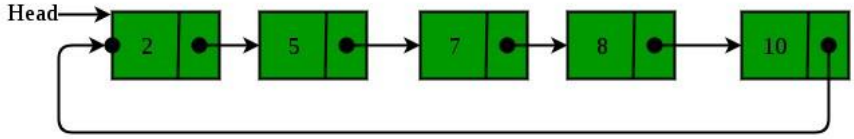
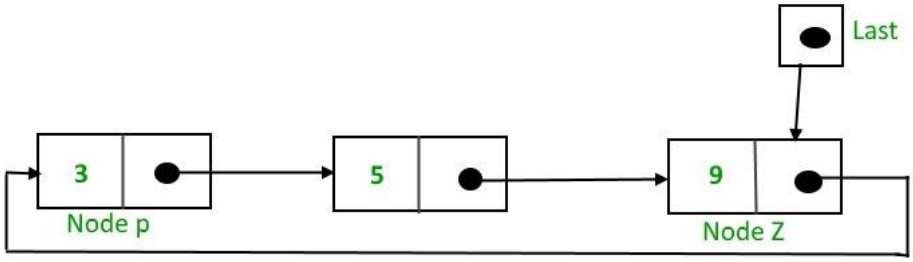
Circular Linked List

> *A **circular linked** list is a linked list where all nodes are connected to form a circle. There is no NULL at the end. A circular linked list can be a singly circular linked list or doubly circular linked list.*

Below is a pictorial representation of Circular Linked List:



Implementation:
To implement a circular singly linked list, we take an external pointer that points to the last node of the list. If we have a pointer last pointing to the last node, then *last -> next* will point to the first node.



The pointer ***last*** points to node **Z** and ***last -> next*** points to the node **P**.

Why have we taken a pointer that points to the last node instead of first node?

For insertion of node in the beginning we need traverse the whole list. Also, for insertion and the end, the whole list has to be traversed. If instead of start pointer we take a pointer to the last node then in both the cases there won't be any need to traverse the whole list. So insertion in the begging or at the end takes constant time irrespective of the length of the list.

Below is a sample program to create and traverse in a Circular Linked List in both Java and C++:

C++ Java

```cpp
// A complete C++ program to demonstrate the working of Circular Linked Lists
#include<bits/stdc++.h>
using namespace std;
// Circular Linked List Node
struct Node
{
    int data;
    struct Node *next;
};
// Function to add a node at the end of a Circular Linked List
struct Node *addEnd(struct Node *last, int data)
{
    if (last == NULL)
    {
        // Creating a node dynamically.
        struct Node *temp = new Node;

        // Assigning the data.
        temp -> data = data;
        last = temp;
```

```
        // Creating the link.
        last -> next = last;
        return last;
    }
    struct Node *temp = new Node;
    temp -> data = data;
    temp -> next = last -> next;
    last -> next = temp;
    last = temp;
    return last;
}
// Function to traverse a Circular Linked list Using a pointer to the Last Node
void traverse(struct Node *last)
{
    struct Node *p;
    // If list is empty, return.
    if (last == NULL)
    {
        cout << "List is empty." << endl;
        return;
    }
    // Pointing to first Node of the list.
    p = last -> next;
    // Traversing the list.
    do
    {
        cout << p -> data << " ";
        p = p -> next;

    }
    while(p != last->next);

}

// Driver Program
int main()
{
    struct Node *last = NULL;

    last = addEnd(last, 6);
    last = addEnd(last, 4);
    last = addEnd(last, 2);
    last = addEnd(last, 8);
    last = addEnd(last, 12);
    last = addEnd(last, 10);

    traverse(last);

    return 0;
}
```

Output:

```
6 4 2 8 12 10
```

Advantages of Circular Linked Lists:

1. Any node can be a starting point. We can traverse the whole list by starting from any point. We just need to stop when the first visited node is visited again.
2. Useful for implementation of a queue. Unlike this implementation, we don't need to maintain two pointers for front and rear if we use a circular linked list. We can maintain a pointer to the last inserted node and front can always be obtained as next of last.
3. Circular lists are useful in applications to repeatedly go around the list. For example, when multiple applications are running on a PC, it is common for the operating system to put the running applications on a list and then to cycle through them, giving each of them a slice of time to execute, and then making them wait while the CPU is given to another application. It is convenient for the operating system to use a circular list so that when it reaches the end of the list it can cycle around to the front of the list.
4. Circular Doubly Linked Lists are used for implementation of advanced data structures like Fibonacci Heap.