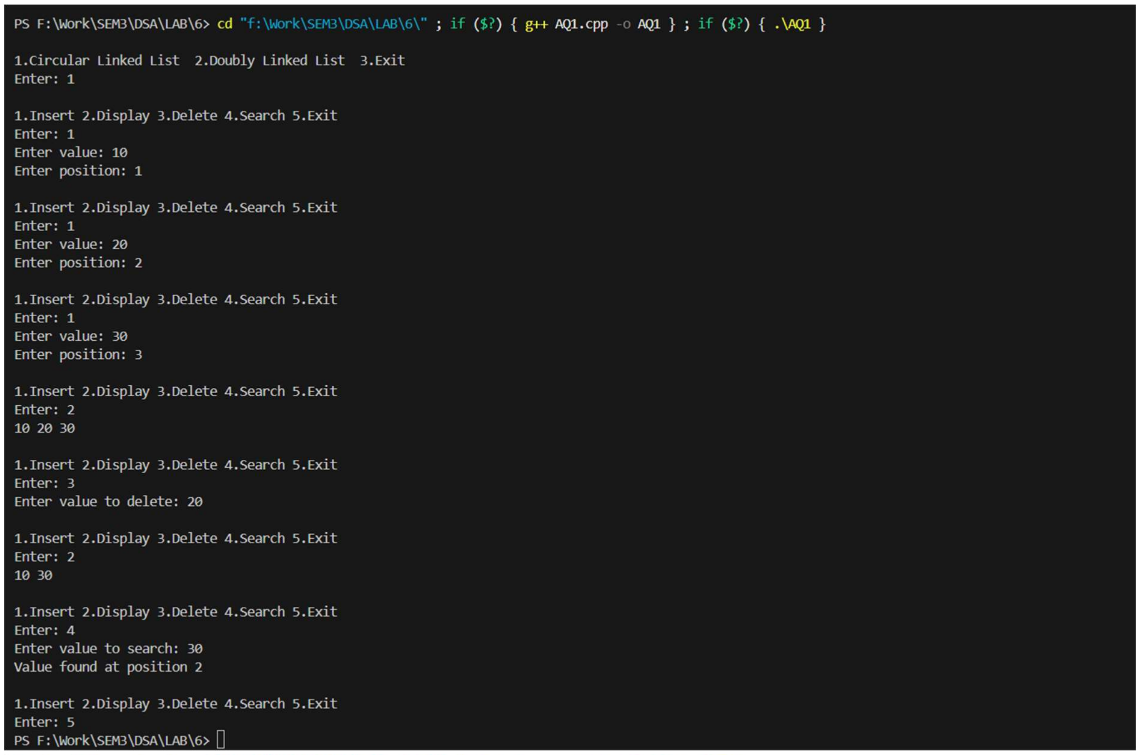
AQ1:

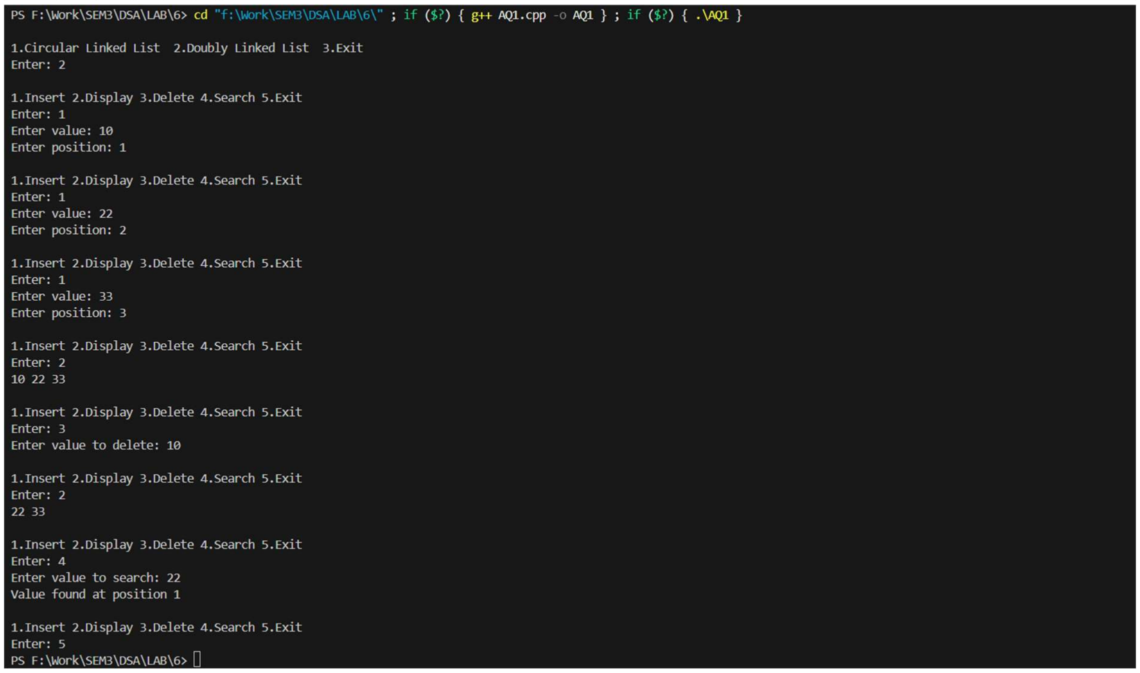
```cpp
#include <iostream>
using namespace std;

struct Node {
    int data;
    Node *next, *prev;
};

Node* CLLinsertAtPosition(Node *last, int data, int pos) {
    if (last == NULL) {
        if (pos != 1) {
            cout << "Invalid position!" << endl;
            return last;
        }
        Node *newNode = new Node();
        newNode->data = data;
        newNode->next = newNode;
        return newNode;
    }
    Node *newNode = new Node();
    newNode->data = data;
    Node *curr = last->next;
    if (pos == 1) {
        newNode->next = curr;
        last->next = newNode;
        return last;
    }
    for (int i = 1; i < pos - 1; ++i) {
        curr = curr->next;
        if (curr == last->next) {
            cout << "Invalid position!" << endl;
            delete newNode;
            return last;
        }
    }
    newNode->next = curr->next;
    curr->next = newNode;
    if (curr == last) last = newNode;
    return last;
}

Node* CLLdeleteByValue(Node *last, int value) {
    if (last == NULL) {
        cout << "List empty" << endl;
        return last;
    }
    Node *curr = last->next, *prev = last;
    do {
        if (curr->data == value) {
            if (curr == last && curr->next == last) {
                delete curr;
                return NULL;
            }
            if (curr == last->next) {
                prev->next = curr->next;
                delete curr;
                return last;
            }
            if (curr == last) {
                prev->next = curr->next;
                delete curr;
                last = prev;
                return last;
            }
            prev->next = curr->next;
            delete curr;
            return last;
        }
        prev = curr;
        curr = curr->next;
    } while (curr != last->next);
    cout << "Value not found" << endl;
    return last;
}

void CLLdisplay(Node *last) {
    if (last == NULL) {
        cout << "List empty" << endl;
        return;
    }
    Node *head = last->next;
    while (true) {
        cout << head->data << " ";
        head = head->next;
        if (head == last->next) break;
    }
    cout << endl;
}

void CLLsearch(Node *last, int value) {
    if (last == NULL) {
        cout << "List empty" << endl;
        return;
```

```cpp
    }
    Node *curr = last->next;
    int pos = 1;
    bool found = false;
    do {
        if (curr->data == value) {
            cout << "Value found at position " << pos << endl;
            found = true;
            break;
        }
        curr = curr->next;
        pos++;
    } while (curr != last->next);
    if (!found) cout << "Value not found" << endl;
}



Node* DLLinsertAtPosition(Node *head, Node *&tail, int data, int pos) {
    Node *newNode = new Node();
    newNode->data = data;
    newNode->next = newNode->prev = NULL;

    if (head == NULL) {
        if (pos != 1) {
            cout << "Invalid position!" << endl;
            delete newNode;
            return head;
        }
        head = tail = newNode;
        return head;
    }

    if (pos == 1) {
        newNode->next = head;
        head->prev = newNode;
        head = newNode;
        return head;
    }

    Node *curr = head;
    for (int i = 1; i < pos - 1 && curr->next != NULL; ++i) curr = curr->next;

    if (pos > 1 && curr == tail) {
        curr->next = newNode;
        newNode->prev = curr;
        tail = newNode;
        return head;
    }
    if (curr == NULL) {
        cout << "Invalid position!" << endl;
        delete newNode;
        return head;
    }

    newNode->next = curr->next;
    newNode->prev = curr;
    curr->next->prev = newNode;
    curr->next = newNode;
    return head;
}

Node* DLLdeleteByValue(Node *head, Node *&tail, int value) {
    if (head == NULL) {
        cout << "List empty" << endl;
        return head;
    }

    Node *curr = head;
    while (curr!=NULL && curr->data != value) curr = curr->next;
    if (curr==NULL) {
        cout << "Value not found" << endl;
        return head;
    }

    if (curr == head && curr == tail) {
        delete curr;
        head = tail = NULL;
        return head;
    }

    if (curr == head) {
        head = head->next;
        head->prev = NULL;
        delete curr;
        return head;
    }

    if (curr == tail) {
        tail = tail->prev;
        tail->next = NULL;
        delete curr;
        return head;
    }

    curr->prev->next = curr->next;
    curr->next->prev = curr->prev;
    delete curr;
    return head;
}

void DLLdisplay(Node *head) {
    if (head == NULL) {
        cout << "List empty" << endl;
        return;
    }
    Node *temp = head;
    while (temp!=NULL) {
        cout << temp->data << " ";
        temp = temp->next;
    }
    cout << endl;
}

void DLLsearch(Node *head, int value) {
    if (head == NULL) {
        cout << "List empty" << endl;
        return;
    }
    Node *curr = head;
    int pos = 1;
    bool found = false;
    while (curr!=NULL) {
        if (curr->data == value) {
            cout << "Value found at position " << pos << endl;
            found = true;
            break;
        }
        curr = curr->next;
        pos++;
    }
    if (!found) cout << "Value not found" << endl;
}

int main() {
    int mainChoice;
    while (true) {
        cout << "\n1.Circular Linked List  2.Doubly Linked 
List  3.Exit\nEnter: ";
        cin >> mainChoice;
        if (mainChoice == 3) return 0;

        if (mainChoice == 1) {
            Node *last = NULL;
            int choice, data, pos;
            while (true) {
                cout << "\n1.Insert 2.Display 3.Delete 4.Search 5.Exit\nEnter:
";
                cin >> choice;
                if (choice == 5) return 0; // Exit program
                if (choice == 1) {
                    cout << "Enter value: "; cin >> data;
                    cout << "Enter position: "; cin >> pos;
                    last = CLLinsertAtPosition(last, data, pos);
                } else if (choice == 2) {
                    CLLdisplay(last);
                } else if (choice == 3) {
                    cout << "Enter value to delete: "; cin >> data;
                    last = CLLdeleteByValue(last, data);
                } else if (choice == 4) {
                    cout << "Enter value to search: "; cin >> data;
                    CLLsearch(last, data);
                }
            }
        }

        else if (mainChoice == 2) {
            Node *head = NULL, *tail = NULL;
            int choice, data, pos;
            while (true) {
                cout << "\n1.Insert 2.Display 3.Delete 4.Search 5.Exit\nEnter:
";
                cin >> choice;
                if (choice == 5) return 0; // Exit program
                if (choice == 1) {
                    cout << "Enter value: "; cin >> data;
                    cout << "Enter position: "; cin >> pos;
                    head = DLLinsertAtPosition(head, tail, data, pos);
                } else if (choice == 2) {
                    DLLdisplay(head);
                } else if (choice == 3) {
                    cout << "Enter value to delete: "; cin >> data;
                    head = DLLdeleteByValue(head, tail, data);
                } else if (choice == 4) {
                    cout << "Enter value to search: "; cin >> data;
                    DLLsearch(head, data);
                }
            }
        }
    }
    return 0;
}
```

Output:



```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ1.cpp -o AQ1 } ; if ($?) { .\AQ1 }

1.Circular Linked List  2.Doubly Linked List  3.Exit
Enter: 1

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 10
Enter position: 1

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 20
Enter position: 2

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 30
Enter position: 3

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 2
10 20 30

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 3
Enter value to delete: 20

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 2
10 30

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 4
Enter value to search: 30
Value found at position 2

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 5
PS F:\Work\SEM3\DSA\LAB\6>
```

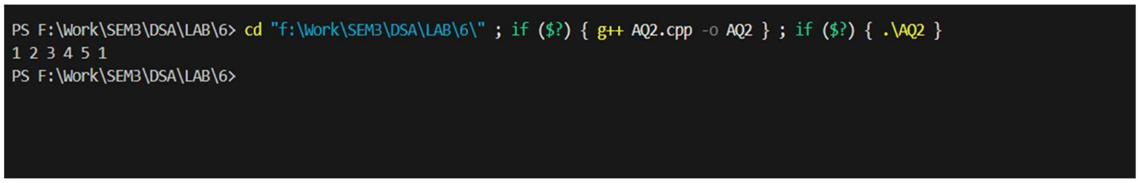


```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ1.cpp -o AQ1 } ; if ($?) { .\AQ1 }

1.Circular Linked List  2.Doubly Linked List  3.Exit
Enter: 2

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 10
Enter position: 1

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 22
Enter position: 2

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 1
Enter value: 33
Enter position: 3

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 2
10 22 33

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 3
Enter value to delete: 10

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 2
22 33

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 4
Enter value to search: 22
Value found at position 1

1.Insert 2.Display 3.Delete 4.Search 5.Exit
Enter: 5
PS F:\Work\SEM3\DSA\LAB\6>
```

AQ2:

```cpp
#include <iostream>
using namespace std;

class Node {
public:
    int data;
    Node* next;

    Node(int x) {
        data = x;
        next = NULL;
    }
};

void DisplayCLL(Node* head) {
    if (head == NULL)
    return;

    Node* curr = head;
    int result = 0;

    do {
        cout<<curr->data<<" ";
        curr = curr->next;
        result++;
    } while (curr != head);
    cout<<curr->data<<" ";
}

int main() {
    Node* head = new Node(1);
    head->next = new Node(2);
    head->next->next = new Node(3);
    head->next->next->next = new Node(4);
    head->next->next->next->next = new Node(5);
    head->next->next->next->next->next = head;

    DisplayCLL(head);

    return 0;
}
```

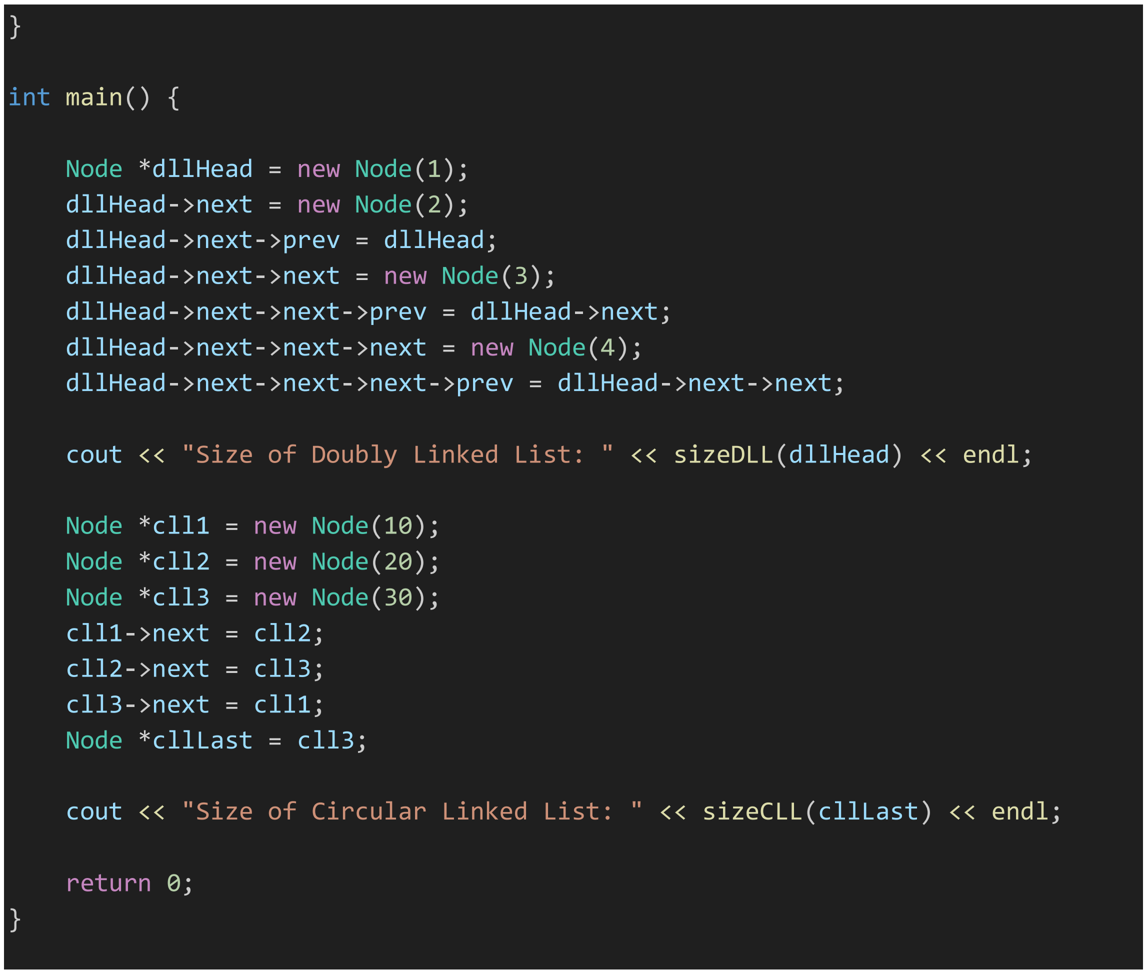
Output:



```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ2.cpp -o AQ2 } ; if ($?) { .\AQ2 }
1 2 3 4 5 1
PS F:\Work\SEM3\DSA\LAB\6>
```

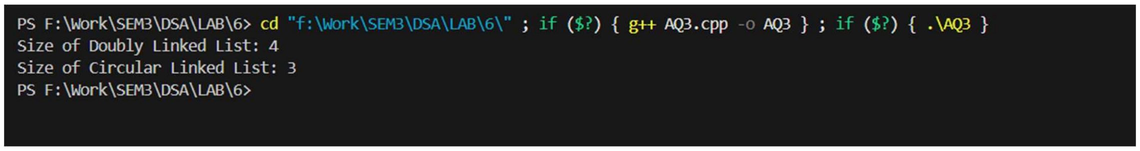
AQ3:

```cpp
#include <iostream>
using namespace std;

class Node {
public:
    int data;
    Node *next;
    Node *prev;
    Node(int val) {
        data = val;
        next = NULL;
        prev = NULL;
    }
};

int sizeDLL(Node *head) {
    int count = 0;
    Node *curr = head;
    while (curr != NULL) {
        count++;
        curr = curr->next;
    }
    return count;
}

int sizeCLL(Node *last) {
    if (last==NULL)
    return 0;
    int count = 0;
    Node *curr = last->next;
    Node *head = last->next;
    do {
        count++;
        curr = curr->next;
    } while (curr != head);
    return count;
```



```cpp
}

int main() {

    Node *dllHead = new Node(1);
    dllHead->next = new Node(2);
    dllHead->next->prev = dllHead;
    dllHead->next->next = new Node(3);
    dllHead->next->next->prev = dllHead->next;
    dllHead->next->next->next = new Node(4);
    dllHead->next->next->next->prev = dllHead->next->next;

    cout << "Size of Doubly Linked List: " << sizeDLL(dllHead) << endl;

    Node *cll1 = new Node(10);
    Node *cll2 = new Node(20);
    Node *cll3 = new Node(30);
    cll1->next = cll2;
    cll2->next = cll3;
    cll3->next = cll1;
    Node *cllLast = cll3;

    cout << "Size of Circular Linked List: " << sizeCLL(cllLast) << endl;

    return 0;
}
```

Output:

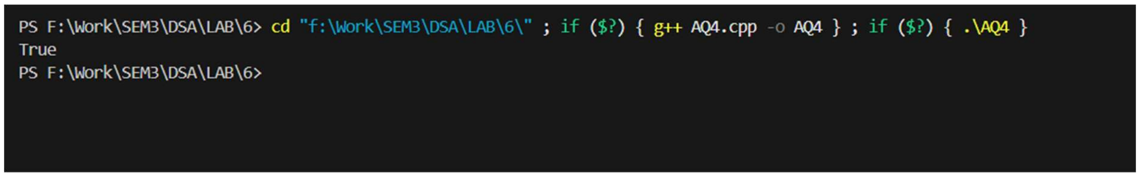


```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ3.cpp -o AQ3 } ; if ($?) { .\AQ3 }
Size of Doubly Linked List: 4
Size of Circular Linked List: 3
PS F:\Work\SEM3\DSA\LAB\6>
```

AQ4:

```cpp
#include <iostream>
using namespace std;

struct Node {
    char data;
    Node *next;
    Node *prev;
    Node(char val) {
        data = val;
        next = prev = NULL;
    }
};

bool isPalindrome(Node *head) {
    if (head==NULL) return true;

    Node *tail = head;
    while (tail->next) tail = tail->next;

    Node *front = head;
    while (front != tail && front->prev != tail) {
        if (front->data != tail->data)
            return false;
        front = front->next;
        tail = tail->prev;
    }
    return true;
}

int main() {
    Node *head = new Node('L');
    head->next = new Node('E');
    head->next->prev = head;
    head->next->next = new Node('V');
    head->next->next->prev = head->next;
    head->next->next->next = new Node('E');
    head->next->next->next->prev = head->next->next;
    head->next->next->next->next = new Node('L');
    head->next->next->next->next->prev = head->next->next->next;

    if (isPalindrome(head))
        cout << "True" << endl;
    else
        cout << "False" << endl;
    return 0;
}
```

Output:

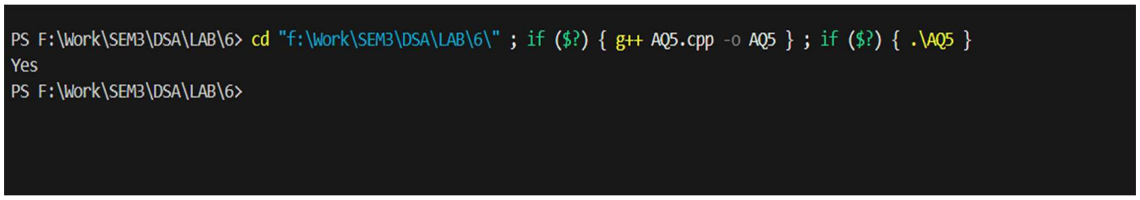


```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ4.cpp -o AQ4 } ; if ($?) { .\AQ4 }
True
PS F:\Work\SEM3\DSA\LAB\6>
```

AQ5:

```
#include <iostream>
using namespace std;

struct Node
{
    int data;
    Node *next;
    Node(int x)
    {
        data = x;
        next = NULL;
    }
};

bool isCircular(Node *head)
{
    if (head==NULL)
        return true;

    Node *curr = head;
    while (curr!=NULL && curr->next != head)
        curr = curr->next;

    if (curr==NULL)
        return false;

    return true;
}

int main()
{
    Node *head = new Node(1);
    head->next = new Node(2);
    head->next->next = new Node(3);
    head->next->next->next = new Node(4);
    head->next->next->next->next = head;

    if (isCircular(head))
        cout << "Yes\n";
    else
        cout << "No\n";

    return 0;
}
```

Output:



```
PS F:\Work\SEM3\DSA\LAB\6> cd "f:\Work\SEM3\DSA\LAB\6\" ; if ($?) { g++ AQ5.cpp -o AQ5 } ; if ($?) { .\AQ5 }
Yes
PS F:\Work\SEM3\DSA\LAB\6>
```