



# GLOBAL INSTITUTE OF ENGINEERING & TECHNOLOGY

(Approved by AICTE & Affiliated to JNTUH)

Survey No. 179, Chilkur (V), Moinabad (M), Ranga Reddy Dist. TS.

Phone: 8790101015 / 9959250205

e-mail: [principal.giet.u6@gmail.com](mailto:principal.giet.u6@gmail.com)

JNTUH Code (U6)

CIVIL - CSE - MECH - ECE - EEE - MBA - M.Tech. EAMCET Code- GLOB

## Department of Computer Science and Engineering

**Mrs. M. Jhansi Lakshmi**

M.Tech.,(Ph.D)

**Associate Professor & Head**

Lr.No: GIET/CSE/Brdg Cour/001/07/2015-16

Date: 06/07/2015

To

The Principal

Global Institute of Engineering & Technology

Moinabad

Respected Madam,

Sub: Permission to Conduct Bridge Course for the Students of CSE-II Year-reg.

\*\*\*\*\*

This is to get it to your kind notice that we Department of Computer Science and Engineering are interested to conduct a Bridge Course On '**Data Structure using C**' to the students of CSE-II Year from 13/07/2015 to 18/07/2015, which is undertaken for students benefit as a value addition to curriculum of course.

These classes help students to strengthen their basics and bridge gap between intermediate and engineering. These classes give them a brief idea of computer science engineering.

Kindly accord approval so as to make necessary arrangements for conducting the classes for students of Computer Science and Engineering -II Year - Academic Year: 2015-16.

Thanking you.

*H.L.*  
06/7/2015

**H.O.D**

HEAD

Department of Computer Science & Engg.  
Global Institute of Engineering & Technology  
Chilkur (V), Moinabad (M), R.R. Dist.T.S.-501504.

**Cc to :**

**Director** - for information

**Dy. Director**- for information

**Dean** - for information



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## Department of Computer Science and Engineering

**Mrs. M. Jhansi Lakshmi**  
M.Tech.,(Ph.D)  
**Associate Professor & Head**

Lr.No: GIET/CSE/Brdg Cour/006/07/2015-16

Date 09/07/2015

### CIRCULAR

All the students of CSE-II Year are informed to express their interest by enrolling their name for the One week Bridge course on “**Data Structure using C**” starting from 13/07/2015 to 18/07/2015 . The detailed syllabus for the course is attached for your information. Concerned mentors are instructed to submit the list of students enrolled within two days to the undersigned. For further information, you can contact the Course Coordinator.

*M. Jhansi Lakshmi*  
9/7/2015

**H.O.D**  
**HEAD**

Department of Computer Science & Engg.  
Global Institute of Engineering & Technology  
Chilkur (V), Moinabad (M), R.R. Dist.T.S.-501504.

#### **Cc to :**

Principal – *for information*

Mentor— *for information*

Head H&S - *for information*

Notice board

File



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## Department of Computer Science and Engineering

### COURSE SYLLABUS FOR “Data Structure using C”

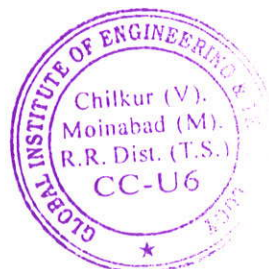
<u>S.no</u>	Topics to delivered	Duration Class work +Lab Practice (in hours)
1	Introduction to Data structures Categories of Data Structure:	6
2	Sparse Matrix and its Representations Program on Matrix	6
3	Stack and its operations. Programs on Stack	6
4	Queue and its operations Programs on queue	6
5	Linked List Programs on Linked List	6
6	Doubly Linked List Programs on Doubly Linked List	6

*Teja*  
Coordinator

*[Signature]*  
H.O.D

HEAD

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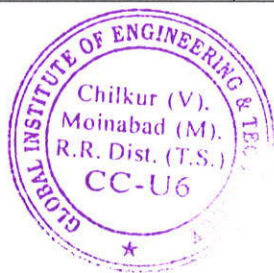
## Department of Computer Science and Engineering

### LIST OF STUDENTS ENROLLED FOR BRIDGE COURSE

#### ACADEMIC YEAR: 2015-2016

S.No	Roll no	Name of the student	Year	Dept
1	14U61A0501	AFSHAH SABA	II	CSE
2	14U61A0502	AFSHEEN FATIMA	II	CSE
3	14U61A0503	ASMA TAHASEEN	II	CSE
4	14U61A0504	AYESHA FATIMA	II	CSE
5	14U61A0505	AZRA SHIREEN	II	CSE
6	14U61A0506	HASNANI SANIL FIROZ BHAI	II	CSE
7	14U61A0507	ILORA SARKAR	II	CSE
8	14U61A0508	JAVERIYA IMROSE	II	CSE
9	14U61A0509	KAHKASHAN NISHAT	II	CSE
10	14U61A0510	KANDULA SAI KRISHNA	II	CSE
11	14U61A0511	MAHEEN FALHA	II	CSE
12	14U61A0512	MD HAMAD EHTHESHAM	II	CSE
13	14U61A0513	MD ASGHAR SIDDIQUI	II	CSE
14	14U61A0514	MOHD ASLAM	II	CSE
15	14U61A0515	MOHD MUSTAFA	II	CSE
16	14U61A0516	MOHD SAIF UDDIN	II	CSE
17	14U61A0517	RAHABA KOUSAR	II	CSE
18	14U61A0518	RUMANA ARSHI	II	CSE
19	14U61A0519	SABIYA BEGUM	II	CSE
20	14U61A0520	SANA BEGUM	II	CSE
21	14U61A0521	SHAHEDA BEGUM	II	CSE
22	14U61A0522	SHAIK ABDUL KHADER	II	CSE
23	14U61A0523	SHAZIA FATIMA	II	CSE
24	14U61A0524	SUMAIYA JABEEN	II	CSE
25	14U61A0525	SUMAYYA SAMREEN	II	CSE
26	14U61A0527	SYED ZIA UR RAHMAN	II	CSE
27	14U61A0528	TAHSEEN UNNISA	II	CSE
28	14U61A0529	TAPAS KUMAR ADHIKARI	II	CSE
29	14U61A0530	TASNEEM FATIMA	II	CSE
30	14U61A0531	UZMA JABEEN FATHIMA	II	CSE
31	14U61A0532	YOGESH MODI	II	CSE

Teja  
Coordinator



H.O.D  
HEAD

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## Department of Computer Science and Engineering

Bridge Course

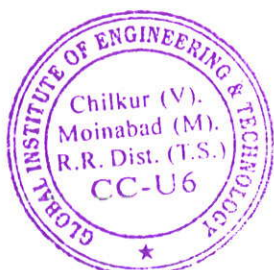
On

Data Structure Using C

(13<sup>th</sup> July to 18<sup>th</sup> July 2015)

### PROGRAMME SCHEDULE

	Forenoon (FN)		Afternoon(AN)
Day1	INAUGURATION	Introduction to Data structures Mr. Rahul Ravinder Assistant Professor JBREC ,Moinabad	Categories of Data Structure:
Day2	Sparse Matrix and its Representations Mr. Rahul Ravinder Assistant Professor JBREC,Moinabad.		Practical implementation of Program on Matrix
Day3	Stack and its operations. Mr. Rahul Ravinder Assistant Professor JBREC ,Moinabad		Practical implementation of Programs on Stack
Day4	Queue and its operations Mr. Rajiv Kumar Asst. Professor Dept.of CSE CMREC Hyderabad		Practical implementation of Programs on queue
Day5	Linked List Mr. Rajiv Kumar Asst. Professor Dept.of CSE CMREC Hyderabad.		Practical implementation of Programs on Linked List
Day6	Doubly Linked List Mr. Rajiv Kumar Asst. Professor Dept.of CSE CMREC Hyderabad.		Practical implementation of Programs on Doubly Linked List



*Teja*

Coordinator  
Mr. Teja Goud  
Assistant Professor  
Department of CSE



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 Department of Computer Science and Engineering  
 Bridge Course  
 On

Data Structure using C

## ATTENDANCE SHEET

S.No	Roll Number	Name of the Participant	Programme	Year	ATTENDANCE											
					Day-1 (13/07/2015)		Day-2 (14/07/2015)		Day-3 (15/07/2015)		Day-4 (16/07/2015)		Day-5 (17/7/2015)		Day-6 (18/7/2015)	
					FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN
1	14U61A0501	AESHAA SABA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	14U61A0502	AFSHEEN FATIMA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	14U61A0503	ASMA TAHASEEN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	14U61A0504	AYESHA FATIMA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	14U61A0505	AZRA SHREEN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	14U61A0506	HASNANI SANIL FIROZ BHAI	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	14U61A0507	LORA SARKAR	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	14U61A0508	JAVERIYA IMROSE	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	14U61A0509	KAHAKSHAN NISHAT	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	14U61A0510	KANDULA SAI KRISHNA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	14U61A0511	MAHEEN FALHA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	14U61A0512	MOHAMMED HAMAD EHTHESHAM	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13	14U61A0513	MOHD ASGHAR SIDDIQUI FOUAD	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	14U61A0514	MOHD ASLAM	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	14U61A0515	MOHD MUSTAFA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	14U61A0516	MOHD SAIF UDDIN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	14U61A0517	RAHABA KOUSAR	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	14U61A0518	RUMANA ARSHI	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
19	14U61A0519	SABIYA BEGUM	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	14U61A0520	SANA BEGUM	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
21	14U61A0521	SHAHEDA BEGUM	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
22	14U61A0522	SHAIK ABDUL KHADER	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
23	14U61A0523	SHAZIA FATIMA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
24	14U61A0524	SUMAIYA JABEEN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
25	14U61A0525	SUMAYYA SAMREEN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
26	14U61A0527	SYED ZIA UR RAHMAN	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
27	14U61A0528	TAHSEEN UNNISA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
28	14U61A0529	TAPAS KUMAR ADHIKARI	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
29	14U61A0530	TASNEEM FATIMA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
30	14U61A0531	UZMA JABEEN FATHIMA	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
31	14U61A0532	YOGESH MODI	B.Tech	II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

HABAB

Department of Computer Science & Engg.

Global Institute of Engineering & Technology

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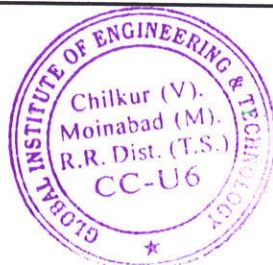
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Department of Computer Science and Engineering

Attendance Sheet of Bridge course on " Data Structure using C"

S. NO	H.T.No	NAME OF THE PARTICIPANT	Year	Dept	13/7/2015	14/7/2015	15/7/2015	16/7/2015	17/7/2015	18/7/2015	Total	Percentage
1	14U61A0501	AFSHAH SABA	II	CSE	6	6	6	6	6	6	36	100
2	14U61A0502	AFSHEEN FATIMA	II	CSE	6	6	6	6	6	6	36	100
3	14U61A0503	ASMA TAHASEEN	II	CSE	6	6	6	6	6	0	30	83.33333333
4	14U61A0504	AYESHA FATIMA	II	CSE	6	6	6	6	6	6	36	100
5	14U61A0505	AZRA SHIREEN	II	CSE	6	6	6	6	6	6	36	100
6	14U61A0506	HASNANI SANIL FIROZ BHAI	II	CSE	6	6	6	6	6	6	36	100
7	14U61A0507	ILORA SARKAR	II	CSE	6	0	6	6	6	6	30	83.33333333
8	14U61A0508	JAVERTIYA IMROSE	II	CSE	6	6	6	6	6	0	30	83.33333333
9	14U61A0509	KAHKASHAN NISHAT	II	CSE	6	6	6	6	6	6	36	100
10	14U61A0510	KANDULA SAI KRISHNA	II	CSE	6	6	6	6	6	6	36	100
11	14U61A0511	MAHEEN FALHA	II	CSE	6	0	6	6	6	6	30	83.33333333
12	14U61A0512	MOHAMMED HAMAD EHTHESHAM	II	CSE	6	6	6	6	6	6	36	100
13	14U61A0513	MOHD ASGHAR SIDDIQUI FOUAD	II	CSE	6	6	6	0	0	6	24	66.66666667
14	14U61A0514	MOHD ASLAM	II	CSE	6	6	6	6	6	6	36	100
15	14U61A0515	MOHD MUSTAFA	II	CSE	6	6	6	6	6	6	36	100
16	14U61A0516	MOHD SAIF UDDIN	II	CSE	6	6	6	6	6	6	36	100
17	14U61A0517	RAHABA KOUSAR	II	CSE	6	6	0	6	6	6	30	83.33333333
18	14U61A0518	RUMANA ARSHI	II	CSE	6	6	0	6	6	6	30	83.33333333
19	14U61A0519	SABIYA BEGUM	II	CSE	6	6	0	6	6	6	30	83.33333333
20	14U61A0520	SANA BEGUM	II	CSE	6	6	0	6	6	6	30	83.33333333
21	14U61A0521	SHAHEDA BEGUM	II	CSE	6	6	6	6	6	6	36	100
22	14U61A0522	SHAIK ABDUL KHADER	II	CSE	6	6	6	6	6	6	36	100
23	14U61A0523	SHAZIA FATIMA	II	CSE	6	6	6	6	6	6	36	100
24	14U61A0524	SUMAIYA JABEEN	II	CSE	6	6	0	6	6	6	30	83.33333333
25	14U61A0525	SUMAYYA SAMREEN	II	CSE	6	6	6	6	6	6	36	100
26	14U61A0527	SYED ZIA UR RAHMAN	II	CSE	6	6	0	6	6	6	30	83.33333333
27	14U61A0528	TAHSEEN UNNISA	II	CSE	6	6	6	6	6	6	36	100
28	14U61A0529	TAPAS KUMAR ADHIKARI	II	CSE	6	6	6	6	6	6	36	100
29	14U61A0530	TASNEEM FATIMA	II	CSE	6	6	6	6	6	6	36	100
30	14U61A0531	UZMA JABEEN FATHIMA	II	CSE	6	6	6	6	6	6	36	100
31	14U61A0532	YOGESH MODI	II	CSE	6	6	6	6	6	6	36	100



*[Signature]*

H.O.D

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## Department of Computer Science and Engineering

Bridge Course  
On  
Data Structure Using C  
(13<sup>th</sup> July to 18<sup>th</sup> July 2015)

### FEEDBACK FORM

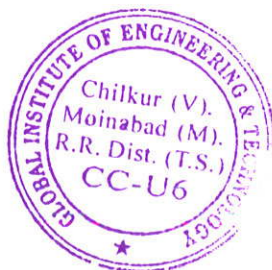
Please evaluate your rating of the course by placing a tick in the appropriate box.

1. Poor 2. Satisfactory 3. Good 4. Very good 5. Excellent

Branch and Year: *CSE II Year*

Date: *18/07/2015*

ASPECTS	RATING				
	Excellent 5	Very good 4	Good 3	Satisfactory 2	Poor 1
Relevance of contents	<input checked="" type="checkbox"/>				
Trainer was knowledgeable and skillful		<input checked="" type="checkbox"/>			
Quality of input provided	<input checked="" type="checkbox"/>				
Quality of presentations		<input checked="" type="checkbox"/>			
Adherence to the time schedule	<input checked="" type="checkbox"/>				
Opportunity given to participant to clear doubts		<input checked="" type="checkbox"/>			
Identify ways to build on current skills and knowledge	<input checked="" type="checkbox"/>				
Overall learning experience		<input checked="" type="checkbox"/>			
How has the course enhanced your skills or understanding of this topic?					
<i>Yes</i>					
Specify problems faced by you during the course?					
<i>NO</i>					
Any Other Comments:					
<i>NO</i>					





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**Department of Computer Science and Engineering**

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*DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING*

## *Bridge Course*

On

"DATA STRUCTURE USING C"

From

13-07-2015 to 18-07-2015

**CSE-II**

**ACADEMIC YEAR-2015-16**

A Bridge course on 'Data Structure using C' was organized by the Department of Computer science and Engineering for Second years. A one week Bridge course was held in the Room No 65 of from 13<sup>th</sup> July -18<sup>th</sup> July 2015 and its objective was to further enhance and strengthen the technical skills of the students in Computer Science. The course was attended by 31 students (A.Y. 2015-16).

About Bridge Course: The Bridge Course is aimed to act as a buffer for the Students, with an objective to provide adequate time for the transition to hard-core engineering courses. During this interaction of bridge course week with the faculty and their classmates, the students will be equipped with the knowledge and the confidence needed to take on bigger challenges as future engineers of this country.

Objectives:

- To provide adequate time for the transition to hard-core engineering courses.
- Focus on fostering a strong sense of ethical judgment and moral fortitude.
- Applications based self-learning and intermingling of a large cross section of students from vastly varying backgrounds.
- The students will be equipped with the knowledge and the confidence needed to take on bigger challenges.
- Nurture a deeper understanding of the local and global world and our place in at as concerned citizens of the world.
- Interactive and Active Learning by Doing have been weaved into the Bridge Course.
- Active learning with the help of other students

  
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Department of Computer Science & Engg.  
Global Institute of Engineering & Technology  
Chikur (V), Moinebad (M), R.R. Dist.T.S.-501504.

# DAY 1

## Introduction to Data structures

In computer terms, a data structure is a Specific way to store and organize data in a computer's memory so that these data can be used efficiently later. Data may be arranged in many different ways such as the logical or mathematical model for a particular organization of data is termed as a data structure. The variety of a particular data model depends on the two factors

Firstly, it must be loaded enough in structure to reflect the actual relationships of the data with the real world object.

Secondly, the formation should be simple enough so that anyone can efficiently process the data each time it is necessary.

### Categories of Data Structure:

The data structure can be sub divided into major types:

Linear Data Structure

Non-linear Data Structure

### Linear Data Structure:

A data structure is said to be linear if its elements combine to form any specific order. There are basically two techniques of representing such linear structure within memory.

First way is to provide the linear relationships among all the elements represented by means of linear memory location. These linear structures are termed as arrays.

The second technique is to provide the linear relationship among all the elements represented by using the concept of pointers or links. These linear structures are termed as linked lists.

The common examples of linear data structure are:

Arrays

Queues

Stacks

Linked lists

### Non linear Data Structure:

This structure is mostly used for representing data that contains a hierarchical relationship among various elements.

Examples of Non Linear Data Structures are listed below:

Graphs, family of trees and, table of contents

**Tree:** In this case, data often contain a hierarchical relationship among various elements. The data structure that reflects this relationship is termed as rooted tree graph or a tree.



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# DAY 2

## Sparse Matrix and its representations

A matrix is a two-dimensional data object made of m rows and n columns, therefore having total m x n values. If most of the elements of the matrix have **0 value**, then it is called a sparse matrix.

### Why to use Sparse Matrix instead of simple matrix ?

**Storage:** There are lesser non-zero elements than zeros and thus lesser memory can be used to store only those elements.

**Computing time:** Computing time can be saved by logically designing a data structure traversing only non-zero elements..

Example:

0 0 3 0 4

0 0 5 7 0

0 0 0 0 0

0 2 6 0 0

Representing a sparse matrix by a 2D array leads to wastage of lots of memory as zeroes in the matrix are of no use in most of the cases. So, instead of storing zeroes with non-zero elements, we only store non-zero elements. This means storing non-zero elements with **triples- (Row, Column, value)**.

Sparse Matrix Representations can be done in many ways following are two common representations:

1. Array representation
2. Linked list

### representation **Method 1: Using**

**Arrays** #include<stdio.h>

int main()

{

// Assume 4x5 sparse

matrix int

sparseMatrix[4][5] =

{

{0, 0, 3, 0, 4},

{0, 0, 5, 7, 0},

{0, 0, 0, 0, 0},

{0, 2, 6, 0, 0}

};

int size = 0;

for (int i = 0; i < 4; i++)

for (int j = 0; j < 5;

j++)

if (sparseMatrix[i][j] !=

0) size++;

int compactMatrix[3][size];

// Making of new matrix



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# DAY 3

## STACK

A stack is an Abstract Data Type (ADT), commonly used in most programming languages. It is named stack as it behaves like a real-world stack, for example – a deck of cards or a pile of plates, etc.

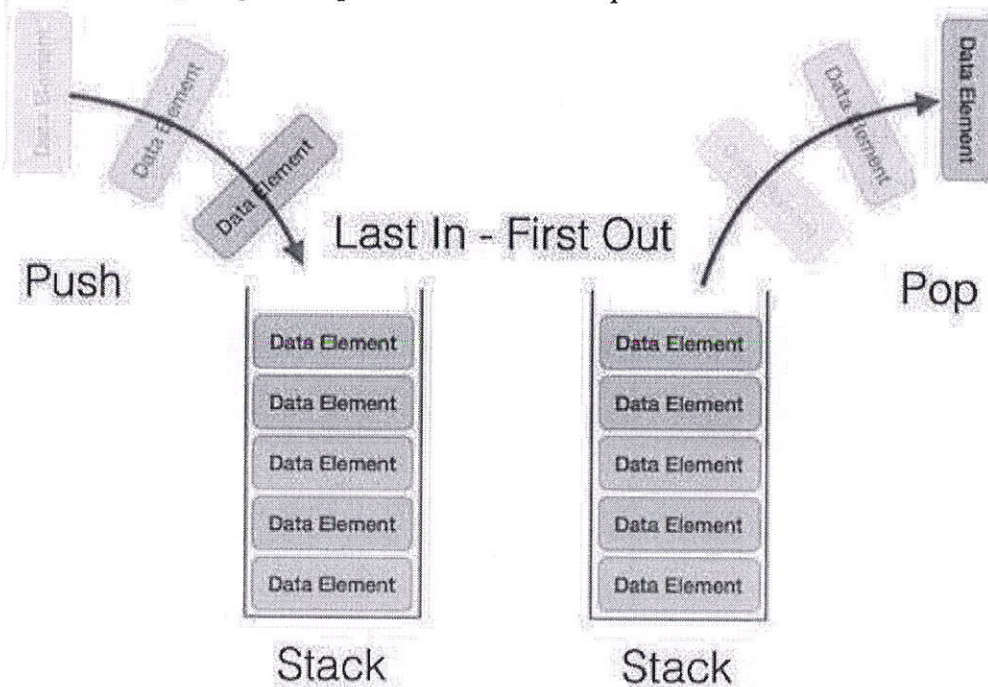


For example, we can place or remove a card or plate from the top of the stack only. Likewise, Stack ADT allows all data operations at one end only. At any given time, we can only access the top element of a stack.

This feature makes it LIFO data structure. LIFO stands for Last-in-first-out. Here, the element which is placed (inserted or added) last, is accessed first. In stack terminology, insertion operation is called **PUSH** operation and removal operation is called **POP** operation.

### Stack Representation

The following diagram depicts a stack and its operations –



A stack can be implemented by means of Array, Structure, Pointer, and Linked List. Stack can either be a fixed size one or it may have a sense of dynamic resizing. Here, we are going to implement stack using arrays, which makes it a fixed size stack implementation.

### Basic Operations

Stack operations may involve initializing the stack, using it and then de-initializing it. Apart from these basic stuffs, a stack is used for the following two primary operations –

- **push()** – Pushing (storing) an element on the stack.

# DAY 4

## QUEUE

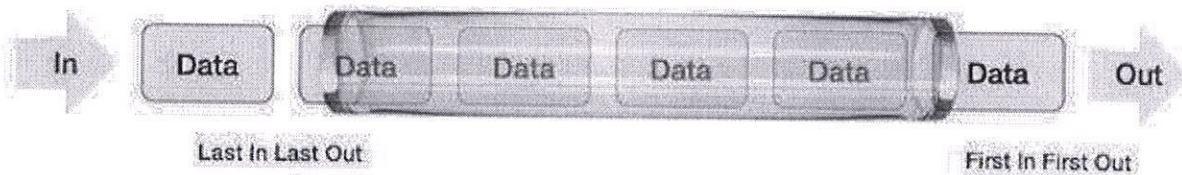
Queue is an abstract data structure, somewhat similar to Stacks. Unlike stacks, a queue is open at both its ends. One end is always used to insert data (enqueue) and the other is used to remove data (dequeue). Queue follows First-In-First-Out methodology, i.e., the data item stored first will be accessed first.



A real-world example of queue can be a single-lane one-way road, where the vehicle enters first, exits first. More real-world examples can be seen as queues at the ticket windows and bus-stops.

### Queue Representation

As we now understand that in queue, we access both ends for different reasons. The following diagram given below tries to explain queue representation as data structure –



## Queue

As in stacks, a queue can also be implemented using Arrays, Linked-lists, Pointers and Structures. For the sake of simplicity, we shall implement queues using one-dimensional array. **Basic Operations**

Queue operations may involve initializing or defining the queue, utilizing it, and then completely erasing it from the memory. Here we shall try to understand the basic operations associated with queues –

- **enqueue()** – add (store) an item to the queue.
- **dequeue()** – remove (access) an item from the queue.

Few more functions are required to make the above-mentioned queue operation efficient. These are –

- **peek()** – Gets the element at the front of the queue without removing it.
- **isfull()** – Checks if the queue is full.
- **isempty()** – Checks if the queue is empty.

In queue, we always dequeue (or access) data, pointed by **front** pointer and while enqueueing (or storing) data in the queue we take help of **rear** pointer.

# DAY 5

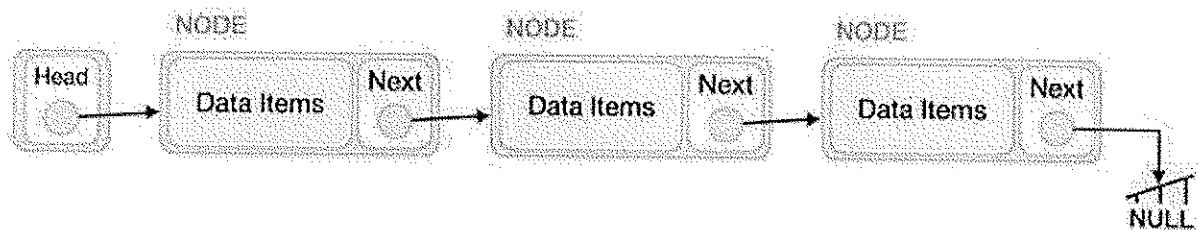
## LINKED LIST

A linked list is a sequence of data structures, which are connected together via links. Linked List is a sequence of links which contains items. Each link contains a connection to another link. Linked list is the second most-used data structure after array. Following are the important terms to understand the concept of Linked List.

- **Link** – Each link of a linked list can store a data called an element.
- **Next** – Each link of a linked list contains a link to the next link called Next.
- **LinkedList** – A Linked List contains the connection link to the first link called First.

### Linked List Representation

Linked list can be visualized as a chain of nodes, where every node points to the next node.



- Each link carries a data field(s) and a link field called next.
- Each link is linked with its next link using its next link.
- Last link carries a link as null to mark the end of the list.

### Types of Linked List

Following are the various types of linked list.

- **Simple Linked List** – Item navigation is forward only.
- **Doubly Linked List** – Items can be navigated forward and backward.
- **Circular Linked List** – Last item contains link of the first element as next and the first element has a link to the last element as previous.

### Basic Operations

Following are the basic operations supported by a list.

- **Insertion** – Adds an element at the beginning of the list.
- **Deletion** – Deletes an element at the beginning of the list.
- **Display** – Displays the complete list.
- **Search** – Searches an element using the given key.
- **Delete** – Deletes an element using the given key.

### Insertion Operation

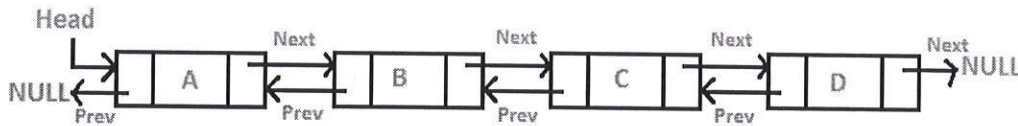
Adding a new node in linked list is a more than one step activity. We shall learn this with diagrams here. First, create a node using the same structure and find the location where it has to be inserted.

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# DAY 6

## Doubly Linked List

A Doubly Linked List (DLL) contains an extra pointer, typically called *previous pointer*, together with next pointer and data which are there in singly linked list.



Following is representation of a DLL node in C language.

```
/* Node of a doubly linked list
*/ struct Node {
    int data;
    struct Node* next; // Pointer to next node in DLL
    struct Node* prev; // Pointer to previous node in DLL
};
```

Following are advantages/disadvantages of doubly linked list over singly linked list.

### Advantages over singly linked list

- 1) A DLL can be traversed in both forward and backward direction.
- 2) The delete operation in DLL is more efficient if pointer to the node to be deleted is given.
- 3) We can quickly insert a new node before a given node.

In singly linked list, to delete a node, pointer to the previous node is needed. To get this previous node, sometimes the list is traversed. In DLL, we can get the previous node using previous pointer.

### Disadvantages over singly linked list

- 1) Every node of DLL Require extra space for an previous pointer. It is possible to implement DLL with single pointer though
- 2) All operations require an extra pointer previous to be maintained. For example, in insertion, we need to modify previous pointers together with next pointers. For example in following functions for insertions at different positions, we need 1 or 2 extra steps to set previous pointer.

### Insertion

A node can be added in four ways

- 1) At the front of the DLL
- 2) After a given node.
- 3) At the end of the DLL
- 4) Before a given node.

#### 1) Add a node at the front: (A 5 steps process)

The new node is always added before the head of the given Linked List. And newly added node becomes the new head of DLL. For example if the given Linked List is