

Data Structures and Algorithms – CS2402

Midterm 1

50 points - 50 minutes

Make sure that you justify all your answers. Two points will be given for the clarity of presentation of your answers.

Exercise 1 (7 points) Determine the running time function and the corresponding big-Oh notation of the following fragment of code:

```
int sum=0;
for (int i = 0; i < n; i += 2)
    for (int j = 0; j < i; j += 1)
        sum++;
```

Exercise 2 (5 points) Determine the running time function and the corresponding big-Oh notation of the following fragment of code:

```
for (int i = 1; i ≤ n2; i* = 3)
    my_procedure;
// where my_procedure is known to run in running time p(n)
```

Exercise 3 (12 points)

- Describe the Josephus problem (2 points).
- Explain why you can solve it using a linked-list, and also using an array (2 points).
- Discuss the pros and cons of each (2 points).
- Give and justify the complexity of the method using an array, and then using a linked-list, when the number of people is N , and you eliminate the n^{th} person each time (6 points).

Exercise 4 (24 points)

1. What is a stack? describe the data structure. (4 points)
2. Describe Depth-First Search. (3 points) You can use examples to help you describe the method.
3. Give the algorithm (pseudo-code) for DFS. And explain how/why you use a stack to implement DFS. (6 points)

4. Suppose you implement DFS to find a solution to a constraint problem. Does the method you've just described (in question 4.3) allow to return all solutions? **(6 points)**
- (a) If so, 1. explain why, and 2. explain how to modify your algorithm to return only the first solution found.
 - (b) If not, 1. explain how to modify your algorithm so that it returns all solutions, and 2. explain why this modified algorithm actually returns all solutions.
5. What is the time complexity of DFS, if d_{max} is the size of the longest branch in your search tree, and b the maximum number of alternatives given at each choice point? **(5 points)**