**Birla Institute of Technology & Science, Pilani**
**Work-Integrated Learning Programmes Division**
**Second Semester 2020-2021**

**EC-2 Regular Mid-Semester Test**

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|---|---|---|
| Course Title | : | Data Structures and Algorithms Design |
| Course No | : | SS ZG519 |
| Total | : | 35 marks |
| Nature of Exam | : | Open Book |
| Duration | : | 2 hours |
| Date | : | 06/03/2021 (FN) |

**No. of Pages = 2**
**No. of Questions = 11**

**Note:**

1. **Please follow all the Instructions to Candidates given on the cover page of the answer book.**
2. **All parts of a question should be answered consecutively. Each answer should start from a fresh page.**
3. **Assumptions made if any, should be stated clearly at the beginning of your answer.**

1. Find $C$ and $n_0$ to prove that $12 \log_2 n \in O(n^{1/2})$. (2*Marks*)

2. Suppose $f_1(n)$ is $O(g_1(n))$ and $f_2(n)$ is $O(g_2(n))$. Prove that $f_1(n)f_2(n)$ is $O(g_1(n)g_2(n))$. (3*Marks*)

3. Write a recursive algorithm to compute the product of two positive integers m and n using only addition. (3*Marks*)

4. Find a closed form solution (without using asymptotic notation) using iterative substitution method for the following recurrence equation. You have to justify your answer by providing intermediate steps.

$$T(n) = \begin{cases} b & \text{if } n < 2 \\ 8T(n/2) + bn & \text{Otherwise} \end{cases}$$

(4*Marks*)

5. Characterize the following recurrence equation using the master method (Your answer should be in big theta notation). You have to justify your answer by providing intermediate steps.

$$T(n) = \begin{cases} b & \text{if } n < 2 \\ 7T(n/3) + n & \text{Otherwise} \end{cases}$$

(3*Marks*)

6. Write a pseudocode for all stack operations (push, pop, size, top, isEmpty) when stacks are implemented using queues. (You are only allowed to use methods from queue Abstract Data Type). (5*Marks*)

7. Write a pseudocode for insertBefore(p,e) to insert the element e before the node p in a doubly linked list. What is the running time for your implementation. (3*Marks*)

8. Draw a (single) binary tree T such that

   - Each internal node of T stores a single character.
   - A preorder traversal of T yields BCDEFGA.
   - An inorder traversal of tree T yields DCEBFAG.

(2*Marks*)

9. Let the heap be implemented using the binary tree ADT and it can be accessed using only the methods of binary tree ADT (we don't know whether array or linked list is used to implement it). Write a pseudocode for finding the next node (that is, the new insertion point) in a tree $T$ given the last node $u$. (3*Marks*)

10. Illustrate the performance of the heap-sort algorithm on the input sequence: (68,21,53,60,23,9,39,48) (4*Marks*)

11. Draw the hash table of size 11 resulting from hashing the keys 56, 82, 86, 69, 64, 116, 37, 52, 42. Using the hash function h(i) = (i - 5) mod 11 and assuming collisions are handled by chaining. Intermediate steps are needed to justify your answer. (3*Marks*)