

1. The hash function  $\text{hash}(\text{key}) = \text{key} \bmod \text{tablesize}$  and linear probing are used to insert the keys 37, 38, 72, 48, 98, 11, 56 into hash table with indices 0.....6. Determine the order of keys in the array.
  - A. 48, 98, 37, 38, 11, 56, 72
  - B. 11, 72, 56, 37, 38, 48, 98
  - C. **98, 56, 37, 38, 72, 11, 48**
  - D. None of the above
  
2. Which of the following hash functions are used in symbol table applications?
  - A. Modulo arithmetic
  - B. Digit analysis
  - C. (c)Folding
  - D. **Midsquare**
  
3. Name the method for resolving collisions in which if the location mapped is already occupied then the probe sequence followed is determined by the function  $(h(\text{key} + i^2) \% b)$  where  $b$  is the table size and  $i$  varies from 0 to  $b-1$ .
  - A. linear probing
  - B. **quadratic probing**
  - C. random probing
  - D. double hashing
  
4. Consider a hash table of size 11.  $\text{key} \% \text{table\_size}$  is used as primary hash function and quadratic probing is used for collision resolution. What is the number of collisions that occur, while inserting the following numbers?  
10 20 1 9 13 24 61 15 22 79
  - A. 10
  - B. 6
  - C. 8
  - D. **11**
  
5. Average time complexity of an normal interpolation search is
  - A.  $O(n)$
  - B.  $O(\log_2 n)$
  - C.  **$O(\log_2 (\log_2 n))$**
  - D.  $O(\log_2 n)^2$
  
6. The balanced factor of a AVL tree can be
  - A. **-1,0,+1**
  - B. -2, -1,0,+1,+2
  - C. -2,0,+2
  - D. None of these
  
7. Key value appear only once in the case of a
  - A. **B-tree**
  - B.  $B^+$  tree

- C. both a and b
- D. None of these

8. In a threaded binary tree, a right thread point to

- A. inorder predecessor
- B. **inorder successor**
- C. right sibling
- D. None of these

9. What kind of list is best to answer questions such as "What is the item at position n?"

- A. **Lists implemented with an array.**
- B. Doubly-linked lists.
- C. Singly-linked lists.
- D. Doubly-linked or singly-linked lists are equally best

10. Here is an array of ten integers: 5 3 8 9 1 7 0 2 6 4. Draw this array after the FIRST iteration of the outer loop in a selection sort (sorting from smallest to largest).

- A. 3 5 8 1 7 0 2 6 4 9
- B. **0 3 8 9 1 7 5 2 6 4**
- C. 3 0 1 8 9 7 2 4 6 5
- D. none of these

11. In a selection sort of n elements, how many times is the swap function called in the complete execution of the algorithm?

- A. 1
- B. **n - 1**
- C. n log n
- D.  $n^2$

12. Selection sort and quick sort both fall into the same category of sorting algorithms. What is this category?

- A.  $O(n \log n)$  sorts
- B. Divide-and-conquer sorts
- C. **Interchange sorts**
- D. Average time is quadratic.

13. What is the worst-case time for quick sort to sort an array of n elements?

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

14. What is the worst-case time for merge sort to sort an array of  $n$  elements?

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

15. Suppose we are sorting an array of eight integers using quicksort, and we have just finished the first partitioning with the array looking like this:

2 5 1 7 9 12 11 10. Which statement is correct?

- A. The pivot could be either the 7 or the 9.**
- B. The pivot could be the 7, but it is not the 9.
- C. The pivot is not the 7, but it could be the 9.
- D. Neither the 7 nor the 9 is the pivot

16. What is the worst-case time for heap sort to sort an array of  $n$  elements?

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

17. Consider the usual algorithm for determining whether a sequence of parentheses is balanced. What is the maximum number of parentheses that will appear on the stack AT ANY ONE TIME when the algorithm analyzes:  $((()())())$ ?

- A. 1
- B. 2
- C. 3**
- D. 4
- E. 5 or more

18. Here is an infix expression:  $4+3*(6*3-2)$ . Suppose that we are using the usual Stack algorithm to convert the expression from infix to postfix notation. What is the maximum number of symbols that will appear on the stack AT ANY ONE TIME during the conversion of this expression?

- A. 1
- B. 2
- C. 3
- D. 4**
- E. 5

19. Suppose the numbers 1, 2, 3, 4, 5 and 6 arrive in an input stream in that order. Which of the following sequences can be realized as the output of stack?

- A. 1 2 3 4 5 6
- B. 6 5 4 3 2 1**

- C. 2 4 3 6 5 1
- D. 1 5 2 4 3 6
- E. 1 3 5 2 4 6
- F.

20. A binary search tree is generated by inserting in order the following integers:  
50,15,62,5,20,58,91,3,8,37,60,24. The number of nodes in the left sub-tree and the right sub-tree of the root respectively is
- A. (4,7)
  - B. **(7,4)**
  - C. (8,3)
  - D. (3,8)
21. Which of the following is essential for converting an infix expression to the postfix form efficiently
- A. **operator stack**
  - B. operand stack
  - C. an operand stack and operator stack
22. Three algorithms do the same task. Algorithm 1 is  $O(\sqrt{n})$ , Algorithm 2 is  $O(n)$  and algorithm 3 is  $O(\log n)$ . Which algorithm should execute the fastest for large values of  $n$ ?
- A. Algorithm 1
  - B. Algorithm 2
  - C. **Algorithm 3**
  - D. All the above
23.  $T(n) = O(n^k)$  is called \_\_\_\_\_ growth.
- A. linear growth
  - B. **polynomial growth**
  - C. exponential growth
24. Suppose cursor refers to a node in a linked list (using the Node class with the data members as data and link). What statement changes cursor so that it refers to the next node?
- A. cursor++;
  - B. cursor = link;
  - C. cursor += link;
  - D. **cursor = cursor.link;**
25. An array A [m][n] is represented in row major form, the address of element A[i][j] would be \_\_\_\_\_
- A. Base address \* i + n + j
  - B. (Base address + n) \* i + j
  - C. **Base address + i \* n + j**
  - D. Base address \* n + i + j

26. The order of an internal node in a B+ tree index is the maximum number of children it can have. Suppose that a child pointer takes 6 bytes, the search field value takes 14 bytes, and the block size is 512 bytes. What is the order of the internal node?

- A) 24
- B) 25
- C) **26**
- D) 27

27. The best data structure to check whether an arithmetic expression has balanced parentheses is a

- A) queue
- B) **stack**
- C) tree
- D) list

28. A Priority-Queue is implemented as a Max-Heap. Initially, it has 5 elements. The level-order traversal of the heap is given below:

10, 8, 5, 3, 2. Two new elements 1 and 7 are inserted in the heap in that order. The level-order traversal of the heap after the insertion of the elements is

- A) 10, 8, 7, 5, 3, 2, 1
- B) 10, 8, 7, 2, 3, 1, 5
- C) 10, 8, 7, 1, 2, 3, 5
- D) **10, 8, 7, 3, 2, 1, 5**

29. Consider the following C program segment

```
struct CellNode {
    struct CellNode *leftChild ;
    int element;
    struct CellNode *rightChild ;
};
int DoSomething (struct CellNode *ptr)
{
    int value = 0 ; if (ptr != NULL)
    {   if (ptr->leftChild != NULL)
        value = 1 + DoSomething (ptr -> leftChild) ;
        if (ptr -> rightChild != NULL)
        value = max (value, 1 + DoSomething (ptr -> rightChild)) ;
    }
    return (value);
}
```

The value returned by the function DoSomething when a pointer to the root of a non-empty tree is passed as argument is

- A) The number of leaf nodes in the tree
- B) The number of nodes in the tree

- C) The number of internal nodes in the tree  
**D) The height of the tree**

30. 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 (the height is the maximum distance of a leaf node from the root)?

- A) 2  
**B) 3**  
C) 4  
D) 6

31. 'Algorithm' was named after the 9<sup>th</sup> century Persian mathematician

- A. Al- Allahberdi  
**B. Al-Khowarizmi**  
C. Al-Khosrow  
D. None of the above

32. Instruction space of an algorithm depends on

- A. Options specified at the time of compilation**  
B. Options specified at the time of execution  
C. Both a and b  
D. None of the above

33. Which among the following is an item not included in environment stack.

- A. Return address  
B. Return value  
**C. Value of parameters passed as reference variables**  
D. Both b and c

34. A program step is syntactically or semantically meaningful segment of a program whose execution time is

- A. independent of instantaneous characteristics**  
B. dependent of instantaneous characteristics

35. Step count value of a declarative statement is

- A. 0**  
B. 1  
C. Depend on expression  
D. None of the above

36. Step count value of a function statement is

- A. 0**

- B. 1
- C. Depend on method of passing formal parameters
- D. None of the above

37. Step count of the code fragment given below is

```
int Madd (int a[], int b[], int c[], int n)
{
    For (int i=0; i<m; i++)
    For (int j=0; j<n; j++)
    c[i][j] = a[i][j] + b[i][j];
    return c[0][0];
}
```

- A.  $2mn + 2m + 1$
- B.  **$2mn + 2m + 2$**
- C.  $3mn + 2m + 1$
- D.  $2mn + 3m + 1$

38. Which among the following asymptotic notation is used to denote the lower bound of an algorithm

- A. Big 'Oh' Notation
- B. **Omega Notation ( $\Omega$ )**
- C. Theta Notation
- D. Both b and c

39. Given the complexity of function  $f(n) = 100n^2 + 6n + 2$  is  $O(n^2)$ . What will be the value of the break even point is

- A. 7
- B. **101**
- C. 8
- D. None of the above

40. For a given function  $f(n)$  which among the following represents Big 'Oh' notation.

- A.  $< cg(n) < f(n)$
- B.  $0 \leq cg(n) \leq f(n)$
- C.  $0 < f(n) < cg(n)$
- D.  **$0 \leq f(n) \leq cg(n)$**

41. Which of these is the correct big-O expression for  $1+2+3+\dots+n$ ?

- A.  $O(\log n)$
- B.  $O(n)$

C.  $O(n \log n)$

D.  **$O(n^2)$**

42. Which of the following formulas in big-O notation best represent the expression  $n^2 + 35n + 6$ ?

A.  $O(n^3)$

B.  **$O(n^2)$**

C.  $O(n)$

D.  $O(42)$

43. What term is used to describe an  $O(n)$  algorithm.

A. Constant

B. **Linear**

C. Logarithmic

D. Quadratic

44. Here is some code for an *integer* variable  $n$ :

```
while (n > 0)
{
    n = n/10; // Use integer division
}
```

What is the worst-case time analysis for the above loop?

A.  **$O(1)$**

B.  $O(\log n)$

C.  $O(n)$

D.  $O(n^2)$

45. Express the formula  $(n - 2) * (n - 4)$  using big-O notation:

A.  $O(1)$

B.  $O(8)$



C.  $O(\log n)$

D.  $O(n)$

E. **None of the above**

46. Answer true or false for this statement: For all possible inputs, a linear algorithm to solve a problem must perform faster than a quadratic algorithm to solve the same problem.

A. **TRUE.**

B. **FALSE.**

47. Why is it important to test boundary values when testing programs?

A. Calculating by hand, it's easy to find the right answers for boundary values.

B. Debuggers are easier to use when testing boundary values.

C. In practice, a large proportion of errors arise from boundary values.

D. **The correct execution of a function on all boundary values proves a function is correct.**

48. What does a run-time analysis usually count?

A. **The number of arithmetic and other operations required for the program to run**

B. The number of megabytes required for the program to run

C. The number of seconds required for the program to run

D. The number of seconds plus the number of megabytes

49. A variable which can be accessed by all modules in a program are called

Local variable

Internal variable

External variable

**Global variable**

50. In what kind of storage structure for strings one can easily insert, delete concatenate and rearrange sub strings

fixed length storage structure

variable length storage with fixed maximum

**linked list storage**

array storage type

51. A linear list in which elements can be added or removed at either end but not in the middle is known as

Queue

**Deque**

Stack

Tree

52. The time required to insert an element in a stack with linked implementation is

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

53. A binary tree in which if all its level except possible the last, have the maximum number of nodes and all the nodes at the last level appear as far left as possible is known as

- A. Full binary tree
- B. 2- tree
- C. threaded tree
- D. **complete binary tree**

54. The five items A B C D & E are pushed in a stack one after the other starting from A. The stack is popped four times and each element is inserted in a queue. Then two elements are deleted from the queue and pushed back on the stack. Now one item is popped from the stack. The popped item is

- A
- B**
- C
- D

55. The time require to search an element in a binary search tree having n elements is

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

56. Consider n elements are to be sorted. The worst case time complexity of Bubble sort is

- A.  $O(1)$
- B.  $O(\log_2 n)$
- C.  **$O(n)$**
- D.  **$O(n^2)$**

57. The worst case time complexity of straight insertion sort algorithm to sort n elements is

$O(n)$

$O(n \log_2 n)$   
 $O(n^{1.2})$   
 **$O(n^2)$**

58. The worst case time complexity of binary insertion sort algorithm to sort  $n$  elements is

$O(n)$   
 $O(n \log_2 n)$   
 $O(n^{1.2})$   
 **$O(n^2)$**

50. Which of the following sorting procedure is the slowest

- A. Quick sort
- B. Heap sort
- C. Merge sort
- D. **Bubble sort**

A. 61.

60 How many value can be held by an array  $A(-1..m, 1..m)$ ?

- A.  $m$
- B.  $m^2$
- C.  $m(m+1)$
- D.  **$m(m+2)$**

61. A complete binary tree with the property that the value at each node is at least as large as the values at its children is known as

- A. Binary search tree
- B. AVL tree
- C. Complete balanced tree
- D. **Heap**

62. The goal of hashing is to produce a search that takes

- A.  $O(1)$  time
- B.  $O(n^2)$  time
- C.  **$O(\log n)$  time**
- D.  $O(n \log n)$  time

63. A sort which compares adjacent element in a list and switches where necessary is a

- A. Insertion sort
- B. Heap sort
- C. Quick sort
- D. **Bubble sort**

64. A sort which iteratively passes through a list to exchange the first element with any element less than it and then repeats with a new first element is called

- A. Insertion sort
- B. **selection sort**
- C. heap sort
- D. Quick sort

65. Worst case complexity of quick sort is

- A.  **$O(n^2)$**
- B.  $O(n \log n)$
- C.  $O(\log n)$
- D.  $O(1)$

66. Worst case complexity of Shell sort is

- A.  $O(n^2)$
- B.  **$O(n^{1.5})$**
- C.  $O(\log n)$
- D.  $O(1)$

67. Best case complexity of Shell sort is

- A.  $O(n^2)$
- B.  **$O(n(\log_2 n)^2)$**
- C.  $O(\log n)$
- D.  $O(1)$

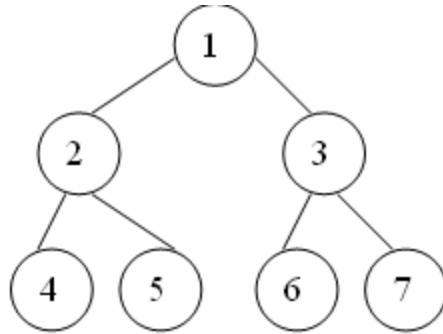
68. Best case complexity of Shell sort is

- A.  $O(n^2)$
- B.  $O(n(\log_2 n)^2)$
- C.  **$O(\log_2 n)$**
- D.  $O(1)$

69. Number of sub trees of a node is called

- A. **Degree**
- B. Level
- C. Height
- D. Depth

70. Inorder result of the tree given below



- A. **4,2,5,1,6,3,7.**
  - B. 1,2,4,5,3,6,7
  - C. 4,5,2,6,7,3,1
  - D. None of the above
71. Number of sub trees of a node is called
- A. **Degree**
  - B. Level
  - C. Height
  - D. Depth
72. In C, precedence determines when operator
- A. **is evaluated first**
  - B. is most important
  - C. is fastest
  - D. operates on the largest number
73. The argument of printf() function is known as
- A. **Control string**
  - B. Newline character
  - C. preprocessor
  - D. All of the above
74. The feature that allows you to define new data types that are equivalent to existing data type is
- A. pointer
  - B. **typedef**
  - C. structure
  - D. union
75. The string containing certain required formatting information is called
- A. argument
  - B. character array
  - C. character string
  - D. **control string**
76. After constructing a sorted binary insertion tree, to produce a sorted array of numbers, what must be done?
- A. Pre order traversal

- B. Pre order traversal
- C. Inorder traversal
- D. **Top down traversal**

77. Which of the following sorting algorithms yield approximately the same worst-case and average-case running behaviour in  $O(n \log n)$ .

- A. Bubble sort and selection sort
- B. **Heap sort and merge sort**
- C. Quick sort and Radix sort
- D. Tree sort and Median-of-3 Quick sort

78. Let  $X=(a,b,c)$  be a set of three elements. The number of algebraic binary operations that can be defined on  $X$  are:

- A.  $3^3$
- B.  $3^2$
- C.  $3^8$
- D.  **$3^9$**

79. Enumeration is

- A. A set of numbers
- B. A list of strings
- C. A set of legal values possible for a variable
- D. **A list of operators**

80. How many comparisons are required to sort an array of length 5 if a straight selection sort is used and the array is already sorted in the opposite order?

- A. **20**
- B. 1
- C. 10
- D. 15

81. If the memory for the run-time stack is only 150 cells (words), how big can  $N$  be in  $\text{Factorial}(N)$  before encountering stack overflow?

- A. 24
- B. 15
- C. **66**
- D. 80

82. A one-dimensional array  $A$  has indices 1..75. Each element is a string and takes up three memory words. The array is sorted at location 1120 decimal. The starting address of  $A[49]$  is

- A. 1164
- B. **1264**
- C. 1386
- D. 1451

83. The maximum amount of information that is available with one positioning of the disk access arm of a removable disk pack is

- A. **A cylinder data**
- B. A track of data
- C. A plate of data
- D. A block of data

84. A search technique where we keep expanding nodes with least accumulated cost so far is called

- A. Hill-climbing
- B. Best-fit
- C. **Branch-and-bound**
- D. Breadth-first

85. If  $|A| = m$  and  $|B| = n$  are sizes, how many binary relations are there from set A to set B ?

- A.  $mn$
- B.  $(mn)!$
- C.  $[\text{Max}(m,n)]^2$
- D.  $2^{mn}$

86. The main() function is always

- A. A called function
- B. **A calling function**
- C. Recursive function
- D. Used at the end of the program

87. If you are not careful in your choice of hash functions it is possible to have collisions in which the search time goes to the order of  $O(?)$  in a search table of size N :

- A. 1
- B.  $\log_2 N$
- C. N
- D.  $N!$

88. The number of canonical expressions that we can develop over a 3-valued Boolean algebra is:

- A. 8
- B. 16
- C. 32
- D. **64**

89. Which sort will operate in quadratic time relative to the number of elements in the array (on the average)?

- A. Quick sort
- B. **Bubble sort**
- C. Merge sort
- D. Heap sort

90. What symbol causes a pop in the stack-evaluation of fully-paranthesized infix expressions, such as  $((2+3)*(5+7))$  ? Assume, the expression is read from left to right. Choose the best of most definite answer.
- 2
  - +
  - )
  - (
91.  $f(x) = (7x^6 + 3x^4 + 17x + 9) / (0.01x^3 * x^{-1})$  is Big-O of what?
- F is  $O(n^7)$  but not  $O(n^6)$
  - F is  $O(n^6)$  but not  $O(n^5)$
  - F is  $O(n^5)$  but not  $O(n^4)$**
  - F is  $O(n^4)$  but not  $O(n^3)$
92. Convert  $(a+b) * (c+d)$  to postfix
- \*+ab+cd
  - ab+\*cd+
  - abcd++\*
  - ab+cd+\***
93. How many nodes are there in a complete binary tree of level 5?
- 15
  - 25
  - 33
  - 63**
94. Determining all possible decompositions of sequential machines requires ----- time in N, where N is the number of states
- logarithmic
  - exponential**
  - $N \log(N)$
  - quadratic
95. How many nodes are there in level N of a complete binary tree?
- $\text{Log}_2 N$
  - $2^k - 1$
  - $2^{k-1}$**
  - None of the above
96. How many nodes are there in a complete binary tree of height N?
- $\text{Log}_2 N$
  - $2^k - 1$**
  - $2^{k-1}$
  - None of the above
97. Disk requests are received by a disk drive for cylinders 5,25,18,3,39,8 and 35 in that order. A seek takes 5 msec per cylinder moved. How much seek time is needed to



serve these requests for a Shortest Seek First Algorithm? Assume that the arm is at cylinder 20 when the last of these requests is made with none of the requests yet served

- A. 125
- B. **295**
- C. 575
- D. 750

98. Determining (exactly) that a number  $n$  is prime requires (according to the standard algorithm):

- A. Logarithmic time ( in terms of  $n$ )
- B. **Linear time**
- C. Quadratic time
- D. Exponential time

99. How many nodes are there in the largest maximal independent set of the complete bipartite graph  $K(4,2)$ ?

- A. 2
- B. 3
- C. **4**
- D. 5

100. In a complete binary tree of  $n$  nodes, how far are the most distant two nodes? Assume each edge in the path counts as 1. Assume  $\log(n)$  is log base 2

- A. about  $\log(n)$
- B. **about  $2 \log(n)$**
- C. about  $3 \log(n)$
- D. about  $4 \log(n)$