B.Sc. Engg. / HD CSE 3rd Semester

16 March 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **WINTER SEMESTER, 2017-2018**

DURATION: 1 Hour 30 Minutes — **FULL MARKS: 75**

CSE 4303: Data Structures

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **4 (four)** questions. Answer any **3 (three)** of them.

Figures in the right margin indicate marks.

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1. a) Define data structure and mention some of its major applications. Consider the data in Figure 1, which gives different flights of an airline. Discuss one way of storing the data so as to decrease the time in execution the following: 9

   i. Find the origin and destination of a flight, given the flight number.

   ii. Given city A and city B, find whether there is a flight from A to B, and if there is, find its flight number.

	CITY
1	Atlanta
2	Boston
3	Chicago
4	Miami
5	Philadelphia

(a)

	NUMBER	ORIG	DEST
1	701	2	3
2	702	3	2
3	705	5	3
4	708	3	4
5	711	2	5
6	712	5	2
7	713	5	1
8	715	1	4
9	717	5	4
10	718	4	5

(b)

Figure 1: Figure for the question no. 1 (a)

   b) Analyze the worst case scenario of Insertion sort and Quick sort. For the following array and the specified search key, what will be the number of iterations performed by binary search? 8
   array = {-6, 3, 4, 7, 9, 10, 11, 15, 16, 18, 19, 22, 25 , 33, 47}, *search key* = 12

   c) In a singly linked list, can you speed up the two $O(n)$ operations of 8

   i. Inserting before an arbitrary node

   ii. Erasing any node that is not the last node

   If possible then describe the solution approach with appropriate figure.

2. a) Define Deque. Translate Q into its equivalent postfix expression P using stack. 9
   Q = (A + B * C / D – E + F / G / (H + I))

   b) Explain how queue can be utilized for encoding and decoding a message with a repeated key. Assume you have queues with operations: *enqueue()*, *dequeue()*, *front()*, *isEmpty()*. How would you use the queue methods to implement a stack, in particular, *push()* and *pop()* operation? 10

   c) What is garbage collection? Discuss how and when garbage collection takes place. 6

3. a) Draw the necessary trees for inserting the following numbers one by one into a max-heap. 8
   7, 2, 1, 9, 12, 3, 14
   Now pop the two largest elements off the heap. Draw the heap after each such extraction.

b) Compare Big-oh, Big-omega, and Big-theta. Use figure if necessary. For each pair of functions $f(n)$ and $g(n)$ given below: 9

i. Write Θ in the box if $f(n) = \Theta(g(n))$
ii. Write O in the box if $f(n) = O(g(n))$
iii. Write Ω in the box if $f(n) = \Omega(g(n))$
iv. Write X in the box if none of these relations holds

If more than one such relation holds, write only the strongest one. No explanation needed.

$f(n)$	n^2	$n \lg n$	4^{n+4}	3^n	$n \lg n$
$g(n)$	n^3	n	2^{2n+2}	2^n	$n^{\frac{101}{100}}$
O, Θ, Ω or X					

c) Explain which one provides more benefits to store any type of data in between binary search tree and binary search. Let T be a binary search tree storing 128 entries. What is the smallest and height possible height of T? [Note: The height of a tree is the length (number of edges) of the longest path. A tree consisting of just one node has height 0.] 8

4. a) For each of the following situations, name the best sorting algorithm: 10

i. The array is mostly sorted already (a few elements are in the wrong place)
ii. You need an $O(n \log n)$ sort even in the worst case and you cannot use any extra space except for a few local variables.
iii. You have many compound data sets to sort separately and each one has around 100 elements.
iv. Instead of sorting the entire data set, you only need the k smallest elements where k is an input to the algorithm but is likely to be much smaller than the size of the entire data.
v. The ages (in years) of the people of Bangladesh is stored randomly in a file with at least 1 year. Now, you are given a very simple task of sorting all the ages in descending order.

b) Write short note and two real life applications for each of the followings: 6

i. Circular linked list
ii. Stack
iii. Priority queue

c) Explain Time-Space Tradeoff with suitable example. Analyze the code of Figure 2 and find out the complexity in terms of Big-O notation step by step. (try to make the upper bound tighter) 9

```
void complexity(){
      int i,j,c=2,n;
      for (i = 1; i <= n/c; i++){
            for (j = n; j > 0; j = j/c) {
                  printf("Learn Teamwork!");
            }
      }
      for (i = 1; i <= n; i = i*c) {
            printf("Teamwork Wins!!");
      }
}
```

Figure 2: Figure for the question no. 4 (c)