

KYAMBOGO UNIVERSITY

FACULTY OF SCIENCE

Department of Computer Science

University Examinations 2018/2019

Third Year, Semester One Examination for Bachelor of Information Technology and Computing

SCS 3102 Data Structures and Algorithms

Date: Wednesday 5th December 2018

Time: 12:00pm – 3:00pm

Instructions to Candidates:

- ❖ This paper consists of six questions
- ❖ Attempt any five questions
- ❖ All questions carry equal marks
- ❖ Start each question on a new page
- ❖ Relevant examples and illustrations will carry additional marks

Question 1

- (a) Explain the following terms
- (i) Structure → A user defined data type in C++ that allows to combine data items of different kinds under a single name. Better handling. (2 Marks)
 - (ii) Class → A user-defined type / data structure declared with a keyword class that has variables & functions.
 - (iii) Array → Data structure that stores data of the same type. Either integer, Boolean, double but can't contain mixed types.
 - (iv) Linked List → An ordered set consisting of various no. of elements. we insertions & deletions can be made.
- (b) (i) An array is static while a linked list is dynamic, discuss data types. (3 Marks)
- (ii) Briefly describe how structures are used in the construction of the linked lists (3 Marks)
- (c) Give any three advantages and three limitations of using arrays as data structures (6 Marks)

Question 2

- Correctness
- Time complexity
- Space complexity
- (a) Give any three characteristics of a Data Structure
 - (b) Give any three justifications for the need to use a Data Structure
 - (c) Give six characteristics of an algorithm
 - (d) Explain the time and space factors in Algorithm Complexity
 - (e) Explain any four basic operations carried out by algorithms on Data Structures

It is relatively expensive to insert & delete elements in an array.

An array occupies a block of memory space.

Sequential storage wastes space, if only a small fraction of location is used. (3 Marks)

The size of an array is fixed & cannot be modified as & when needed.

An array stores its elements in a contiguous manner.

1 of 4

Traverse
Insertion
Deletion
Search
Sort
Update.

measured by counting the no. of key operations required by the algorithm.

Question 3

Step by step procedure which defines a set of instructions to be executed in a certain order to get the desired output.

- (a) Define the term Algorithm (2 Mark)
 (b) The steps of an algorithm are specified as follows;

1. Start
2. Set $J = K$
3. Repeat steps 4 and 5 while $J < N$
4. Set $LA[J] = LA[J + 1]$
5. Set $J = J+1$
6. Set $N = N-1$
7. Stop

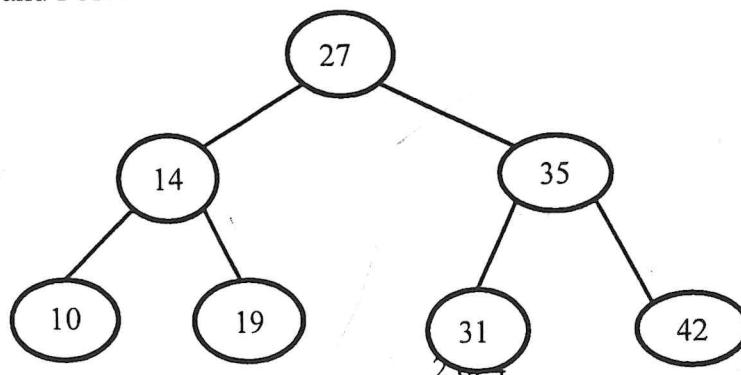
Deletion operation.

Describe the operation that is achieved by the above algorithm (2 Mark)

- (c) Given a list $L = \{7, 3, 11, 1, 9, 4\}$, briefly describe how each of the following algorithm can be used to sort the list (4 Marks@)
- (i) Quick sort
 - (ii) Insertion sort
 - (iii) Selection sort
 - (iv) Bubble sort

Question 4 ✓

- (a) With at least two examples of each, differentiate between the following (2 Marks@)
- (i) Linear data structures and non-linear data structures
 - (ii) Primitive data types and abstract data types
- (b) With the use of a well-drawn diagram of a tree data structure, explain the following terms (2 Marks@)
- (i) Root node
 - (ii) Degree of a node
 - (iii) Level of a node
 - (iv) Branch node
 - (v) Terminal node
- (c) Using the binary search tree shown in the diagram below, indicate the path for the Inorder, Preorder and Postorder Traversals (2 Marks@)



Question 5 ✓

- (a) (i) In relation to algorithm analysis, explain what is meant by Big Oh notation (2 Marks)
- (ii) After analyzing different algorithms performing a task, the following time complexities were obtained; $O(n)$, $O(n^2)$, $O(n^3)$, $O(\log n)$, arrange the time complexities beginning with the fastest to the slowest. (2 Marks)
- (b) Find the equivalent of the following expressions in terms of the Big Oh notation (2 Marks@)
- (i) $6n^4 - 2n^3 + 3$
 - (ii) $n^2 + \log n$
 - (iii) $3n^3 - 2n^2 + 8n - 5$
 - (iv) $2^n + 3n^2$
- (c) Express the following expressions which are Infix notations to their corresponding prefix and post fix notations; (2 Marks@)
- (i) $(a+b)*(c+d)$
 - (ii) $a/b+c/d$
 - (iii) $a+b*c/d-e$
 - (iv) $((a+b)*c)-d$

Question 6

- (a) The steps of an algorithm are specified as follows;

1. Start
2. Set $a = 0$
3. Set $b = 1$
4. $k = a + b$
5. Print a
6. Print b
7. $c = b$
8. $b = b + a$
9. $a = c$
10. $k = k + b$
11. if $b < 7$
12. $b = b + 1$ goto 6
12. Stop

- (i) Construct a flowchart for the above algorithm (3 Marks)
- (ii) Carry out a dry run and state the output sequence of the algorithm (4 Marks)
- (iii) Study the output sequence in b (ii) above and suggest the next three terms of the sequence (3 Marks)

~~A + B + C / D~~

BODMAS

~~A * B + C D /~~

~~A B * + C D /~~

~~A B * C D / +~~

(iv) By using a *for loop*, write a computer program that implements the above Algorithm

(3 Marks)

(v) State the values of c and k after executing the algorithm

(2 Marks)

(b) (i) Given the algorithm below, briefly explain line 2 to line 8

(3 Mark)

1. begin

2. IF N = MAX, return

3. ELSE

4. N = N + 1

5. SEEK Location index

6. For All Elements from A[index] to A[N]

7. Move to next adjacent location

8. A[index] = New_Element

9. end

(ii) Briefly describe what the above algorithm does

(2 Marks)

Union

Private

Structure

Public

Object

Protected

Record

Attributes = Fields = Column

Dynamic data structure / Static

Linked List : A collection of data structures linked up in a chain

Types of Linked Lists

Simply

Doubly

Circular

$5 \times 4 \times 3 \times 2 \times 1$

KYAMBOGO UNIVERSITY
FACULTY OF SCIENCE
Department of Computer Science

University Examinations 2016/2017

**Second Year, Semester One Examinations for the Degree of Bachelor of Information
Technology and Computing**

IT 215: Data Structures and Algorithms

Date: Monday 28th November 2016

Time: 8.00 a.m. – 11.00 a.m.

Instructions to candidates:

Attempt any five (5) questions out of seven

All questions carry equal marks

Start each question on a new page

Question 1

- | | |
|---|-----------|
| (a) Give three characteristics of a Data structure | (3 Marks) |
| (b) Give any three justifications for the need to use a Data Structure | (3 Marks) |
| (c) Give six characteristics of an Algorithm | (6 Marks) |
| (d) Explain the time and space factors in Algorithm Complexity | (2 Marks) |
| (e) List any six basic operations carried out by algorithms on Data Structure | (3 Marks) |
| (f) Give one example of Built-in Data type | (1 Mark) |

Question 2

- (a) With well labeled diagrams, Explain the following linear data structures by definition (In words and using the C- Language), then indicate the most suitable application for each; (4 Marks @)

- (i) Double Linked List
- (ii) Stack
- (iii) Queue
- (iv) Linked List

- (b) The following simple code involves a pointer and an array data structure. Study it and show the output and use of the program (4 Marks)

```

include <stdio.h>
const int MAX = 3;
int main () {
    int var[] = {10, 100, 200};
    int i, *ptr[MAX];
    for ( i = 0; i < MAX; i++) {
        ptr[i] = &var[i];
    }
    for ( i = 0; i < MAX; i++) {
        printf("Value of var[%d] = %d\n", i, *ptr[i]);
    }
    return 0;
}

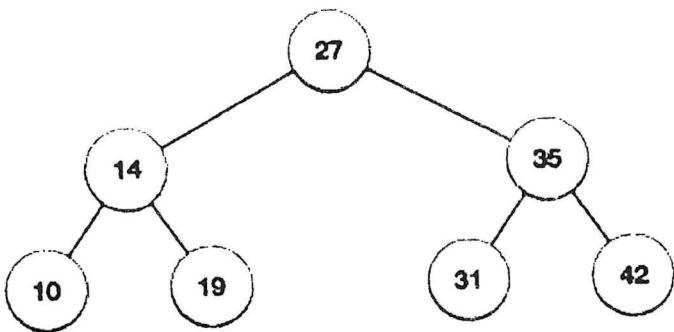
```

Question 3

- (a) With the use of a well-drawn diagram of a tree data structure, define the following tree concepts (1 Mark@)

- (i) Leaf
- (ii) Root
- (iii) Path
- (iv) Parent
- (v) Child
- (vi) Subtree
- (vii) Visiting
- (viii) Traversing
- (ix) Level
- (x) Key

- (b) Explain the basic characteristics of a binary search tree (3 Marks)
 (c) Using the binary search tree shown in the diagram below, indicate the path for the Inorder, Preorder and Postorder Traversals. (6 Marks)



(d) Write a C- language definition for a tree data structure

(1 Mark)

Question 4

(a) With the use of a well-drawn diagram of a graph data structure, define the following graph concepts (1 Mark@)

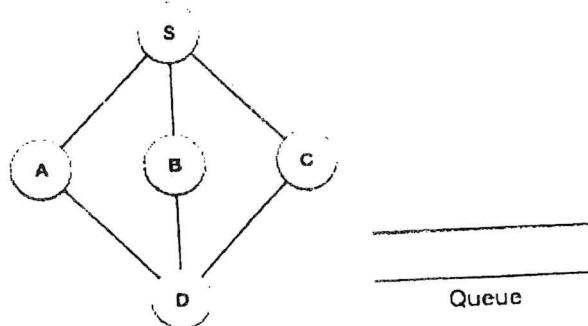
- (i) |Vertex
- (ii) Edge
- (iii) Adjacency
- (iv) Path
- (v) Loop
- (vi) Connectivity

(b) List four applications of the graph data structure in modern science (2 Marks)

(c) Using graph diagram shown below indicate the path for Depth First Search and Bread

First Search Algorithms and indicate in each the stack and queue elements involved at each stage starting from the S vertex and using the alphabetical (descending order).

(8 Marks)



(d) Explain the basic operations that can be carried out on a Graph Data structure (4 Marks)

Question 5

- (a) Give six qualities of a good sorting Algorithm? (3 Marks)
- (b) Given an array of ten(10) elements, indicate the C-programming code (Logical and Loops only) for the following sorting algorithms and indicate the running time using the Big Oh Notation; (3 Marks@)
- (i) Bubble sort
 - (ii) Insertion Sort
 - (iii) Selection Sort
 - (iv) Merge sort
- (c) Explain what is meant by the following data structure and algorithm terms;
- (a) Greedy Algorithm
 - (b) Divide and Conquer
 - (c) Dynamic Programming
 - (d) Binary Search
 - (e) Hashing

Question 6

- (a) Define the Big Oh Notation and fine the equivalent of the following expressions in terms of the Big Oh Notation; (2 Mark@)
- (i) $3n^3 - 2n^2 + 8n - 5$
 - (ii) $n^2 + \log n$
 - (iii) $6n^4 - 2n^3 + 5$
 - (iv) $2^n + 3n^2$
 - (v) $2^n + \log n^2$
- (b) Express the following expressions which are in Infix notations to their corresponding prefix and post fix notations; (2 Marks@)
- (i) $(a + b) * (c + d)$
 - (ii) $a / b + c / d$
 - (iii) $a + b * c / d - e$
 - (iv) $((a + b) * c) - d$
 - (v) $(a + b) * (c / d)$

KYAMBOGO UNIVERSITY

FACULTY OF SCIENCE

Department of Computer Science

University Examinations 2020/2021

Third Year, Semester One Examination for Bachelor of Information Technology and
Computing

SCS 3102 Data Structures and Algorithms

Date: Thursday 16th December 2021

Time: 2:00pm – 5:00pm

Instructions to Candidates:

- ❖ This paper consists of six questions
- ❖ Attempt any five questions
- ❖ All questions carry equal marks
- ❖ Start each question on a new page
- ❖ Relevant examples and illustrations carry additional marks

Question 1

- (a) (i) Explain row major order and column major order for a 2-dimensional array (2 marks)
(ii) With example, brief explain Sparse Matrix (2 marks)
- (b) An array X[4.5, 3.7] is stored in a memory whose starting address is 1001. Assume that the word size is 2. Find the following;
- (i) Total elements in array X (2 marks)
(ii) Total memory required to store the entire array (2 marks)
(iii) Location for X[6][6] in row major and column major order (2 marks)
- (c) Explain searching and insertion of elements in an array using algorithms (4 marks)
- (d) Write a C program to perform insert, delete and search operation for 1-dimensional array (6 marks)

Question 2

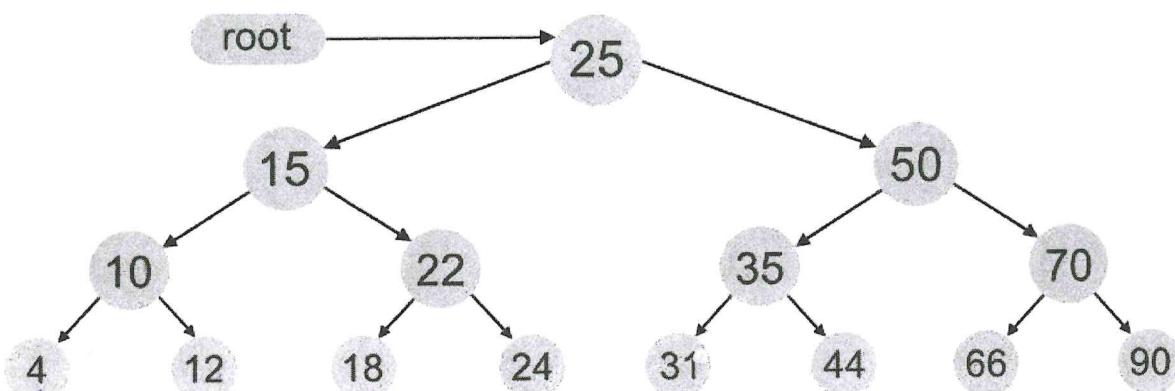
- (a) Define an Algorithm (1 mark)
(b) Explain three characteristics of an algorithm (3 marks)
- (c) Given a list K= {7, 3, 11, 1, 9, 4}, briefly describe how each of the following algorithm can be used to sort the list (4 marks@)
- (i) Insertion sort
(ii) Quick sort
(iii) Selection sort
(iv) Bubble sort

Question 3

- (a) (i) With example, differentiate between stack and queue (4 marks)
(ii) Explain areas where stack can be applied (2 marks)
(iii) How are queues and stacks implemented? (2 marks)
(iv) Write an algorithm to PUSH, POP and PEEP element to/from the stack (4 marks)
- (b) (i) Differentiate between a graph and a heap (4 marks)
(ii) How does depth first traversal works? (2 marks)
- (c) What is a recursive function? (2 marks)

Question 4

- (a) (i) Define a tree in data structures (1 mark)
(ii) Explain any 2 properties of Binary tree (2 marks)
- (b) With the use of an illustration of a tree data structure, explain the following tree concepts (1 mark@)
- (i) Root node
 - (ii) Degree of a node
 - (iii) Parent node
 - (iv) Level of a node
 - (v) Branch node
 - (vi) Siblings
 - (vii) Terminal node
- (c) With examples, differentiate between;
(i) Linear data structures and non-linear data structures (2 marks)
(ii) Primitive data types and abstract data types (2 marks)
- (d) Using the binary search tree shown in the diagram below, indicate the path for the



In-order traversal

- (i) Pre-order traversal

L A Right

Left Right Root

Page 2 of 3

Left Root Right

(2 marks)

(2 marks)

Left Right Root

Root Left Right

Left Root Right

i) Pre-in-order
ii) Post-order

- (ii) Post-order traversals (2 marks)

Question 5

- (a) (i) In relation to algorithm analysis, explain what is meant by Big Oh notation (3 marks)
(Use two functions $f(n)$ and $g(n)$)
- (ii) After analyzing different algorithms performing a task, the following time complexities were obtained; $O(n)$, $O(n^2)$, $O(n^3)$, $O(\log n)$, $O(1)$, $O(n \log n)$, arrange the time complexities beginning with the fastest to the slowest. (3 marks)
- (b) By show of method, find the equivalent of the following expressions in terms of the Big Oh Notation (2 marks@)
- (i) $2n^7 - 6n^5 + 10n^2 - 6$
 - (ii) $6n^4 - 2n^3 + 5$
 - (iii) $n^2 + \log n$
 - (iv) $3n^3 - 2n^2 + 8n - 5$
 - (v) $4^n + 3n^2$

- (c) Study the algorithm below and determine its output assuming $a = 4$, hence compute its Big-Oh (4 marks)

```
void printMatrix(int a) {  
    for(int i=0; i <= a; i++) {  
        for(int j=0; j <= a; j++) {  
            cout << j // Prints out a square matrix  
        }  
    }  
}
```

Question 6

- (a) With illustrations, differentiate between an array and linked list (4 marks)
- (b) (i) An array is static while a linked list is dynamic, discuss (2 marks)
- (ii) Briefly describe how structures are used in the construction of linked lists (2 marks)
- (c) Convert the following expressions to their corresponding prefix and post-fix notations; (2 marks@)
- (i) $a * (b+c/d)$
 - (ii) $((a*b)+(c/d))$
 - (iii) $(a+b)*(c+d)$
 - (iv) $a+b*c/d-e$
 - (v) $((a+b)*c)-d$
 - (vi) $((P+((Q^R)-S))*(U-(P/R)))$

4+1 = 5

4+a =

Group 3

- (a) Give six qualities of a good sorting Algorithm? (3 Marks)
- (b) Given an array of ten(10) elements, indicate the C-programming code (Logical and Loops only) for the following sorting algorithms and indicate the running time using the Big Oh Notation; (3 Marks@)
- (i) Bubble sort
 - (ii) Insertion Sort
 - (iii) Selection Sort
 - (iv) Merge sort
- (c) Explain what is meant by the following data structure and algorithm terms;
- (a) Greedy Algorithm
 - (b) Divide and Conquer
 - (c) Dynamic Programming
 - (d) Binary Search
 - (e) Hashing

Group 4✓

- (a) Define the Big Oh Notation and find the equivalent of the following expressions in terms of the Big Oh Notation; (2 Mark@)

- (i) $3n^3 - 2n^2 + 8n - 5 \approx O(n^3)$
- (ii) $n^2 + \log n \approx O(n^2)$
- (iii) $6n^4 - 2n^3 + 5 \approx O(n^4)$
- (iv) $2^n + 3n^2 \approx O(2^n) + O(n^2)$
- (v) $2^n + \log n^2 \approx O(2^n) + O(\log n^2)$

- (b) Express the following expressions which are in Infix notations to their corresponding prefix and post fix notations; Postfix (2 Marks@)

- (i) $(a + b) * (c + d) \quad abcd+*$
- (ii) $a / b + c / d \quad ab/cd/+$
- (iii) $a + (b * c) / d - e \quad a(bc*)/d-e \rightarrow a + (bc*)d/-e \rightarrow abc*d/-e \rightarrow abc*d/te$
- (iv) $((a + b) * c) - d$
- (v) $(a + b) * (c / d)$

15

$2n+3$

$$\log_7 n = O \log^3 n$$

$= 2n+8$

$$\log_5 n$$

return;

- (a) Carry out a dry run and state the output of the flowchart (8marks)
 (b) Write a C program that implements the algorithm in the flowchart (8marks)
 (c) State any 2 advantages and 2 limitations of using flowcharts to demonstrate algorithms (2,2marks)

Group 5 ✓

- (a) Given a list $L = \{7, 3, 11, 1, 9, 4\}$, briefly describe how each of the following algorithms can be used to sort the list. (4marks@)



(i) Quick sort

(ii) Insertion sort

(iii) Selection sort

(iv) Bubble sort

- (b) State the worst case of each of the algorithms in (a) above

Group 7 ✓

- (a) Define what is meant by

(2marks@)

(i) Structure

(ii) Array

(iii) Linked List

(2marks)

- (b) (i) Distinguish between a *structure* and a *class*. (3marks)

(ii) An array is static while a linked list is dynamic, discuss (3marks)

(iii) Briefly describe how structures are used in the construction of linked lists (3marks)

- (c) What do you think are the advantages and limitations of using arrays as data structures? (6marks)

Group 6 ✓

- (a) In relation to tree data structure, define what is meant by each of the following (1mark@)

(i) Root node

(ii) Degree of a node

(iii) Level of a node

(iv) Branch node

(v) Terminal node

$i=0; i < N$ $i++$
 $i=N-1; i >= 0$ $i--$

- (b) Distinguish between

(3marks)

(i) Linear and nonlinear data structures, give an example on each

(ii) Primitive data types and Abstract Data Types, give an example on each

(3marks)

(3marks)

(6marks)

- (c) (i) Briefly describe how collision occurs during hashing process

(ii) Briefly describe any two methods of resolving collision during hashing

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22
30

Name: NABBALA IRENE

RegNo: 17/0/296/ITB/GV

KYAMBOGO UNIVERSITY

Program: BITC 111 SCS 3102 Data Structures and Algorithms Test 1st/11/2019

Duration: 3/4 hr. Attempt all numbers; Circle the most correct answer(s) in this section A

- 1) Inserting an item into the stack when stack is not full is called Operation and deletion of item form the stack, when stack is not empty is called operation.
 (a) push, pop ✓ (b) pop, push (c) insert, delete (d) delete, insert
- 2) A is a data structure that organizes data similar to a line in the supermarket, where the first one in line is the first one out.
 (a) Stacks linked list (b) Queue linked list ✓ (c) Both of them (d) Neither of them
- 3) Identify the data structure which allows deletions at both ends of the list but insertion at only one end.
 (a) Output restricted dequeue (b) Priority queues ✗ (c) Input restricted dequeue (d) Stack C
- 4) Which of the following data structure is non linear type?
 (a) Strings (b) Lists (d) Stacks (d) Graph ✓
- 5) To represent hierarchical relationship between elements, Which data structure is suitable?
 (a) Dequeue (b) Priority (c) Tree ✓ (d) Graph
- 6) A directed graph is if there is a path from each vertex to every other vertex in the digraph.
 (a) Weakly connected (b) Strongly Connected ✓ (c) Tightly Connected (d) Linearly Connected
- 7) Match the following.
 a) Completeness i) How long does it take to find a solution b) Time Complexity ii) How much memory need to perform the search. c) Space Complexity iii) Is the strategy guaranteed to find the solution when there is one.
 (a) a-iii, b-ii, c-i (b) a-i, b-ii, c-iii (c) a-iii, b-i, c-ii ✓ (d) a-i, b-iii, c-ii
- 8) In , search start at the beginning of the list and check every element in the list.
 (a) Linear search ✓ (b) Binary search (c) Hash Search (d) Binary Tree search
- 9) A graph is a collection of nodes, called And line segments called arcs or that connect pair of nodes.
 (a) vertices, edges ✓ (b) edges, vertices (c) vertices, paths (d) graph node, edges
- 10) When new data are to be inserted into a data structure, but there is no available space; this situation is usually called
 (a) Underflow ✗ (b) overflow ✓ (c) houseful (d) saturated
- 11) Operations on a data structure may be
 (a) creation (b) destruction (c) selection (d) all of the above ✓
- 12) Which of the following statement is false?
 (a) Arrays are dense lists and static data structure.
 (b) Data elements in linked list need not be stored in adjacent space in memory
 (c) Pointers store the next data element of a list.
 (d) Linked lists are collection of the nodes that contain information part and next pointer.

Linked list stores an address to the next node

- 13) Each node in a linked list has two pairs of and
(a) Link field and information field ✓ (b) Link field and avail field
(c) Avail field and information field (d) Address field and link field
- 14) When does top value of the stack changes?
(a) Before deletion ✓ (b) While checking underflow
(c) At the time of deletion ✓ (d) After deletion ✓
- 15) The logical or mathematical model of a particular organization of data is called a
(a) Data structure ✓ (b) Data arrangement (c) Data configuration (d) Data formation
- 16) The disadvantage in using a circular linked list is
(a) It is possible to get into infinite loop. ✓ (b) Last node points to first node.
(c) Time consuming (d) Requires more memory space ✓
- 17) A linear list in which each node has pointers to point to the predecessor and successors nodes is called as
(a) Singly Linked List ✓ (b) Circular Linked List
(c) Doubly Linked List (d) Linear Linked List
- 18) The time complexity of quick sort is
(a) $O(n)$ ✓ (b) $O(n^2)$ (c) $O(n \log n)$ ✓ (d) $O(\log n)$
- 19) Which of the following is an application of stack?
(a) finding factorial (b) tower of Hanoi
(c) infix to postfix conversion (d) all of the above ✓
- 20) The time factor when determining the efficiency of algorithm is measured by
(a) Counting microseconds (b) Counting the number of key operations ✓
(c) Counting the number of statements (d) Counting the kilobytes of algorithm
- 21) Which of the following case does not exist in complexity theory?
(a) Best case (b) Worst case (c) Average case (d) Null case ✓
- 22) The elements of an array are stored successively in memory cells because
(a) the architecture of computer memory does not allow arrays to store other than serially
(b) by this way computer can keep track only the address of the first element and the addresses of other elements can be calculated
(c) both of above ✓
(d) none of above
- 23) Is a pile in which items are added at one end and removed from the other.
(a) Stack (b) Queue ✓ (c) List (d) None of the above
- 24) is very useful in situation when data have to be stored and then retrieved in reverse order.
(a) Stack ✓ (b) Queue (c) List (d) Link list
25. Which of the following data structures are indexed structures?
(a) Linked lists (b) Linear arrays ✓ (c) Queue (d) Stack
- 26) (i) Write an algorithm for deletion operation in a linear array LA.
(ii) Given int LA[] = {1,3,5,7,8};, write a C++ implementation code to delete element 5 from the linear array LA (5 marks)