

## DATA AND FILE STRUCTURES

1. Consider an array representation of an  $n$  element binary heap where the elements are stored from index 1 to index  $n$  of the array. For the element stored at index  $i$  of the array ( $i \leq n$ ), the index of the parent is:

- (1) floor  $((i + 1)/2)$
- (2) ceiling  $((i + 1)/2)$
- (3) floor  $(i/2)$
- (4) ceiling  $(i/2)$

Answer: 3

2. The following numbers are inserted into an empty binary search tree in the given order: 10, 1, 3, 5, 15, 12, 16. What is the height of the binary search tree?

- (1) 3
- (2) 4
- (3) 5
- (4) 6

Answer: 1

3. Let  $G$  be an undirected connected graph with distinct edge weight. Let  $E_{\max}$  be the edge with maximum weight and  $E_{\min}$  the edge with minimum weight. Which of the following statements is false?

- (1) Every minimum spanning tree of  $G$  must contain  $E_{\min}$ .
- (2) If  $E_{\max}$  is in minimum spanning tree, then its removal must disconnect  $G$ .
- (3) No minimum spanning tree contains  $E_{\max}$ .
- (4)  $G$  has a unique minimum spanning tree.

Answer: 3

4. A list of  $n$  strings, each of length  $n$ , is sorted into lexicographic order using merge - sort algorithm. The worst case running time of this computation is:

- (1)  $O(n \log n)$
- (2)  $O(n^2 \log n)$
- (3)  $O(n^2 + \log n)$
- (4)  $O(n^3)$

Answer: 2

5. Postorder traversal of a given binary search tree  $T$  produces following sequence of keys: 3, 5, 7, 9, 4, 17, 16, 20, 18, 15, 14

Which one of the following sequences of keys can be the result of an in-order traversal of the tree  $T$ ?

- (1) 3, 4, 5, 7, 9, 14, 20, 18, 17, 16, 15
- (2) 20, 18, 17, 16, 15, 14, 3, 4, 5, 7, 9
- (3) 20, 18, 17, 16, 15, 14, 9, 7, 5, 4, 3
- (4) 3, 4, 5, 7, 9, 14, 15, 16, 17, 18, 20

Answer: 4

6. Which of the following is true for computation time in insertion, deletion and finding maximum and minimum element in a sorted array?

- (1) Insertion- $O(1)$ , Deletion- $O(1)$ , Maximum- $O(1)$ , Minimum- $O(1)$

- (2) Insertion- $O(1)$ , Deletion- $O(1)$ , Maximum- $O(n)$ , Minimum- $O(n)$
- (3) Insertion- $O(n)$ , Deletion- $O(n)$ , Maximum- $O(1)$ , Minimum- $O(1)$
- (4) Insertion- $O(n)$ , Deletion- $O(n)$ , Maximum- $O(n)$ , Minimum- $O(n)$

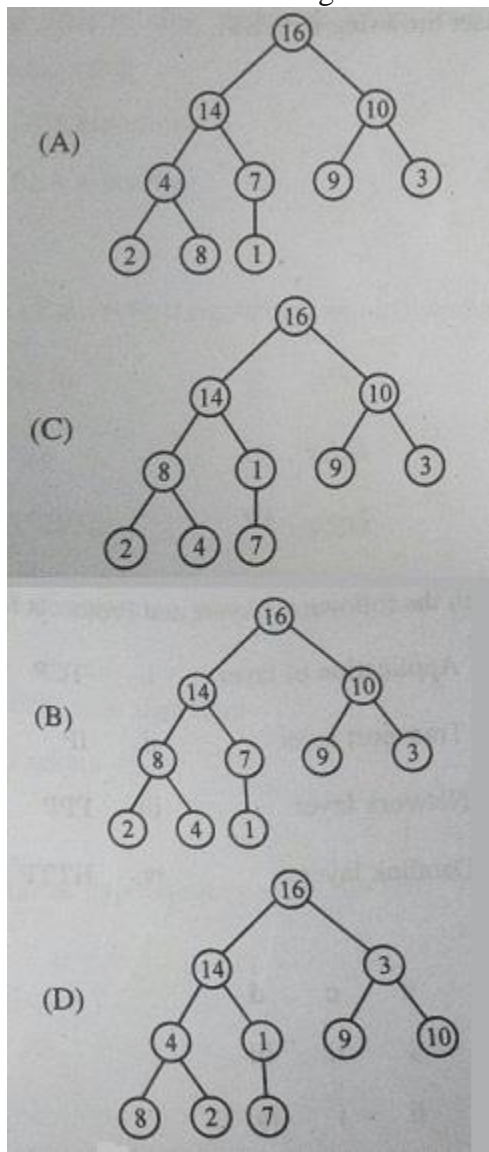
Answer: 3

7. The seven elements A, B, C, D, E, F and G are pushed onto a stack in reverse order, i.e., starting from G. The stack is popped five times and each element is inserted into a queue. Two elements are deleted from the queue and pushed back onto the stack. Now, one element is popped from the stack. The popped item is .....

- (1) A
- (2) B
- (3) F
- (4) G

Answer: 2

8. Which of the following is a valid heap?



(1) A

- (2) B
- (3) C
- (4) D

Answer: 2

9. If  $h$  is chosen from a universal collection of hash functions and is used to hash  $n$  keys into a table of size  $m$ , where  $n \leq m$ , the expected number of collisions involving a particular key  $x$  is less than .....

- (1) 1
- (2)  $1/n$
- (3)  $1/m$
- (4)  $n/m$

Answer: 1

10. Which of the following statements is false?

- (A) Optimal binary search tree construction can be performed efficiently using dynamic programming.
- (B) Breadth-first search cannot be used to find connected components of a graph.
- (C) Given the prefix and postfix walks of a binary tree, the tree cannot be re-constructed uniquely.
- (D) Depth-first-search can be used to find the components of a graph.

- (1) A
- (2) B
- (3) C
- (4) D

Answer: 2

11. Consider an implementation of unsorted single linked list. Suppose it has its representation with a head and a tail pointer (i.e. pointers to the first and last nodes of the linked list). Given the representation, which of the following operation cannot be implemented in  $O(1)$  time ?

- (A) Insertion at the front of the linked list.
- (B) Insertion at the end of the linked list.
- (C) Deletion of the front node of the linked list.
- (D) Deletion of the last node of the linked list.

Answer: D

12. Consider an undirected graph  $G$  where self-loops are not allowed. The vertex set of  $G$  is  $\{(i, j) \mid 1 \leq i \leq 12, 1 \leq j \leq 12\}$ . There is an edge between  $(a, b)$  and  $(c, d)$  if  $|a - c| \leq 1$  or  $|b - d| \leq 1$ . The number of edges in this graph is

- (A) 726
- (B) 796
- (C) 506
- (D) 616

Answer: D

13. The runtime for traversing all the nodes of a binary search tree with  $n$  nodes and printing them in an order is

- (A)  $O(\lg n)$
- (B)  $O(n \lg n)$
- (C)  $O(n)$
- (D)  $O(n^2)$

Answer: C

14. Consider the following statements :

$S_1$ : A queue can be implemented using two stacks.

S<sub>2</sub>: A stack can be implemented using two queues.

Which of the following is correct ?

- (A) S<sub>1</sub> is correct and S<sub>2</sub> is not correct.
- (B) S<sub>1</sub> is not correct and S<sub>2</sub> is correct.
- (C) Both S<sub>1</sub> and S<sub>2</sub> are correct.
- (D) Both S<sub>1</sub> and S<sub>2</sub> are not correct.

Answer: C

15. Given the following prefix expression:

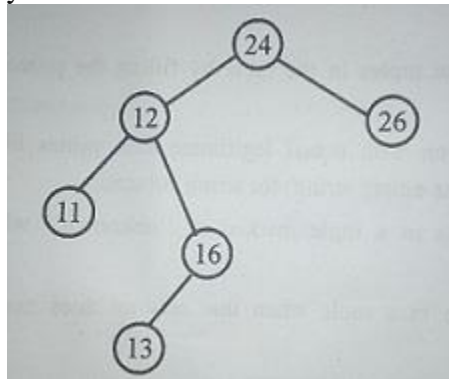
\* + 3 + 3 ↑ 3 + 3 3 3

What is the value of the prefix expression?

- (A) 2178
- (B) 2199
- (C) 2205
- (D) 2232

Answer: C

16. Consider the following binary search tree:



If we remove the root node, which of the node from the left subtree will be the new root?

- (A) 11
- (B) 12
- (C) 13
- (D) 16

Answer: D

17. Consider the following operations performed on a stack of size 5:

Push(a); Pop(); Push(b); Push(c); Pop();

Push(d); Pop(); Pop(); Push(e);

Which of the following statements is correct?

- (A) Underflow occurs
- (B) Stack operations are performed smoothly
- (C) Overflow occurs
- (D) None of the above

Answer: B

18. Suppose you are given a binary tree with n nodes, such that each node has exactly either zero or two children. The maximum height of the tree will be

- (A)  $n/2 - 1$
- (B)  $n/2 + 1$
- (C)  $(n-1)/2$
- (D)  $(n+1)/2$

Answer: C

19. Which of the following is not an inherent application of stack?

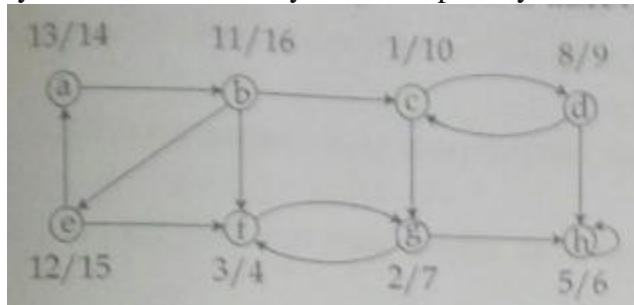
- (A) Implementation of Stack
- (B) Evaluation of a postfix expression
- (C) Job Scheduling
- (D) Reverse a string

Answer: C

20. In how many ways can the string  $A \cap B - A \cap B - A$  be fully parenthesized to yield an infix expression?  
 (A) 15 (B) 14  
 (C) 13 (D) 12

Answer: B

21. In the following graph, discovery time stamps and finishing time stamps of Depth First Search (DFS) are shown as  $x/y$  where  $x$  is discovery time stamp and  $y$  is finishing time stamp.



It shows which of the following depth first forest?

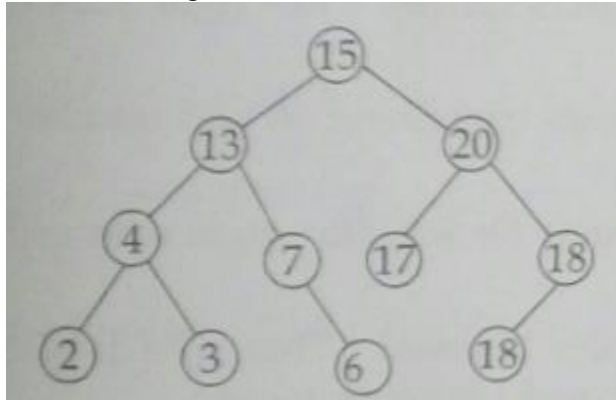
- (A) {a,b,e} {c,d,f,g,h} (B) {a,b,e} {c,d,h} {f,g}  
 (C) {a,b,e} {f,g} {c,d} {h} (D) {a,b,c,d} {e,f,g} {h}

Answer: A

22. The number of disk pages access in B-tree search, where  $h$  is height,  $n$  is the number of keys, and  $t$  is the minimum degree, is:  
 (A)  $\theta(\log_n h*t)$  (B)  $\theta(\log_t n*h)$   
 (C)  $\theta(\log_h n)$  (D)  $\theta(\log_t n)$

Answer: D

23. The inorder traversal of the following tree is:



- (A) 2 3 4 6 7 13 15 17 18 18 20  
 (B) 20 18 18 17 15 13 7 6 4 3 2  
 (C) 15 13 20 4 7 17 18 2 3 6 18  
 (D) 2 4 3 13 7 6 15 17 20 18 18

Answer: D

24. An ideal sort is an in-place-sort whose additional space requirement is .....

- (A)  $O(\log_2 n)$                       (B)  $O(n \log_2 n)$   
 (C)  $O(1)$                               (D)  $O(n)$

Answer: C

25. Consider the following statements:

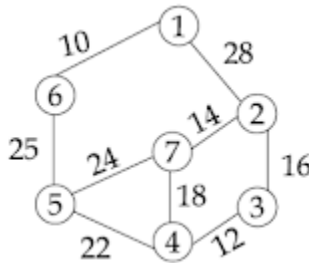
- (a) Depth - first search is used to traverse a rooted tree.  
 (b) Pre - order, Post-order and Inorder are used to list the vertices of an ordered rooted tree.  
 (c) Huffman's algorithm is used to find an optimal binary tree with given weights.  
 (d) Topological sorting provides a labelling such that the parents have larger labels than their children.

Which of the above statements are true ?

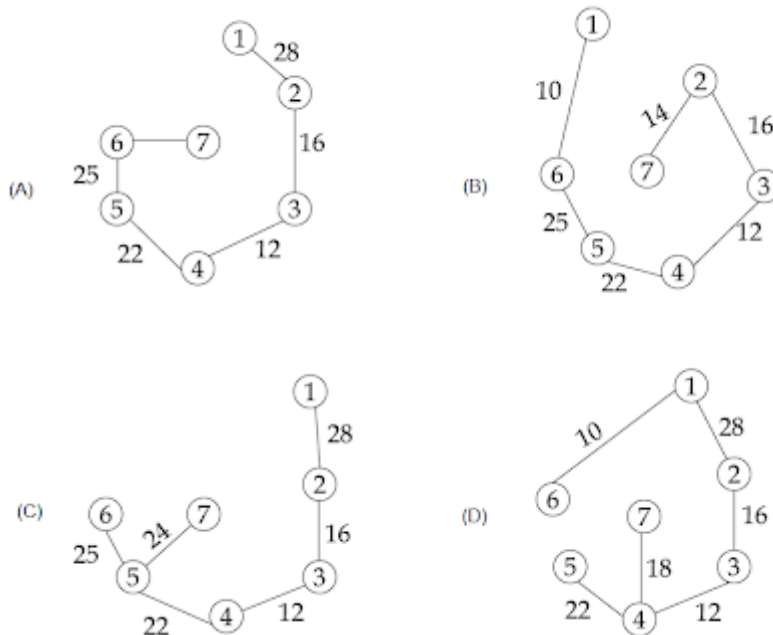
- (A) (a) and (b)                      (B) (c) and (d)  
 (C) (a) , (b) and (c)              (D) (a), (b) , (c) and (d)

Answer: D

26. Consider the given graph:



Its Minimum Cost Spanning Tree is .....



Answer: B

27. The inorder and preorder Traversal of binary Tree are dbeafcg and abdecfg respectively. The post-order Traversal is .....

- (A) dbefacg (B) debfagc  
(C) dbefcga (D) debfgca

Answer: D

28. Level order Traversal of a rooted Tree can be done by starting from root and performing:

- (A) Breadth First Search (B) Depth first search  
(C) Root search (D) Deep search

Answer: A

29. The average case occurs in the Linear Search Algorithm when:

- (A) The item to be searched is in some where middle of the Array  
(B) The item to be searched is not in the array  
(C) The item to be searched is in the last of the array  
(D) The item to be searched is either in the last or not in the array

Answer: A

30. To determine the efficiency of an algorithm the time factor is measured by:

- (A) Counting micro seconds  
(B) Counting number of key operations  
(C) Counting number of statements  
(D) Counting kilobytes of algorithm

Answer: B

31. Convert the following infix expression into its equivalent post fix expression

- (A)  $(A + B^D) / (E - F) + G$   
(B)  $ABD + ^{EF} - / G+$   
(C)  $ABD + ^{EF} / - G+$  (D)  $ABD^ + EF / - G+$

Answer: A

32. You have to sort a list L, consisting of a sorted list followed by a few 'random' elements. Which of the following sorting method would be most suitable for such a task ?

- (A) Bubble sort (B) Selection sort  
(C) Quick sort (D) Insertion sort

33. The directory can be viewed as ..... that translates filenames into their directory entries.

- (A) Symbol table (B) Partition  
(C) Swap space (D) Cache

Answer: A

34. Consider an array A[20, 10], assume 4 words per memory cell and the base address of array A is 100. What is the address of A[11, 5] ? Assume row major storage.

- (A) 560 (B) 565  
(C) 570 (D) 575

Answer: A

35. A full binary tree with n leaves contains

- (A) n nodes (B)  $\log_2 n$  nodes  
(C)  $2n - 1$  nodes (D)  $2^n$  nodes

Answer: C

36. Merge sort makes two recursive calls. Which statement is true after these two recursive calls finish, but before the merge step?
- (A) The array elements form a heap
  - (B) Elements in each half of the array are sorted amongst themselves.
  - (C) Elements in the first half of the array are less than or equal to elements in second half of the array
  - (D) All of the above

Answer: B

37. A text is made up of the characters  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  and  $\sigma$  with the probability 0.12, 0.40, 0.15, 0.08 and 0.25 respectively. The optimal coding technique will have the average length of
- (A) 1.7
  - (B) 2.15
  - (C) 3.4
  - (D) 3.8

Answer: B

38. Searching for an element in the hash table requires  $O(1)$  time for the ..... time, whereas for direct addressing it holds for the ..... time.
- (A) worst-case, average
  - (B) worst-case, worst-case
  - (C) average, worst-case
  - (D) best, average

Answer: C

39. An algorithm is made up of 2 modules  $M_1$  and  $M_2$ . If time complexity of modules  $M_1$  and  $M_2$  are  $h(n)$  and  $g(n)$  respectively, the time complexity of the algorithm is

- (A)  $\min(h(n), g(n))$
- (B)  $\max(h(n), g(n))$
- (C)  $h(n) + g(n)$
- (D)  $h(n) * g(n)$

Answer: B

40. What is the maximum number of parenthesis that will appear on the stack at any one time for parenthesis expression given by

- ( () (()) (()) )
- (A) 2
  - (B) 3
  - (C) 4
  - (D) 5

Answer: B

41. What is the value of the postfix expression ?  
 $a b c d + - * ($  where  $a = 8, b = 4, c = 2$  and  $d = 5$ )

- (A)  $-3/8$
- (B)  $-8/3$
- (C) 24
- (D) -24

Answer: D

42. If the queue is implemented with a linked list, keeping track of a front pointer and a rear pointer, which of these pointers will change during an insertion into a non-empty queue?

- (A) Neither of the pointers change
- (B) Only front pointer changes
- (C) Only rear pointer changes
- (D) Both of the pointers changes

Answer: C

43. .... is often used to prove the correctness of a recursive function.

- (A) Diagonalization
- (B) Communitivity



(C) Mathematical Induction (D) Matrix Multiplication

Answer: C

24. For any B-tree of minimum degree  $t \geq 2$ , every node other than the root must have at least ..... keys and every node can have at most ..... keys.

(A)  $t-1, 2t+1$  (B)  $t+1, 2t+1$

(C)  $t-1, 2t-1$  (D)  $t+1, 2t-1$

Answer: C

44. Given two sorted list of size 'm' and 'n' respectively. The number of comparison needed in the worst case by the merge sort algorithm will be

(A)  $m \times n$  (B)  $\max(m, n)$

(C)  $\min(m, n)$  (D)  $m + n - 1$

Answer: D

45. The IEEE single-precision and double-precision format to represent floating-point numbers, has a length of ..... and ..... respectively.

(A) 8 bits and 16 bits (B) 16 bits and 32 bits

(C) 32 bits and 64 bits (D) 64 bits and 128 bits

Answer: C

46. Consider an undirected graph G with 100 nodes. The maximum number of edges to be included in G so that the graph is not connected is

(A) 2451 (B) 4950

(C) 4851 (D) 9900

Answer: C

47. The amortized time complexity to perform ..... operation(s) in Splay trees is  $O(\lg n)$ .

(A) Search (B) Search and Insert

(C) Search and Delete (D) Search, Insert and Delete

Answer: D

48. Suppose that the splits at every level of Quicksort are in proportion  $1-\beta$  to  $\beta$ , where  $0 < \beta \leq 0.5$  is a constant. The number of elements in an array is n. The maximum depth is approximately

(A)  $0.5 \beta \lg n$

(B)  $0.5 (1-\beta) \lg n$

(C)  $-(\lg n)/(\lg \beta)$

(D)  $-(\lg n)/\lg (1-\beta)$

Answer: D

49. Consider the In-order and Post-order traversals of a tree as given below:

In-order: j e n k o p b f a c l g m d h i

Post-order: j n o p k e f b c l m g h i d a

The Pre-order traversal of the tree shall be

(A) a b f e j k n o p c d g l m h i

(B) a b c d e f j k n o p g l m h i

(C) a b e j k n o p f c d g l m h i

(D) j e n o p k f b c l m g h i d a

Answer: C

50. A simple graph G with n-vertices is connected if the graph has

(A)  $(n-1)(n-2)/2$  edges

- (B) more than  $(n - 1)(n - 2)/2$  edges
- (C) less than  $(n - 1)(n - 2)/2$  edges
- (D)  $\sum_{i=1}^k C(n_i, 2)$  edges

Answer: B

51. Linked Lists are not suitable for .....

- (A) Binary Search
- (B) Polynomial Manipulation
- (C) Insertion
- (D) Radix Sort

Answer: A

52. Which is the correct statement(s) for Non Recursive predictive parser?

S1:  $\text{First}(\alpha) = \{t \mid \alpha \Rightarrow *t\beta \text{ for some string } \beta\} \Rightarrow *t\beta$   
S2:  $\text{Follow}(X) = \{a \mid S \Rightarrow *aXa\beta \text{ for some strings } \alpha \text{ and } \beta\}$

- (A) Both statements S1 and S2 are incorrect.
- (B) S1 is incorrect and S2 is correct.
- (C) S1 is correct and S2 is incorrect.
- (D) Both statements S1 and S2 are correct.

Answer: D

53. Given an open address hash table with load factor  $\alpha < 1$ , the expected number of probes in a successful search is

- (A) Atmost  $1/\alpha \ln(1-\alpha/\alpha)$
- (B) Atmost  $1/\alpha \ln(1/1-\alpha)$
- (C) Atleast  $1/\alpha \ln(1/1-\alpha)$
- (D) Atleast  $1/\alpha \ln(\alpha/1-\alpha)$

Answer: B

54. For a B-tree of height  $h$  and degree  $t$ , the total CPU time used to insert a node is

- (A)  $O(h \log t)$
- (B)  $O(t \log h)$
- (C)  $O(t^2h)$
- (D)  $O(th)$

Answer: D

55. The time complexity to build a heap with a list of  $n$  numbers is

- (A)  $O(\log n)$
- (B)  $O(n)$
- (C)  $O(n \log n)$
- (D)  $O(n^2)$

Answer: B

56. The value of postfix expression:

8 3 4 + - 3 8 2 / + \* 2 \$ 3+ is

- (A) 17
- (B) 131
- (C) 64
- (D) 52

Answer: D

57. Consider the following statements for priority queue:

S1: It is a data structure in which the intrinsic ordering of the elements does determine the result of its basic operations.

S2: The elements of a priority queue may be complex structures that are ordered on one or several fields.

Which of the following is correct?

- (A) Both S1 and S2 are incorrect.
- (B) S1 is correct and S2 is incorrect.
- (C) S1 is incorrect and S2 is correct.
- (D) Both S1 and S2 are correct.

Answer: D

58. The worst case time complexity of AVL tree is better in comparison to binary search tree for
- (A) Search and Insert Operations
  - (B) Search and Delete Operations
  - (C) Insert and Delete Operations
  - (D) Search, Insert and Delete Operations

Answer: D

59. In which tree, for every node the height of its left subtree and right subtree differ almost by one ?

- (A) Binary search tree
- (B) AVL tree
- (C) Threaded Binary Tree
- (D) Complete Binary Tree

Answer: B

60. Suppose that someone starts with a chain letter. Each person who receives the letter is asked to send it on to 4 other people. Some people do this, while some do not send any letter. How many people have seen the letter, including the first person, if no one receives more than one letter and if the chain letter ends after there have been 100 people who read it but did not send it out ? Also find how many people sent out the letter?

- (A) 122 & 22
- (B) 111 & 11
- (C) 133 & 33
- (D) 144 & 44

Answer: C

**Explanation:**

A full m-ary tree with L leaves has  $N = (ML-1)/(M-1)$  vertices and  $i = (L-1)/(M-1)$  internal vertices.

4-ary tree (M=4)

People who saw the letter = nodes

People who did not send the letter = leaves (L=100)

People who sent the letter: internal nodes (i)

$$n = (4 \cdot 100 - 1) / (4 - 1) = 133 \text{ nodes}$$

$$i = (100 - 1) / (4 - 1) = 33$$

61. A hash function f defined as  $f(\text{key}) = \text{key} \bmod 13$ , with linear probing is used to insert keys 55, 58, 68, 91, 27, 145. What will be the location of 79?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Answer: Marks given to all

**Explanation:**

$$f(55) = 3, f(58) = 6, f(68) = 4, f(91) = 0, f(27) = 1, f(145) = 2, f(79) = 5$$

62. Consider the tree given below :



Answer: B

69. Leaves of which of the following trees are at the same level ?

- (A) Binary tree                      (B) B-tree  
(C) AVL-tree                        (D) Expression tree

Answer: B

70. A / B+ tree index is to be built on the name attribute of the relation STUDENT. Assume that all students names are of length 8 bytes, disk block are of size 512 bytes and index pointers are of size 4 bytes. Given this scenario what would be the best choice of the degree (i.e. the number of pointers per node) of the B+ tree ?

- (A) 16                                  (B) 42  
(C) 43                                  (D) 44

Answer: A

71. The Inorder traversal of the tree will yield a sorted listing of elements of tree in

- (A) Binary tree                      (B) Binary search tree  
(C) Heaps                              (D) None of the above

Answer: B

72. Consider the following page trace : 4,3, 2, 1, 4, 3, 5, 4, 3, 2, 1, 5. Percentage of page fault that would occur if FIFO page replacement algorithm is used with number of frames for the JOB m=4 will be

- (A) 8                                    (B) 9  
(C) 10                                  (D) 12

Answer: C

73. Check sum used along with each packet computes the sum of the data, where data is treated as a sequence of

- (A) Integer                            (B) Character  
(C) Real numbers                    (D) Bits

Answer: D

74. Which of the following data structure is linear type ?

- (A) Strings                            (B) Lists  
(C) Queues                            (D) All of the above

75. To represent hierarchical relationship between elements, which data structure is suitable?

- (A) Dequeue                          (B) Priority  
(C) Tree                                (D) All of the above

Answer: C

76. The post order traversal of a binary tree is DEBFCA. Find out the preorder traversal.

- (A) ABFCDE                          (B) ADBFEC  
(C) ABDECF                          (D) ABDCEF

Answer: C

77. B + tree are preferred to binary tree in database because

- (A) Disk capacities are greater than memory capacities  
(B) Disk access much slower than memory access  
(C) Disk data transfer rates are much less than memory data transfer rate  
(D) Disk are more reliable than memory

Answer: B

78. The number of nodes in a complete binary tree of height h (with roots at level 0) is equal to

- (A)  $2^0 + 2^1 + \dots + 2^h$

- (B)  $2^0 + 2^1 + \dots + 2^{h-1}$
- (C)  $2^0 + 2^1 + \dots + 2^{h+1}$
- (D)  $2^1 + \dots + 2^{h+1}$

Answer: A

79. The number of different trees with 8 nodes is

- (A) 256
- (B) 255
- (C) 248
- (D) None of these

Answer: C

80. Given a binary tree whose inorder and preorder traversal are given by

Inorder : EICFBGDJHK

Preorder : BCEIFDGHJK

The post order traversal of the above binary tree is

- (A) IEF CGJKHDB
- (B) IEF CJGKHDB
- (C) IEF CGKJHDB
- (D) IEF CGJKDBH

Answer: A

81. The number of disk accesses performed by insertion operation in B-tree of height h is

- (A)  $O(1)$
- (B)  $O(1gh)$
- (C)  $O(h)$
- (D) None of these

Answer: C

82. Consider a hash table of size  $m = 10000$  and the hash function  $h(k) = \lfloor m(kA \bmod 1) \rfloor$  for  $A = (\sqrt{5}-1)/2$ . The location to the key  $k = 123456$  is

- (A) 46
- (B) 47
- (C) 41
- (D) 43

Answer: C

83. When the priority queue is represented by max heap, the insertion and deletion of an element can be performed in (queue containing n elements)

- (A)  $O(n)$  and  $O(1)$  respectively
- (B)  $O(n)$  and  $O(n)$  respectively
- (C)  $O(1)$  and  $O(1)$  respectively
- (D) None of the above

Answer: C

84. What is the maximum number of nodes in a B-tree of order 10 of depth 3 (root at depth 0)?

- (A) 111
- (B) 999
- (C) 9999
- (D) None of the above

Answer: D

85. A binary tree with 27 nodes has ..... null branches.

- (A) 54
- (B) 27
- (C) 26
- (D) None of the above

Answer: D

86. The time complexity to build a heap of n elements is

- (A)  $O(1)$
- (B)  $O(\lg n)$

- (C)  $O(n)$
- (D)  $O(n \lg n)$

Answer: D

87. Linear probing suffers from a problem known as

- (A) Secondary clustering
- (B) Primary clustering
- (C) Both (A) and (B)
- (D) None of these

Answer: B

88. Which of the following can be the sequence of nodes examined in binary search tree while searching for key 88?

- (A) 90, 40, 65, 50, 88
- (B) 90, 110, 80, 85, 88
- (C) 190, 60, 90, 85, 88
- (D) 65, 140, 80, 70, 88

Answer: C

89. If we have six stack operations pushing and popping each of A, B and C-such that push (A) must occur before push (B) which must occur before push (C), then A, C, B is a possible order for the pop operations, since this could be our sequence : push (A), pop (A), push (B), push (C), pop (C), pop (B). Which one of the following orders could not be the order the pop operations are run, if we are to satisfy the requirements described above?

- (A) ABC
- (B) CBA
- (C) BAC
- (D) CAB

Answer: D

90. What is the most appropriate data structure to implement a priority queue?

- (A) Heap
- (B) Circular array
- (C) Linked list
- (D) Binary tree

Answer: A

91. In a complete binary tree of  $n$  nodes, how far are the two most distant nodes? Assume each edge in the path counts as 1

- (A) About  $\log_2 n$
- (B) About  $2 \log_2 n$
- (C) About  $n \log_2 n$
- (D) About  $2n$

Answer: B

92. A chained hash table has an array size of 100. What is the maximum number of entries that can be placed in the table?

- (A) 100
- (B) 200
- (C) 10000
- (D) There is no upper limit

Answer:

93. In a B tree of order 5, the following keys are inserted as follows :

7, 8, 1, 4, 13, 20, 2, 6 and 5

How many elements are present in the root of the tree?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Answer: B

94. If the number of leaves in a strictly binary tree is an odd number, then what can you say with full conviction about total number of nodes in the tree?

- (A) It is an odd number.
- (B) It is an even number.
- (C) It cannot be equal to the number of leaves.
- (D) It is always greater than twice the number of leaves.

Answer: A

95. The number of edges in a complete graph of n vertices is

- (A) n
- (B)  $n(n - 1)/2$
- (C)  $n(n + 1)/2$
- (D)  $n^2/2$

Answer: B

96. At a hill station, the parking lot is one long drive way snaking up a hill side. Cars drive in and park right behind the car in front of them, one behind another. A car can't leave until all the cars in front of it have left. Is the parking lot more like

- (A) An array
- (B) A stack
- (C) A queue
- (D) A linked list

Answer: C

97. With regard to linked list, which of the following statement is false?

- (A) An algorithm to search for an element in a singly linked list requires  $O(n)$  operations in the worst case.
- (B) An algorithm for deleting the first element in a singly linked list requires  $O(n)$  operations in the worst case.
- (C) An algorithm for finding the maximum value in a circular linked list requires  $O(n)$  operations.
- (D) An algorithm for deleting the middle node of a circular linked list requires  $O(n)$  operations.

Answer: B

98. A hash function f defined as  $f(\text{key}) = \text{key} \bmod 7$ , with linear probing used to resolve collisions. Insert the keys 37, 38, 72, 48, 98 and 11 into the table indexed from 0 to 6. What will be the location of 11?

- (A) 3
- (B) 4
- (C) 5
- (D) 6

Answer: C

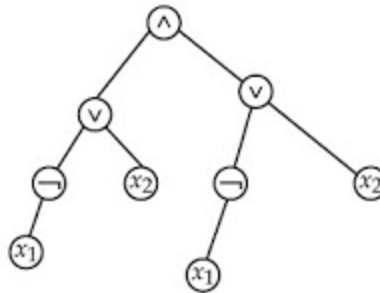
99. In a B tree of order m with p nodes the average number of splits is at most:



- (A)  $\frac{1}{\left(\left\lceil \frac{m}{2} \right\rceil - 1\right)}$
- (B)  $\left(\left\lceil \frac{m}{2} \right\rceil - 1\right)$
- (C)  $\frac{1}{\left\lceil \frac{m}{2} \right\rceil}$
- (D) None

Answer: B

100. The propositional formula given by the tree:



is:

- (A)  $\wedge \vee x_2 \vee x_1 \neg x_1 \neg x_1$
- (B)  $(x_2 \vee \neg x_2) \wedge (x_1 \vee x_2)$
- (C)  $(\neg x_1 \vee x_2) \wedge (\neg x_1 \vee x_2)$
- (D) None

Answer: C

101. Queue is a ..... list.

- (A) LIFO
- (B) LILO
- (C) FILO
- (D) FIFO

Answer: D

102. In a full binary tree of height k, there are ..... internal nodes.

- (A)  $2^k - 1$
- (B)  $2^{k-1}$
- (C)  $2^k$
- (D)  $2^{k+1}$

Answer: A

103. A binary tree is said to have heap property if the elements along any path:

- (A) from leaf to root are non-increasing
- (B) from leaf to root are non-decreasing
- (C) from root to leaf are non-decreasing
- (D) from root to leaf are non-increasing

Answer: D

104. In a heap, every element is ..... of all the elements in the subtree.

- (A) maximum
- (B) minimum
- (C) sum
- (D) product

Answer: A

105. If  $(\text{rear} == \text{maxsize} - 1) \text{ rear} = 0$ ; else  $\text{rear} = \text{rear} + 1$ ; is required in:

- (A) circular queue
- (B) linear queue
- (C) stack
- (D) deque

Answer: D

**Explanation:**

A **double-ended queue** (dequeue, often abbreviated to deque) is an abstract data type that generalizes a queue, for which elements can be added to or removed from either the front (head) or back (tail). It is also often called a head-tail linked list.

106. Which of the following data structures is most efficient in terms of both space and time to reverse a string of characters?

- (A) Linked list
- (B) Stack
- (C) Array
- (D) Tree

Answer: B

107. Which of the following can be the sequence of nodes examined in a binary search tree while searching for key 98?

- (A) 100, 50, 75, 60, 98
- (B) 100, 120, 90, 95, 98
- (C) 200, 70, 100, 95, 98
- (D) 75, 150, 90, 80, 98

Answer: C

108. Which of the following is true for a sorted list with 'n' elements?

- (A) Insertion in a sorted array takes constant time.
- (B) Insertion in a sorted linear linked list takes constant time.
- (C) Searching for a key in a sorted array can be done in  $O(\log n)$  time.
- (D) Searching for a key in a sorted linear linked list can be done in  $O(\log n)$  time.

Answer: C

109. Files that are related to input/output and are used to model serial I/O devices such as terminals, printers and networks are called :

- (A) regular files
- (B) character special files
- (C) directories
- (D) block special files

Answer: D

110. An example of a possible file attribute is:

- (A) minimum size
- (B) permanent flag
- (C) archive flag

(D) EBCDIC flag

Answer: C

111. Consider a rooted tree in which every node has at least three children. What is the minimum number of nodes at level  $i$  ( $i > 0$ ) of the tree? Assume that the root is at level 0:

- (A)  $3^i$  (B)  $3i$   
(C) 3 (D)  $3i + 1$

Answer: A

112. Which of the following data structure is used to implement recursion?

- (A) Arrays (B) Stacks  
(C) Queues (D) Linked lists

Answer: B

113. The height of a binary tree with 'n' nodes, in the worst case is:

- (A)  $O(\log n)$  (B)  $O(n)$   
(C)  $\Omega(n \log n)$  (D)  $\Omega(n^2)$

Answer: B

114. An example of a file extension is:

- (A) text (B) pict  
(C) mp3 (D) web

Answer: C

115. The performance of a file system depends upon the cache hit rate. If it takes 1 msec to satisfy a request from the cache but 10 msec to satisfy a request if a disk read is needed, then the mean time (ms) required for a hit rate 'h' is given by:

- (A) 1 (B)  $h+10(1-h)$   
(C)  $(1-h) + 10h$  (D) 10

Answer: B

116. The time required to find shortest path in a graph with n vertices and e edges is:

- (A)  $O(e)$   
(B)  $O(n)$   
(C)  $O(e^2)$   
(D)  $O(n^2)$

Answer: D

117. Pre order is also known as:

- (A) Depth first order  
(B) Breadth first order  
(C) Topological order  
(D) Linear order

Answer: A

118. The equivalent post fix express for  $d/(e+f) + b*c$  is:

- (A)  $defbc/++$   
(B)  $def+/bc+*$   
(C)  $def+/bc*+$   
(D) None of these

Answer: C

119. Which algorithm has same average, worst case and best case time?

- (A) Binary search  
(B) Maximum of n numbers

- (C) Quick sort
- (D) Fibonacci search

Answer: B

120. Application of data structure in queue is:

- (A) Level wise printing of tree
- (B) Implementation of priority queues
- (C) Function call implementation
- (D) Depth first search in a graph

Answer: B

121. Which algorithm has same average, worst case and best case time?

- (A) Binary search
- (B) Maximum of n number
- (C) Quick sort
- (D) Fibonacci search

Answer: B

122. Binary search tree is an example of:

- (A) Divide and conquer technique
- (B) Greedy algorithm
- (C) Back tracking
- (D) Dynamic Programming

Answer: A

123. What is the time required to insert an element in a stack with linked implementation?

- (A)  $O(\log_2^n)$
- (B)  $O(n)$
- (C)  $O(n \log_2^n)$
- (D)  $O(1)$

Answer: D

124. The equivalent postfix expression for  $d/(e+f) + b*c$ :

- (A) defbc/++\*
- (B) def+/bc+\*
- (C) def+/bc\*+
- (D) None of these

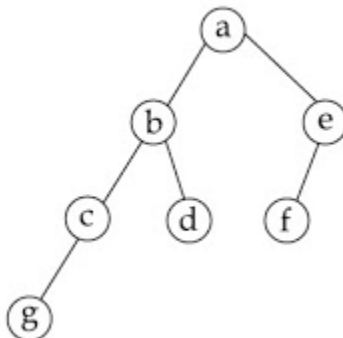
Answer: C

125. Which one of the following is a physical data structure ?

- (A) Array
- (B) Linked lists
- (C) Stacks
- (D) Tables

Answer: A

126. In the balanced binary tree given below, how many nodes will become unbalanced when a node is inserted as a child of the node 'g'.



- (A) 1
- (B) 3
- (C) 7
- (D) 8

Answer: B

127. Pre order is also known as:

- (A) Depth first order
- (B) Breadth first order
- (C) Topological order
- (D) Linear order

Answer: A

128. Which of the following statement is false ?

- (A) Every tree is a bipartite graph
- (B) A tree contains a cycle
- (C) A tree with n nodes contains (n-1) edges
- (D) A tree is connected graph

Answer: B

129. If the postfix form of a string is ABC+-D\*, the actual string is:

- (A) (A-(B+C))\*D
- (B) ((A-B)+C)\*D
- (C) ((A+B)-C)\*D
- (D) (A+(B-C))\*D

Answer: A

130. Application of data structure queue is:

- (A) Level wise printing of tree
- (B) Implementation of priority queues
- (C) Function call implementation
- (D) Depth first search in a graph

Answer: B

131. In what tree, for every node the height of its left subtree and right subtree differ at least by one:

- (A) Binary search tree
- (B) AVL tree
- (C) Threaded binary tree
- (D) Complete tree

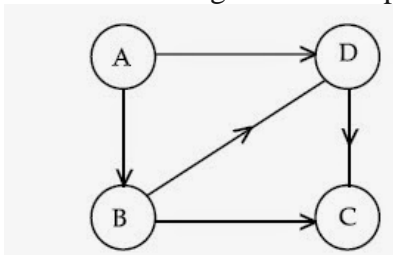
Answer: B

132. A hash function  $f$  defined as  $f(\text{key}) = \text{key} \bmod 7$ , with linear probing it is used to insert the key 37, 38, 72, 48, 98, 11, 56 into a table index from 0 to 6. What will be the locations of 11?

- (A) 3
- (B) 4
- (C) 5
- (D) 6

Answer: C

133. Consider the graph, which of the following is a valid topological sorting?



- (A) ABCD
- (B) BACD
- (C) BADC
- (D) ABDC

Answer: D

134. The initial configuration of queue is a, b, c, d. 'a' is at the front. To get the configuration d, c, b, a how many deletions and additions required:

- (A) 2 deletions, 3 additions
- (B) 3 deletions, 2 additions
- (C) 3 deletions, 4 additions
- (D) 3 deletions, 3 additions

Answer: D

135. Which traversal technique lists the nodes of a binary search tree in ascending order?

- (A) post-order
- (B) in-order
- (C) pre-order
- (D) linear-order

Answer: B

136. What is the time required to insert an element in a stack with linked implementation ?

- (A)  $O(\log_2 n)$
- (B)  $O(n)$
- (C)  $O(n \log_2 n)$
- (D)  $O(1)$

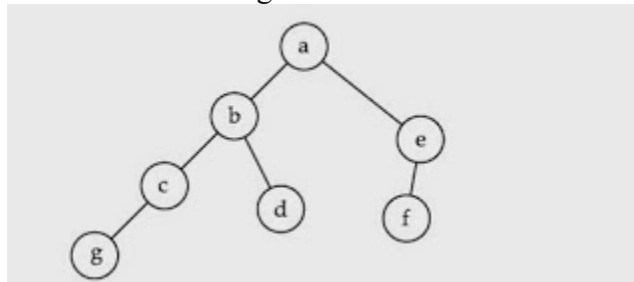
Answer: D

137. Which of the following statement is false ?

- (A) Every tree is a bipartite graph
- (B) A tree contains a cycle
- (C) A tree with n nodes contains n-1 edges
- (D) A tree is a connected graph

Answer: B

138. In the balanced binary tree given below, how many nodes will become unbalanced when a node is inserted as a child of the node "g" ?



- (A) 1
- (B) 3
- (C) 7
- (D) 8

Answer: B

139. If the postfix form of a string is ABC+-D\*, the actual string is:

- (A)  $(A-(B+C))*D$
- (B)  $((A-B)+C)*D$
- (C)  $((A+B)-C)*D$
- (D)  $(A+(B-C))*D$

Answer: A

140. The algorithm that will efficiently sort an array that is nearly sorted except for the interchange of some adjacent pairs of numbers like : { 1, 3, 2, 5, 4, 6 } is:

- (A) Quick sort
- (B) Bubble sort
- (C) Merge sort
- (D) Selection sort

Answer: B

141. What item is at the root after the following sequence of insertions into an empty splay tree:

1, 11, 3, 10, 8, 4, 6, 5, 7, 9, 2 ?

- (A) 1
- (B) 2

(C) 4 (D) 8

Answer: B

142. Suppose we are implementing quadratic probing with a Hash function, Hash (y)=X mode 100. If an element with key 4594 is inserted and the first three locations attempted are already occupied, then the next cell that will be tried is:

(A) 2 (B) 3  
(C) 9 (D) 97

Answer: D

143. Weighted graph:

(A) Is a bi-directional graph  
(B) Is directed graph  
(C) Is graph in which number associated with arc  
(D) Eliminates table method

Answer: C

144. What operation is supported in constant time by the doubly linked list, but not by the singly linked list?

(A) Advance (B) Backup  
(C) First (D) Retrieve

Answer: B

145. How much extra space is used by heap sort?

(A) O(1) (B) O(Log n)  
(C) O(n) (D) O(n<sup>2</sup>)

Answer: A

146. The upper bound and lower bound for the number of leaves in a B-Tree of degree K with height h is given by:

(A)  $K^h$  and  $2\lceil K/2 \rceil^{h-1}$   
(B)  $K * h$  and  $2\lfloor K/2 \rfloor^{h-1}$   
(C)  $K^h$  and  $2\lfloor K/2 \rfloor^{h-1}$   
(D)  $K * h$  and  $2\lceil K/2 \rceil^{h-1}$

Answer: A

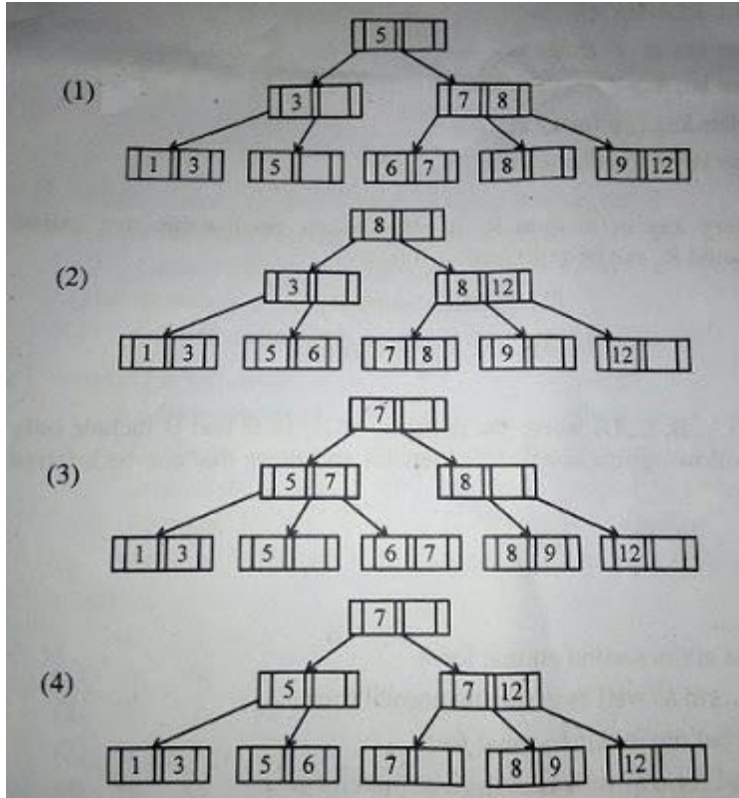
147. The hash function used in double hashing is of the form:

(A)  $h(k, i) = (h_1(k) + h_2(k) + i) \bmod m$  (B)  $h(k, i) = (h_1(k) + h_2(k) - i) \bmod m$   
(C)  $h(k, i) = (h_1(k) + i h_2(k)) \bmod m$  (D)  $h(k, i) = (h_1(k) - i h_2(k)) \bmod m$

Answer: C

148. If following sequence of keys are inserted in a B+ tree with K(=3) pointers:  
8, 5, 1, 7, 3, 12, 9, 6

Which of the following shall be correct B+ tree?



Answer: 1

149. Any decision tree that sorts  $n$  elements has height .....

- (1)  $\Omega(\log n)$
- (2)  $\Omega(n)$
- (3)  $\Omega(n \log n)$
- (4)  $\Omega(n^2)$

Answer: 3

150. Red-black trees are one of many Search tree schemes that are "balanced" in order to guarantee that basic dynamic-set operations take ..... time in the worst case.

- (1)  $O(1)$
- (2)  $O(\log n)$
- (3)  $O(n)$
- (4)  $O(n \log n)$

Answer: 2

151. Consider a hash table of size  $m = 10000$ , and the hash function  $h(K) = \text{floor}(m(KA \bmod 1))$  for  $A = (\sqrt{5} - 1)/2$ . The key 123456 is mapped to location .....

- (A) 46
- (B) 41
- (C) 43
- (D) 48

Answer: B

152. Consider a weighted complete graph  $G$  on the vertex set  $\{v_1, v_2, \dots, v_n\}$  such that the weight of the edge  $(v_i, v_j)$  is  $4|i - j|$ . The weight of minimum cost spanning tree of  $G$  is:

- (A)  $4n^2$
- (B)  $n$
- (C)  $4n - 4$
- (D)  $2n - 2$

Answer: C



153. A priority queue is implemented as a max-heap. Initially, it has five elements. The level-order traversal of the heap is as follows:

20, 18, 15, 13, 12

Two new elements '10' and '17' are inserted in the heap in that order. The level-order traversal of the heap after the insertion of the element is:

(A) 20, 18, 17, 15, 13, 12, 10

(B) 20, 18, 17, 12, 13, 10, 15

(C) 20, 18, 17, 10, 12, 13, 15

(D) 20, 18, 17, 13, 12, 10, 15

Answer: D

154. The number of different binary trees with 6 nodes is .....

(A) 6 (B) 42

(C) 132 (D) 256

Answer: C

155. Let  $A[1..n]$  be an array of  $n$  distinct numbers. If  $i < j$  and  $A[i] > A[j]$ , then the pair  $(i, j)$  is called an inversion of  $A$ . What is the expected number of inversions in any permutation on  $n$  elements?

(A)  $\theta(n)$  (B)  $\theta(\lg n)$

(C)  $\theta(n \lg n)$  (D)  $\theta(n^2)$

Answer: D

156. Which one of the following array represents a binary max-heap?

(A) [26, 13, 17, 14, 11, 9, 15]

(B) [26, 15, 14, 17, 11, 9, 13]

(C) [26, 15, 17, 14, 11, 9, 13]

(D) [26, 15, 13, 14, 11, 9, 17]

Answer: C

157. Match the following:

(a) Huffman codes (i)  $O(n^2)$

(b) Optimal polygon triangulation (ii)  $\theta(n^3)$

(c) Activity selection problem (iii)  $O(n \lg n)$

(d) Quicksort (iv)  $\theta(n)$

Codes:

(a) (b) (c) (d)

(A) (i) (ii) (iv) (iii)

(B) (i) (iv) (ii) (iii)

(C) (iii) (ii) (iv) (i)

(D) (iii) (iv) (ii) (i)

Answer: C

158. Suppose that we have numbers between 1 and 1000 in a binary search tree and want to search for the number 364. Which of the following sequences could not be the sequence of nodes examined?

(A) 925, 221, 912, 245, 899, 259, 363, 364

(B) 3, 400, 388, 220, 267, 383, 382, 279, 364

(C) 926, 203, 912, 241, 913, 246, 364

(D) 3, 253, 402, 399, 331, 345, 398, 364

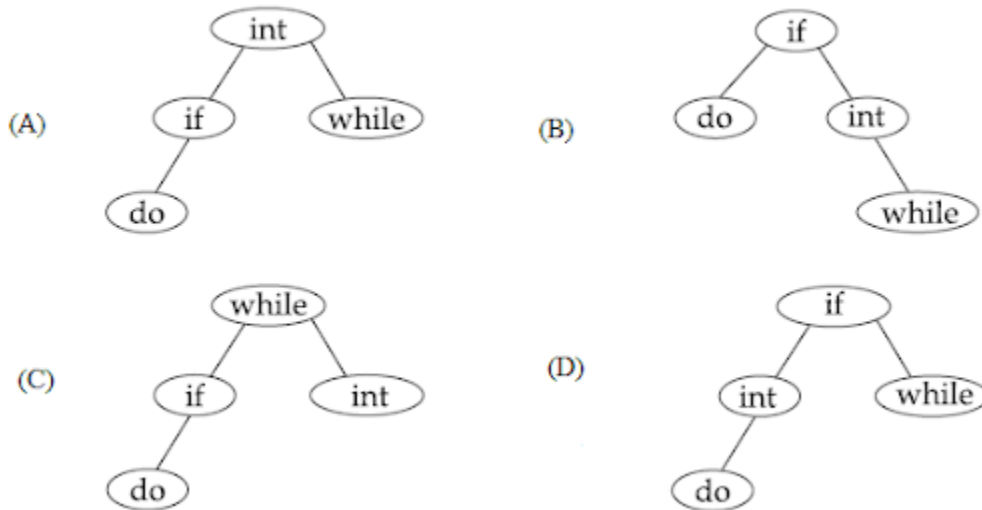
Answer: C

159. A triangulation of a polygon is a set of T chords that divide the polygon into disjoint triangles. Every triangulation of n-vertex convex polygon has ..... chords and divides the polygon into ..... triangles.

- (A) n-2, n-1                      (B) n-3, n-2  
 (C) n-1, n                        (D) n-2, n-2

Answer: B

160. Let  $n=4$  and  $(a_1, a_2, a_3, a_4) = (\text{do}, \text{if}, \text{int}, \text{while})$ . Let  $p(1:4) = (3/8, 3/8, 1/8, 1/8)$  and  $q(1:4) = (2/8, 3/8, 1/8, 1/8)$  where  $p(i)$  and  $q(i)$  denotes the probability with which we search  $a_i$  and the identifier  $x$  being searched satisfy  $a_i < x < a_{i+1}$  respectively. The optimal search tree is given by:



Answer: B

161. Consider a hash table of size  $m=100$  and the hash function  $h(k) = \text{floor}(m(kA \text{ mod } 1))$  for  $A = (\sqrt{5} - 1)/2 = 0.618033$ . Compute the location to which the key  $k = 123456$  is placed in hash table.

- (A) 77    (B) 82  
 (C) 88    (D) 89

Answer: C

162. Let  $f(n)$  and  $g(n)$  be asymptotically non-negative functions. Which of the following is correct?

- (A)  $\theta(f(n) * g(n)) = \min(f(n), g(n))$   
 (B)  $\theta(f(n) * g(n)) = \max(f(n), g(n))$   
 (C)  $\theta(f(n) + g(n)) = \min(f(n), g(n))$   
 (D)  $\theta(f(n) + g(n)) = \max(f(n), g(n))$

Answer: D

163. The number of nodes of height  $h$  in any  $n$  - element heap is .....

- (A)  $h$                               (B)  $z^h$   
 (C)  $\text{ceil}(n/z^h)$     (D)  $\text{ceil}(n/z^{h+1})$

Answer: D

164. Given the symbols A, B, C, D, E, F, G and H with the probabilities  $1/30, 1/30, 1/30, 2/30, 3/30, 5/30, 5/30$  and  $12/30$  respectively. The average Huffman code size in bits per symbol is:

- (A) 67/30      (B) 70/34  
 (C) 76/30      (D) 78/30

Answer: C

165. Suppose that we have numbers between 1 and 1000 in a binary search tree and we want to search for the number 365. Which of the following sequences could not be the sequence of nodes examined ?

- (A) 4, 254, 403, 400, 332, 346, 399, 365  
 (B) 926, 222, 913, 246, 900, 260, 364, 365  
 (C) 927, 204, 913, 242, 914, 247, 365  
 (D) 4, 401, 389, 221, 268, 384, 383, 280, 365

Answer: C

166. .... is used in game trees to reduce the number of branches of the search tree to be traversed without affecting the solution.

- (A) Best first search  
 (B) Goal stack planning  
 (C) Alpha-beta pruning procedure  
 (D) Min-max search

Answer: C

167. The reverse polish notation equivalent to the infix expression

$$((A + B) * C + D)/(E + F + G)$$

- (A) A B + C \* D + E F + G + /  
 (B) A B + C D \* + E F + G + /  
 (C) A B + C \* D + E F G + + /  
 (D) A B + C \* D + E + F G + /

Answer: A

168. Given a binary search trees for a set of  $n=5$  keys with the following probabilities :

i	0	1	2	3	4	5
$p_i$	-	0.15	0.10	0.05	0.10	0.20
$q_i$	0.05	0.10	0.05	0.05	0.05	0.10

The expected optimal cost of the search is

- (A) 2.65  
 (B) 2.70  
 (C) 2.75  
 (D) 2.80

Answer: C

169. Suppose there are  $\log_n$  sorted lists of  $n/\log_n$  elements each. The time complexity of producing a sorted list of all these elements is (use heap data structure)

- (A)  $O(n \log \log_n)$   
 (B)  $\theta(n \log_n)$   
 (C)  $\Omega(n \log_n)$   
 (D)  $\Omega(n^{3/2})$

Answer: A

**Explanation:**

We can merge  $m$  arrays of each size  $n$  in  $O(MN * \log N)$  time using Min Heap.

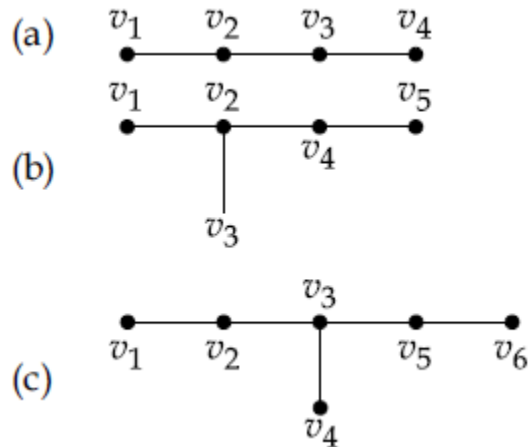
$$M = n/\log n$$

$N = \text{Log}n$

The time complexity =  $O(n/\text{Log}n * \text{Log}n * \text{Log} \text{Log} n) = O(n\text{LogLog}n)$

**VERIFIED**

170. A tree with  $n$  vertices is called graceful, if its vertices can be labelled with integers  $1, 2, \dots, n$  such that the absolute value of the difference of the labels of adjacent vertices are all different. Which of the following trees are graceful?



**Codes:**

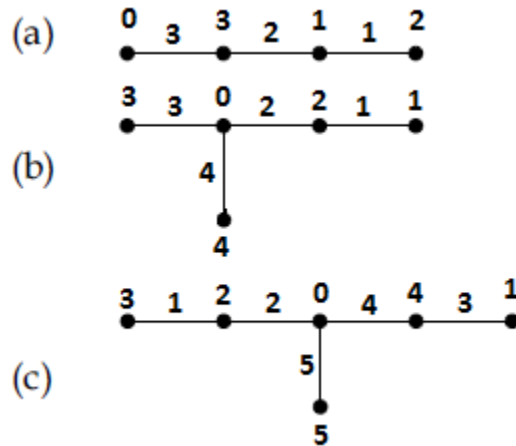
(A) (a) and (b)

(B) (b) and (c)

(C) (a) and (c)

(D) (a), (b) and (c)

Answer: D



From the above figure, we can see that (a), (b) and (c) are graceful.

171. How many edges are there in a forest of  $t$ -trees containing a total of  $n$  vertices ?

(A)  $n+t$

(B)  $n-t$

(C)  $n*t$

(D)  $n^t$

Answer: B

172. The minimum number of nodes in a binary tree of depth  $d$  (root is at level 0) is

(A)  $2^d - 1$

(B)  $2^{d+1} - 1$

(C)  $d + 1$

(D)  $d$

Answer: C

173. The efficient data structure to insert/delete a number in a stored set of numbers is

- (A) Queue (B) Linked list  
(C) Doubly linked list (D) Binary tree

Answer: C

174. Which of the following data structure is Non-linear type?

- (A) Strings (B) Lists  
(C) Stacks (D) None of the above

Answer: D

175. The total number of comparisons in a bubble sort is

- (A)  $0(\log n)$  (B)  $0(n \log n)$   
(C)  $0(n)$  (D) None of the above

Answer: B

176. Which of the following is a bad example of recursion?

- (A) Factorial (B) Fibonacci numbers  
(C) Tower of Hanai (D) Tree traversal

Answer: B

177. Maximum number of edges in a n-Node undirected graph without self loop is

- (A)  $n^2$  (B)  $n(n - 1)$   
(C)  $n(n + 1)$  (D)  $n(n - 1)/2$

Answer: D

178. A hash table has space for 75 records, then the probability of collision before the table is 6% full.

- (A) .25 (B) .20  
(C) .35 (D) .30

Answer: B

**Explanation:**

On .75<sup>th</sup> insertion probability of collision =  $1/75$

On 1.5<sup>th</sup> insertion probability of collision =  $2/75$

On 2.25<sup>th</sup> insertion probability of collision =  $3/75$

On 3<sup>th</sup> insertion probability of collision =  $4/75$

On 3.75<sup>th</sup> insertion probability of collision =  $5/75$

So the required probability is  $1+2+3+4+5/75 = .20$

179. The maximum number of nodes in a binary tree of depth 10 is:

- (A) 1024  
(B)  $2^{10}-1$   
(C) 1000  
(D) None of the above

Answer: D

180. A hash table has space for 75 records, then the probability of collision before the table is 6% full.

- (A) .25 (B) .20  
(C) .35 (D) .30

Answer: B

**Explanation:**

On .75<sup>th</sup> insertion probability of collision =  $1/75$

On 1.5<sup>th</sup> insertion probability of collision =  $2/75$

On 2.25<sup>th</sup> insertion probability of collision =  $3/75$

On 3<sup>th</sup> insertion probability of collision =  $4/75$

On 3.75<sup>th</sup> insertion probability of collision =  $5/75$

So the required probability is  $1+2+3+4+5/75 = .20$

181. Which of the following data structure is Non-linear type?

- (A) Strings      (B) Lists  
(C) Stacks      (D) None of the above

Answer: D

182. The minimum number of nodes in a binary tree of depth d (root is at level 0) is

- (A)  $2^d - 1$       (B)  $2^{d+1} - 1$   
(C)  $d + 1$       (D) d

Answer: C

183. The efficient data structure to insert/delete a number in a stored set of numbers is

- (A) Queue      (B) Linked list  
(C) Doubly linked list      (D) Binary tree

Answer: C

184. How many PUSH and POP operations will be needed to evaluate the following expression by reverse polish notation in a stack machine  $(A * B) + (C * D/E)$  ?

- (A) 4 PUSH and 3 POP instructions  
(B) 5 PUSH and 4 POP instructions  
(C) 6 PUSH and 2 POP instructions  
(D) 5 PUSH and 3 POP instructions

Answer: B

185. In any n-element heap, the number of nodes of height h is

- (A) less than equal to  $\lceil n/2^h \rceil$   
(B) greater than  $\lceil n/2^h \rceil$   
(C) greater than  $\lceil n/2^{h+1} \rceil$   
(D) less than equal to  $\lceil n/2^{h+1} \rceil$

Answer: D

186. A data file of 1,00,000 characters contains only the characters g-l, with the frequencies as indicated in table:

	g	h	i	j	k	l
Frequency in thousand	45	13	12	16	9	5

using the variable-length code by Huffman codes, the file can be encoded with

- (A) 2,52,000 bits  
(B) 2,64,000 bits  
(C) 2,46,000 bits  
(D) 2,24,000 bits

Answer: D

**Explanation:**

A binary code encodes each character as a binary string or codeword. We would like to find a binary code that encodes the file using as few bits as possible, i.e., compresses it as much as possible.

In a fixed-length code each codeword has the same length. In a variable-length code codewords may have different lengths. Here are examples of fixed and variable length codes for our problem (note that a fixed length code must have at least 3 bits per codeword).

	g	h	i	j	k	l
Frequency in 1000	45	13	12	16	9	5
fixed length	000	001	010	011	100	101
variable length	0	101	100	111	1101	1100

The fixed length-code requires 3,00,000 bits to store the file.

The variable-length code uses only

$(45 \times 1 + 13 \times 3 + 12 \times 3 + 16 \times 3 + 9 \times 4 + 5 \times 4) \times 1000 = 2,24,000$  bits.

187. The solution of recurrence relation,  $T(n) = 2T(\text{floor}(\sqrt{n})) + \log n$  is

- (A)  $O(n \log \log \log n)$
- (B)  $O(n \log \log n)$
- (C)  $O(\log \log n)$
- (D)  $O(\log n \log \log n)$

Answer: D

188. In any n-element heap, the number of nodes of height h is

- (A) less than equal to  $\lceil n/2^h \rceil$
- (B) greater than  $\lceil n/2^h \rceil$
- (C) greater than  $\lceil n/2^{h+1} \rceil$
- (D) less than equal to  $\lceil n/2^{h+1} \rceil$

Answer: D

189. A data file of 1,00,000 characters contains only the characters g-l, with the frequencies as indicated in table:

	g	h	i	j	k	l
<b>Frequency in thousand</b>	45	13	12	16	9	5

using the variable-length code by Huffman codes, the file can be encoded with

- (A) 2,52,000 bits
- (B) 2,64,000 bits
- (C) 2,46,000 bits
- (D) 2,24,000 bits

Answer: D

**Explanation:**

A binary code encodes each character as a binary string or codeword. We would like to find a binary code that encodes the file using as few bits as possible, i.e., compresses it as much as possible.

In a fixed-length code each codeword has the same length. In a variable-length code codewords may have different lengths. Here are examples of fixed and variable length codes for our problem (note that a fixed length code must have at least 3 bits per codeword).

	g	h	i	j	k	l
Frequency in 1000	45	13	12	16	9	5
fixed length	000	001	010	011	100	101
variable length	0	101	100	111	1101	1100

The fixed length-code requires 3,00,000 bits to store the file.

The variable-length code uses only

$$(45 \times 1 + 13 \times 3 + 12 \times 3 + 16 \times 3 + 9 \times 4 + 5 \times 4) \times 1000 = 2,24,000 \text{ bits.}$$

190. 49. Suppose you want to delete the name that occurs before “Vivek” in an alphabetical listing. Which of the following data structures shall be most efficient for this operation?

- (A) Circular linked list
- (B) Doubly linked list
- (C) Linked list
- (D) Dequeue

Answer: B

191. Assuming there are n keys and each keys is in the range [0, m-1]. The run time of bucket sort is

- (A) O(n)
- (B) O(n lgn)
- (C) O(n lgm)
- (D) O(n+m)

Answer: D

192. Number of binary trees formed with 5 nodes are

- (A) 32
- (B) 36
- (C) 120
- (D) 42

Answer: D

193. The following postfix expression is evaluated using a stack

$$823^{23} * + 51 * -$$

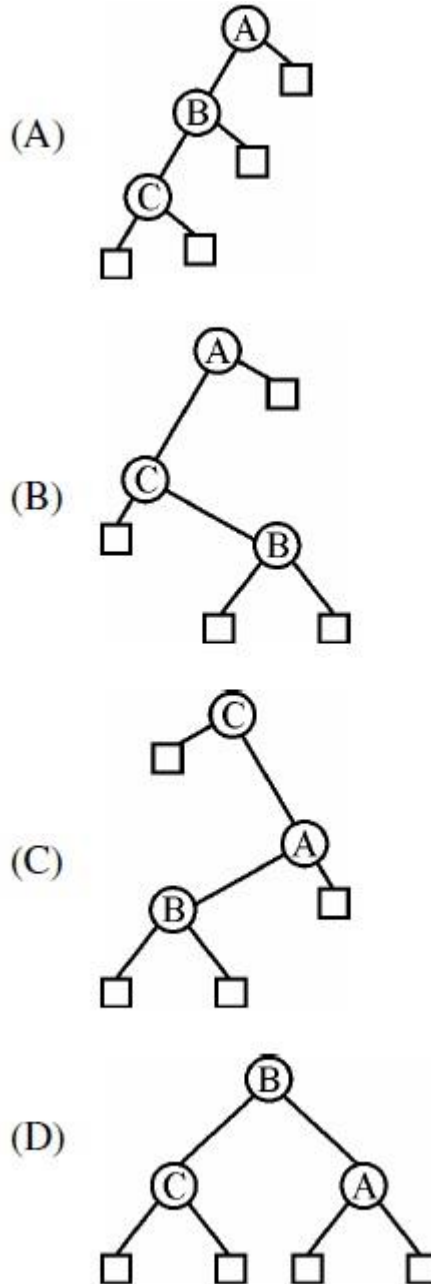
The top two elements of the stack after first \* is evaluated

- (A) 6, 1
- (B) 5, 7
- (C) 3, 2
- (D) 1, 5

Answer: A

194. Which one of the following binary search tree is optimal, if probabilities of successful search and unsuccessful search are same?





Answer: D

195. On a disk with 1000 cylinders (0 to 999) find the number of tracks, the disk arm must move to satisfy all the requests in the disk queue. Assume the last request service was at track 345 and the head is moving toward track 0. The queue in FIFO order contains requests for the following tracks :

123, 874, 692, 475, 105, 376

(Assume SCAN algorithm)

(A) 2013

(B) 1219

- (C) 1967
- (D) 1507

Answer: B

196. Suppose that the splits at every level of quicksort are in the proportion  $(1 - \alpha)$  to  $\alpha$ , where  $0 < \alpha \leq \frac{1}{2}$  is a constant. The minimum depth of a leaf in the recursion tree is approximately given by

- (A)  $-\frac{\lg n}{\lg(1 - \alpha)}$
- (B)  $-\frac{\lg(1 - \alpha)}{\lg n}$
- (C)  $-\frac{\lg n}{\lg \alpha}$
- (D)  $-\frac{\lg \alpha}{\lg n}$

Answer: C

197. The solution of the recurrence relation of

$$T(n) = 3T\left(\text{floor}\left(\frac{n}{4}\right)\right) + n \text{ is}$$

- (A)  $O(n^2)$
- (B)  $O(n \lg n)$
- (C)  $O(n)$
- (D)  $O(\lg n)$

Answer: C

198. If  $h$  is chosen from a universal collection of hash functions and is used to hash  $n$  keys into a table of size  $m$ , where  $n \leq m$ , the expected number of collisions involving a particular key  $K$  is

- (A) less than 1
- (B) less than  $\lg n$
- (C) greater than 1
- (D) greater than  $\lg n$

Answer: A

199. The solution of the recurrence relation

$$T(n) \leq \begin{cases} \theta(1) & \text{if } n \leq 80 \\ T\left(\frac{n}{5}\right) + T\left(\frac{7n}{10} + 6\right) + O(n) & \text{if } n > 80 \end{cases}$$

is :

- (A)  $O(\lg n)$       (B)  $O(n)$
- (C)  $O(n \lg n)$     (D) None of the above

Answer: D

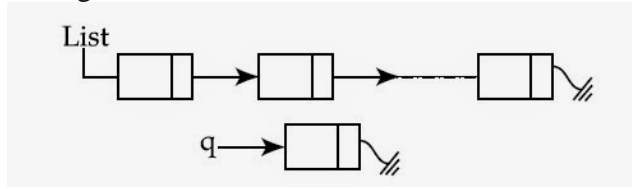
200. The order of a leaf node in a B+ tree is the maximum number of children it can have. Suppose that block size is 1 kilobytes, the child pointer takes 7 bytes long and search field value takes 14 bytes long. The order of the leaf node is .....

- (1) 16

- (2) 63
- (3) 64
- (4) 65

Answer: Marks to all

201. Consider the following linked list:



Which of the following piece of code will insert the node pointed to by q at the end of the list ?

- (A) for (p=list; p!=NULL; p=p->next);  
p=q;
- (B) for (p=list; p!=NULL; p=p->next);  
p->next=q;
- (C) for (p=list; p->next !=NULL; p=p->next);  
p=q;
- (D) for (p=list; p->next !=NULL; p=p->next);  
p->next=q;

Answer: D

34. Which of the following is not collision Resolution Technique?

- (A) Hash addressing
- (B) Chaining
- (C) Indexing
- (D) None of these

Answer: C

32. Which of the following is not collision resolution technique?

- (A) Hash addressing
- (B) Chaining
- (C) Both (A) and (B)
- (D) Indexing

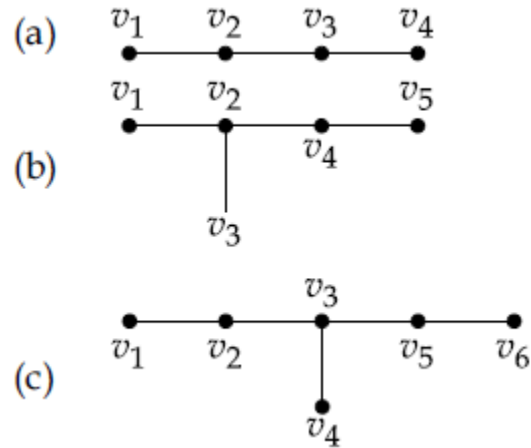
Answer: D

2. The number of different spanning trees in complete graph,  $K_4$  and bipartite graph  $K_{2,2}$  have ..... and ..... respectively.

- (A) 14, 14
- (B) 16, 14
- (C) 16, 4
- (D) 14, 4

Answer: C

5. A tree with n vertices is called graceful, if its vertices can be labelled with integers 1, 2, ...,n such that the absolute value of the difference of the labels of adjacent vertices are all different. Which of the following trees are graceful?



**Codes:**

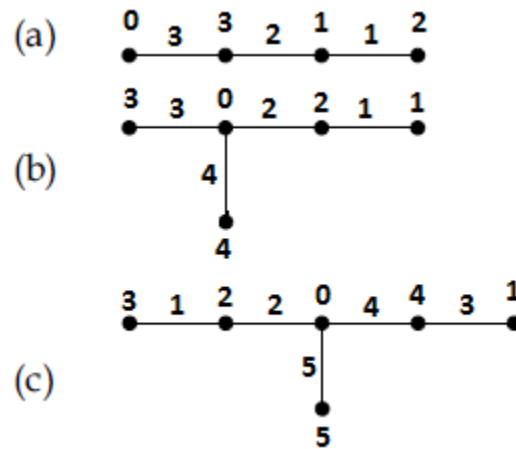
(A) (a) and (b)

(B) (b) and (c)

(C) (a) and (c)

(D) (a), (b) and (c)

Answer: D



From the above figure, we can see that (a), (b) and (c) are graceful