add two decimal numbers 524198 and 487998. Note that the result should be stored in four file registers. Save your program in a file named `BCD.asm`. Assemble and verify your code using MPLAB. You should submit the `BCD.asm` and `BCD.lst` files.

Question 3 (21 marks)
Use the program below to answer the following questions.

Line Number

```
4   ;-----------------------------------------
5                   cblock 0x03
6                   MyReg
7                   BSR_Set
8                   endc
9
10  ;-----------------------------------------
11                  ORG     0x0000
12
13  Main:           movlb BSR_Set
14                  clrf MyReg, A
15                  clrf MyReg, BANKED
16
17                  movlw 0x78
18                  movwf MyReg, A
19                  movlw 0x37
20                  addwf MyReg, W, A
21
22                  daw
23
24                  movlw 0xF0
25                  iorwf MyReg, F, A
26
27                  movf MyReg, W, A
28                  movwf MyReg, BANKED
29                  movlw 0x00
30                  andwf MyReg, F, BANKED
31
32  ;*****************************************
33  ;End of program
34  ;
35                  END
```

(a) Write down the **12-bit address** of the memory location in which the result of the `iorwf` operation in Line 25 of the above program is stored.

(b) Write down the **12-bit address** of the memory location in which the result of the `andwf` operation in Line 30 of the above program is stored.

(c) What are the statuses of the five flags in the STATUS register immediately following the execution of **Lines 20, 25, 30**? *You must demonstrate how you come up with the statuses of the five flags to receive credit.*

(d) What is the value stored in WREG after the execution of Line 22? Determine the five flags in the STATUS register immediately after the execution of Line 22. *You must demonstrate how your answers to receive credit.*

Question 4 (30 marks)

(a) For the following program, calculate the relative/absolute addresses (marked by "??"). You must show detailed calculations. Otherwise, you will obtain 0 mark in this question.

(b) Provide a brief description of the goal of the program. (Hint: What is stored in FinalReg?)

(c) Analyze the source code, draw a chart describing the flow of the program and explain how the goal stated in your answer to Part (b) is accomplished.

```
Program
Memory   Machine      LINE                  SOURCE
Address  Code
                      00005                  CBLOCK 0x000
                      00006                  FirstReg
                      00007                  SecondReg
                      00008                  ThirdReg
                      00009                  FinalReg
                      00010                  endc
                      00011
000000                00012                  org 0x000000
000000 EF?? F???      00013                  goto Main
                      00014 ;------------------------------
000048                00015                org 0x000048
000048 0E3C           00016 Main:          movlw d'60'
00004A 6E00           00017                movwf FirstReg, A
00004C 0E16           00018                movlw d'22'
00004E 6E01           00019                movwf SecondReg, A
000050 0E37           00020                movlw d'55'
000052 6E02           00021                movwf ThirdReg, A
                      00022
000054 5000           00023 Here:          movf FirstReg, W, A
000056 6E03           00024                movwf FinalReg, A
000058 5C01           00025                subwf SecondReg, W, A
00005A E6??           00026                bn Final2
00005C D???           00027                bra Continue
00005E C001 F003      00028 Final2:        movff SecondReg, FinalReg
000062 5003           00029 Continue:      movf FinalReg, W, A
000064 6002           00030                cpfslt ThirdReg, A
000066 D???           00031                bra Over
000068 C002 F003      00032 Final3:        movff ThirdReg, FinalReg
00006C D???           00033 Over:          bra $
```