BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2017 - 2018
COURSE: DATA STRUCTURES AND ALGORITHMS (CS F211)
TEST 1 (CLOSED BOOK)

DURATION: 50 Minutes
WEIGHTAGE: 20% (40 Marks) **DATE: 25 – FEB – 2018**
This question paper has 2 pages.

Answer in a word

1. a. List any two applications of stack **[2 M]**

b. What is the best and worst case time complexity of quick sort? **[1 M]**

c. How can the worst case complexity of quick sort improved? **[1 M]**

d. Merge sort can be implemented in-place TRUE/FALSE **[1 M]**

e. Radix sort runs in _____ time **[1 M]**

f. The best case performance of insertion sorting is **[1 M]**

a) O(n) b) log n c)$O(n^2)$ d)O(n log n)

Answer in detail

2. Programs A and B are analyzed and found to have worst-case running times no greater than $150\,n\,\log_2 n$ and n^2, respectively. Answer the following questions if possible: **[4 M]**

a. Which program has the better guarantee on the running time, for large values of n (n > 10,000)?

b. Which program has the better guarantee on the running time, for small values of n (n < 100)?

3. Is $2^{n+1} = O(2^n)$? Is $2^{2n} = O(2^n)$? Prove or justify your statement. **[2+2M]**

4. Consider a array based implementation of STACK. Assume that the array's size is 3 elements maximum. Show the contents of the Stack (trace through) at each step, for the following sequence of operations: Make sure to handle exceptions like empty/full etc. **[5 M]**

	A[0]	A[1]	A[2]	Exception Condition (if any)
PUSH Z				
POP				
PUSH X				
PUSH F				
PUSH D				

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PUSH B				
POP				
POP				
POP				
POP				

5. Given two sorted singly linked lists, L1 and L2, write a procedure in pseudocode to compute L1 ∩ L2 using only the basic list operations. **[5 M]**

6. Illustrate/Trace through the operation of PARTITION procedure of QUICKSORT once for sorting the following input data in ascending order: A [13; 19; 9; 12; 8; 7; 4; 2; 6; 11]. **[10 M]**

7. Write the pseudocode for recursive factorial computation. Represent the execution time using a recurrence equation and solve it using iterative substitution method. **[5 M]**

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BPDC, Dubai - Second Semester, 2017-2018

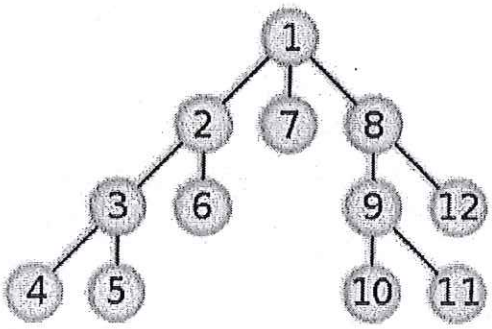
Course No: CS F211 | **Quiz 1 (Closed Book)** | **Course Title: DSA**
Date: 20th Mar 2018 | | **Weightage: 5%**
Duration: 20 Min | **(CS)** | **Max. Marks. 10**

Id No: **Name:**

Name of the Faculty:

There are three pages in this question paper

1. Consider the given tree and answer the questions **4M**



a. 1,8,6,5 is a path in the tree
   i. True
   ii False **Ans:** _____

b. The height of the tree is
   i. 3
   ii. 2
   iii. 4
   iv. None of the above **Ans:** _____

   The children of node 2 is/are
   i. 6
   ii. 3
   iii. 3, 6
   iv. 3, 6, 4, 5 **Ans:** _____

c. The pre-order and post-order traversal of the tree visits the nodes in the order
   i. 1, 2, 3, 4, 7, 6, 5, 8, 9, 10, 12, 11 and 9, 12, 10,11, 4, 5, 3, 6, 2, 7, 1, 8
   ii. 1, 2, 7, 8, 3, 6, 9, 12, 4, 5, 10, 11 and 4, 5, 3, 6, 2, 10, 11, 9, 12,8,1, 7
   iii. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 4, 5, 3, 6, 2, 1, 7, 10, 11, 9, 12,8
   iv. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 4, 5, 3, 6, 2, 7, 10, 11, 9, 12,8,1

   Ans: _____

PTO

BPDC, Dubai - Second Semester, 2017-2018

Course No: CS F211 | **Quiz 1 (Closed Book)** | **Course Title: DSA**
Date: 20th Mar 2018 | **(CS)** | **Weightage: 5%**
Duration: 20 Min | **Max. Marks. 10**

2. Given input {4371, 1323, 6173, 4199, 4344, 9679, 1989} and hash function as $h(x) = x \; mod \; 10$; answer the following **3M**

   a. The hash code values after applying the hash function to the input are in the order
      i. {3, 3, 9, 4, 1, 9, 9}
      ii. {3, 9, 4, 3, 9, 1, 9}
      iii. {1, 3, 3, 9, 4, 9, 9}
      iv. None of the above

      Ans: _____

   b. 1989 will be placed in index _____ of the hash table if quadratic probing is used to solve the collision
      i. 9
      ii. 0
      iii. 10
      iv. 8
      v. 3

      Ans: _____

   c. The load factor of the table after inserting three elements (i.e. 4371, 1323, 6173} is _____

      i. 0.7
      ii. 0.4
      iii. 0.3
      iv. 0.03

      Ans: _____

3. Assume a Bloom filter with $m = 10$. Let the number of hash functions used be $k = 2$ and the hash functions are **2M**

$$h_1(k) = (2 * k) \; mod \; 10$$
$$h_2 = 7 * (k - 3) \; mod \; 10$$

The following state of the bloom filter is obtained after Insert (5), Insert (40) and Insert (14)

0	0	0	0	1	0	1	1	0	1
0	1	2	3	4	5	6	7	8	9

   a. The output of bloom filter for Query (30) and Query (12) is _____ respectively
      i. Not present and May be present
      ii. May be present and Not present

iii. May be present and May be present
iv. Not present and Not present

Ans: _____

b. Among the output to the above Queries which one is considered as false positive? Why?

Ans: _____

4. A hash table of length 10 uses open addressing with hash function h(k)=k mod 10, and linear probing. After inserting 6 values into an empty hash table, the table is shown below. Which one of the following choices gives a possible order in which the key values could have been inserted in the table? **1M**

		42	23	34	52	46	33		
0	1	2	3	4	5	6	7	8	9

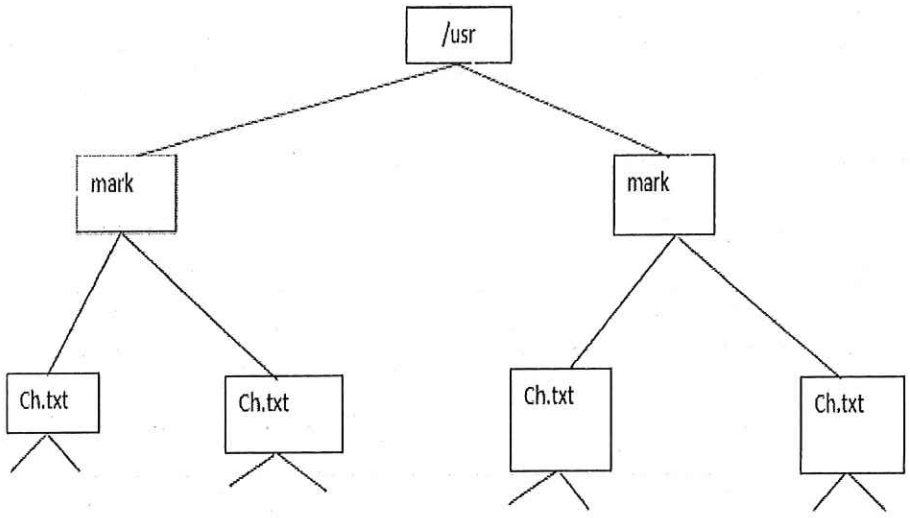
i. 46, 42, 34, 52, 23, 33
ii. 34, 42, 23, 52, 33, 46
iii. 46, 34, 42, 23, 52, 33
iv. 42, 46, 33, 23, 34, 52

Ans: _____

BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2017 - 2018
COURSE: DATA STRUCTURES AND ALGORITHMS (CS F211)
TEST 2 (OPEN BOOK)

DURATION: 50 Minutes
WEIGHTAGE: 20% (40 Marks) **DATE: 09 – APR – 2018**
There are two pages in this question paper

1. Consider a Unix-like file system depicted as a binary tree as shown in following figure. Let the internal nodes represent sub-directories and the root of the tree represents the root of the file system. The leaf nodes correspond to files. Each node in the tree stores a pair (name, size). Name represents the name of the file or directory or sub-directory and size gives the size of the same. Write a recursive algorithm/pseudocode to compute and print the space used by files, subdirectories and the root directory. **[5 M]**



2. The postorder traversal of a binary tree is 8, 9, 6, 7, 4, 5, 2, 3, 1. The inorder traversal of the same tree is 8, 6, 9, 4, 7, 2, 5, 1, 3. Draw the tree step by step. What is the height of the tree? **[4 M]**

3. Given a non-empty binary search tree, write a pseudocode to return the minimum key value found in that tree **[3 M]**

4. A certain Professor Amongus claims that the order in which a fixed set of elements is inserted into a binary search tree does not matter-the same tree results every time. State if Professor Amongus's claim is correct or wrong. Justify using an example. **[4 M]**

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5. How many bits are required per node to store the height of a node in an *N*-node AVL tree? What is the smallest AVL tree that overflows an 8-bit height counter? **[4 M]**

6. Insert the following sequence of nodes in an initially empty AVL tree 1,2,3,4,5,10,9,8,7,6. Show your work (calculation of height of the nodes and rotations if any) step by step at each insertion. **[10 M]**

7. Show (trace through) the successive steps of HEAPSORT for sorting the following characters in descending order for the array ARR given below. Assume you build the MIN-heap using *n* insert operations where *n* is the total number of elements in the array. ARR = [R, B, T, A, G, L, S, D] **[10 M]**

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BITS PILANI DUBAI CAMPUS, DIAC, DUBAI
CS F211 DATA STRUCTURES AND ALGORITHMS
SECOND SEMESTER 2017 - 2018
COMPREHENSIVE EXAMINATION

Date & Session : 20 – MAY – 2018 & AN **Time: 12.30 pm – 3.30 pm**
Weightage : 35% (70 Marks)

Note: Answer PART A and PART B in separate answer books.

PART A (35 MARKS)

1. Is $N^2 \log N + N^2 = O(N^2)$. Prove or justify your answer **[1 M]**
2. Suppose we are sorting an array of eight integers using quicksort, and we have just finished the first partitioning with the array looking like this: 2, 5, 1, 4, 9, 12, 11, 10. Guess the pivot used for partitioning. Justify your answer. **[2 M]**
3. Let P be a shortest path from some vertex s to some other vertex t in a directed graph. If the weight of each edge in the graph is increased by one, will P still be a shortest path from s to t. Justify your answer with an example **[2 M]**
4. Insert the keys R, Y, F, X, A, M, C, D, T, V, W in that order into an initially empty B-tree of order 6. Show your work step by step highlighting overflow and split if any after each insertion. **[5 M]**
5. Consider the string "GOOGOL". **[2+3 M]**
   a. Identify all the suffixes of the string
   b. Draw the compressed suffix trie for the string
6. Consider the string "adbcdfegdhaaadb" **[7+3 M]**
   a. Construct the Huffman encoding tree and list an optimal Huffman code for the characters in the string
   b. Compute the number of bits required to transmit the string using
      i. Seven bit ASCII encoding
      ii. Huffman code computed above
7. a. Draw the binary min heap that results from inserting the keys 11, 9, 12, 14, 3, 15, 7, 8, 1 in that order into an initially empty binary heap one element at a time. Show your work after each insertion. **[8+2 M]**
   b. Perform a single deletemin() on the final heap you created in 7(a). Draw the heap after the deletion

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PART B (35 MARKS)

1. Represent the graph in *Figure 1* using adjacency matrix. **[1 M]**

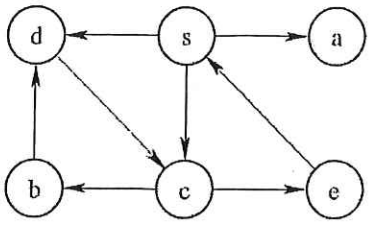

Figure 1

2. "The running time of Radix sort is effectively independent of whether the input is already sorted". Comment on the above statement as either true or false. Justify your answer using suitable example. **[2 M]**

3. How can you implement two stacks using only one array? Your stack routines should not declare an overflow unless every slot in the array is used. Explain your implementation using a diagram. **[2 M]**

4. Consider the following recursive function mystery(n) **[2+3 M]**

   a. Write down the complete recurrence relation T(n) for the running time of mystery(n). Be sure you include a base case T(0).
   b. Solve the recurrence equation using iterative back substitution method.

```
int mystery (int n)
{
        int answer;
        if ( n > 0)
        {
                m = n/2;
                a = 2 * mystery(m-1);
                b = 4 * mystery(m-1);
                answer = a+b;
                return answer;
                }
        else
                return 1;
}
```

5. Consider the AVL tree in *Figure 2*. Delete the node with key 41. Draw the tree after the deletion. Label each node in the tree with its height. Check if the height balance property holds good. Else perform **[5 M]**

PTO

necessary rotations (as many as required) to convert the tree back to an AVL tree. Show your work step by step clearly.

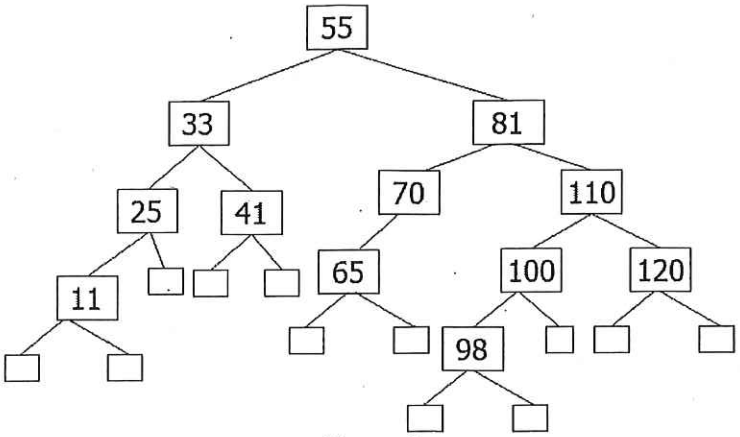

Figure 2

6. Consider the digraph shown in *Figure 3*. Compute the shortest path from the **source node labelled 1** to all the other nodes in the graph using **Dijkstra's** algorithm. Show your work step by step using a table with fields like vertices, known, distance (d_v) and previous node (p_v). Show the computations at each step clearly. **[10 M]**

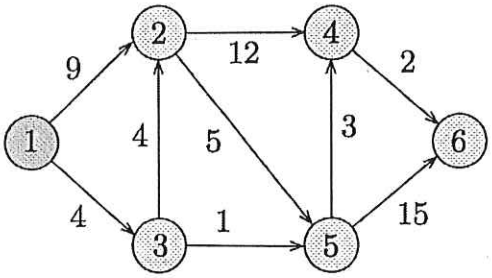

Figure 3

7 Given the keys = {2341, 4234, 2839, 430, 22, 397, 3920}, a hash table of size 7, and hash function h(x) = x mod 7. Compute the hash code. Show the resulting hash table after inserting the values in the given order with each of these collision strategies. Show your work clearly. **[5+5 M]**

a. Separate chaining
b. Linear probing

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