

# Fall 2012: CSE 420: Computer Architecture I

## Project 1

*Due Date: Tuesday, Sept. 18, 8:30a.m., 2012*

### Objective

Assembly language programming

### Preparation

Computer Organization and Design, The Hardware/Software Interface Chapter 2.

### Problem 1: String handling [20 points]

Declare a string in the data section:

```
.data
string: .ascii "abcdefgh"
```

Write a program that converts the string to all upper case characters. Do this by subtracting  $0x20$  to each character in the string.

### Problem 2: Arithmetic expressions and Function Call [30 points]

1. Write a subroutine that takes three arguments,  $c$ ,  $x$ , and  $y$ . It then computes and returns  $c*x*y$ .
2. Use the subroutine to evaluate the following function of  $u$  and  $v$ :

$$5u^2 - 12uv + 6v^2$$

The calculation of all the three terms must be done using the function you have written.

**[Undergraduate students]** Statically define  $u$ , and  $v$  to any value you want, and then print out the value of the expression.

**[Graduate students]** Prompt the user to enter  $u$ , and  $v$ , and then print out the value of the expression.

### Problem 3: Pointers [30 points]

Write a program in MIPS assembly language that will compute the sum of all the elements in an array. Write this program using a function “PSum”, that takes two parameters, a pointer to the running sum, and a pointer to the current element.

The “C” function looks like this:

```
int sum = 0;
int *sump = &sum;

void PSum(int *s, int *e)
{
    *s += *e;
}

void sumOfArr(int *a, int size)
{
    for (int i=0; i<size; i++)
    {
        a[i] = i;
    }

    for (int i=0; i<size; i++)
    {
        PSum(sump, a+i);
    }

    printf("sum = %d\n", sum);
}

void main()
{
    int a[10];

    sumOfArr(a, 10);

    return 0;
}
```

#### Problem 4: Recursion [20 points]

##### [Undergraduate students]

Write a program in MIPS Assembly Language that to find  $B(i, x)$ , where  $B(i, x)$  is defined recursively as:

```
int B(int i, int x)// assume i > 0, x > 0
{
    if (x>0) return B(i,x-1);
    else if (i>0) return B(i-1, i-1)+1;
    else return 0;
}
```

The program should take 2 numbers,  $i$  and  $x$ , and compute  $B(i, x)$  for them.

##### [Graduate students]

Write a program in MIPS Assembly Language that to find  $A(m, n)$ , where  $A(m, n)$  is defined recursively as:

```
int A(int m, int n)
{
    if (m==0) return n+1;
    else if ((m>0) && (n==0)) return A(m-1,1);
    else if ((m>0) && (n>0)) return A(m-1, A(m,n-1));
}
```

The program should take 2 numbers,  $m$  and  $n$ , and compute  $A(m, n)$  for them.

This function is a very rapidly growing function. Even values of 4 for  $m$  and  $n$  will yield an extremely large number.  $A(4, 2)$  is about  $2 \times 10^{19728}$ . So use small values of  $m \leq 3$ ,  $n \leq 4$ .

### Submission Instructions

1. This project is an *individual* project.
2. Save your program files with extension *.s* or *.asm*.
3. Zip all files into one file and submit it on the blackboard.
4. File name convention: *ASUID\_FirstName\_LastName\_Project\_1.version*. The one that fails to follow the convention may get points deducted by 10 points.

#### Attention:

Only last submission will be graded if multiple submissions are found.

The last time to submit is Tuesday, Sept. 18<sup>th</sup> 8:30 a.m., 2012.

Late submission is not acceptable. In this case, ZERO will be given.

#### Scoring criteria:

1. Working programs (70%).
2. Program comments and readability (30%) - Your submitted source code should have enough comments to describe the design of your program.