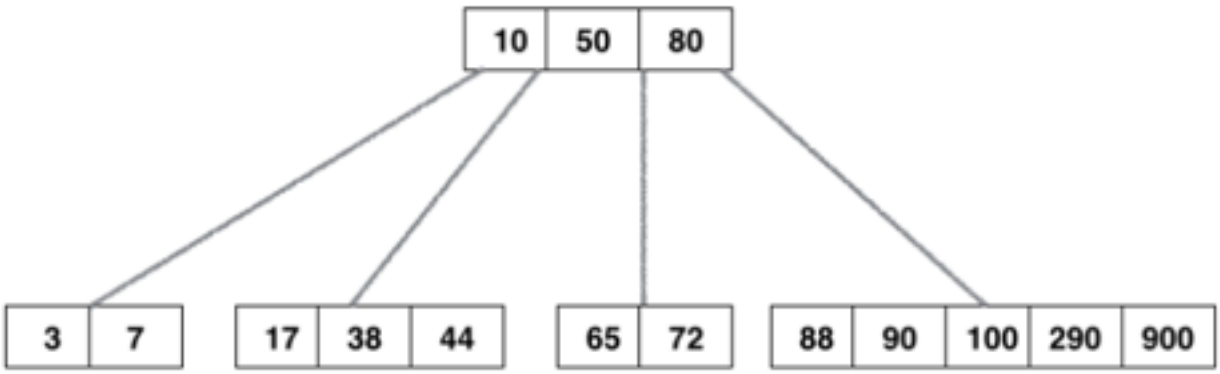
Computer Science III Final Exam **Indian Statistical Institute**
May 2019
Duration: 3 hrs, Total Marks 100

Part I Answer any 10 of the following - 2 marks each, total 20 marks

1. The amount of memory used by an instance of an algorithm as a function of its input size is called its ……..
2. The worst case time complexity of Linear search is ……..
3. Tower of Hanoi is a complex age-old puzzle solvable by using the ……. data structure
4. BST searches on an average complete in …….
5. AVL Trees and Splay Trees are examples of ……
6. Use the …… notation to signify knowledge of lower and upper bounds of running time of an algorithm
7. Worst Case time complexity for Shell Sort has been found to be dependent on ……..
8. Heap sort and Quick sort use no auxiliary memory in addition to the input array and hence they are called ……
9. A variation of merge sort algorithm that sorts large data sets in memory size chunks at a time is an example of …….
10. An example of a stable sort algorithm is ……
11. To get a best case time complexity of O(1) for Insert, Delete and Search operations, use a ……..
12. The following illustration is an example of a …….



Part II Answer the following

13. Memory Management - **Total 15 marks**

Given the following C code:, using C syntax, do the following: - 2 marks each

```
int * inptr_1;  int * iptr_2 = NULL;
struct student_node {
    int id;
    char name[30];
};
int * getptr () {
        int a;
        return a;
}
main() {
…….
printf("%d\n", getptr());
….}
```

a. Allocate memory of size 100 to inptr_1.
b. Allocate memory enough to hold 10 data items of type struct student_node; to inptr_2.
c. Change the allocated memory size of inptr_1 to 200
d. Deallocate inptr_2 and cleanup the pointer.
e. Allocate 50 ints in memory to inptr_2 and initialise the locations to 0
f. Match the following: - 1 mark each

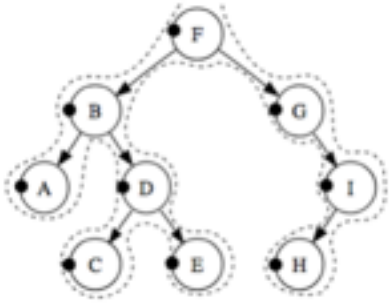
(i)	Dangling pointer	(i)	`float * fp = malloc(20);`

(ii)	Wild pointer	(ii)	`char * getptr() {`
			`  char cs;`
			`  return &cs;`
			`}`

(iii)	Null pointer	(iii)	`int * p = (int *) malloc(10);`
			`callsomefunc(p);`
			`free(p);`

(iv)	void pointer	(iv)	`int * ip;` `printf("%d\n", *ip);`
(v)	invalid pointer	(v)	`int * p = NULL;`

14. Given the following BST, write separate recursive functions and show the order of data output in each case - **Total 15 marks**



a. prints the tree in order - 5 marks
b. prints the tree preorder - 5 marks
c. prints the tree postorder - 5 marks

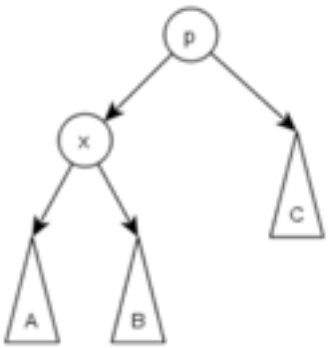
15. Given the following data values, illustrate the Shell Sort algorithm. Use gaps of 4, 2, 1 in that order - **10 marks**
    8, 28, 47, 2, 17, 90, 22, 13, 87, 56

16. Using the basic data structure for a Binary Tree as shown in C below - **Total 10 marks**

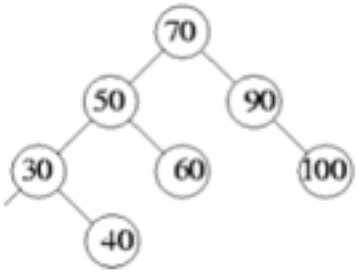
```
struct node {
        int key;
        struct node * leftchild;
        struct node * rightchild;
};
```

a. Define Balance Factor as it relates to AVL trees - 2 marks
b. Modify the above struct to define a basic node of an AVL tree - 2 marks
c. Given the following preorder AVL trees (i) 10, 20, 30 (ii) 30, 20, 10 (iii) 30, 10 ,20 (iv) 10, 30 ,20 clearly and neatly illustrate and label the rotations required to balance the tree in each case - 6 marks

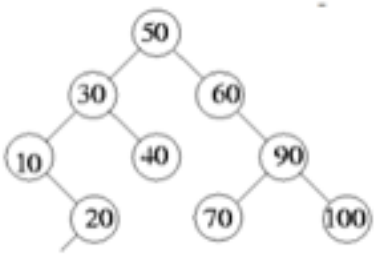
17. Splay Tree - Given the trees below, do the following; **Total 10 marks**
    a. show the intermediate steps and the final tree after a Search for x - 3 marks



b. show the intermediate steps and the final tree after 80 is inserted - 3 marks



c. show the intermediate steps and the final tree after 30 is deleted - 3 marks



d. State one example of an application of Splay Trees - 1 mark

18. Starting from an empty tree, insert numbers 1-10 one-by-one into a B-tree of order 3. - **Total 10 marks**

19. Do the following: **total 10 marks**
    a. Given #define SIZE 10
       Use SIZE to define a numerical Hash function to convert the following keys into corresponding array indices: 21, 14, 2, 32, 67, 49, 17, 84, 389, 23. Show the Hash Table. - 4 marks
    b. Given the following values, illustrate the Counting Sort algorithm - 6 marks
       12, 33, 7, 932, 67, 1671, 3, 41