PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

CS314—Data Structures & Algorithms

SEMESTER ONE EXAMINATION

THURSDAY 2ND JUNE 2022

TIME ALLOWED: 3 HOURS

INSTRUCTIONS

1. Write your name and student number clearly on the front of the answer booklet.
2. There are seven (7) questions in the Examination Booklet.
3. You have 10 minutes to read this paper. Please **do not** write during this time.
4. All answers must be written in the examination answer booklet.
5. Attempt All Questions.
6. Notes, mobile phones, textbooks and dictionaries are NOT allowed in this exam.
7. Use blue or black ink—not pencil or red ink.
8. **Do not write** anything or **turn this page** until you are told to do so.

Marking Scheme

Questions	Marks
Question 1	/9
Question 2	/15
Question 3	/13
Question 4	/10
Question 5	/13
Question 6	/10
Question 7	/16
Total	**/86**

Question 1: [3+3+3=9 marks]

a) What are the two issues of measuring program performance based on execution time? Also explain why it is not fair to compare performance of two algorithms based just on execution time.

b) What is the difference between a Set and Map abstract data types in Java?

c) What is the difference between the Set abstract data structure and sequential data structures like `ArrayList`, `Arrays`, `LinkedList` in terms of inserting elements?

Question 2: [5+5+5=15 marks]

a) Given the formal definition: A function f(n) is O(g(n)) if for some constant c and for values of n greater than some value n_0: ***ie:*** **$f(n) <= c * g(n)$.** That is the complexity of an algorithm as function of problem size ***n*** and that ***g(n)*** is an upper-bound on that complexity. The actual time of problem will be no worse than the ***g(n)*** – ie. ***f(n)=O(g(n)).*** Given $f(n)=5n^2+4$ and $g(n)=n^2$, show that the function ***f(n)*** is bounded by the function ***g(n).*** For what values of constant c and n will this ***f(n)=O(g(n))*** be satisfied.

b) Analyse and derive the time complexity of Compute method given below.

```
1    public static void compute(int n){
2         int count=0;
3         for(int i=0;i<=n;i++){
4            for(int j=0;j<=n;j++){
5               for(int k=0;j<=n;k++){
6                    count+=1;
7               }
8            }
9         }
10    }
```

c) Analyze and derive the time complexity for the following code.

```
1    public static void compute(int n){
2     int count=0;
3        if(0<=n && n<10){
4         for(int i=0;i<=n;i++){
5            for(int j=1;j<=n;j++){
6               for(int k=i;k<n;k++){
7                    count+=1;
8               }
9            }
10        }
11     }else if(n>=10){
12        for(int i=0;i<=n;i++){
13           for(int j=1;j<=n;j++){
14                   count+=1;
15           }
16        }
17     }
18   }
```

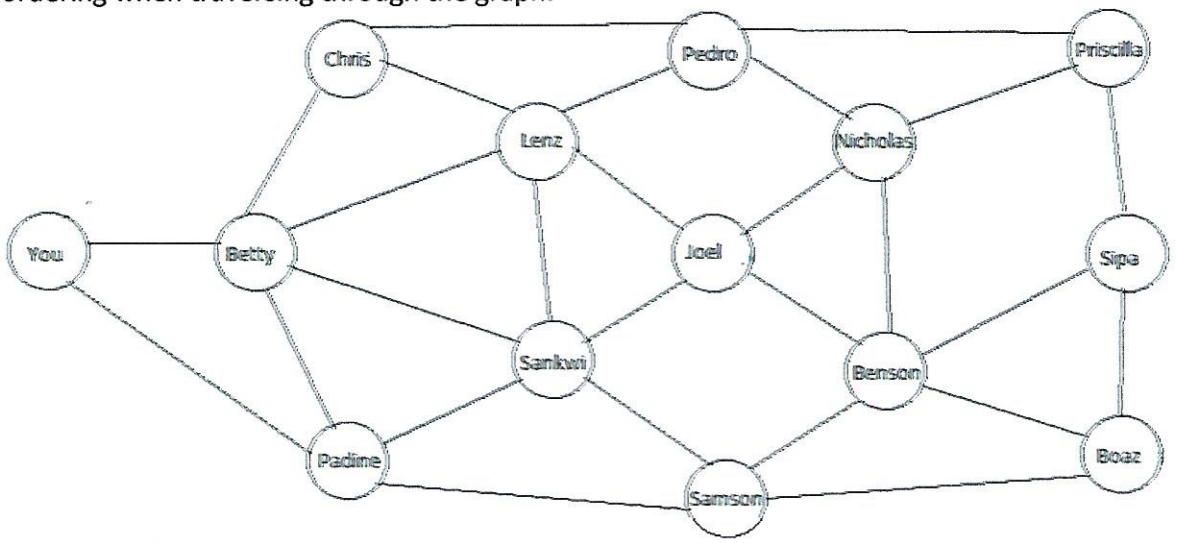
Question 3: [5+8=13 marks]

a) Illustrate using a diagram how the Merge Sort works using the array of ten elements.
`[2 9 5 4 8 1 6 7 3 0]`

b) Analyze the time complexity of the algorithm of applying the Merge Sort algorithm on the array in Question 3(a).

Question 4: [5 + 5 = 10 marks]

Below is a connectivity graph showing staff members at Mathematics and Computer Science Department. Suppose you want to make to reach the node that contains *Sipa*. Use natural ordering when traversing through the graph.



a) Use Breadth First Search (BSF) algorithm to traverse the graph to get to the node containing Sipa.

b) Use Depth First Search (DFS) algorithm to traverse the graph to get to the node containing Sipa.

Question 5: Binary Search Tree [5 + 2+2+2+2=13 marks]

a) Draw a binary search tree by inserting the following names from left to right.
`Joel,Betty,Mirriam,Lenz,Chris,Benson,Boaz,Dorothy,Benny,Kuna,Beta,Sipa,Luke,Pedro`

b) State whether the binary search tree in (a) is full, complete or neither full nor complete and explain your answer.

c) Who are the descendants of Betty?

d) Who are the ancestors of Kuna?

e) Insert two node into the tree in (a) with the following names **Bobby** and **Ursul** respectively.

Question 6: [(2 + 2) + 6 =10 marks]

a) For this question refer to Question 5 (a). State the order of traversal of the Binary Search Tree using the traversal orders:
   (i) Preorder Traversal
   (ii) Postorder Traversal

b) Convert the binary tree in Question 5 (a) into a MIN HEAP binary search tree.

Question 7: [(4+2)+10=16 Marks] Map implementation table

a) Below is a heap implementation using an array. Each node in the heap stores the values given in the array. The implementation of the heap is based on the heap numbering scheme.

50	20	30	15	18	28	29	13	14	16	17	22	23	26	27	10	11	2	3	4	5	6	7	20	21	0	1	24	25	20	21

   (i) What are the children of Node 10? Which values are stored on those nodes?
   (ii) What is the parent of Node 21? What value is stored at the parent node of Node 21?

b) Consider the string X=10110110100101001110... Let S_1, S_2,...,S_8 denote the first eight suffixes of X. Derive the suffixes and construct the suffix tree called the "trie" associated with these eight strings.

.....END OF EXAMINATION.....