COMP2611 Spring 2016 Homework #2

(Due Monday Apr 11, 5:00PM)

Name: ______________________________ **Stu ID:** ___________________________

Notes:

- This is an individual assignment; all work submitted by you must be your own.
- Submit your written answers in a pdf file zipped with all the MIPS assembly files (do not change the assembly file names)
- Upload your work via CASS, naming the zip file <*your_stu_id*>*.zip.* You can submit it as many times as you wish. We will only take account of the version available at the deadline.

Question 1: Searching for an integer in an array (10 marks)

Write a full MIPS assembly language program to search whether a user-input integer value exists in a randomly generated array of integers. Refer to the skeleton file "`searchArray.s`" for more details. You should follow the usage of registers as specified in the skeleton. Do not change the filename.

Question 2: Finding the Minimum and the Maximum values in an array (10 marks)

By referring to the following C/C++ code of the bubble sort algorithm that sorts an array of signed integers in ascending order, complete the "`bubbleSort.s`" skeleton program provided to you. For simplicity, you can assume the array `a[]` has a fixed size 10 (i.e contains 10 arbitrary integers). You should follow the usage of registers as specified in the skeleton. You need to complete the code under the "TODO" comment in the skeleton. Do not change the file name.

```
bubbleSort(int a[], int n){       /*n is the size of the array a */

      int i,j,temp;

      for (i=0; i<n-1; i++) {

        for (j=0; j<n-1-i; j++)

          if (a[j+1] < a[j]) {   /* compare the two neighbors */

            temp = a[j];         /* swap a[j] and a[j+1]      */

            a[j] = a[j+1];

            a[j+1] = temp;

        }

      }

}
```

Question 3: Switch/case with large numbers (10 marks)

To check whether it is the mid-term exam day or not, assume you supply in input the date as an integer formatted as “YYYYMMDD” in the following C++ code. Translate the C++ code below into a MIPS assembly instructions in the skeleton file “`switch.s`” provided to you. Assume the user always enters a valid date and the value of the `date` variable is stored in the register `$v0`. Fill in your code for the three TODOs in the skeleton. Do not change the file name.

```
int date;

cout << "Please enter the date in YYYYMMDD format:";

cin >> date;

switch (date) {
  case 20160310:
    cout << "Midterm 1 date\n";
    break;
  case 20160414:
    cout << "Midterm 2 date\n";
    break;
  default:
    cout << "Not a midterm date";
  }
```

Question 4: Performance Evaluation (10 marks)

The number of clock cycles per instruction for the instruction classes of two hardware architectures `Arch1` and `Arch2` are given below. Assume architecture `Arch1` has a clock frequency of **500Mhz**, and architecture `Arch2` has a clock frequency of **1GHz**, answer the following questions.

Arch1	Number of clock cycles required
Instruction class A1	3
Instruction class B1	4
Instruction class C1	8

Arch2	Number of clock cycles required
Instruction class A2	2
Instruction class B2	2
Instruction class C2	2

a) The compilers of a high-level language program generate 500,000 instructions for architecture `Arch1` and 3,000,000 instructions for `Arch2`. If the number of instructions is divided equally among all the classes of instructions for both machines, what are the CPU times required by `Arch1` and `Arch2` in running the program? (Assume here and in the sequel that on either architecture, for this program, each and every instruction is executed once and only).

Arch1= ((500 000 instructions /3)*3 cycles+(500 000 instructions /3)*4cycles+(500 000 instructions /3)*8 cycles)*1/(500*10^6)=0.005 seconds

Arch2 = (3 000 000*2)/ (1000*10^6) = 0.006 seconds

b) What should the clock rate of Arch2 be so that Arch2 will have the same performance as Arch1 for the high-level language program?

(0.006/0.005) * 1000 MHz = 1200 MHz

c) Assume that Arch2 has been improved by reducing the number of clock cycles for the instructions of class C2. What is the maximum allowed number of clock cycles for the C2 instructions, if the improvement is to make Arch2 as fast as Arch1 in executing the program?

Assume instructions of C2 requires x cycles, then we have

3 000 000*((2+2+x)/3)*(1/1 000 000 000) <= 0.005

x (1 000 000 / 1 000 000 000) <= 0.001

x <= 1

Therefore the instructions of class C2 can take at most 1 cycle if the improvement is to make Arch2 as fast as Arch1 for the program.

d) An improved compiler for `Arch2` has been developed. The new compiler generates less instructions for the same high-level language program. It generates 5% of class A2 instructions as that of the original compiler on `Arch2`, it generates 15% of class B2 instructions and 20% of class C2 instructions as that of the original compiler. Assume the clock of `Arch2` still runs at the rate of **1000MHz**, what is the new CPU time for running the program under `Arch2`?

The total number of instruction generated under the new compiler

= (3 000 000*0.05/3)+ (3 000 000*0.15/3)+ (3 000 000*0.2/3)

= 400 000

CPU Time required = (400 000 * 2 / 1 000 000 000) = 0.0008 seconds