

## CS2.201: Computer Systems Organization

Professor: Praveen Paruchuri

Spring 2022

International Institute of Information Technology, Hyderabad

---

### Assignment 2

Deadline: 23:55, June 20, 2022

**Instructions:** Read all the instructions below carefully before you start working on the assignment.

- There are 5 problems for this assignment.
- The assignments will be manually evaluated for plagiarism. Any and all forms of plagiarism will result in zero marks for this assignment.
- Instructions for first two questions
  - Write well-organised code using procedures for repeated operations.
  - Writing complete code with successful execution guarantees full marks. Failure on test cases will result in penalisation. Therefore ensure all edge cases are handled.
  - For the first question, marks will be awarded **only if it is implemented using stacks, and no other data structures.**
  - For the second question, marks will be awarded **only if it is implemented using recursive functions, and no other method.**
  - Hard coded solutions will get a straight zero.
  - Comment every line of your code and justify why you write that statement. Total of 5 marks for commented code.
- Total marks for assignment is 100.
- Make sure you do assignment yourself. Assignment evaluations will be conducted.
- Submit the solution for question 3,4,and 5 a,b in a *pdf* format(4 and 5 a,b should be handwritten).

**Submission format:** Strictly adhere to the following submission format. Failure to do so may result in an erroneous evaluation of your assignment.

- The following directory structure is expected,

```
./<roll_number>
├── q1
│   ├── q1.s
│   └── q1.c
├── q2
│   ├── q2.s
│   └── q2.c
├── assignment2.pdf
└── q5
```

- q5 is an executable file.
- Zip the `./<roll_number>` folder and name the zipped folder as `<roll_number>_assign2.zip`

Assume all the integer variables to be long long int. In case of error or invalid input return '-1'. Overflow cases to be handled (You can use remainder function).

**Problem 1:**

20 marks

**Stack**

There are  $n$  students standing in a line. You are given the height for each student. For each student find the height of the nearest taller person to the right of the student. In case no such student exists, the answer is -1. Write a function in x86 assembly code for the problem.

**Input/Output Format**

- You will be given the integer  $n$ , the number of students.  $1 \leq n \leq 100$
- The input and output arrays will be stored in the memory with only the base address provided.

**Sample Test Case**

$n = 6$

Input sequence of numbers - [ 4, 4, 5, 2, 10, 8 ]

Output sequence of numbers - [ 5, 5, 10, 10, -1, -1]

Explanation- For zeroth element(i.e. height of first person in the line- 4) the next greater height is of 5. Similarly for second element it is 10 and for fourth element there is no greater height in the remaining line, hence -1 is the output.

**Problem 2:**

20 marks

**Recursion**

Given a number  $n$ , find count of all binary sequences of length  $2 \times n$  such that sum of first  $n$  bits is same as sum of last  $n$  bits. Write a function in x86 assembly code for the problem.

**Input/Output Format**

- Input: You will be given the integer  $n$   
 $1 \leq n$
- Output: Return the integer denoting the number of possible sequences.

**Sample Test Case**

Input:  $n = 1$

Output: 2

There are 2 sequences of length  $2 \times n$ , the sequences are 00 and 11

Input:  $n = 2$

Output: 6

There are 6 sequences of length  $2 \times n$ , the sequences are 0101, 0110, 1010, 1001, 0000 and 1111

**Problem 3:**

10 marks

Find and provide detailed information about your system. It should contain information regarding your system's operating system, kernel modules, file systems, processor, memory, PCI devices, USB devices, battery, sensors, storage, DMI.

Benchmark score of at least one of the following CPU Blowfish, CPU cryptohash, CPU Fibonacci, CPU N-Queens, CPU Zlib, FPU FFT, FPU Raytracing and GPU Drawing.

**Problem 4:**

15 marks

What does *assemblycode* (0xc,0x15) return? Submit the flag as a hexadecimal value (starting with '0x'). Also write comments for each line of the assembly code and illustrate the status of the stack after each stack operation. The solution should not exceed two pages

Note : In the case of loops you may show the stack status while entering and exiting the loop.

*assemblycode*(a,b) implies

push b

push a

call *assemblycode*

## Listing 1: x86 Code

```
1 assemblycode:
2     <+0>: push ebp
3     <+1>: mov ebp,esp
4     <+3>: sub esp,0x10
5     <+6>: mov eax,DWORD PTR [ebp+0xc]
6     <+9>: mov DWORD PTR [ebp-0x4],eax
7     <+12>: mov eax,DWORD PTR [ebp+0x8]
8     <+15>: mov DWORD PTR [ebp-0x8],eax
9     <+18>: jmp 0x50c <asm2+31>
10    <+20>: add DWORD PTR [ebp-0x4],0x1
11    <+24>: add DWORD PTR [ebp-0x8],0xaf
12    <+31>: cmp DWORD PTR [ebp-0x8],0xa3d3
13    <+38>: jle 0x501 <asm2+20>
14    <+40>: mov eax,DWORD PTR [ebp-0x4]
15    <+43>: leave
16    <+44>: ret
```

**Problem 5:**

10 + 5 + 5 marks

- (a) This question is to help you explore more about the executable files you have been using. Here a C program and its a.out are provided. You have to figure out what is wrong with the given a.out file. You may refer to the following links to get an idea about ELF files .....(max 50 words)

ELF - Understanding ELF  
patchelf - Patchelf

- (b) What information can you infer from the binary file? (max 25 words, mention one or two points).
- (c) Write an executable file q5 which prints "hello there" on running ./q5 (Hint: search up "Shebang")