

Data Structure - I

Introduction to Data Structure

1. Define data structure. [CU 2006]
2. Classify data structure with respect to Linearity, Homogeneity and Accessibility.
3. What is an abstract data type (ADT)? [CU 2012]
4. Distinguish between Data structure and ADT. [CU 2006]
5. Differentiate between linear and non-linear data structure. [SU 2012 CU 2006]
6. Are data types data structures? Justify. [SU 2014]
7. Define an algorithm in C. What are the basic properties of an algorithm in C?
8. How efficiency of an algorithm and/or function in C is measured?
9. Differentiate between time complexity and space complexity of an algorithm.
10. "A program is an algorithm coded in a high level language" - Justify. [CU 2009]
11. Define the following terms – Big oh, Big theta and Big omega notation.

Array

1. Define an array.
2. Define the terms with respect to an array – size, type, base, and index.
3. What value are automatically initialized in an array which is not explicitly initialized? [CU 2014]
4. Consider, an array $A[-15..64]$ is stored in a memory whose starting address in 459. Assume that the word size for each element is 2. Then obtain the following [SU 2012]
 - (a) How many elements are there in A?
 - (b) If one byte word of the memory is equal to 2 bytes, then how much memory is required to store the entire array?
 - (c) What is the actual location of $A[50]$?
 - (d) What is the location of the 10^{th} element?
 - (e) Which element is located at 589?
5. Write an algorithm and/or function in C that will –
 - (a) Insert a new item in an intermediate position of an array.
 - (b) Delete an existing item from an array
6. Write an algorithm and/or function in C to merge two arrays of size n_1 and n_2 respectively.
7. What do you mean by divide-n-conquer based algorithm. [SU 2012 2014 CU 2005]
8. Write an algorithm and/or function in C for searching an element in a list of elements using binary search. (both using/ without using recursion)
9. How many comparisons are required to locate an item using binary search technique in a list of N items?
10. Why linked list is not a suitable data structure to search an element using binary search? [SU 2013]
11. Differentiate between – Linear search and Binary search.
12. When and why would you prefer to use binary search instead of using sequential search?

13. What do you mean by – row major and column major representation of an array. State indexing formula for finding the address of an given element 2-D array respectively. [SU 2013 CU 2005 2010 2012]
14. A 2-D array TABLE[6][8] is stored in row-major order with base address 351. What is the physical address of TABLE[3][4]. [CU 2014]
15. Let a 3D matrix name 'A' is in memory from the address 3172. It has 3 dimension named row, column and height. Each of them starts from 1 and ended with 5, 6 and 7 respectively. Now each element of the matrix takes 2 bytes in memory. Then find the physical address of the element A[3][4][3]. [CU 2007]
16. Define a sparse matrix. State the procedures of representing a sparse matrix using – an array and a linked list.
17. Write an algorithm to get the transpose of a sparse matrix. [CU 2014]

Stack

1. Define a stack. State the operations that can be performed in a stack.
2. Write an algorithm and/or function in C for implementing stack operations using an array.
3. Write an algorithm and/or function in C for implementing stack operations using a linked list.
4. A stack is to be implemented using an array. Give the statements to perform *push* operation where the associated declarations are [CU 2014]

```
int stack[100];
int top = 0;
```

5. Imagine that we have two empty stack of integers, s_1 and s_2 . Draw a picture of each stack after the following operations.

```
pushStack(s1, 3);
pushStack(s1, 5);
pushStack(s1, 7);
pushStack(s1, 9);
while. Not (emptyStack(s1))
Begin
    popStack(s1,x);
    popStack(s1,x);
    popStack(s2,x);
Endwhile
```

Variable x is to store the data temporarily in between the operations. [CU 2012]

6. Why an infix expression is converted to Polish or Reverse Polish notation for evaluation.
7. State the advantages of using postfix notation over infix notation. [CU 2009 2011 2013]
8. What do you mean a balanced arithmetic expression in terms parenthesis. Write an algorithm and/or function in C for verifying whether an arithmetic expression containing parentheses is balanced or not. [CU 2004 2005 2010]
9. Write an algorithm and/or function in C that will convert
 - (a) An infix expression to postfix form [CU 2006 2013]
 - (b) An infix expression to prefix form
 - (c) A prefix expression to postfix form using stack.
10. Consider the infix expression $4 + 3 * (6 * 3 - 12)$. Suppose that a stack-based algorithm is used to convert the expression to its equivalent postfix form. What is the minimum size of the stack needed for algorithm to work properly? [CU 2013]
11. Consider the infix expression

$$Q = A + (B * C - (D / E - F) * G) * H$$

Convert the above expression into equivalent postfix form. [CU 2012]

12. Give the postfix and prefix expression of the following. [CU 2007]

$(a + (a + (a + (a + (a + a))))))$

13. Write an algorithm and/or function in C to evaluate a postfix/ prefix expression. [SU 2011]

14. Consider the arithmetic expression in postfix form

$7\ 5\ 2\ +\ *\ 4\ 1\ 5\ -\ /\ -$

(a) Find the value of the expression using stack.

(b) Find the equivalent prefix expression.

[CU 2013]

15. Explain why and how stack is used in recursion?

[SU 2012]

16. State the problem definition for Tower of Hanoi problem. Write a recursive algorithm and/or function in C to solve the problem.

17. Differentiate between – recursion and iteration.

[CU 2008]

18. What do you mean by exit criteria of recursion? Explain with suitable example – Tail recursion.

19. Write an algorithm and/or function in C to –

(a) Find the sum of first N natural numbers.

[CU 2007]

(b) Find factorial of a given integer.

[SU 2009 2012 2014]

(c) Find GCD of two integers.

(d) Find a^x .

(e) Generate Fibonacci elements. Also draw the recursion tree for Fibo(6)

[SU 2013]

(f) Reverse a string.

[CU 2012]

(g) Reverse a given integer.

[CU 2006]

20. Let a and b denote positive integers. Suppose a function Q is defined recursively as follows

$Q(a, b) = 0$ if $a < b = Q(a-b, b) + 1$, $b \leq a$

Find the values of $Q(14,3)$.

[CU 2012]

21. Consider the following function and remove recursion from it

```
int funct(int a, int b)
{
    if(a % b == 0)
        return(b);
    else
        return (funct(b, a % b));
}
```

22. What do you mean by Tail recursion? Explain with example.

[SU 2014]

Queue

1. What is a queue? Mention an application of queue that would improve your daily life.

[CU 2012]

2. A queue is implemented by two pointers REAR and FRONT. Insertion is performed at REAR and deletion is performed from FRONT. Write an algorithm and/or function in C that will implement a linked queue using a single pointer that will act as both FRONT and REAR.

[CU 2007 2009]

3. Explain the limitations of implementing a queue using array. Suggest a resolution to this problem.

[SU 2009]

4. What is a circular queue?

[CU 2002 2006 2011]

5. Write an algorithm and/ or functions in C to

- (a) insert an item in a circular queue. [CU 2002 2006 2011]
- (b) delete an item from a circular queue.
- 6. Write the overflow and underflow conditions for a circular queue.
- 7. Distinguish between circular linked queue and Linearly linked queue. [CU 2006]
- 8. Why a priority queue is used to implement a ready queue in priority scheduling? Write algorithm and/or function in C for inserting a new item in a priority queue. [SU 2013]
- 9. Differentiate between a queue and DeQue. Write algorithm and/or function in C for inserting a new item at front and deleting an existing item from rear.

Polynomial Representation

- 1. How a polynomial of a given degree is represented? Explain with example. [CU 2006 2007 2014]
- 2. Suggest a suitable scheme for representing the following polynomial $-28x^2y^3 + x^2y^3z^5 + 8z^3$ and $20a^2 - 14a^2b^2 + c^2 + 3abc - 9$
- 3. Write an algorithm and/or function in C to add two polynomials.
- 4. Write an algorithm and/or function in C to multiply two polynomials. [CU 2004]

Linked list

- 1. Give the disadvantages of singly linked list over contiguous list.
- 2. Compare: Sequential and Linked allocation of storage. [SU 2014 CU 2005 2008]
- 3. Write an algorithm and/or function in C to perform the following in a singly linked list
 - (a) Traverse the nodes. [CU 2011]
 - (b) Insert a new item in the beginning.
 - (c) Insert a new item at the end.
 - (d) Insert a new item after a particular position.
 - (e) Insert a new item after a particular value. [SU 2011]
 - (f) Delete an item from the beginning.
 - (g) Delete an item from the end. [CU 2013]
 - (h) Delete an item from a particular position.
 - (i) Delete an item before a given item. [CU 2011]
 - (j) Delete an item with a particular value.
 - (k) Search a given node. [CU 2006 2008]
 - (l) Reverse the nodes. [SU 2009 CU 2009 2011 2013]
 - (m) Sort the nodes.
 - (n) Delete the nodes with values greater than a given values.
 - (o) Delete the nodes with negative items.
- 4. Write an algorithm and/or function in C to split a linked list with positive integers into two lists, such that the one list contains all the positive integers and the other contains the negative integers. [CU 2014]
- 5. State the advantages of using doubly linked list as compared to singly linked list. [CU 2012]
- 6. Write an algorithm and/or function in C to merge the nodes of two singly linked lists.
- 7. Let $X = (x_1, x_2, x_3, \dots, x_n)$ and $Y = (y_1, y_2, y_3, \dots, y_m)$ be two linked lists. Write an algorithm and/or function in C to merge the two lists to obtain a new list $Z = (x_1, y_1, x_2, y_2, \dots, x_m, y_m, x_{m+1}, \dots, x_n)$ if $m \leq n$ and $Z = (x_1, y_1, x_2, y_2, \dots, x_n, y_n, y_{n+1}, \dots, y_m)$ if $m > n$. [CU 2009]
- 8. Given two sorted lists L_1 and L_2 . Write an algorithm and/or function in C to find $L_1 \cup L_2$ and $L_1 \cap L_2$. [CU 2006 2008]

9. Write a function that traverses a linked list of integers and deletes all nodes whose keys are negative. [CU 2007]
10. Write an algorithm and/or function in C to perform the following in a doubly linked list
- Traverse the nodes.
 - Insert a new item in the beginning.
 - Insert a new item at the end.
 - Insert a new item after a particular position.
 - Insert a new item after a particular value.
 - Delete an item from the beginning.
 - Delete an item from the end.
 - Delete an item from a particular position.
 - Delete an item with a particular value.
 - Search a given node.
 - Sort the nodes.
 - reverse the node of the list. [CU 2012]
11. You are supplied with (i) a doubly linked list of integers and (ii) the pointer to any arbitrary given node of the list. Write an algorithm and/ or function in C to achieve the following
- traverse the information part of the node pointed by the given pointer
 - then traverse the predecessor and successor of this node
 - then traverse the predecessor of previous predecessor and successor of the previous successor and so on until all the nodes of the list is traversed. [CU 2010]
12. For a doubly linked list write a function of swap two adjacent nodes just by manipulating pointers and not by changing their values. [CU 2007]
13. Write an algorithm to delete the p^{th} node counted from the end of a doubly linked list. [SU 2014]
14. Write an algorithm and/or function in C to concatenate two given circular doubly linked lists.
15. Write an algorithm and/or function in C that will find the distance (i.e. the number of nodes) between two given elements. [CU 2013]
16. Write an algorithm and/or function in C to delete the nodes of a circular linked list in constant time. [SU 2009]