Istanbul Bilgi University

CMPE 211 Data Structure and Algorithms

2017-2018 Fall Midterm Exam

Name : ..... Department : .....

Student No : ..... Date : .....

Grade : .....

You have 75 min to answer 5 questions. Make sure that you explain in detail all your steps - thoughts. You may get extra points for an appropriate observation, you may lose some points due to an obscure solution.

[20P] Q.1 (a) What is the time complexity of the following program. (b) Propose a modification in the code, in order to reduce the time complexity. Then calculate the time complexity of your proposal.

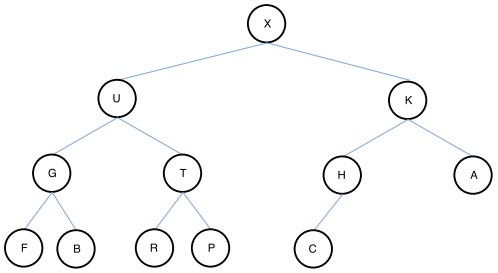
```
1       public long power(int x, int n){
2           if (n == 0) return 1;
3           if (n%2 == 0)
4               return power(x,n/2) * power(x,n/2);
5           else
6               return x * power(x,n/2) * power(x,n/2);
7       }
```

[20P] Q.2 Compare the running times for two algorithms T_A and T_B running on different computers A and B, over input size $n = 10^7$. What is your conclusion?

	Computer Power
A	10^{10} instructions per sec.
B	10^7 instructions per sec.

	Algorithm Time
A	$T_A(n) = n^2$
B	$T_B(n) = n + 2T_B(n/2)$ with base case: $T_B(1) = 1$

[20P] Q.3 Describe how insertion and deletion are handled in Max-Heap. (a) Give the array representation of the heap shown below. (b) Insert item Q to the binary heap. Indicate any entries that changed. (c) Remove max and show resulting array and tree.



[20P] Q.4 Suppose you have implemented memory of an agent as an ordered-array. Memory holds information about a set of items. Indicate the worst-case running time of each operations below. Explain your results in detail.

know(item)	*does item exist in the set, if so return its index.*	
learn(item)	*add unknown item to its correct place*	
forget(item)	*delete the given item from the set*	
recommend()	return the item who has max value in the set	
rank(item)	return the number of items in the set that are less than given item	

[20P] Q.5 (a) Describe how merge sort operates? (b) What is its main disadvantage compared to quick sort? (c) Write the array content after all intermediate *merging* steps during the merge-sort.

Original Array	9	2	8	7	1
First Merge					
Second Merge					
Third Merge					
Fourth Merge					
Fifth Merge					

Alphabetical Order A-B-C-D-E-F-G-H-I-J-K-L-M-N-O-P-Q-R-S-T-U-V-W-X-Y-Z

Logarithm $log_2(10^6) = 19$ and $log_2(10^7) = 23$