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Section: A

Department: BS Artificial Intelligence

Semester: 3

DSA Assignment

1. **Write a program to delete the first node in a doubly linked list**

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

struct DoublyLinkedNode {
   int value;
   DoublyLinkedNode* next;
   DoublyLinkedNode* previous;
};

void removeFirstNode(DoublyLinkedNode*& head) {
   if (!head) return; // Empty list, nothing to remove

   DoublyLinkedNode* toDelete = head;
   if (head->next) {
      head = head->next;
      head->previous = nullptr;
   } else {
      head = nullptr; // Only one node in the list
   }
   delete toDelete;
}

void printList(DoublyLinkedNode* head) {
   while (head) {
      cout << head->value << " ";
      head = head->next;
   }
   cout << endl;
}

int main() {
   // Initialize a doubly linked list with three nodes
   DoublyLinkedNode* head = new DoublyLinkedNode{1, nullptr, nullptr};
   head->next = new DoublyLinkedNode{2, nullptr, head};
   head->next->next = new DoublyLinkedNode{3, nullptr, head->next};

   cout << "Initial list: ";
   printList(head);

   // Remove the first node
   removeFirstNode(head);

   cout << "After removing the first node: ";
   printList(head);

   return 0;
}
```

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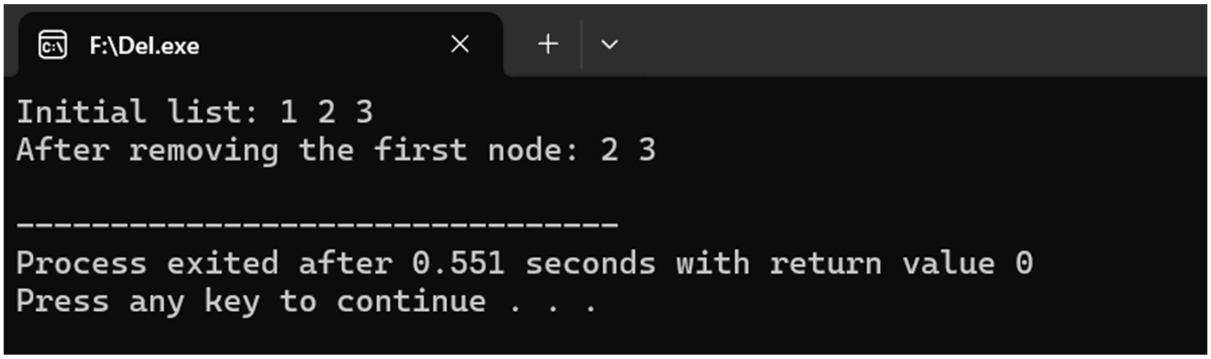
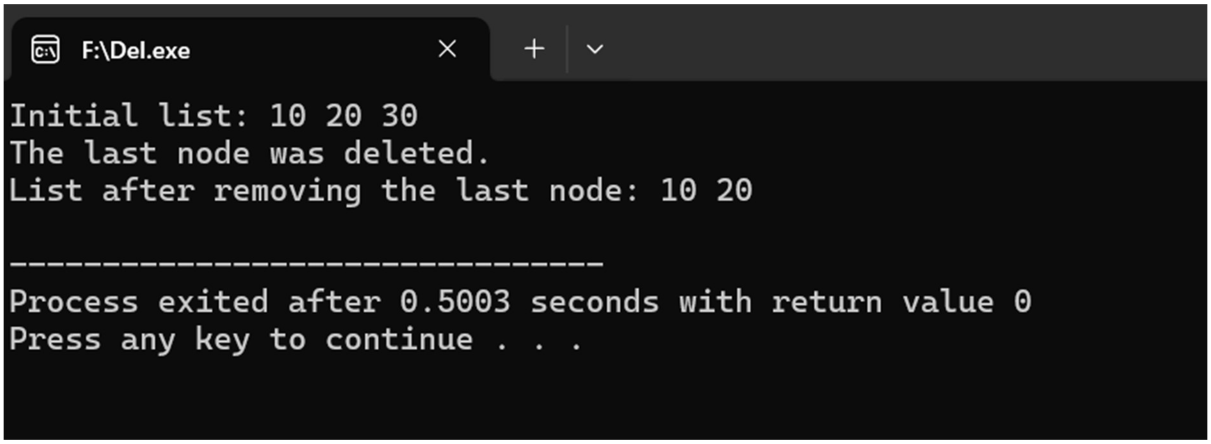


1. **How can you delete the last node in a doubly linked list? Write the code**

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

// Structure for a Node in a doubly linked list
struct Node {
   int value;
   Node* prev;
   Node* next;

   // Constructor to initialize the node
   Node(int val) : value(val), prev(nullptr), next(nullptr) {}
};

// Function to remove the last node from the doubly linked list
void removeLastNode(Node*& head) {
   if (!head) { // Check if the list is empty
      cout << "The list is empty, no nodes to delete." << endl;
      return;
   }
   if (head->next == nullptr) { // Only one node in the list
      delete head;
      head = nullptr;
      cout << "The last node was deleted." << endl;
      return;
   }

   Node* current = head;
   // Traverse to the last node
   while (current->next != nullptr) {
      current = current->next;
   }

   // Update the previous node's next pointer to null
   current->prev->next = nullptr;
   delete current; // Free the memory of the last node
   cout << "The last node was deleted." << endl;
}

// Function to print the elements of the doubly linked list
```

DSA Assignment

```
void printList(Node* head) {
    Node* current = head;
    while (current != nullptr) { // Traverse the list and print values
        cout << current->value << " ";
        current = current->next;
    }
    cout << endl;
}

// Function to append a new node at the end of the doubly linked list
void appendToEnd(Node*& head, int value) {
    Node* newNode = new Node(value);
    if (!head) { // If the list is empty
        head = newNode;
        return;
    }

    Node* current = head;
    while (current->next != nullptr) { // Traverse to the last node
        current = current->next;
    }
    current->next = newNode; // Link the new node at the end
    newNode->prev = current;
}

// Main function to demonstrate the doubly linked list operations
int main() {
    Node* head = nullptr;

    // Add nodes to the list
    appendToEnd(head, 10);
    appendToEnd(head, 20);
    appendToEnd(head, 30);

    cout << "Initial list: ";
    printList(head);

    // Remove the last node
    removeLastNode(head);

    cout << "List after removing the last node: ";
    printList(head);

    return 0;
}
```

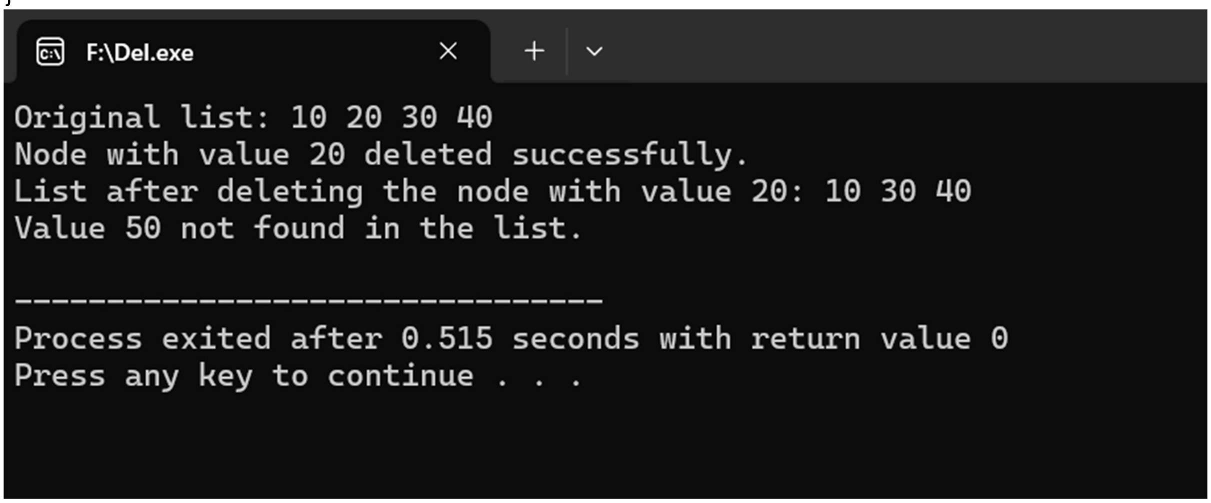


2. Write code to delete a node by its value in a doubly linked list

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

// Define a Node of the doubly linked list
struct Node {
   int data;
   Node* prev;
   Node* next;

   Node(int val) : data(val), prev(nullptr), next(nullptr) {}
};

// Function to delete a node by its value in a doubly linked list
void deleteNodeByValue(Node*& head, int value) {
   if (head == nullptr) { // If the list is empty
      cout << "The list is empty." << endl;
      return;
   }

   Node* temp = head;

   // Search for the node with the specified value
   while (temp != nullptr && temp->data != value) {
      temp = temp->next;
   }

   if (temp == nullptr) { // Value not found
      cout << "Value " << value << " not found in the list." << endl;
      return;
   }

   // Node with the value found
   if (temp == head) { // If it's the head node
      head = head->next;
      if (head != nullptr) {
```

```
        head->prev = nullptr;
      }
  } else if (temp->next == nullptr) { // If it's the last node
      temp->prev->next = nullptr;
  } else { // If it's a middle node
      temp->prev->next = temp->next;
      temp->next->prev = temp->prev;
  }

  delete temp; // Free the memory of the node
  cout << "Node with value " << value << " deleted successfully." << endl;
}

// Function to display the doubly linked list
void displayList(Node* head) {
  Node* temp = head;
  while (temp != nullptr) {
      cout << temp->data << " ";
      temp = temp->next;
  }
  cout << endl;
}

// Function to insert a node at the end of the doubly linked list
void appendNode(Node*& head, int data) {
  Node* newNode = new Node(data);
  if (head == nullptr) { // If the list is empty
      head = newNode;
      return;
  }

  Node* temp = head;
  while (temp->next != nullptr) { // Traverse to the last node
      temp = temp->next;
  }

  temp->next = newNode;
  newNode->prev = temp;
}

// Main function to demonstrate the doubly linked list operations
int main() {
  Node* head = nullptr;

  // Add nodes to the doubly linked list
  appendNode(head, 10);
  appendNode(head, 20);
  appendNode(head, 30);
  appendNode(head, 40);

  cout << "Original list: ";
  displayList(head);
```

```
    // Delete a node by value
    deleteNodeByValue(head, 20);
    cout << "List after deleting the node with value 20: ";
    displayList(head);

    // Try deleting a non-existent value
    deleteNodeByValue(head, 50);

    return 0;
}
```



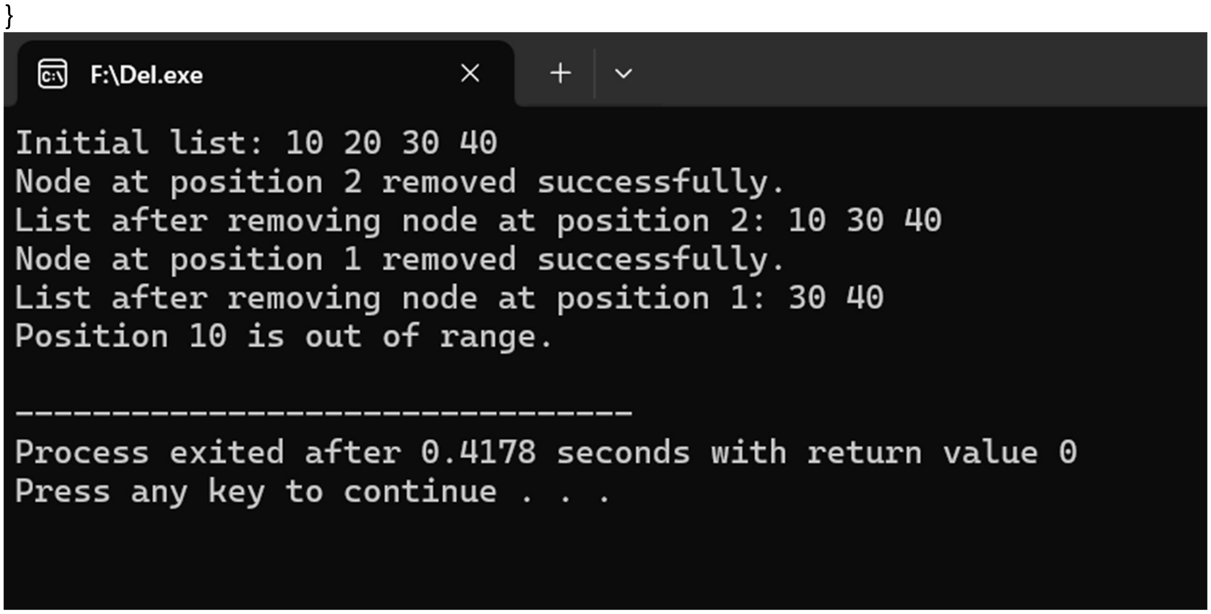

```
Original list: 10 20 30 40
Node with value 20 deleted successfully.
List after deleting the node with value 20: 10 30 40
Value 50 not found in the list.

--------------------------------
Process exited after 0.515 seconds with return value 0
Press any key to continue . . .
```

3. How would you delete a node ata specific position in a doubly linked list?

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

// Structure for a Node in a doubly linked list
struct Node {
    int value;
    Node* previous;
    Node* next;

    // Constructor to initialize a node
    Node(int val) : value(val), previous(nullptr), next(nullptr) {}
};

// Function to remove a node from a specified position in the doubly linked list
void removeNodeAtPosition(Node*& head, int position) {
    if (!head) { // Check if the list is empty
        cout << "The list is currently empty." << endl;
        return;
    }

    if (position <= 0) { // Validate the position
        cout << "Invalid position. Please provide a position greater than 0." << endl;
        return;
    }
```

```
    Node* current = head;
    int index = 1;

    // Traverse the list to locate the target position
    while (current != nullptr && index < position) {
        current = current->next;
        index++;
    }

    if (!current) { // Position exceeds the number of nodes in the list
        cout << "Position " << position << " is out of range." << endl;
        return;
    }

    // Handle the removal of the node
    if (current == head) { // Case: Remove the first node
        head = head->next;
        if (head) {
            head->previous = nullptr;
        }
    } else if (!current->next) { // Case: Remove the last node
        current->previous->next = nullptr;
    } else { // Case: Remove a node in the middle
        current->previous->next = current->next;
        current->next->previous = current->previous;
    }

    delete current; // Deallocate the memory
    cout << "Node at position " << position << " removed successfully." << endl;
}

// Function to display the elements of the doubly linked list
void printList(Node* head) {
    Node* temp = head;
    while (temp) { // Traverse the list and print values
        cout << temp->value << " ";
        temp = temp->next;
    }
    cout << endl;
}

// Function to add a new node to the end of the doubly linked list
void addNodeToEnd(Node*& head, int value) {
    Node* newNode = new Node(value);
    if (!head) { // Check if the list is empty
        head = newNode;
        return;
    }

    Node* current = head;
    while (current->next) { // Traverse to the last node
```

```
        current = current->next;
    }

    current->next = newNode; // Link the new node to the end
    newNode->previous = current;
}

// Main function to test the doubly linked list operations
int main() {
    Node* head = nullptr;

    // Add nodes to the list
    addNodeToEnd(head, 10);
    addNodeToEnd(head, 20);
    addNodeToEnd(head, 30);
    addNodeToEnd(head, 40);

    cout << "Initial list: ";
    printList(head);

    // Remove the node at position 2
    removeNodeAtPosition(head, 2);
    cout << "List after removing node at position 2: ";
    printList(head);

    // Remove the head node
    removeNodeAtPosition(head, 1);
    cout << "List after removing node at position 1: ";
    printList(head);

    // Attempt to remove a node at an invalid position
    removeNodeAtPosition(head, 10);

    return 0;
}
```

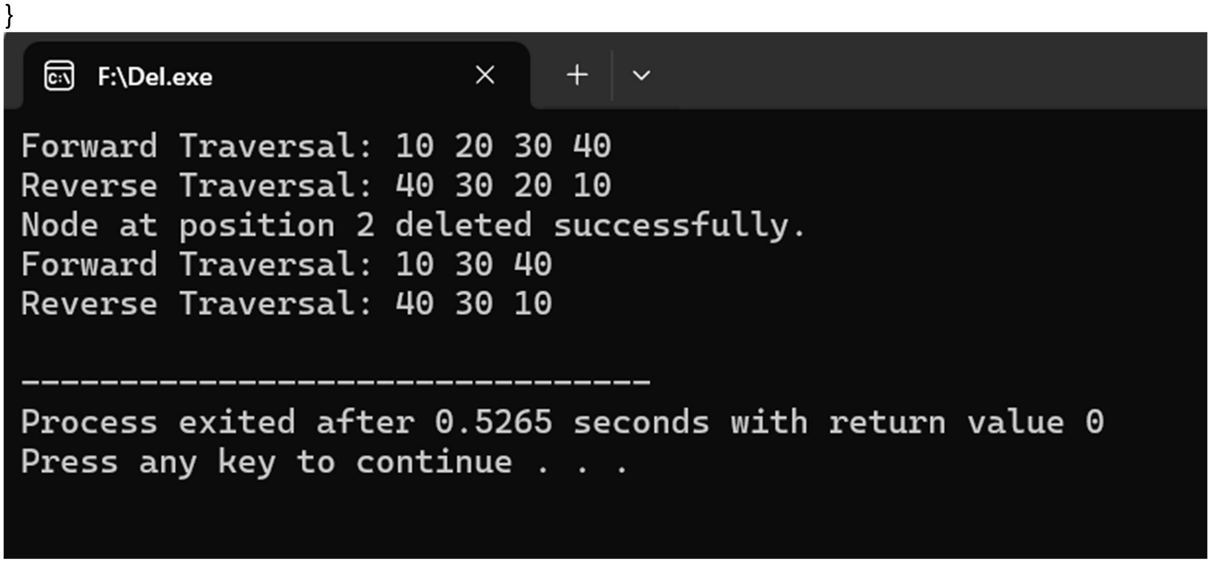


4. After deleting a node, how will you write the forward and reversal traversal functions?

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

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

   // Constructor to initialize a node
   Node(int val) : data(val), prev(nullptr), next(nullptr) {}
};

// Function to perform forward traversal
void forwardTraversal(Node* head) {
   cout << "Forward Traversal: ";
   Node* temp = head;
   while (temp != nullptr) {
      cout << temp->data << " ";
      temp = temp->next;
   }
   cout << endl;
}

// Function to perform reverse traversal
void reverseTraversal(Node* head) {
   if (head == nullptr) { // If the list is empty
      cout << "Reverse Traversal: List is empty." << endl;
      return;
   }

   // Move to the last node
   Node* temp = head;
   while (temp->next != nullptr) {
      temp = temp->next;
   }

   // Traverse backward from the last node
   cout << "Reverse Traversal: ";
   while (temp != nullptr) {
      cout << temp->data << " ";
      temp = temp->prev;
   }
   cout << endl;
}

// Function to append a node to the end
void appendNode(Node*& head, int data) {
   Node* newNode = new Node(data);
```

```
    if (head == nullptr) { // If the list is empty
        head = newNode;
        return;
    }

    Node* temp = head;
    while (temp->next != nullptr) { // Traverse to the last node
        temp = temp->next;
    }

    temp->next = newNode;
    newNode->prev = temp;
}

// Function to delete a node at a specific position
void deleteNodeAtPosition(Node*& head, int position) {
    if (head == nullptr) { // If the list is empty
        cout << "The list is empty." << endl;
        return;
    }

    if (position <= 0) { // Invalid position
        cout << "Invalid position. Position should be greater than 0." << endl;
        return;
    }

    Node* temp = head;
    int currentIndex = 1;

    // Traverse to the node at the specified position
    while (temp != nullptr && currentIndex < position) {
        temp = temp->next;
        currentIndex++;
    }

    if (temp == nullptr) { // Position exceeds the list size
        cout << "Position " << position << " exceeds the list size." << endl;
        return;
    }

    // Handle deletion
    if (temp == head) { // Deleting the head node
        head = head->next;
        if (head != nullptr) {
            head->prev = nullptr;
        }
    } else if (temp->next == nullptr) { // Deleting the last node
        temp->prev->next = nullptr;
    } else { // Deleting a middle node
        temp->prev->next = temp->next;
        temp->next->prev = temp->prev;
    }
```

```
    delete temp; // Free the memory of the node
    cout << "Node at position " << position << " deleted successfully." << endl;
}

int main() {
    Node* head = nullptr;

    // Add nodes to the doubly linked list
    appendNode(head, 10);
    appendNode(head, 20);
    appendNode(head, 30);
    appendNode(head, 40);

    // Perform forward and reverse traversal before deletion
    forwardTraversal(head);
    reverseTraversal(head);

    // Delete a node at position 2
    deleteNodeAtPosition(head, 2);

    // Perform forward and reverse traversal after deletion
    forwardTraversal(head);
    reverseTraversal(head);

    return 0;
}
```

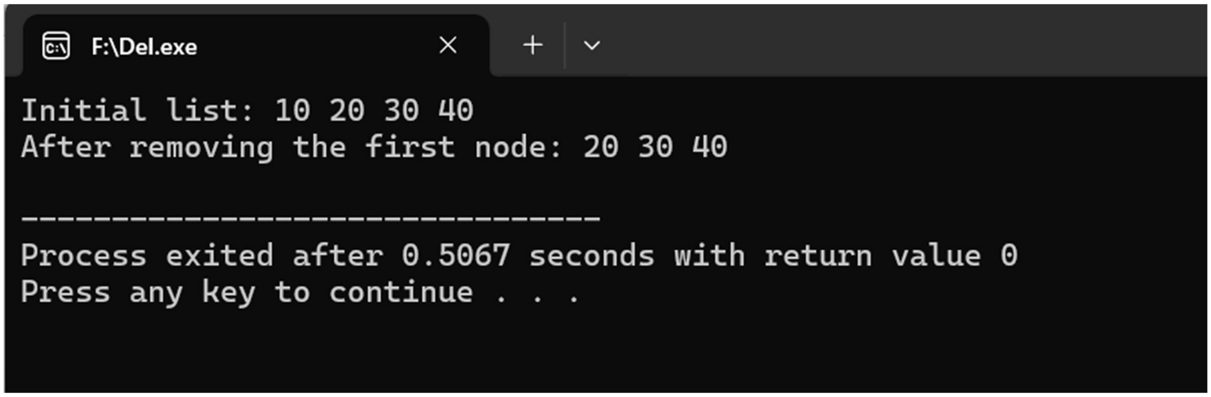


Circular Linked List

1. **Write a program to delete the first node in a circular linked list**

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

// Structure to define a node
struct Node {
   int value;
   Node* nextNode;

   // Constructor to initialize a new node
   Node(int val) : value(val), nextNode(nullptr) {}
};

// Function to remove the first node
void removeFirstNode(Node*& head) {
   if (!head) { // Check if the list is empty
      cout << "The list is empty. Nothing to remove." << endl;
      return;
   }

   if (head->nextNode == head) { // Single node in the list
      delete head;
      head = nullptr;
      return;
   }

   // Locate the last node in the list
   Node* lastNode = head;
   while (lastNode->nextNode != head) {
      lastNode = lastNode->nextNode;
   }

   // Update the head and adjust the last node's pointer
   Node* temp = head;
   head = head->nextNode;
   lastNode->nextNode = head;

   // Delete the old head node
   delete temp;
}

// Function to add a new node at the end of the circular linked list
void appendNode(Node*& head, int value) {
   Node* newNode = new Node(value);

   if (!head) { // If the list is empty
      head = newNode;
      newNode->nextNode = head; // Point to itself to make it circular
      return;
```

```
    }

    Node* current = head;
    while (current->nextNode != head) { // Traverse to the last node
        current = current->nextNode;
    }

    current->nextNode = newNode;
    newNode->nextNode = head; // Complete the circular link
}

// Function to print the contents of the circular linked list
void printList(Node* head) {
    if (!head) { // Check if the list is empty
        cout << "The list is empty." << endl;
        return;
    }

    Node* current = head;
    do {
        cout << current->value << " ";
        current = current->nextNode;
    } while (current != head);
    cout << endl;
}

// Main function to test
int main() {
    Node* head = nullptr;

    // Add nodes to the list
    appendNode(head, 10);
    appendNode(head, 20);
    appendNode(head, 30);
    appendNode(head, 40);

    cout << "Initial list: ";
    printList(head);

    // Remove the first node
    removeFirstNode(head);

    cout << "After removing the first node: ";
    printList(head);

    return 0;
}
```



2. How can you delete the last node in a circular linked list? Write the code. Code:

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

// Node structure for circular linked list

struct Node {

int data;

Node* next;

};

// Function to delete a node with a specific value

void deleteNodeByValue(Node*& head, int target) {
```

```
if (!head) { // Check if the list is empty
cout << "The list is empty" << endl;
return;
}
Node* current = head;
Node* prev = nullptr;
// Case 1: The list contains a single node
if (head->data == target && head->next == head) {
delete head;
head = nullptr;
return;
}
// Case 2: The node to delete is the head node
if (head->data == target) {
// Locate the last node
while (current->next != head) {
current = current->next;
}
Node* toDelete = head;
head = head->next; // Update the head pointer
current->next = head; // Link the last node to the new head
delete toDelete;
return;
}
// Case 3: The node to delete is in the middle or at the end
do {
prev = current;current = current->next;
```

```
if (current->data == target) {
prev->next = current->next;
delete current;
return;
}
} while (current != head);
cout << "Value " << target << " not found in the list." << endl;
}
void addNodeToEnd(Node*& head, int value) {
Node* newNode = new Node();
newNode->data = value;
if (!head) {
head = newNode;
newNode->next = head;
return;
}
Node* temp = head;
while (temp->next != head) {
temp = temp->next;
}
temp->next = newNode;
newNode->next = head;
}
// Function to display the circular linked list
void displayList(Node* head) {
if (!head) {
cout << "The list is empty." << endl;
```

```
return;
}
Node* temp = head;
do {
cout << temp->data << " ";
temp = temp->next;
} while (temp != head);
cout << endl;}
int main() {
Node* head = nullptr;
// Add nodes to the list
addNodeToEnd(head, 10);
addNodeToEnd(head, 20);
addNodeToEnd(head, 30);
addNodeToEnd(head, 40);
cout << "Initial list: ";
displayList(head);
// Remove a node
deleteNodeByValue(head, 20);
cout << "After removing node with value 20: ";
displayList(head);
// delete a non-existent node
deleteNodeByValue(head, 50);
cout << "After attempting to delete node with value 50: ";
displayList(head);
return 0;
```

}

```
Initial list: 10 20 30 40
After removing node with value 20: 10 30 40
Value 50 not found in the list.
After attempting to delete node with value 50: 10 30 40

--------------------------------
Process exited after 0.1763 seconds with return value 0
Press any key to continue . . .
```

1. Write a function to delete a node by its value in a circular linked list.

```
#include <iostream>

using namespace std;

struct Node {

   int value;

   Node* nextNode;

};


// Function to remove a node by its value in a circular linked list

void removeNodeByValue(Node*& head, int targetValue) {

   if (head == nullptr) { // Check if the list is empty

      cout << "The list is empty. Nothing to remove." << endl;

      return;

   }


   Node* current = head;

   Node* prev = nullptr;
```

DSA Assignment

```
// Case 1: The list contains only one node
if (head->value == targetValue && head->nextNode == head) {
    delete head;
    head = nullptr;
    return;
}

// Case 2: The target node is the head node
if (head->value == targetValue) {
    // Find the last node
    while (current->nextNode != head) {
        current = current->nextNode;
    }
    Node* toDelete = head;
    head = head->nextNode; // Update the head pointer
    current->nextNode = head; // Adjust the last node's link
    delete toDelete;
    return;
}

// Case 3: The target node is in the middle or end of the list
do {
    prev = current;
    current = current->nextNode;

    if (current->value == targetValue) {
        prev->nextNode = current->nextNode;
```

```
        delete current;
        return;
      }
    } while (current != head);

    // If the target  not found
    cout << "Value " << targetValue << " not found in the list." << endl;
}

// Function to add a new node
void addNode(Node*& head, int value) {
    Node* newNode = new Node();
    newNode->value = value;
    if (head == nullptr) {
      head = newNode;
      newNode->nextNode = head;
      return;
    }

    Node* temp = head;
    while (temp->nextNode != head) {
      temp = temp->nextNode;
    }

    temp->nextNode = newNode;
    newNode->nextNode = head;
}
```

```
// Function to print the contents
void printList(Node* head) {
    if (head == nullptr) {
        cout << "The list is empty." << endl;
        return;
    }

    Node* temp = head;
    do {
        cout << temp->value << " ";
        temp = temp->nextNode;
    } while (temp != head);
    cout << endl;
}

// Main function for operations
int main() {
    Node* head = nullptr;

    addNode(head, 10);
    addNode(head, 20);
    addNode(head, 30);
    addNode(head, 40);

    cout << "Initial list: ";
    printList(head);
```

```
    // Remove a node by its value
    removeNodeByValue(head, 20);

    cout << "After removing the node with value 20: ";
    printList(head);

    // Attempt to remove a value that does not exist
    removeNodeByValue(head, 50);

    cout << "After attempting to remove a node with value 50: ";
    printList(head);

    return 0;
}
```

```
Initial list: 10 20 30 40
After removing the node with value 20: 10 30 40
Value 50 not found in the list.
After attempting to remove a node with value 50: 10 30 40

--------------------------------
Process exited after 0.1508 seconds with return value 0
Press any key to continue . . .
```

2. How will you delete a node at a specific position in a circular linked list?

```
#include <iostream>
```

```
using namespace std;
struct Node {
int value;
Node* nextNode;
};
// Function to remove a node from specific pos
void removeNodeAt(Node*& head, int position) {
if (head == nullptr) {
cout << "The list is empty" << endl;
return;
}
// Handle removal of the head node
if (position == 0) {
if (head->nextNode == head) {
delete head;
head = nullptr;
} else {
Node* last = head;
while (last->nextNode != head) {
last = last->nextNode;
}Node* toDelete = head;
head = head->nextNode;
last->nextNode = head;
delete toDelete;
}
return;
}
```

```
Node* current = head;
Node* prev = nullptr;
int currentIndex = 0;
// Traverse the list to find
while (current->nextNode != head && currentIndex < position) {
prev = current;
current = current->nextNode;
currentIndex++;
}
if (current->nextNode == head && currentIndex < position) { // Out of bounds
cout << "Position exceeds the list size." << endl;
return;
}
//remove
prev->nextNode = current->nextNode;
delete current;
}
// Function to add node at end
void addNode(Node*& head, int value) {
Node* newNode = new Node();
newNode->value = value;
if (head == nullptr) {
head = newNode;
newNode->nextNode = head;
return;
}
Node* temp = head;
```

```
while (temp->nextNode != head) {temp = temp->nextNode;
}
temp->nextNode = newNode;
newNode->nextNode = head;
}
// Function to display the contents of the circular linked list
void printList(Node* head) {
if (head == nullptr) {
cout << "The list is empty." << endl;
return;
}
Node* temp = head;
do {
cout << temp->value << " ";
temp = temp->nextNode;
} while (temp != head);
cout << endl;
}
// Main function
int main() {
Node* head = nullptr;
// Add nodes to the list
addNode(head, 10);
addNode(head, 20);
addNode(head, 30);
addNode(head, 40);
cout << "Initial list: ";
```

printList(head);

// Remove the node at position 2

removeNodeAt(head, 2);

cout << "After removing node at position 2: ";

printList(head);

// Attempt to remove a node at an invalid positionremoveNodeAt(head, 5);

cout << "After attempting to remove node at position 5: ";

printList(head);

return 0;

}

```
Initial list: 10 20 30 40
After removing node at position 2: 10 20 40
Position exceeds the list size.
After attempting to remove node at position 5: 10 20 40

--------------------------------
Process exited after 0.1527 seconds with return value 0
Press any key to continue . . .
```

3. Write a program to show forward traversal after deleting a node in a circular linked list.

#include <iostream>

using namespace std;

// Definition of a node in a circular linked list

struct Node {

int value;

Node* nextNode;

};

```
void removeNodeAtPosition(Node*& head, int position) {
if (!head) { // Check if the list is empty
cout << "The list is empty. Nothing to remove." << endl;
return;
}
if (position == 0) {
// If there's only one node in the list
if (head->nextNode == head) {
delete head;
head = nullptr;
} else {
Node* lastNode = head;while (lastNode->nextNode != head) { // Locate the last node
lastNode = lastNode->nextNode;
}
Node* temp = head;
head = head->nextNode;
lastNode->nextNode = head;
delete temp;
}
return;
}
Node* current = head;
Node* previous = nullptr;
int index = 0;
// reach the specified position
while (current->nextNode != head && index < position) {
previous = current;
```

```
current = current->nextNode;
index++;
}
// If the position is out of bounds
if (current->nextNode == head && index < position) {
cout << "Invalid position: Out of bounds." << endl;
return;
}
// Adjust links and delete the node
previous->nextNode = current->nextNode;
delete current;
}
// Function to add a new node to the end
void addNode(Node*& head, int value) {
Node* newNode = new Node();
newNode->value = value;
if (!head) { // Check if the list is empty
head = newNode;
newNode->nextNode = head;
return;}
Node* current = head;
while (current->nextNode != head) {
current = current->nextNode;
}
current->nextNode = newNode;
newNode->nextNode = head; }
// Function to display the circular linked list
```

```
void printList(Node* head) {
if (!head) { // Check if the list is empty
cout << "The list is empty." << endl;
return;
}
Node* current = head;
do {
cout << current->value << " ";
current = current->nextNode;
} while (current != head);
cout << endl;
}
// Main function to test the functionality
int main() {
Node* head = nullptr;
// Adding nodes to the list
addNode(head, 10);
addNode(head, 20);
addNode(head, 30);
addNode(head, 40);
cout << "Initial list: ";
printList(head);
// Remove the node at position 2
removeNodeAtPosition(head, 2);
cout << "After removing the node at position 2: ";printList(head);
// Remove the node at position 0 (head node)
removeNodeAtPosition(head, 0);
```

```
cout << "After removing the head node: ";

printList(head);

return 0;

}
```

```
Initial list: 10 20 30 40
After removing the node at position 2: 10 20 40
After removing the head node: 20 40

--------------------------------
Process exited after 0.1828 seconds with return value 0
Press any key to continue . . .
```

Binary Search Tree

1. **Write a program to count all the nodes in a binary search tree.**

```
#include <iostream>

using namespace std;

// Structure for a node in a Binary Search Tree (BST)

struct TreeNode {

int value;

TreeNode* left;

TreeNode* right;

TreeNode(int val) {

value = val;

left = right = nullptr;

}

};
```

DSA Assignment

```
// Function to add a node to the Binary Search TreeTreeNode* insertNode(TreeNode* root, int val) {
if (root == nullptr) {
return new TreeNode(val);
}
if (val < root->value) {
root->left = insertNode(root->left, val);
} else if (val > root->value) {
root->right = insertNode(root->right, val);
}
return root;
}
// Function to calculate the total number of nodes in the Binary Search Tree
int getNodeCount(TreeNode* root) {
if (root == nullptr) {
return 0;
}
// Recursively count nodes in both the left and right subtrees, and add 1 for the
current node
return 1 + getNodeCount(root->left) + getNodeCount(root->right);
}
// Function for in-order traversal of the BST and printing node values
void inorderPrint(TreeNode* root) {
if (root != nullptr) {
inorderPrint(root->left);
cout << root->value << " ";
inorderPrint(root->right);
```

```
}
}
// Main function
int main() {
TreeNode* root = nullptr;
// Insert values into the BST
root = insertNode(root, 50);
root = insertNode(root, 30);root = insertNode(root, 20);
root = insertNode(root, 40);
root = insertNode(root, 70);
root = insertNode(root, 60);
root = insertNode(root, 80);
cout << "In-order traversal of the Binary Search Tree: ";
inorderPrint(root);
cout << endl;
// Calculate and print the number of nodes in the BST
int totalNodes = getNodeCount(root);
cout << "Total number of nodes in the BST: " << totalNodes << endl;
return 0;
}
```

```
In-order traversal of the Binary Search Tree: 20 30 40 50 60 70 80
Total number of nodes in the BST: 7

--------------------------------
Process exited after 0.1619 seconds with return value 0
Press any key to continue . . .
```

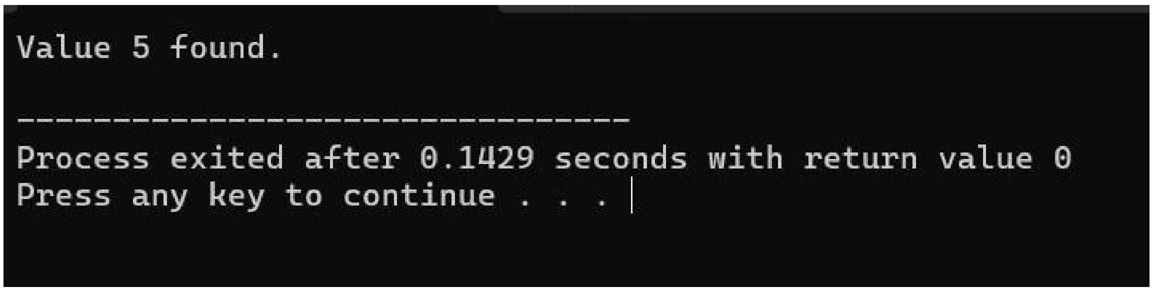
2. **How can you search for a specific value in a binary search tree? Write the code.**

DSA Assignment

Code:

```
#include <iostream>
using namespace std;
// Node structure
struct Node {
int data;
Node* left;
Node* right;
Node(int val) {
data = val;
left = NULL;
right = NULL;
}};
// Function to search for a value
bool search(Node* root, int key) {
if (root == NULL) return false;
if (root->data == key) return true;
if (key < root->data) return search(root->left, key);
return search(root->right, key);
}
int main() {
Node* root = new Node(10);
root->left = new Node(5);
root->right = new Node(15);
int searchKey = 5;
if (search(root, searchKey)) {
cout << "Value " << searchKey << " found." << endl;
```

```
} else {

cout << "Value " << searchKey << " not found" << endl;

}

return 0;

}
```



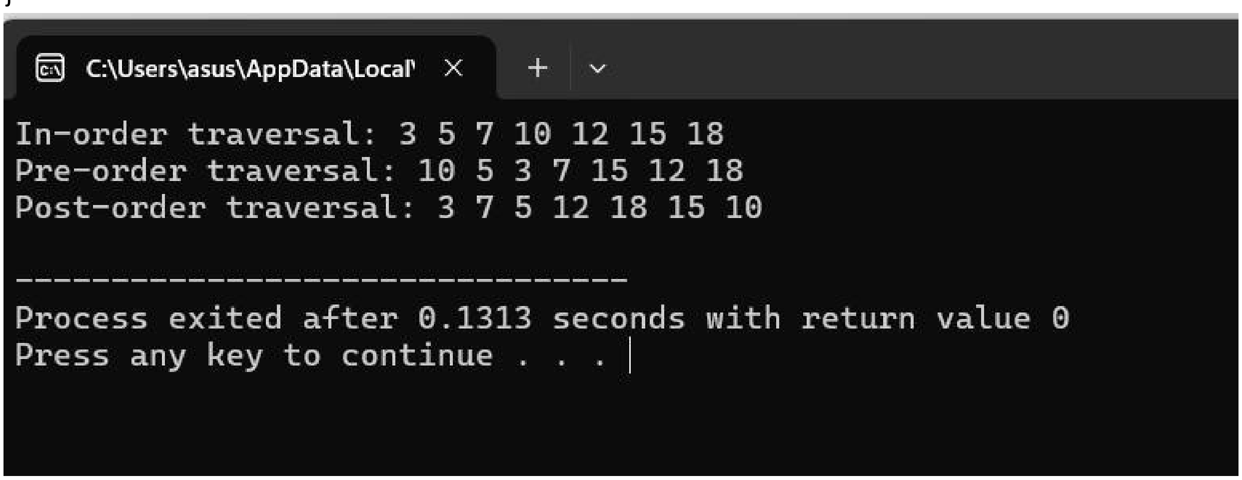
```
Value 5 found.

--------------------------------
Process exited after 0.1429 seconds with return value 0
Press any key to continue . . .
```

3. Write code to traverse a binary search tree in in-order, pre-order, and post order.

```
#include <iostream>

using namespace std;

// Define a TreeNode structure for the binary tree

struct TreeNode {int value;

TreeNode* left;

TreeNode* right;

TreeNode(int val) {

value = val;

left = nullptr;

right = nullptr;

}

};

// In-order Traversal (Left, Root, Right)

void inorderTraversal(TreeNode* root) {
```

```
if (root == nullptr) return;
inorderTraversal(root->left);
cout << root->value << " ";
inorderTraversal(root->right);
}
// Pre-order Traversal (Root, Left, Right)
void preorderTraversal(TreeNode* root) {
if (root == nullptr) return;
cout << root->value << " ";
preorderTraversal(root->left);
preorderTraversal(root->right);
}
// Post-order Traversal (Left, Right, Root)
void postorderTraversal(TreeNode* root) {
if (root == nullptr) return;
postorderTraversal(root->left);
postorderTraversal(root->right);
cout << root->value << " ";
}
// Main function to test the traversal functions
int main() {
TreeNode* root = new TreeNode(10);
root->left = new TreeNode(5);
root->right = new TreeNode(15);
root->left->left = new TreeNode(3);root->left->right = new TreeNode(7);
root->right->left = new TreeNode(12);
root->right->right = new TreeNode(18);
```

```
// In-order Traversal
cout << "In-order traversal: ";
inorderTraversal(root);
cout << endl;
// Pre-order Traversal
cout << "Pre-order traversal: ";
preorderTraversal(root);
cout << endl;
// Post-order Traversal
cout << "Post-order traversal: ";
postorderTraversal(root);
cout << endl;
return 0;
}
```



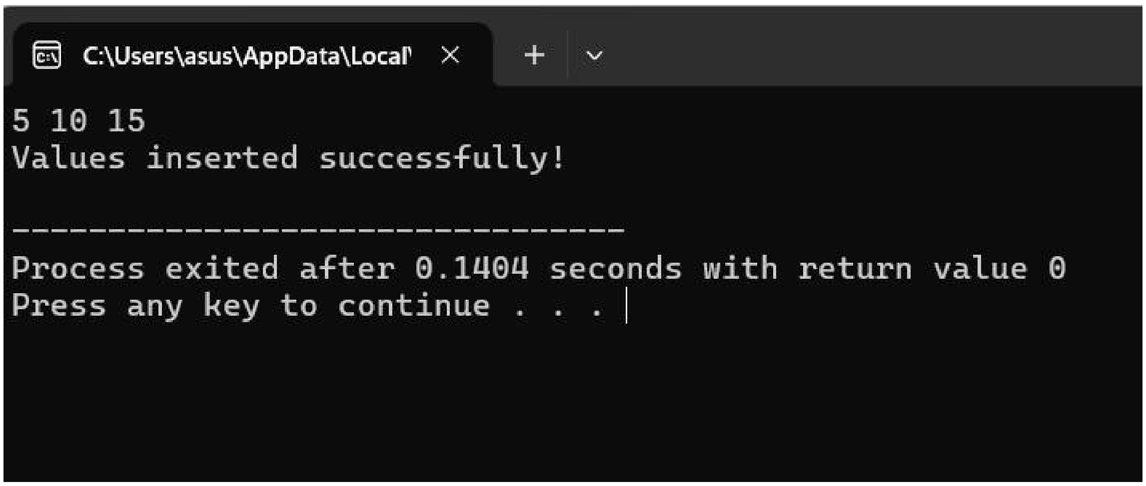
4. How will you write reverse in-order traversal for a binary search tree? Show it in code.

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

DSA Assignment

```
struct Node {
int data;
Node* left;Node* right;
Node(int val) {
data = val;
left = NULL;
right = NULL;
}
};
void inorder(Node* root) {
if (root == NULL) return;
inorder(root->left);
cout << root->data << " ";
inorder(root->right);
}
// Function to insert a new value
Node* insert(Node* root, int val) {
if (root == NULL) {
return new Node(val);
}
if (val < root->data) {
root->left = insert(root->left, val);
} else if (val > root->data) {
root->right = insert(root->right, val);
}
return root;
}
```

```
int main() {
Node* root = NULL;
root = insert(root, 10);
root = insert(root, 5);
root = insert(root, 15);
inorder(root);
cout << "\nValues inserted successfully!" << endl;
return 0;}
```



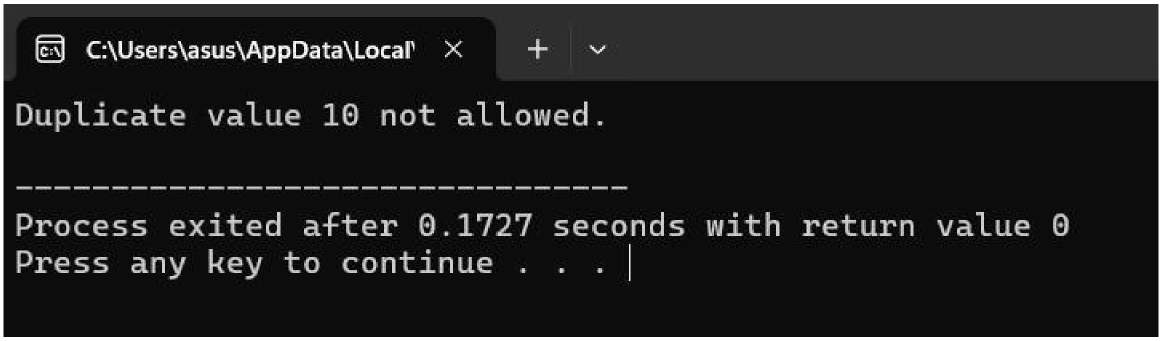
5. Write a program to check if there are duplicate values in a binary search tree.

Code:

```
#include <iostream>
using namespace std;
// Node structure
struct Node {
int data;
Node* left;
Node* right;
Node(int val) {
```

```
data = val;
left = NULL;
right = NULL;
}
};
// Function to insert a value (with duplicate check)
Node* insert(Node* root, int val) {
if (root == NULL) {
return new Node(val);
}
if (val < root->data) {
root->left = insert(root->left, val);
} else if (val > root->data) {
root->right = insert(root->right, val);} else {
cout << "Duplicate value " << val << " not allowed." << endl;
}
return root;
}
// Main function to test duplication handling
int main() {
Node* root = NULL;
root = insert(root, 10);
root = insert(root, 5);
root = insert(root, 15);
root = insert(root, 3);
root = insert(root, 7);
root = insert(root, 12);
```

```
root = insert(root, 10); // Duplicate Values
root = insert(root, 18);
return 0;
```




```
}
```

6. How can you delete a node from a binary search tree? Write code for deleting a leaf, a node with one child, and a node with two children. code:

```
#include <iostream>
using namespace std;
// Structure representing a node in the Binary Search Tree
struct TreeNode {
int value;TreeNode* left;
TreeNode* right;
TreeNode(int val) {
value = val;
left = nullptr;
right = nullptr;
}
};
// Function to find the node with the minimum value
TreeNode* findMinNode(TreeNode* root) {
```

```
while (root && root->left != nullptr) {
```

```
root = root->left;
}
return root;
}
// Function to remove a node from the Binary Search Tree
TreeNode* removeNode(TreeNode* root, int key) {
if (root == nullptr) return root;
if (key < root->value) {
root->left = removeNode(root->left, key);
} else if (key > root->value) {
root->right = removeNode(root->right, key);
} else {
// Node to be deleted found
// Case 1: Node has no left child
if (root->left == nullptr) {
TreeNode* temp = root->right;
delete root;
return temp;
}
// Case 2: Node has no right child
else if (root->right == nullptr) {
TreeNode* temp = root->left;
delete root;
return temp;
}// Case 3: Node has two children
TreeNode* temp = findMinNode(root->right); // Get the minimum node from the
right subtree
```

root->value = temp->value; // Replace current node's value with the in-order

successor's value

root->right = removeNode(root->right, temp->value); // Delete the in-order

successor

}

return root;

}

// Main function to demonstrate node deletion in the Binary Search

Tree int main() {

TreeNode* root = new

TreeNode(10); root->left = new

TreeNode(5);

root->right = new TreeNode(15);

root->left->left = new

TreeNode(3); root->left->right =

new TreeNode(7);

root->right->left = new

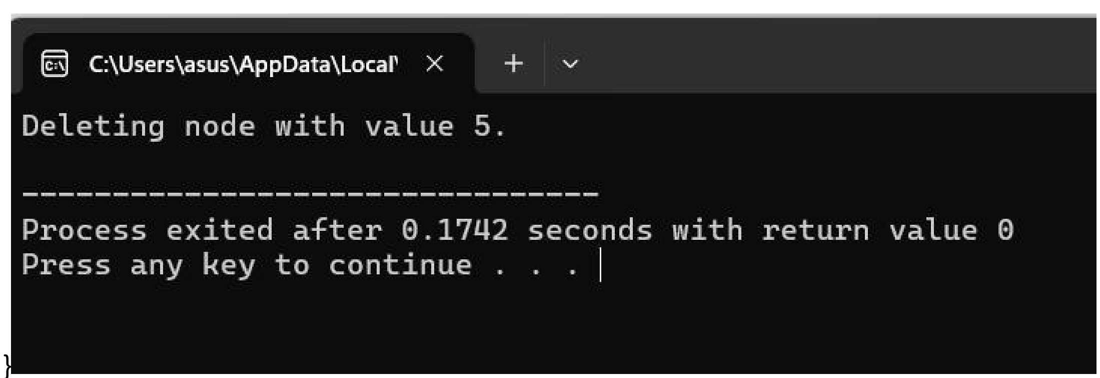
TreeNode(12); root->right->right =

new TreeNode(18);

cout << "Deleting node with value 5." <<

endl; root = removeNode(root, 5);

return 0;



}

DSA Assignment