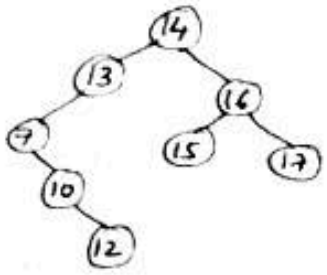
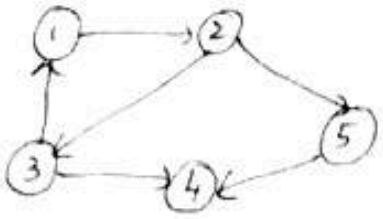
K.S. INSTITUTE OF TECHNOLOGY, BENGALURU - 560109
THIRD INTERNAL TEST QUESTION PAPER 2022-23ODDSEMESTER

SET: A

USN

Degree	:	B.E.	Semester	:	III
Branch	:	Computer Science &Design	Course Code	:	21CS32
Course Title	:	Data Structures and Applications	Date	:	27/03/2023
Duration	:	60 Minutes	Max Marks	:	20

Note: Answer **ONE full** question from each part.
K-Levels: K1-Remebering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Q No.	Questions	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Create** an AVL tree with the data elements 20, 30& 25. Demonstrate using AVL rotations	4	CO5	K3
(b)	**Define** i)Red-black trees ii)AVL-trees with an example each and **Instruct** the properties of Red-Black Trees	4	CO5	K3
(c)	**Make use of** the given Splay tree,delete 12,14,16 and 20 using top-down splay tree deletion and perform Splaying. 	4	CO5	K3
	OR			
2(a)	**Explain** Graphs .For the given directed graph G(V,E) Obtain the adjacency matrix and also Obtain the adjacency list representation. 	4	CO5	K3
b)	**Explain** Hashing. Contrast different types of hashing functions. Consider a hash table of size 10,using quadratic probing, insert the keys 72,27,22,31.	4	CO5	K3
(c)	**Explain** the following (i)Digraph (ii)Complete directed graph	4	CO5	K3

	iii)Complete Undirected Graph iv)Multigraph			
	PART –B			
3(a)	**Construct** binary tree for a given in order and post order sequence *In order : BDAEFC* *Post order: DBFECA*	**4**	**CO4**	**K3**
(b)	**Explain** Expression tree in brief. Construct Expression tree for the given expression ((6+(3-2)*5)^2+3)	**4**	**CO4**	**K3**
	OR			
4(a)	**Design** and develop C-function *i)* To search a node in Binary search tree *ii)* To find the height of binary tree	**4**	**CO4**	**K3**
(b)	**Demonstrate** Right In-threaded binary tree. Design a C-function to find the inorder Successor of a node in threaded binary tree	**4**	**CO4**	**K3**

Deepa S.R

Deepa

(SUSHMA A)

Deepa

Name & Signature of Course In charge | **Name & Signature of Module Coordinator** | **HOD -CSD** | **Principal**

K.S. INSTITUTE OF TECHNOLOGY, BENGALURU - 560109
THIRD INTERNAL TEST QUESTION PAPER 2022-23ODDSEMESTER

SET: B

USN | | | | | | | | | |

Degree	:	**B.E.**	**Semester**	:	**III**
Branch	:	**Computer Science &Design**	**Course Code**	:	**21CS32**
Course Title	:	**Data Structures and Applications**	**Date**	:	**27/03/23**
Duration	:	**60 Minutes**	**Max Marks**	:	**20**

Note: Answer **ONE full** question from each part.

K-Levels: K1-Remebering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Q No.	Questions	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Contrast** the following with an example each (i)AVL Trees (ii)Splay Trees	**4**	**CO5**	**K3**
(b)	**Review** Hashing .construct and classify different types of hash functions. Solve collision resolution by applying quadratic probing technique	**4**	**CO5**	**K3**
(c)	**Construct** a Red-black tree considering data elements 10,18,7,15,16,30,25.	**4**	**CO5**	**K3**
	OR			
2(a)	**Instruct** the properties of a Red-black trees with an example red-black tree.	**4**	**CO5**	**K3**
(b)	**Create** an AVL tree with the data elements 20, 30& 25. Demonstrate using AVL rotations	**4**	**CO5**	**K3**
(c)	**Construct** a Splay tree by inserting data elements 12,14,16 and 20.Also Perform deletion of 12 and 14.	**4**	**CO5**	**K3**
	PART –B			
3(a)	**Construct** binary tree for a given in order and post order sequence In order : BDAEFC Post order: DBFECA	**4**	**CO4**	**K3**
(b)	**Explain** threaded binary tree. Design a C-function to find inorder successor of any node pointed by pointer ptr.	**4**	**CO4**	**K3**
	OR			
4(a)	**Explain** expression tree with an example. **construct** expression tree for the given expression ((6+(3-2)*5)^2+3)	**4**	**CO4**	**K3**
(b)	**Design** and develop C-function (i) To search a node in Binary search tree (ii) C-function to find the height of binary tree	**4**	**CO4**	**K3**

Sue (SUSHMA A)

Deepa · S.R
Deepa

Deepa

Kumar

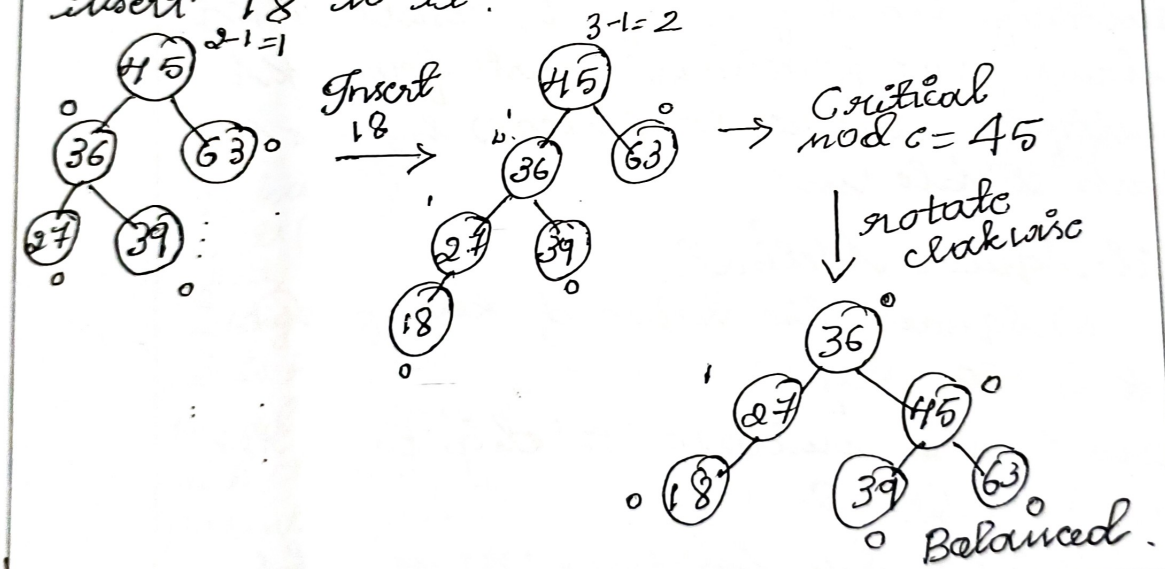
Name & Signature of | **Name & Signature of** | **HOD -CSD** | **Principal**

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
IIINTERNAL ASSESSMENT 2022 – 23ODD SEMESTER

SCHEME AND SOLUTION

SET- B

Degree	: B.E	Semester :	III
Branch	: COMPUTER SCIENCE & DESIGN	Course Code :	21CS32
Course Title	: DATA STRUCTURES & APPLICATIONS	Max Marks :	20

Q.NO.	POINTS	MARKS
1(a)	i) AVL trees :- It is a self-balancing binary tree invented by Adelson-Velsky-Landis in 1962. • The tree is named AVL after its inventors • In AVL tree is also called as the heights of two subtrees of node may differ by atmost one. • Hence, AVL tree is also called as height-balanced tree. Ex:- Consider the AVL tree given and insert 18 to it.  	4M
	ii) Splay tree :- It is a type of self adjusting binary tree (BST). → Insertion, deletion takes O(log n) → In pratical situations, time complexity may be better than O(log n) in case of splay trees.	

Q.NO	POINTS

b) Hashing :- Hashing is a technique to convert a range of key values into a range of indexes of an array.

Hash function :- A hash function is a mathematical formula, when applied to a key, produces an integer value that acts as index or address of hash table at which key is stored.

different has functions :-

a) Division Method :- hash function 'h' is division method including 'x' as the integer key.

b) Multiplication Method :

Steps: a) Choose a constant 'A' such that $0 < A < 1$

b) Multiply the key k by A, result is kA

c) Extract the fractional part from kA.

d) Multiply, the result of step c) by the size of hash table 'm'.

4M

c) Mid-Square Method.

Steps. a) Square the value of key find k^2 where k is the key.

b) Extract the middle 'r' digits of the key k^2 $h(k) = s$.

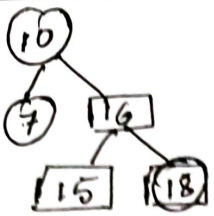
s is obtained by selecting 'r' digits from k^2

d) folding.

divide the key value into no of parts... divide k in to parts $k_1, k_2 \ldots k_n$ where each part has same number of digits Except the last part which may have lesser digits than other parts. Add the individual parts obtain the sum $k_1 + k_2 + \ldots + k_n$, the hash table is produced by ignoring the last carry.

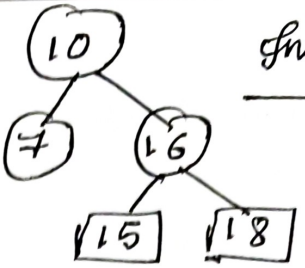
Q.NO.	POINTS	MARKS
c)	Red-black tree. 10. 18, 7, 15, 16, 30, 25. 0 → black. □ → Red. Insert 10 into RB tree → 10 (it is new node, so black in color) Insert 18 (it is node & tree is not empty) → 10 — 18 (18 is red in colour) Insert 7 → 10 (Black) — 7 (Red), 18 (Red) Insert 15 → 10 — 7, 18 (Red) — 15 (Red) (red-red conflict) Check colour of its parent → Sibling (i.e node 7) it is Red, we should recolour it and check if parents parent (i.e 10) is root node or not black 10 — black 7, 18 (Black) — 15 (red) As 10 is root node, No need to recolour it	4 M
	Insert 16 in the tree → 10 (Black) — 7 (B), 18 (B) — 15 (red) — 16 (red) (Red-Red conflict) Check parents → Sibling color here, the parent's Sibling is NULL, hence rotate & recolour. (it is LR rotation)	

Q.NO.	POINTS	MARKS

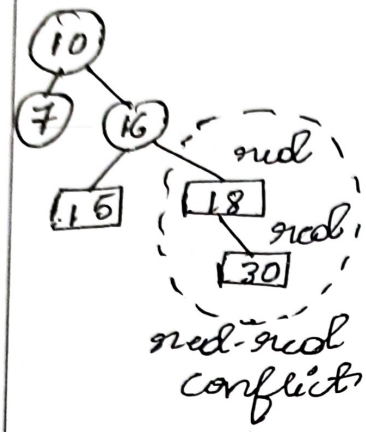


recolor

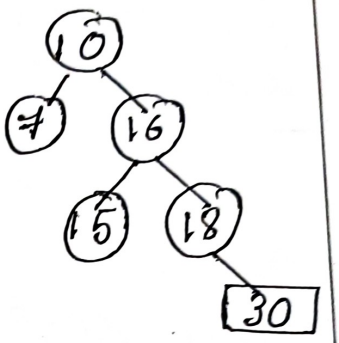
grandparent (18) & grandchild (16)



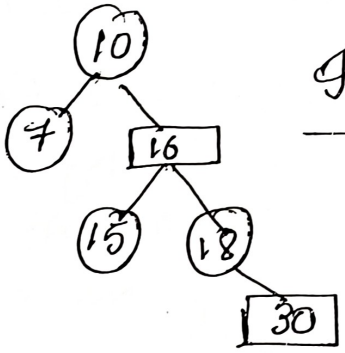
Insert 30



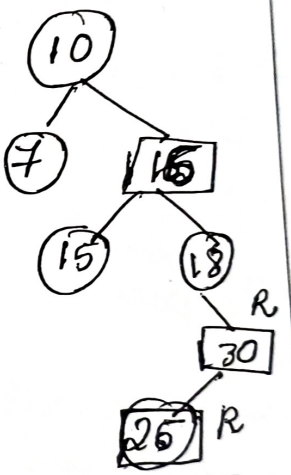
Check the color of parent's sibling it is red (i.e 15), recolor and check parent's parent, if not root, then recolor it



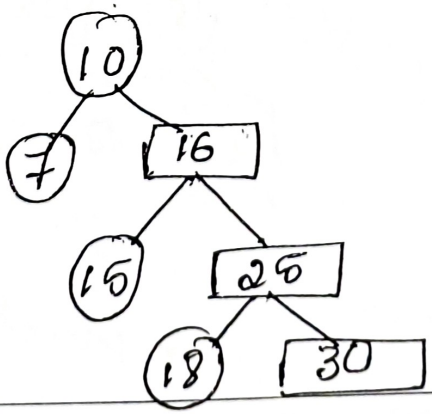
parent's parent is 16, it is not root, so recolor, it

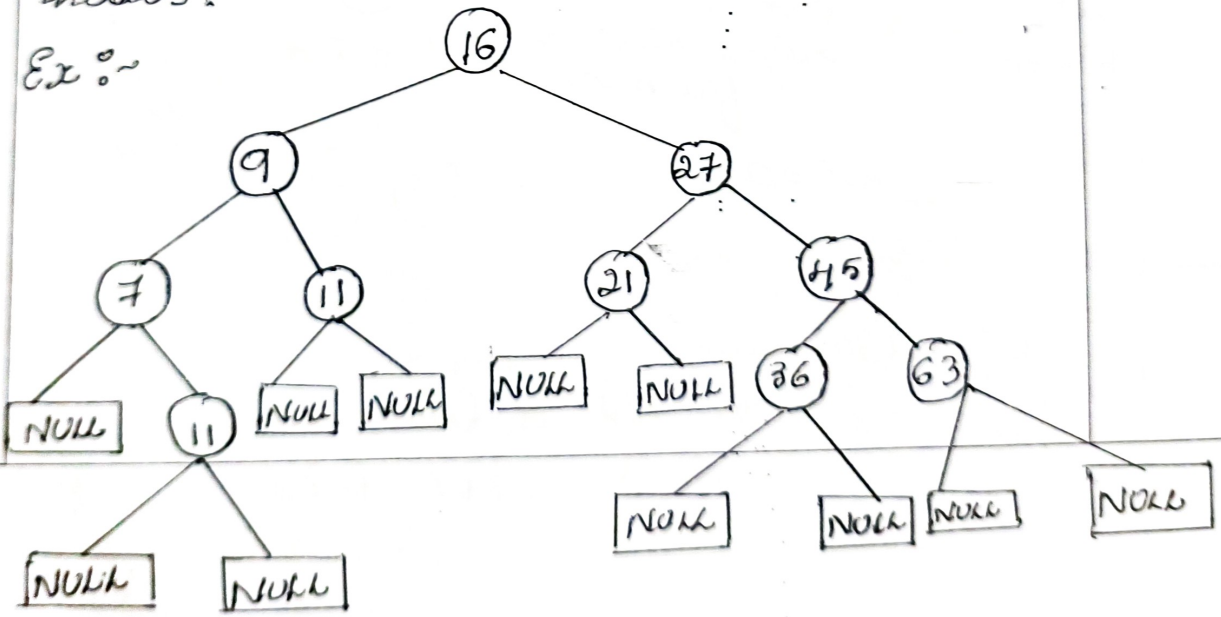


Insert 25



The parent's sibling is NULL, hence rotate & recolour it is RL rotation

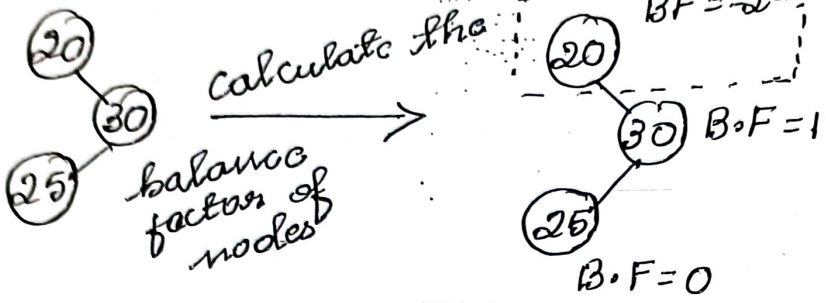


Q.NO.	POINTS	MARKS
2a)	Properties of a Red black tree • red black tree is a binary search tree in which every node has color which is either red or black. → The additional requirements are: 1. The colour of node is either red or black. 2. The colour of node is always black 3. All leaf nodes are black. 4. Every red node has both the children coloured in black. 5. Every simple path from given node to any of its leaf nodes has an equal number of black nodes. Ex:- 	4M

Q.NO.	POINTS	MARKS

26. AVL tree :- 20, 30 and 25.

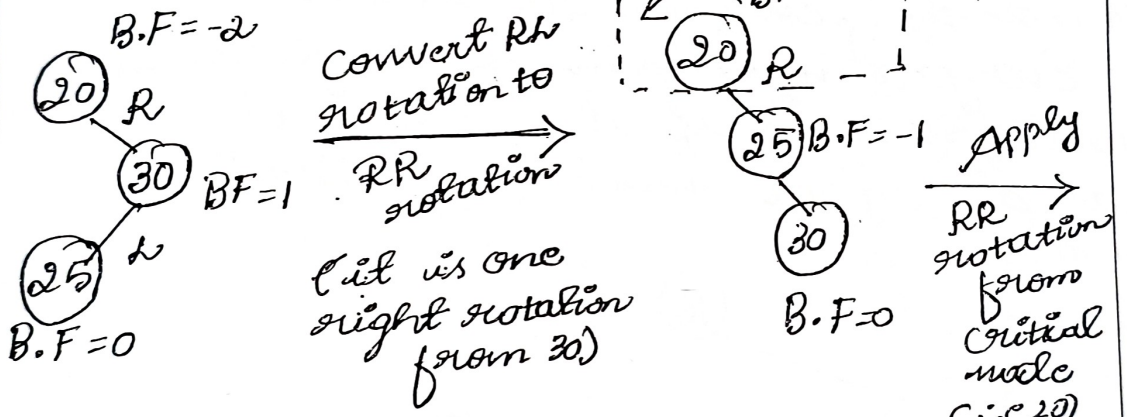
Insertion is same as binary search tree:

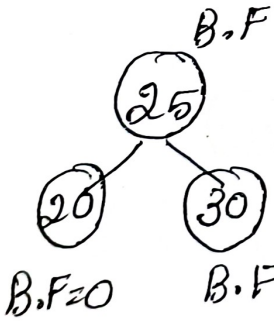


The node 20 is critical node as it have balance factor -2, it is not balanced AVL tree

Apply rotation to balance

It is RL rotation.





It is balanced AVL tree.

POINTS | MARKS

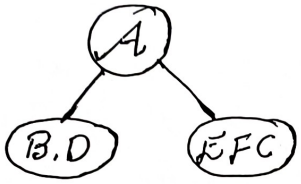
3a. InOrder : BDAEFC
PostOrder : DBFECA

• Consider postorder sequence from last to first element. and in postorder always last element is root of binary tree

DBFECA
← postorder

→ Root is A. Identify A in inOrder:

B D A E F C
left root right

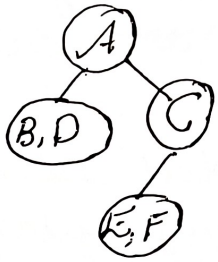


→ Consider, next element from last in postorder

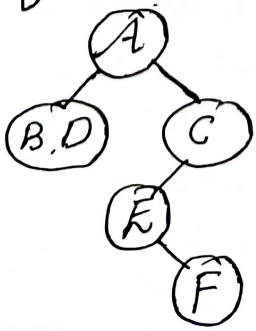
4M

→ It is C, So C is root of right subtree of A

→ InOrder, E and F are left of C

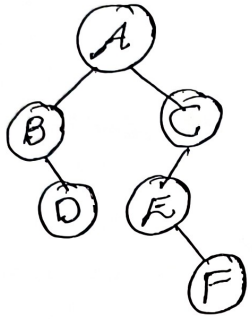


Consider next element from last in postorder it is E and it is the root of left subtree of C and in Order, F is the right of E. So it is the right child of E.



Q.NO.	POINTS

After processing C, F, E, A are in postorder. Next element in postorder is B, and it is left of root, thus B is the root of left subtree of A.
In inOrder, D is the right of B, so D is the right child of B.



3 b) Threaded-binary tree :- In a binary tree with n-nodes out of 2n links, (n+1) link are NULL links, these links are replaced by address of some nodes in binary tree, which facilitate upward movement in the tree.

. The address of some node by which NULL links are replaced are called as 'Threads'

. To construct the threaded binary tree, follow the following rules:
Assume that pointer ptr points to a node:

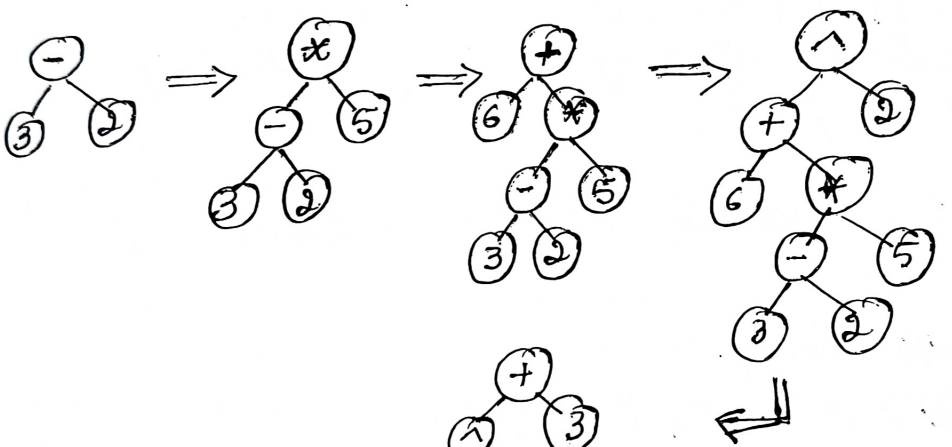
1. if ptr → leftchild is NULL, replace this NULL value with address of a node that is visited just before node pointed by ptr. in an inorder traversal.
. replace the NULL value, in leftchild of node 'x' by the inorder predecessor 'y' of x in inorder sequence.
The resultant tree is called "left threaded binary tree"

Q.NO	POINTS	MARKS
	2. If ptr → right child is NULL, replace this NULL value with address of a node that is visited just after node pointed by ptr in inorder sequence. → that is replace the NULL value in rightchild of node 'x' by inorder sucessor y of node 'x' in inorder sequence. the resultant is called "right Threaded binary tree"	
	• C- function to find inorder Successor of any node pointed by pointer ptr.	

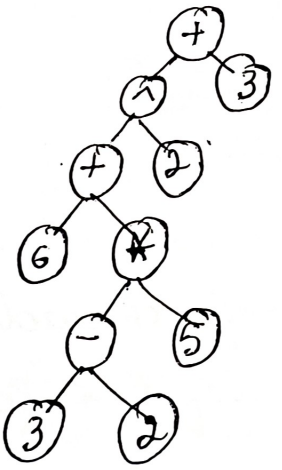
	NODE inorder_Successor (NODE x)
	{
	NODE temp;
	temp = x → right child;
	if (x → rightthread == 1)
	return temp;
	while (temp → leftthread != 1)
	temp = temp → left child;
	return temp;
	}
		4M

Q.NO.	POINTS	MARKS
4(a)	((6+(3-2)*5)^2+3)	4M

Left operand	Operator	Right Operand
3	-	2 (highest priority)
(3-2)	*	5 (* is next priority in parenthesis)
6	+	(3-2)*5
6+(3-2)*5	^	2
(6+(3-2)*5)^2	+	3.



Final Expression tree.



NO.	POINTS	MARKS
4 b)	C- Function to find height of binary tree:-	

```
int max(int a, int b)
{
return (a > b) ? a ; b;
}
int height (NODE root)
 {
  if (root == = NULL)
  return - 1;
  return 1+ max (height (root → lchild),
                 height (root → rchild));
}
```

4M

COURSE INCHARGE

HOD

K.S. INSTITUTE OF TECHNOLOGY, BENGALURU - 560109
FIRST INTERNAL TEST QUESTION PAPER 2022-23 EVEN SEMESTER

SET: A

Degree	:	B.E	USN		
Branch - Stream	:	Computer Science and Design	Semester	:	4
Course Title	:	Design and Analysis of Algorithms	Course Type / Code	:	21CS42
Duration	:	60 Minutes	Date	:	26-06-2023
			Max Marks	:	20

Note: Answer **ONE full** question from each part.
K-Levels: K1-Remebering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Q No.	Questions	Marks	CO	K-Level
	PART-A			
1(a)	**Outline** the meaning of an algorithm?Explain the criteria to be satisfied by an algorithm.	4	CO1	K2
(b)	**Design** and **Develop** an algorithm for matrix multiplication and derive its mathematical analysis	4	CO1	K3
(c)	**Derive** mathematical analysis of recursive algorithm for finding factorial of a number.	4	CO1	K3
	OR			
2(a)	**Summarize** an order of growth of time complexity.For each of the following functions indicate how much the function value will change if its argument is increased four fold. a.$\log_2 n$ b.n c.n^2 d.2^n	4	CO1	K2
(b)	**Develop** an algorithm for sequential search and derive its best,worst and average case complexity.	4	CO1	K3
(c)	**Design** an algorithm for selection sort.Trace the algorithm for the following data set. 10,6,3,15,88,63,49,9	4	CO1	K3
	PART –B			
3(a)	**Make use of** merge sort algorithm and trace the following data set and also construct a tree of recursive tree calls made. 8,4,1,6,7,2,3,9	4	CO2	K3
(b)	**Make use of** quick sort algorithm and trace for the following data set considering first element as pivot. 10,6,3,15,88,63,49,9	4	CO2	K3
	OR			

4(a)	**Build** MAX MIN recursive algorithm , trace the following data set and also construct a tree of recursive calls made. 10,6,3,15,88,63,49,9	4	CO2	K3
(b)	**Explain** divide and conquer method of programming.	4	CO2	K2

(S. Subhash Kumar)

Sushma (SUSHMA A)

Name & Signature of Course In charge:

Name & Signature of Module Coordinator:

HOD CSD

Principal

K.S. INSTITUTE OF TECHNOLOGY, BENGALURU - 560109
FIRST INTERNAL TEST QUESTION PAPER 2022-23 EVEN SEMESTER

SET: B

USN										

Degree : B.E
Branch - Stream : Computer Science and Design
Course Title : Design and Analysis of algorithms
Duration : 60 Minutes

Semester : 4
Course Type / Code : 21CS42
Date : 26-06-2023
Max Marks : 20

Note: Answer **ONE full** question from each part.
K-Levels: K1-Remebering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Q No.	Questions	Marks	CO	K-Level
	PART-A			
1(a)	**Develop** an algorithm for sequential search and derive its best,worst and average case complexity	4	CO1	K3
(b)	**Summarize** an order of growth of time complexity.For each of the following functions indicate how much the function value will change if its argument is increased four fold. a.$\log_2 n$ b.n c.n^2 d.2^n	4	CO1	K2
(c)	**Design** and **Develop** an algorithm to count the bits in the binary representation of a non-negative integer,also analyze its time complexity.	4	CO1	K3
	OR			
2(a)	**Design** an algorithm for selection sort.Trace the algorithm for the following data set. 32,13 ,10,25,14,2	4	CO1	K3
(b)	**Outline** the meaning of an algorithm?Design an algorithm to find the maximum element in an array using non recursive approach also analyze its time complexity.	4	CO1	K2
(c)	**Derive** mathematical analysis of recursive algorithm for finding factorial of a number.	4	CO1	K3
	PART –B			
3(a)	**Explain** divide and conquer method of programming.	4	CO2	K2
(b)	**Build** MAX MIN recursive algorithm ,trace the following data set and also construct a tree of recursive calls made 10,6,3,15,88,63,49,9	4	CO2	K3
	OR			

4(a)	**Make use of** quicksort algorithm for and trace the following data set considering first element as pivot. 8,4,1,6,7,2,3,9	4	CO2	K3
(b)	**Make use of** merge sort algorithm , trace the following data set and also construct a tree of recursive calls made. 8,4,1,6,7,2,3,9.	4	CO2	K3

Sushma A

Name & Signature of Course In charge:

S. Subhash Kumar

Name & Signature of Module Coordinator:

HOD CSD

Principal

Silchar

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
I INTERNAL ASSESSMENT 2022 – 23 EVEN SEMESTER

SCHEME AND SOLUTION

SET-B

Degree	:	B.E	Semester	: 4
Branch	:	COMPUTER SCIENCE AND DESIGN	Course Code	: 21CS42
Course Title	:	DESIGN AND ANALYSIS OF ALGORITHMS	Max Marks	: 20

Q.NO	POINTS	MARKS

1(a)	Develop an algorithm for Sequential Search and derive its best, worst and average case complexity.
	
	ALGORITM Sequential Search (A[0.... n-1], k)
	// Searches for a given value in a given array by Sequential Search
	// Input : An array A[0.... n-1] and a Search key k
	// Output : The index of the first element of A that Matches k or -1 if there are no matching elements
	
	i ← 0
	while i<n and A[i] ≠ k do
	i ← i+1
	if i<n return i
	else return -1
	
	1) $C_{worst}(n) = n$
	
	2) $C_{best}(n) = 1$
	
	3) Average case $C_{avg}(n)$
		4M

Q(b) Summarize an order of growth of time complexity for each of the following functions indicate how much the function value will change if its argument is increased four fold.

a) $\log^2 n$ b) n c) n^2 d) 2^n

- Let $f(n) = \log_2 n$

if the argument is increased four fold, we get $\log_2 4n$

$$g(n) = \log_2 4n$$

express $g(n)$ interms of $f(n)$.

$$g(n) = \log_2 4n$$

$$= \log_2 4 + \log_2 n$$

$$= 2 + \log_2 n$$

$$g(n) = 2 + f(n)$$

4m

- Let $f(n) = n$

if the argument is increased four fold, we get ~~log~~ $4n$

$$g(n) = 4n$$

$$g(n) = 4 \cdot f(n)$$

- n^2

Let $f(n) = n^2$

$g(n) = 4n^2$

$g(n) = 4^2 \cdot n^2$

$g(n) = 16 \cdot n^2$

$g(n) = 16 \cdot f(n)$

- 2^{n+1}

Let $f(n) = 2^n$

$g(n) = 2^{4n}$

$g(n) = 2^{3n} \cdot 2^n$

$g(n) = (2^n)^3 \cdot f(n)$.

4M

1(c) Design and develop an algorithm to count the bits in the binary representation of a non-negative integer, also analyze its time complexity.

ALGORITHM BinRec(n)

// Input : A positive decimal integer n

// Output : The number of binary digits in n's binary representation

if n = 1 return 1

else return T3inRec[(n/2)] + 1

Consider the relation,

$t(n) = 1 + t(n/2)$ $\quad t(n/2) = 1 + t(n/2)$

$t(n) = i + t(n/2^i)$

Let $2^i = n \longrightarrow (1)$

$t(n) = i + t(1)$

$t(n) = i$

Consider eqv (1)

$2^i = n$, take log B.S

$i \log_2 2 = \log_2 n$

$i = \log_2 n$

$t(n) = \log_2 n$

So, the time complexity is given by

$t(n) \in \Theta(\log_2 n)$

4M

2a) Design an algorithm for Selection Sort. Trace the algorithm for the following data set.

32, 13, 10, 25, 14, 2

```
void SelectionSort (Type a[], int n)
{
  for (int i=1 ; i<=n ; i++) {
     int j = i;
     for (int k= i+1; k<=n ; k++)
        if (a[k] < a[j] ) j=k;
     Type t = a[i];
     a[i] = a[j];
     a[j] = t;
  }
}
```

Given items	After pass 1	After pass 2	After pass 3
32	2	2	2
13	13	10	10
10	10	13	13
25	25	25	14
14	14	14	25
2	32	32	32

4M

2b) Outline the meaning of an algorithm? design an algorithm for the maximum element in an array using non recursive approach also analyze its time complexity

- An algorithm is a finite set of instructions that, if followed accomplishes a particular task.

```
void max(int i, Typed Max)
{ if(i==1)
    Max = a[i];
  else if(i==j-1)
    if(a[i]>a[j])
    {
      Max = a[j]
    }
}
```

Time Complexity : O(N).

2(C) Derive Mathematical analysis of recursive algorithm for finding factorial of a number. 4M

```
Algorithm f(n)
// Input : A non negative integer n
// Output : The value of n!
if n=0 return 1
else return f(n-1)*n.
```

Analysis

$$f(n) = \begin{cases} 0 & \text{if } n=0 \\ 1 + f(n-1) & \text{otherwise.} \end{cases}$$

$t(n) = 1 + t(n-1)$

Let $i = n$, $t(0)$

$t(n) = n + t(n-n)$

$= n + t(0)$

$= n + 0$

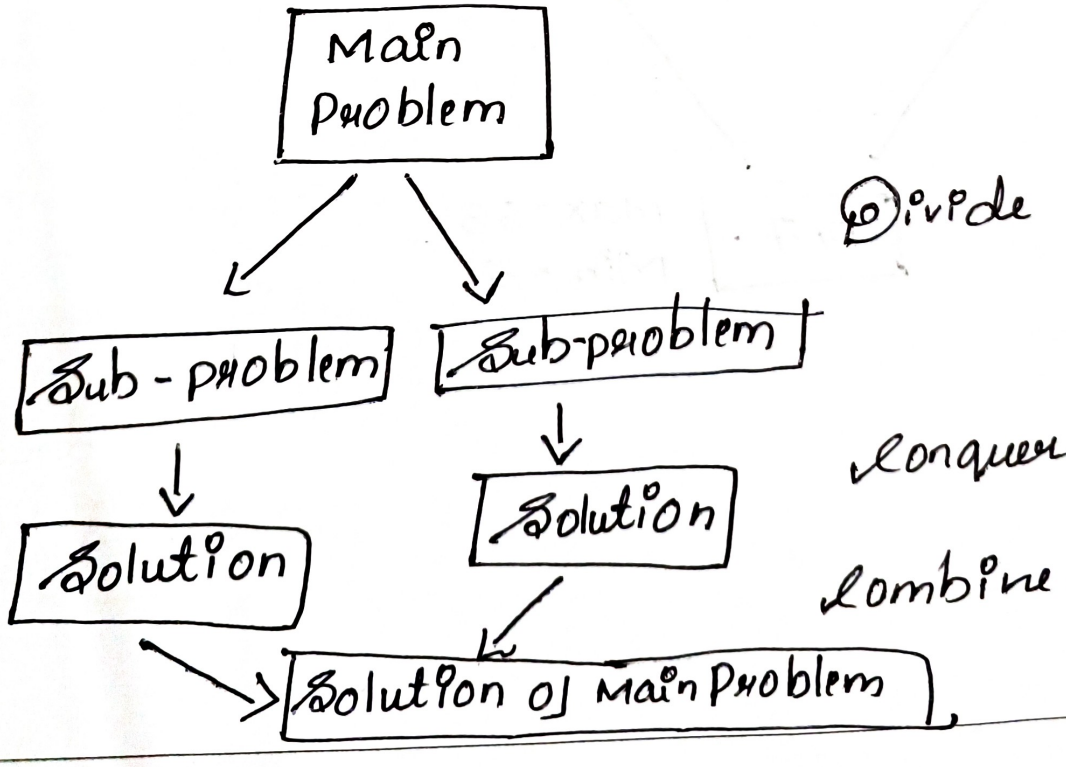
$= n$

The time complexity of factorial of N is

$t(n) \in O(n)$

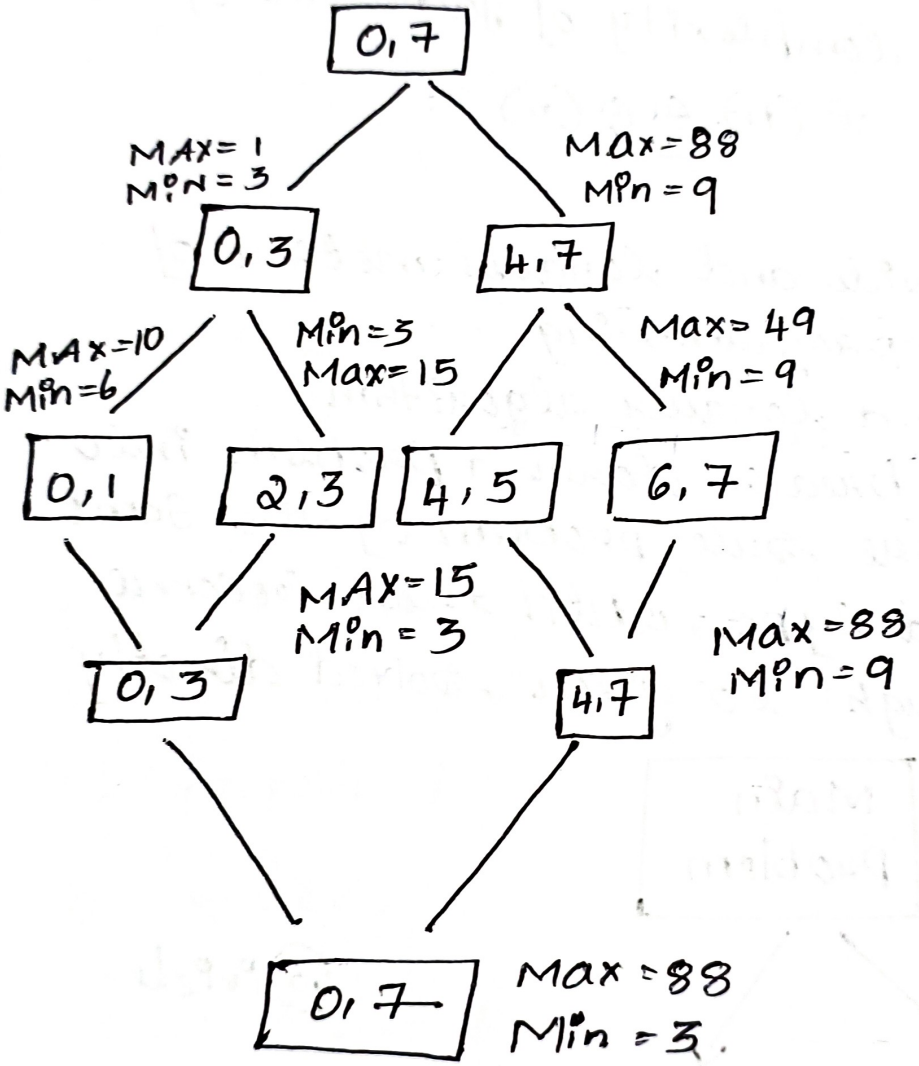
3a) Explain divide and conquer method of programming

→ A divide and conquer algorithm recursively breaks down a problem into two (or) more sub-problem of the same or related type, until these become simple enough to given solved directly (4M)



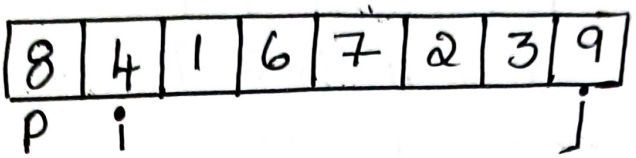
3b) Build MAX MIN recursive algorithm for and trace the following data set and also construct a tree of recursive calls made

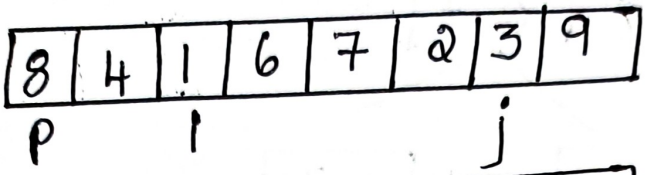
10, 6, 3 15, 88, 63, 49, 9
0 1 2 3 4 5 6 7

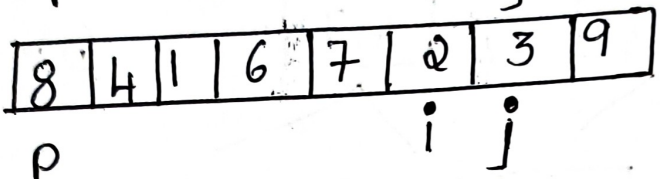


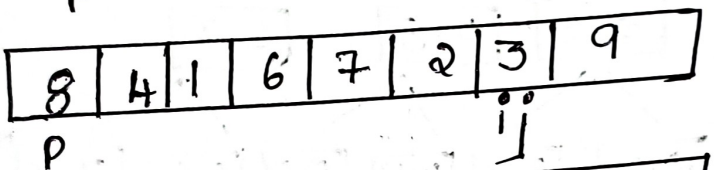
4M

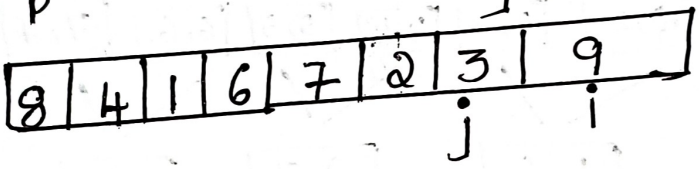
a) Make use of quicksort algorithm for and trace the following data set considering first element as a pivot

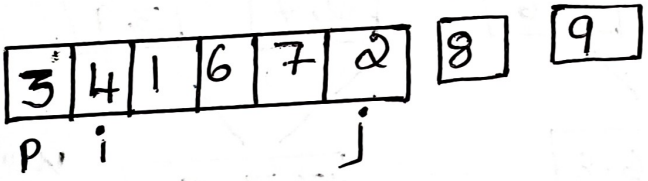


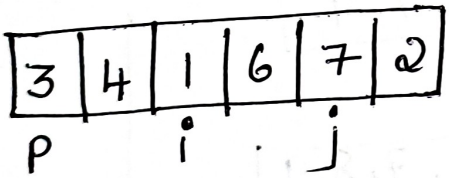


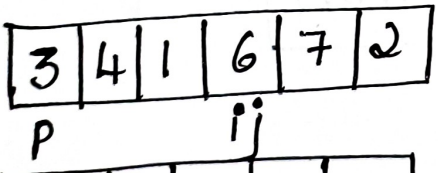


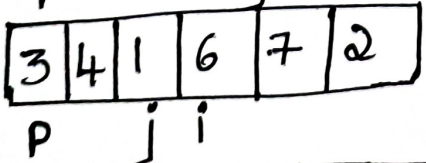


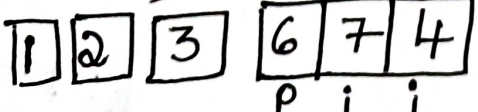


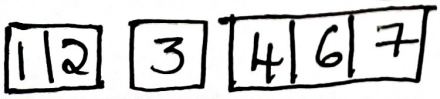






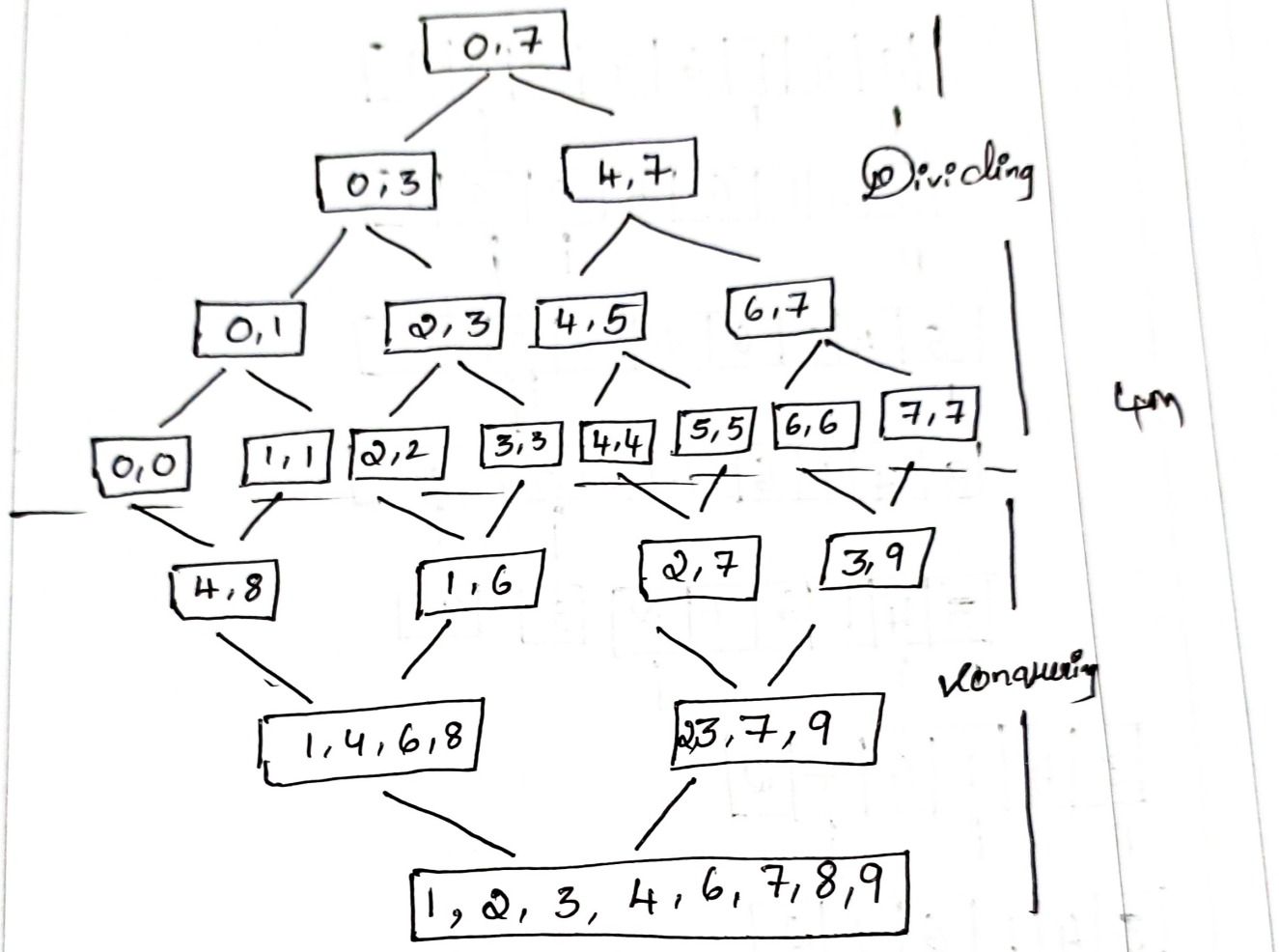






4b) Make use of Merge sort algorithm trace the following data set and Construct a tree of recursive tree calls Made

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



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