Gebze Technical University
Department of Computer Engineering
CSE 321 Introduction to Algorithm Design
Fall 2018
Midterm Exam
November 14th 2018

Student ID and Name	Q1 (20)	Q2 (20)	Q3 (20)	Q4 (20)	Q5 (20)	Total

Read the instructions below carefully

- All cases of confirmed cheating will be reported for disciplinary action.
- You have 150 minutes.

Q1.

Consider insertion sort and quicksort. For each algorithm, what will be the worst case asymptotic bound on the running time if you additionally know that

a) the input is already sorted?

b) the input is reversely sorted?

c) the input is a list containing *n* copies of the same number?

For each case and each sorting algorithm, explain and justify your answer in detail. **(20 points)**

Q2. A directed graph is *strongly connected* if there is a path between any pair of two vertices. Propose an algorithm that uses DFS and checks whether a given directed graph is strongly connected. **(20 points)**

Q3. For each of the following functions, indicate the class θ(g(n)) the function belongs to. (Use the simplest g(n) possible in your answers). List these functions according to their order of growth. Prove your assertions. (Any immediate answer without justification will not be graded.) **(20 points)**

a. $(n^2+1)^{10}$

b. $\sqrt{10n^2+7n+3}$

c. $2n \log((n+2)^2)+(n+2)^2\log(n/2)$

d. $2^{n+1}+3^{n-1}$

e. $\lfloor log(n) \rfloor$

Q4.

Solve the following recurrence relations **(20 points)**.

a) $x(n)=x(n-1)+5$ for $n>1$, $x(1)=0$

b) $x(n)=3x(n-1)$ for $n>1$, $x(1)=4$

c) $x(n)=x(n-1)+n$ for $n>0$, $x(0)=0$

d) $x(n)=x(n/2)+n$ for $n>1$, $x(1)=1$ (solve for $n=2^k$)

e) $x(n)=x(n/3)+1$ for $n>1$, $x(1)=1$ (solve for $n=3^k$)

Q5. An *independent set* in a graph is a set of pairwise non-adjacent vertices. Given a graph G and a positive integer *k*, the *independent set problem* determines whether G contains an independent set of size *k*. Design an exhaustive search algorithm for this problem. **(20 points)**