DATA STRUCTURE AND ALGORITHM

LAB -1

AUGUST 24, 2025

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Lab Tasks

Q1. Bank Account Management System

Suppose you are developing a bank account management system, and you have defined the BankAccount class with the required constructors. You need to demonstrate the use of these constructors in various scenarios.

1. Default Constructor Usage: Create a default-initialized BankAccount object named account1. Print out the balance of account1.

2. Parameterized Constructor Usage: Create a BankAccount object named account2 with an initial balance of $1000. Print out the balance of account2.

3. Copy Constructor Usage: Using the account2 you created earlier, create a new BankAccount object named account3 using the copy constructor. Deduct $200 from account3 and print out its balance. Also, print out the balance of account2 to ensure it hasn't been affected by the transaction involving account3.

Q2. Exam Class with Dynamic Memory Allocation (DMA)

Create a C++ class named "Exam" using DMA designed to manage student exam records, complete with a shallow copy implementation. Define attributes such as student name, exam date, and score within the class, and include methods to set these attributes and display exam details.

As part of this exercise, intentionally omit the implementation of the copy constructor and copy assignment operator. Afterward, create an instance of the "Exam" class, generate a shallow copy, and observe any resulting issues.

Q3. Box Class with Dynamic Memory Allocation and Rule of Three

Create a C++ class Box that uses dynamic memory allocation for an integer. Implement the Rule of Three by defining a destructor, copy constructor, and copy assignment operator. Demonstrate the behavior of both shallow and deep copy using test cases.

Solutions

Q1. Bank Account Management System

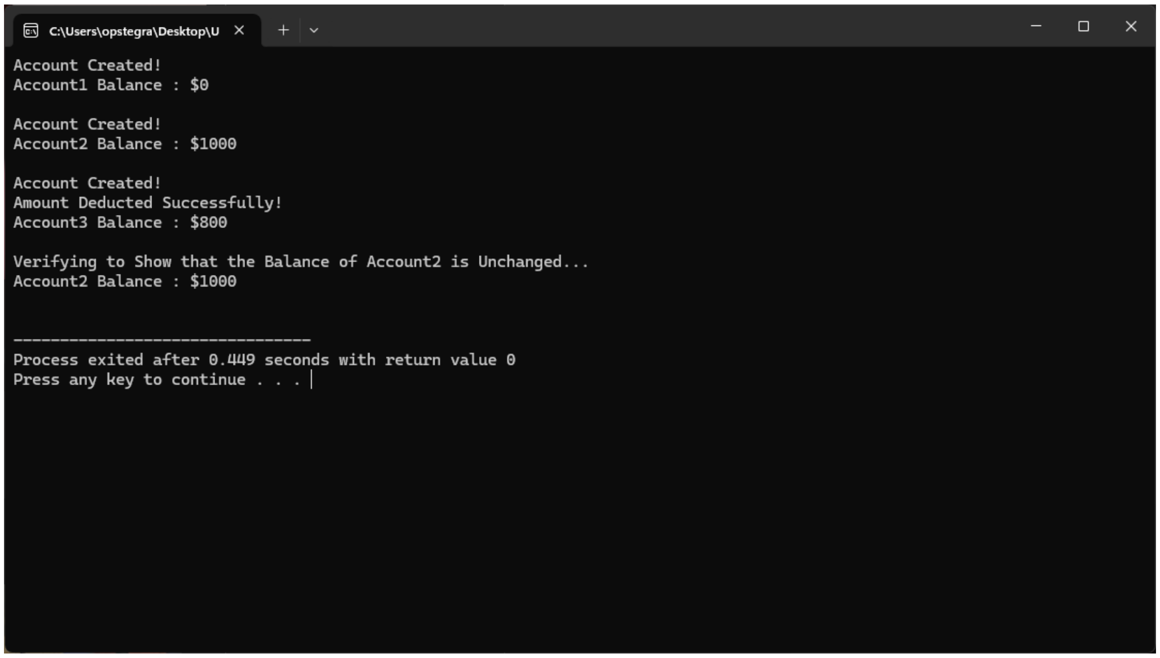
```
#include <iostream>
                                                                // Easy Access to Input and
Output Operations


using namespace std;
                                                                // So we dont have to write
"std::" before every library features (like cout,cin,endl ,etc)


class BankAccount {
                                                                // Defining the BankAccount
Class


        private :
                                                                                // Access
Modifier , private, makes member accessible only inside the class


                double Balance;
                                                                        // Data Member


        public  :
                                                                                // Access
Modifier , public, allows functions to be accessible from outside


        //Constructors
```

```
	BankAccount () : Balance(00.00) {
								// Default Constructor - Initializes
Account with $0 if no paramater is passed!

		cout<<"Account Created!"<<endl;

	}


	BankAccount (double x)  {
						// Parameterized Constructor - Initializes Account's
Balance with the paramater passed!

		if( x < 00.00 ) {

		Balance=00.00;

	}

		else {

			Balance=x;

		}

		cout<<"Account Created!"<<endl;

	}


	BankAccount(const BankAccount &other) {
							// Copy Constructor - Used to Create a copy
of another Object

		cout<<"Account Created!"<<endl;

		Balance = other.Balance;

	}


	// Methods
```

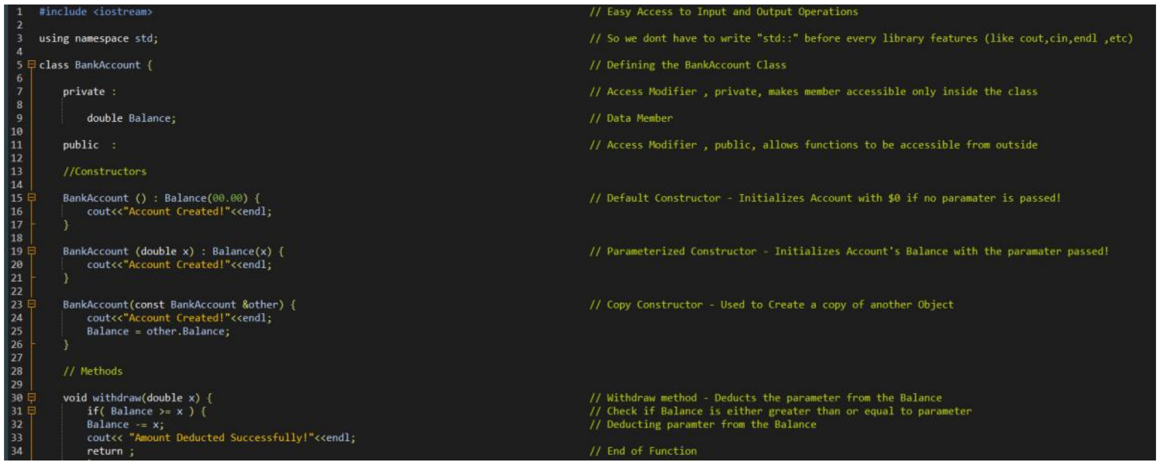
```
        void withdraw(double x) {
                                                                      // Withdraw method -
Deducts the parameter from the Balance

                if( Balance >= x ) {
                                                                      // Check if Balance is either
greater than or equal to parameter

                Balance -= x;
                                                                              // Deducting paramter
from the Balance

                cout<< "Amount Deducted Successfully!"<<endl;

                return ;
                                                                                      // End of
Function

                }

                cout<< "Insufficient Balance!"<<endl;
                                                      // If not Sufficient Balance

                return ;

        }


        void deposit(double x) {
                                                                      // Deposit Method - Adds
Paramter to the Balance

                if(x > 00.00) {
                                                                      // Checks if the Parameter is
Positive

                Balance+=x;

                cout<< "Amount Deposited Successfully!"<<endl;

                return ;
                                                                                      // End of
Function

                }

                cout<< "Deposit can't be less than or equal to 0!"<<endl;
                                      // Invalid Parameter
        }

        double getBalance() const {
                                                        // Getter Method - Allows main to
Access the Private Members
                return Balance;
        }

};

int main() {

        // Default Constructor Usage
        BankAccount account1;
                                                                        // Will Initialize with
$0 Balance
        cout<<"Account1 Balance : $"<<account1.getBalance()<<endl<<endl;
                                // Prints Balance for Account1

        // Parameterized Constructor Usage
        BankAccount account2(1000.00);
                                                                // Will Initialize with $1000
Balance
        cout<<"Account2 Balance : $"<<account2.getBalance()<<endl<<endl;
                                // Prints Balance for Account2

        // Copy Constructor Usage
        BankAccount account3 = account2;
                                                        // Will Initialize Balance of Account3
with the Balance of Account2
```

```
            account3.withdraw(200.00);
                                                                    // Deducting $200.00 from
Account3

            cout<<"Account3 Balance : $"<<account3.getBalance()<<endl<<endl;
                                    // Prints Balance for Account3



            cout<<"Verifying to Show that the Balance of Account2 is Unchanged..."<<endl;

            cout<<"Account2 Balance : $"<<account2.getBalance()<<endl<<endl;
                                    // Prints Balance for Account2



            return 0;
                                                                                //End of
Program



}
```

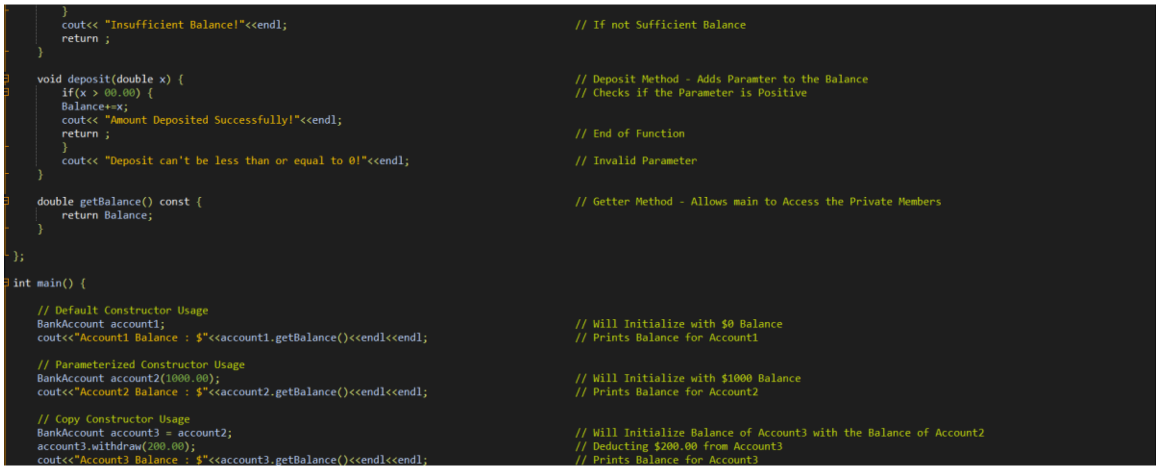
Q1. Screenshots



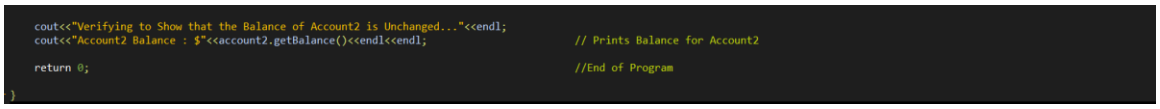
```
Account Created!
Account1 Balance : $0

Account Created!
Account2 Balance : $1000

Account Created!
Amount Deducted Successfully!
Account3 Balance : $800

Verifying to Show that the Balance of Account2 is Unchanged...
Account2 Balance : $1000


--------------------------------
Process exited after 0.449 seconds with return value 0
Press any key to continue . . .
```



```cpp
#include <iostream>                                      // Easy Access to Input and Output Operations

using namespace std;                                     // So we dont have to write "std::" before every library features (like cout,cin,endl ,etc)

class BankAccount {                                      // Defining the BankAccount Class

    private :                                            // Access Modifier , private, makes member accessible only inside the class

        double Balance;                                  // Data Member

    public  :                                            // Access Modifier , public, allows functions to be accessible from outside

    //Constructors

    BankAccount () : Balance(00.00) {                    // Default Constructor - Initializes Account with $0 if no paramater is passed!
        cout<<"Account Created!"<<endl;
    }

    BankAccount (double x) : Balance(x) {                // Parameterized Constructor - Initializes Account's Balance with the paramater passed!
        cout<<"Account Created!"<<endl;
    }

    BankAccount(const BankAccount &other) {              // Copy Constructor - Used to Create a copy of another Object
        cout<<"Account Created!"<<endl;
        Balance = other.Balance;
    }

    // Methods

    void withdraw(double x) {                            // Withdraw method - Deducts the parameter from the Balance
        if( Balance >= x ) {                             // Check if Balance is either greater than or equal to parameter
        Balance -= x;                                    // Deducting paramter from the Balance
        cout<< "Amount Deducted Successfully!"<<endl;
        return ;                                         // End of Function
```



```cpp
        }
        cout<< "Insufficient Balance!"<<endl;            // If not Sufficient Balance
        return ;
    }

    void deposit(double x) {                             // Deposit Method - Adds Paramter to the Balance
        if(x > 00.00) {                                  // Checks if the Parameter is Positive
        Balance+=x;
        cout<< "Amount Deposited Successfully!"<<endl;
        return ;                                         // End of Function
        }
        cout<< "Deposit can't be less than or equal to 0!"<<endl;   // Invalid Parameter
    }

    double getBalance() const {                          // Getter Method - Allows main to Access the Private Members
        return Balance;
    }

};

int main() {

    // Default Constructor Usage
    BankAccount account1;                                // Will Initialize with $0 Balance
    cout<<"Account1 Balance : $"<<account1.getBalance()<<endl<<endl;   // Prints Balance for Account1

    // Parameterized Constructor Usage
    BankAccount account2(1000.00);                       // Will Initialize with $1000 Balance
    cout<<"Account2 Balance : $"<<account2.getBalance()<<endl<<endl;   // Prints Balance for Account2

    // Copy Constructor Usage
    BankAccount account3 = account2;                     // Will Initialize Balance of Account3 with the Balance of Account2
    account3.withdraw(200.00);                           // Deducting $200.00 from Account3
    cout<<"Account3 Balance : $"<<account3.getBalance()<<endl<<endl;   // Prints Balance for Account3
```



```cpp
    cout<<"Verifying to Show that the Balance of Account2 is Unchanged..."<<endl;
    cout<<"Account2 Balance : $"<<account2.getBalance()<<endl<<endl;   // Prints Balance for Account2

    return 0;                                            //End of Program

}
```

Q2. Exam Class with Dynamic Memory Allocation (DMA)

```
#include <iostream>
                                                  // Easy Access to Input and Output
Operations

using namespace std;
                                                  // So we don't have to write "std::" before
every library feature (like cout, cin, endl, etc)

class Exam {
                                                                  // Defining the Exam Class

  private:
                                                                  // Access Modifier: private,
makes member accessible only inside the class
    char* name;
                                                  // Data Member: dynamically allocated
memory for student name
    char* date;
                                                  // Data Member: dynamically allocated
memory for exam date
    int score;
                                                          // Data Member: storing exam score

  public:
```

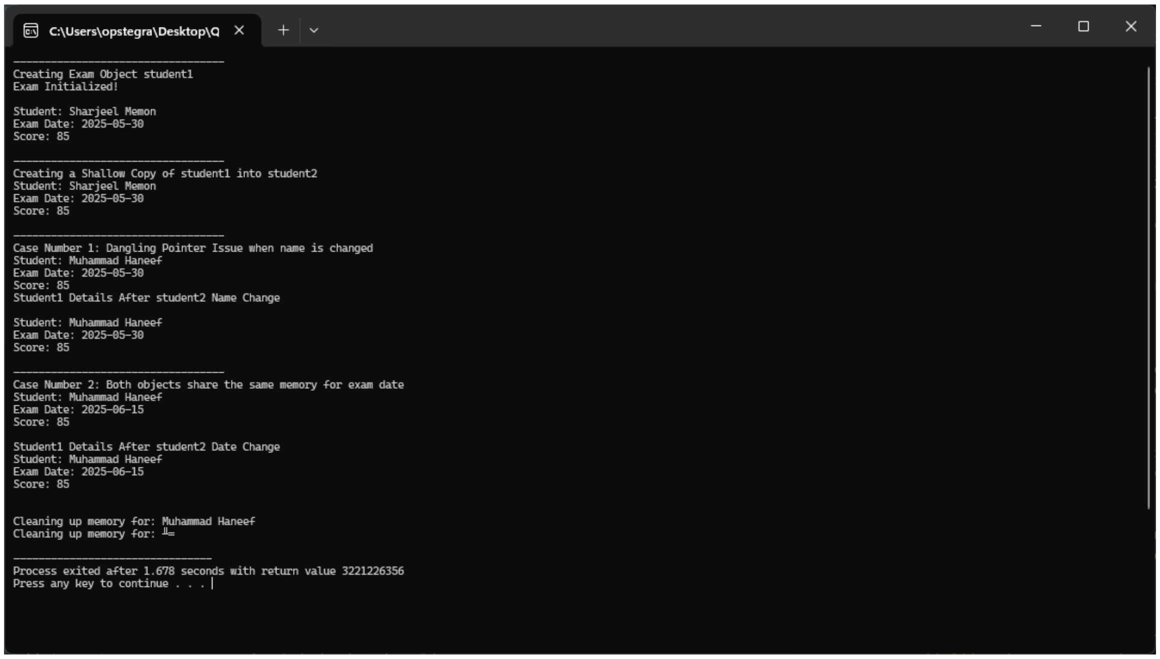
```
                                                             // Access Modifier: public,
allows functions to be accessible from outside

  // Setters
  void setScore(int x ) {
                                              // Method to set exam score
    score = x ;
                                                   // Assign new score
  }

  void setDate(const char* x ) {
                                                                                 //
Method to set exam date
    strcpy(date, x );
                                              // Copy new date into allocated memory
  }

  void setName(const char* x) {
                                                                                 //
Method to set student's name
    if (name != nullptr) {
                                              // If memory already allocated, free it
    delete[] name;
                                                   // Free old memory before setting new name
    }
    name = new char[strlen( x ) + 1];
                                                                   // Allocate memory
for new name
```

```
        strcpy(name, x );
                                                    // Copy new name into allocated memory
    }


    // Constructors
    Exam(const char* x, const char* y, int z) {
                                                                        // Parameterized Constructor
        name = new char[strlen( x ) + 1];
                                                                                // Allocating memory
for the student name
        strcpy(name, x );
                                                    // Copying student name into the allocated
memory
        date = new char[strlen( y ) + 1];
                                                                                // Allocating memory
for the exam date
        strcpy(date, y );
                                                    // Copying exam date into the allocated memory
        score = z;
                                                                // Assigning the exam score
        cout << "Exam Initialized!" << endl<<endl;
                                                                                // Message when
exam is initialized
    }


    // Display Method
    void displayDetails() const {
                                                                                                //
Method to display student's exam details
```

```
        cout << "Student: " << name << endl << "Exam Date: " << date << endl <<"Score: " <<
score << endl;  // Print details of the exam

    }


    // Destructor

    ~Exam() {

                                                                                    // Destructor to free
dynamically allocated memory

        string cleanupMessage = (name) ? name : "Unknown OR Nullptr";
                                                                        // Prepare the cleanup message

        cout << "Cleaning up memory for: " << cleanupMessage << endl;
                                                                // Display cleanup message

        delete[] name;

                                                                // Free memory for name

        delete[] date;

                                                                // Free memory for exam date

    }


};


int main() {


    // Creating Exam Object Using Parameterized Constructor

    cout << "----------------------------------" << endl;

    cout << "Creating Exam Object student1" << endl;

    Exam student1("Sharjeel Memon", "2025-05-30", 85);
                                                                                // Creates Exam
object with initial values
```

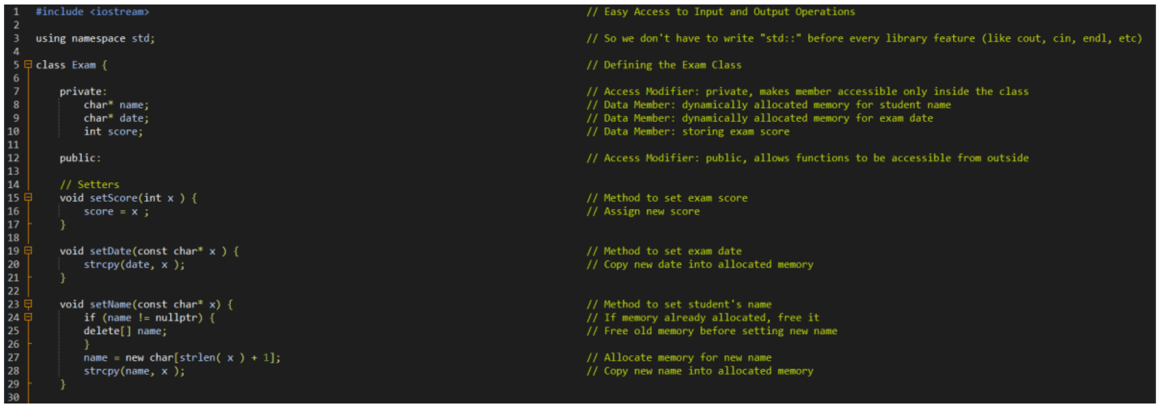
```
    student1.displayDetails();
                                                     // Display the details of student1
    cout << endl;


    // Creating a Shallow Copy of student1
    cout << "----------------------------------" << endl;
    cout << "Creating a Shallow Copy of student1 into student2" << endl;
    Exam student2 = student1;
                                                     // Creates student2 as a shallow copy of student1
    student2.displayDetails();
                                                     // Display the details of student2
    cout << endl;


    // Case Number 1: Shallow Copy Issue - Dangling Pointer
    cout << "----------------------------------" << endl;
    cout << "Case Number 1: Dangling Pointer Issue when name is changed" << endl;
    student2.setName("Muhammad Haneef");
                                                                                  // Changing
the name of student2
    student2.displayDetails();
                                                     // Display student2's details after name change
    cout << "Student1 Details After student2 Name Change" << endl << endl;
    student1.displayDetails();
                                                     // student1 shows garbage value for the name
(dangling pointer)
    cout << endl;
    // Case Number 2: Shared Memory Issue - Exam Date is shared

    cout << "---------------------------------" << endl;

    cout << "Case Number 2: Both objects share the same memory for exam date" << endl;

    student2.setDate("2025-06-15");
                                                                                        // Changing
the exam date of student2

    student2.displayDetails();

                                                // Display student2's details after changing the
date

    cout << endl;


    cout << "Student1 Details After student2 Date Change" << endl;

    student1.displayDetails();

                                                // student1's exam date also changes as they share
the same memory

    cout << endl << endl;


    return 0;

                                                                          // End of Program

}
```

Q2. Screenshots

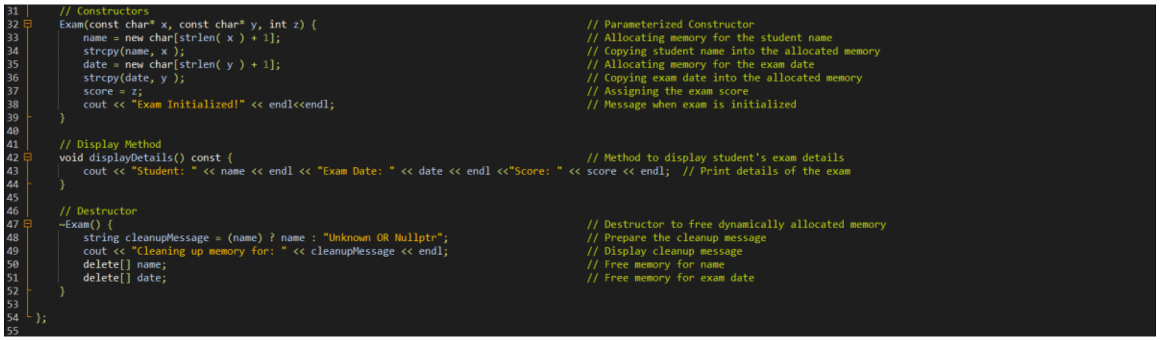


```
C:\Users\opstegra\Desktop\Q
```

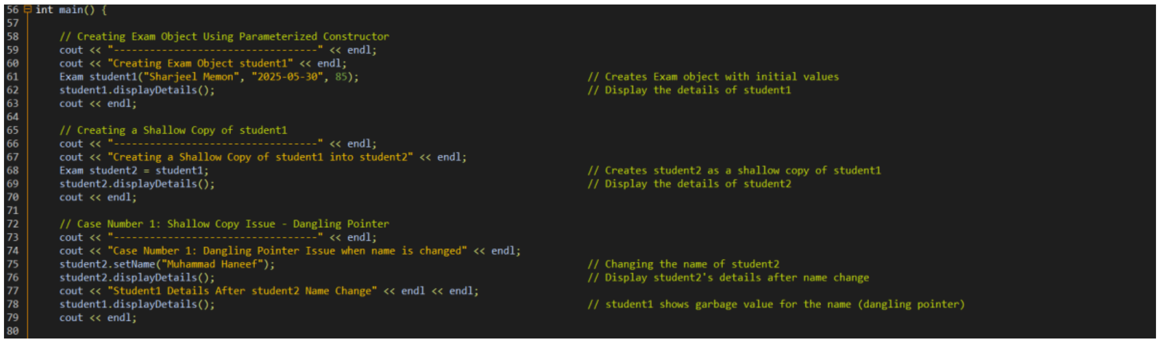
```
----------------------------------
Creating Exam Object student1
Exam Initialized!

Student: Sharjeel Memon
Exam Date: 2025-05-30
Score: 85

----------------------------------
Creating a Shallow Copy of student1 into student2
Student: Sharjeel Memon
Exam Date: 2025-05-30
Score: 85

----------------------------------
Case Number 1: Dangling Pointer Issue when name is changed
Student: Muhammad Haneef
Exam Date: 2025-05-30
Score: 85
Student1 Details After student2 Name Change

Student: Muhammad Haneef
Exam Date: 2025-05-30
Score: 85

----------------------------------
Case Number 2: Both objects share the same memory for exam date
Student: Muhammad Haneef
Exam Date: 2025-06-15
Score: 85

Student1 Details After student2 Date Change
Student: Muhammad Haneef
Exam Date: 2025-06-15
Score: 85


Cleaning up memory for: Muhammad Haneef
Cleaning up memory for: ╨═

--------------------------------
Process exited after 1.678 seconds with return value 3221226356
Press any key to continue . . .
```



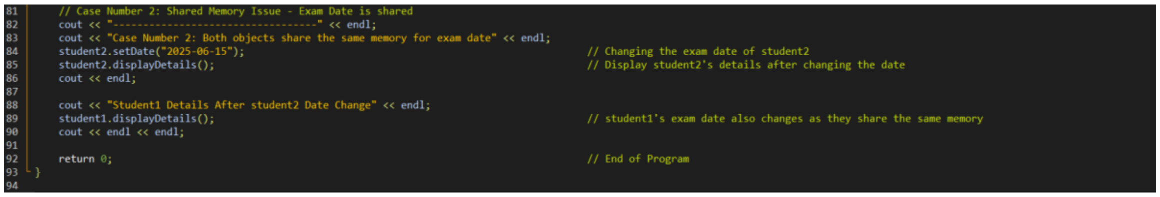
```cpp
#include <iostream>                                                      // Easy Access to Input and Output Operations

using namespace std;                                                     // So we don't have to write "std::" before every library feature (like cout, cin, endl, etc)

class Exam {                                                             // Defining the Exam Class

    private:                                                             // Access Modifier: private, makes member accessible only inside the class
        char* name;                                                      // Data Member: dynamically allocated memory for student name
        char* date;                                                      // Data Member: dynamically allocated memory for exam date
        int score;                                                       // Data Member: storing exam score

    public:                                                              // Access Modifier: public, allows functions to be accessible from outside

    // Setters
    void setScore(int x ) {                                              // Method to set exam score
        score = x ;                                                      // Assign new score
    }

    void setDate(const char* x ) {                                       // Method to set exam date
        strcpy(date, x );                                                // Copy new date into allocated memory
    }

    void setName(const char* x) {                                        // Method to set student's name
        if (name != nullptr) {                                           // If memory already allocated, free it
        delete[] name;                                                   // Free old memory before setting new name
        }
        name = new char[strlen( x ) + 1];                                // Allocate memory for new name
        strcpy(name, x );                                                // Copy new name into allocated memory
    }

```



```cpp
    // Constructors
    Exam(const char* x, const char* y, int z) {                          // Parameterized Constructor
        name = new char[strlen( x ) + 1];                                // Allocating memory for the student name
        strcpy(name, x );                                                // Copying student name into the allocated memory
        date = new char[strlen( y ) + 1];                                // Allocating memory for the exam date
        strcpy(date, y );                                                // Copying exam date into the allocated memory
        score = z;                                                       // Assigning the exam score
        cout << "Exam Initialized!" << endl<<endl;                       // Message when exam is initialized
    }

    // Display Method
    void displayDetails() const {                                        // Method to display student's exam details
        cout << "Student: " << name << endl << "Exam Date: " << date << endl <<"Score: " << score << endl;  // Print details of the exam
    }

    // Destructor
    ~Exam() {                                                            // Destructor to free dynamically allocated memory
        string cleanupMessage = (name) ? name : "Unknown OR Nullptr";    // Prepare the cleanup message
        cout << "Cleaning up memory for: " << cleanupMessage << endl;    // Display cleanup message
        delete[] name;                                                   // Free memory for name
        delete[] date;                                                   // Free memory for exam date
    }

};

```



```cpp
int main() {

    // Creating Exam Object Using Parameterized Constructor
    cout << "----------------------------------" << endl;
    cout << "Creating Exam Object student1" << endl;
    Exam student1("Sharjeel Memon", "2025-05-30", 85);                                      // Creates Exam object with initial values
    student1.displayDetails();                                                              // Display the details of student1
    cout << endl;

    // Creating a Shallow Copy of student1
    cout << "----------------------------------" << endl;
    cout << "Creating a Shallow Copy of student1 into student2" << endl;
    Exam student2 = student1;                                                               // Creates student2 as a shallow copy of student1
    student2.displayDetails();                                                              // Display the details of student2
    cout << endl;

    // Case Number 1: Shallow Copy Issue - Dangling Pointer
    cout << "----------------------------------" << endl;
    cout << "Case Number 1: Dangling Pointer Issue when name is changed" << endl;
    student2.setName("Muhammad Haneef");                                                    // Changing the name of student2
    student2.displayDetails();                                                              // Display student2's details after name change
    cout << "Student1 Details After student2 Name Change" << endl << endl;
    student1.displayDetails();                                                              // student1 shows garbage value for the name (dangling pointer)
    cout << endl;

```



```cpp
    // Case Number 2: Shared Memory Issue - Exam Date is shared
    cout << "----------------------------------" << endl;
    cout << "Case Number 2: Both objects share the same memory for exam date" << endl;
    student2.setDate("2025-06-15");                                                         // Changing the exam date of student2
    student2.displayDetails();                                                              // Display student2's details after changing the date
    cout << endl;

    cout << "Student1 Details After student2 Date Change" << endl;
    student1.displayDetails();                                                              // student1's exam date also changes as they share the same memory
    cout << endl << endl;

    return 0;                                                                               // End of Program
}

```

Q3. Box Class with Dynamic Memory Allocation and Rule of Three

```
#include <iostream>

                                                // Easy Access to Input and Output
Operations


using namespace std;

                                                // So we don't have to write "std::" before
every library feature (like cout, cin, endl, etc)


class Box {

                                                                // Defining the Box Class


private:

                                                                        // Access Modifier,
private, makes member accessible only inside the class

  int* BoxSize;

                                                        // Data Member: dynamically
allocated memory for BoxSize

  bool deepCopy;

                                                        // A flag for deep copy vs shallow
copy (runtime controlled)


public:

                                                                                // Access
Modifier, public, allows functions to be accessible from outside
```

```
  // Constructors


  Box() : BoxSize(new int(0)), deepCopy(true) {
                                                                             // Default Constructor
- Initializes BoxSize with 0 if no parameter is passed

    cout << "Box Created with default size!" << endl;
                                                             // Message when the box is created

  }


  Box(int size) : BoxSize(new int(size)), deepCopy(true) {
                                                             // Parameterized Constructor -
Initializes BoxSize with the given size

    cout << "Box Created with size " << *BoxSize << endl;
                                                             // Message when the box is created
with a specified size

  }


  // Copy Constructor

  Box(const Box &other) {

                                                 // Copy Constructor - Used to Create a copy of
another Object

    if (other.deepCopy) {

      BoxSize = new int(*(other.BoxSize));
                                                                      // Deep copy: allocating new
memory and copying the value of BoxSize

      cout << "Box Created by copying with size " << *BoxSize << endl;
                                                 // Message when a box is created by copying
another box

    } else {

      BoxSize = other.BoxSize;
                                                                                    // Shallow
copy: both objects point to the same memory
```

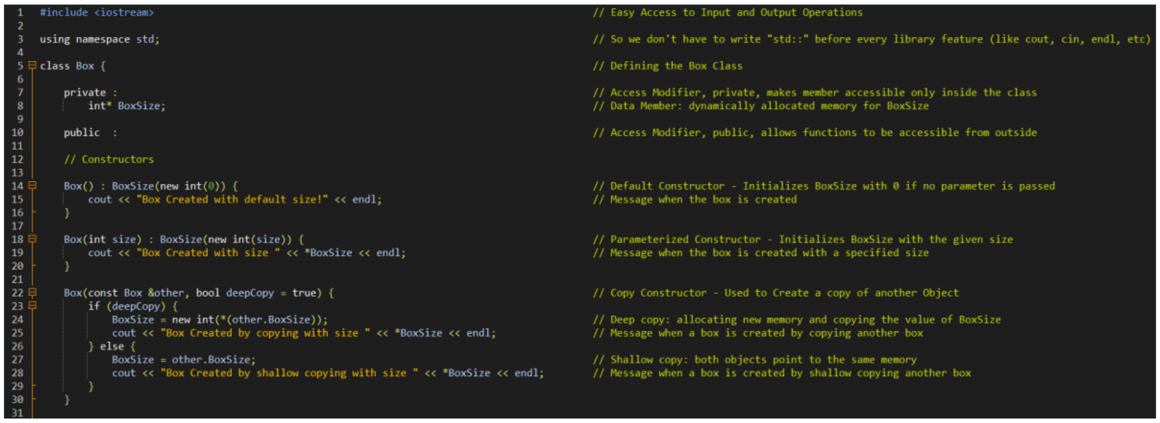
```
            cout << "Box Created by shallow copying with size " << *BoxSize << endl;
                                                            // Message when a box is created by shallow
copying another box
        }
    }


    // Methods


    void setBoxSize(int size) {
                                                                                                    //
Method to set the size of the Box
        *BoxSize = size;

                                                            // Assigning the given size to BoxSize
    }


    int getBoxSize() const {

                                                            // Getter Method - Allows main to Access the
Private Member
        return *BoxSize;

                                                            // Returning the size of the Box
    }


    // Setter for deepCopy flag (to change at runtime)
    void setDeepCopy(bool value) {
        deepCopy = value;

                                                            // Allow modification of deepCopy flag at runtime
    }
```

```
  // Copy Assignment Operator

  Box& operator=(const Box& other) {
                                                                          // Assignment
operator to handle assignment between two Box objects

      if (this != &other) {

                                                // Check for self-assignment

          delete BoxSize;

                                                // Free the existing memory

          if (other.deepCopy) {

              BoxSize = new int(*(other.BoxSize));
                                                            // Perform deep copy

              cout << "Box Assigned with size " << *BoxSize << endl;
                                                     // Message after deep copy assignment

          } else {

              BoxSize = other.BoxSize;
                                                                    // Perform shallow
copy

              cout << "Box Assigned by shallow copy with size " << *BoxSize << endl;
                                                // Message after shallow copy assignment

          }

      }

      return *this;

                                                     // Returning the current object

  }


  // Destructor

  ~Box() {
```

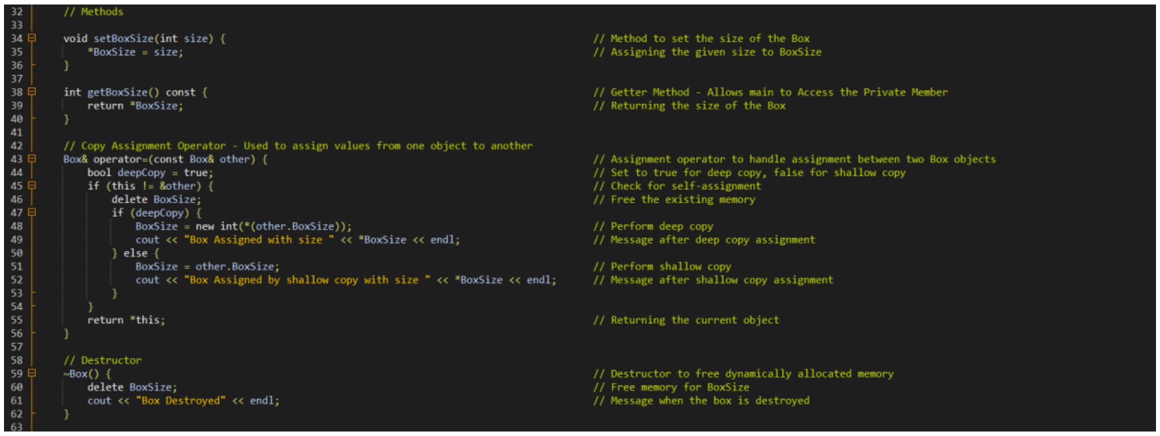
```
                                                            // Destructor to free
dynamically allocated memory

    delete BoxSize;

                                        // Free memory for BoxSize

    cout << "Box Destroyed" << endl;
                                                                   // Message when the
box is destroyed

  }


};


int main() {

  cout << "---- Deep Copy Example ----" << endl;

  Box box1(10);

                                                       // Will initialize with BoxSize 10

  cout << "Box1 (Initial) Size: " << box1.getBoxSize() << endl;
                                              // Prints Box1's size



  Box box2(box1);

                                              // Deep copy using the copy constructor
(deepCopy is true by default)

  cout << "Box2 (After Deep Copy) Size: " << box2.getBoxSize() << endl;
                                              // Should be 10, independent from Box1



  box2.setBoxSize(20);

                                        // Modify box2's size

  cout << "Box1 Size (After Box2 Change): " << box1.getBoxSize() << endl;
                                              // Should remain 10, no effect due to deep
copy
```

```
    cout << "Box2 Size (After Change): " << box2.getBoxSize() << endl;
                                                        // Should be 20 (modified)


    cout << endl;

                                                                 // New Line for clarity


    cout << "---- Shallow Copy Example ----" << endl;

    Box box3(30);

                                                                 // Will Initialize with BoxSize 30

    cout << "Box3 (Initial) Size: " << box3.getBoxSize() << endl;
                                                        // Prints Box3's size


    // Set deepCopy to false at runtime to demonstrate shallow copy

    box3.setDeepCopy(false);

                                                   // Change to shallow copy mode at runtime

    Box box4 = box3;

                                                        // Shallow copy using the copy constructor

    cout << "Box4 (After Shallow Copy) Size: " << box4.getBoxSize() << endl;
                                                   // Should be 30, both Box3 and Box4 point to the
same memory


    box4.setBoxSize(40);

                                                   // Modify box4's size

    cout << "Box3 Size (After Box4 Change): " << box3.getBoxSize() << endl;
                                                        // Should also be 40, since they share
memory

    cout << "Box4 Size (After Change): " << box4.getBoxSize() << endl << endl;
                                                   // Should be 40 (modified)
    // Copy Assignment Example (Deep Copy)

    cout << "---- Copy Assignment Example (Deep Copy) ----" << endl;

    Box box5(50);

    box5 = box1;

                                                            // Deep copy using the assignment
operator

    cout << "Box5 Size (After Deep Copy Assignment): " << box5.getBoxSize() << endl;
                                              // Should be 10

    box1.setBoxSize(40);

                                              // Changing Size to 40

    cout << "Box1 Size (After Change): " << box1.getBoxSize() << endl;
                                                    // Should be 40

                                              cout << "Box5 Size (After Changing Box1 Size): " <<
box5.getBoxSize() << endl << endl;  // Should still be 10 (deep copy)


    // Copy Assignment Example (Shallow Copy)

    cout << "---- Copy Assignment Example (Shallow Copy) ----" << endl;

    Box box6(60);

    box6.setDeepCopy(false);

                                              // Set shallow copy mode at runtime

    box6 = box3;

                                                            // Shallow copy using the assignment
operator (box3 and box6 will share memory)

    box6.setBoxSize(70);

                                              // Modify box6

    cout << "Box3 Size (After Shallow Copy Assignment): " << box3.getBoxSize() << endl;
                                              // Should be 70 (shared memory with box6)
    cout << "Box6 Size (After Change): " << box6.getBoxSize() << endl << endl;
                                                                            // Should be 70 (modified)



    return 0;

                                                                                            // End of Program

}
```

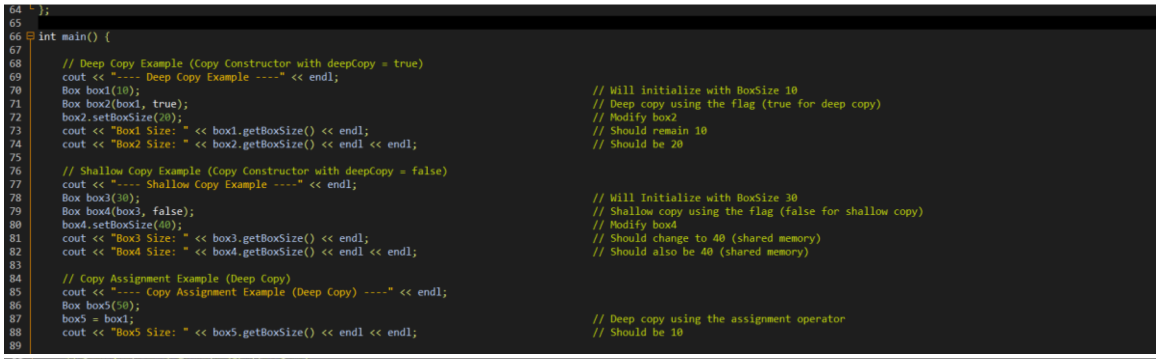
Q3 . Screenshots



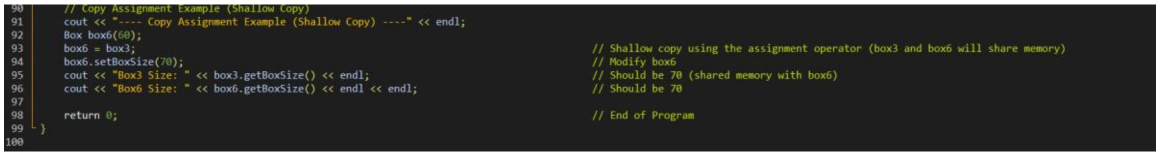
```cpp
#include <iostream>                                                                         // Easy Access to Input and Output Operations

using namespace std;                                                                        // So we don't have to write "std::" before every library feature (like cout, cin, endl, etc)

class Box {                                                                                 // Defining the Box Class

    private :                                                                               // Access Modifier, private, makes member accessible only inside the class
        int* BoxSize;                                                                       // Data Member: dynamically allocated memory for BoxSize

    public  :                                                                               // Access Modifier, public, allows functions to be accessible from outside

    // Constructors

    Box() : BoxSize(new int(0)) {                                                           // Default Constructor - Initializes BoxSize with 0 if no parameter is passed
        cout << "Box Created with default size!" << endl;                                   // Message when the box is created
    }

    Box(int size) : BoxSize(new int(size)) {                                                // Parameterized Constructor - Initializes BoxSize with the given size
        cout << "Box Created with size " << *BoxSize << endl;                               // Message when the box is created with a specified size
    }

    Box(const Box &other, bool deepCopy = true) {                                           // Copy Constructor - Used to Create a copy of another Object
        if (deepCopy) {
            BoxSize = new int(*(other.BoxSize));                                            // Deep copy: allocating new memory and copying the value of BoxSize
            cout << "Box Created by copying with size " << *BoxSize << endl;                // Message when a box is created by copying another box
        } else {
            BoxSize = other.BoxSize;                                                        // Shallow copy: both objects point to the same memory
            cout << "Box Created by shallow copying with size " << *BoxSize << endl;        // Message when a box is created by shallow copying another box
        }
    }

```



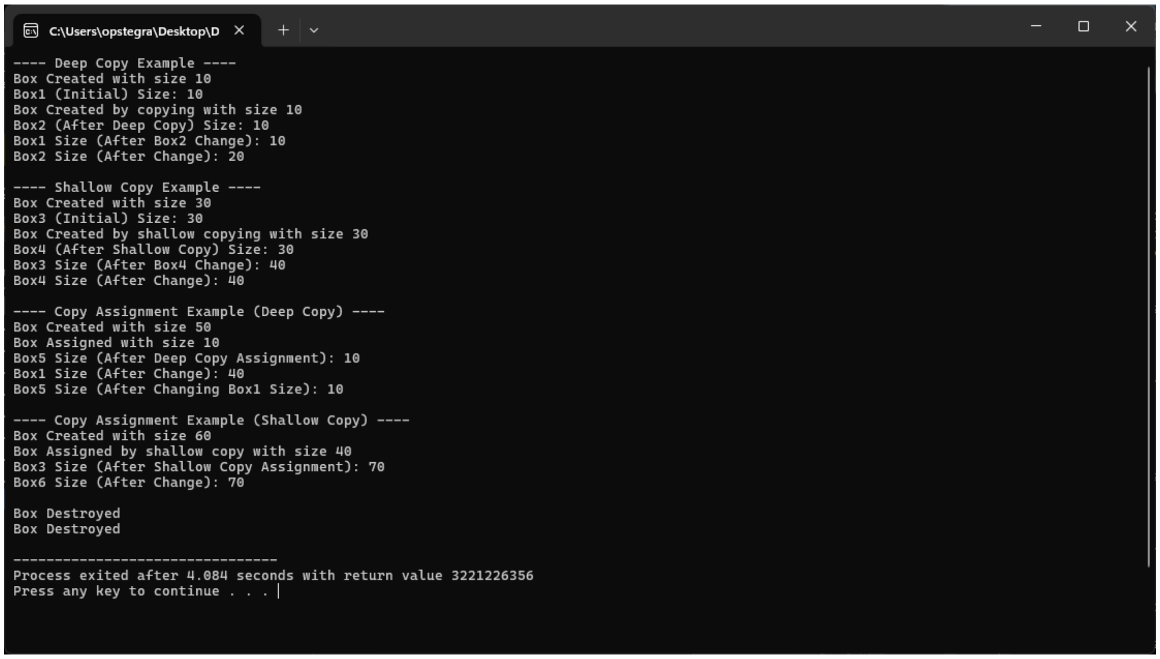
```cpp
    // Methods

    void setBoxSize(int size) {                                                             // Method to set the size of the Box
        *BoxSize = size;                                                                    // Assigning the given size to BoxSize
    }

    int getBoxSize() const {                                                                // Getter Method - Allows main to Access the Private Member
        return *BoxSize;                                                                    // Returning the size of the Box
    }

    // Copy Assignment Operator - Used to assign values from one object to another
    Box& operator=(const Box& other) {                                                      // Assignment operator to handle assignment between two Box objects
        bool deepCopy = true;                                                               // Set to true for deep copy, false for shallow copy
        if (this != &other) {                                                               // Check for self-assignment
            delete BoxSize;                                                                 // Free the existing memory
            if (deepCopy) {
                BoxSize = new int(*(other.BoxSize));                                        // Perform deep copy
                cout << "Box Assigned with size " << *BoxSize << endl;                      // Message after deep copy assignment
            } else {
                BoxSize = other.BoxSize;                                                    // Perform shallow copy
                cout << "Box Assigned by shallow copy with size " << *BoxSize << endl;      // Message after shallow copy assignment
            }
        }
        return *this;                                                                       // Returning the current object
    }

    // Destructor
    ~Box() {                                                                                // Destructor to free dynamically allocated memory
        delete BoxSize;                                                                     // Free memory for BoxSize
        cout << "Box Destroyed" << endl;                                                    // Message when the box is destroyed
    }

```



```cpp
};

int main() {

    // Deep Copy Example (Copy Constructor with deepCopy = true)
    cout << "---- Deep Copy Example ----" << endl;
    Box box1(10);                                                                           // Will initialize with BoxSize 10
    Box box2(box1, true);                                                                   // Deep copy using the flag (true for deep copy)
    box2.setBoxSize(20);                                                                    // Modify box2
    cout << "Box1 Size: " << box1.getBoxSize() << endl;                                     // Should remain 10
    cout << "Box2 Size: " << box2.getBoxSize() << endl << endl;                             // Should be 20

    // Shallow Copy Example (Copy Constructor with deepCopy = false)
    cout << "---- Shallow Copy Example ----" << endl;
    Box box3(30);                                                                           // Will Initialize with BoxSize 30
    Box box4(box3, false);                                                                  // Shallow copy using the flag (false for shallow copy)
    box4.setBoxSize(40);                                                                    // Modify box4
    cout << "Box3 Size: " << box3.getBoxSize() << endl;                                     // Should change to 40 (shared memory)
    cout << "Box4 Size: " << box4.getBoxSize() << endl << endl;                             // Should also be 40 (shared memory)

    // Copy Assignment Example (Deep Copy)
    cout << "---- Copy Assignment Example (Deep Copy) ----" << endl;
    Box box5(50);
    box5 = box1;                                                                            // Deep copy using the assignment operator
    cout << "Box5 Size: " << box5.getBoxSize() << endl << endl;                             // Should be 10

```



```cpp
    // Copy Assignment Example (Shallow Copy)
    cout << "---- Copy Assignment Example (Shallow Copy) ----" << endl;
    Box box6(60);
    box6 = box3;                                                                            // Shallow copy using the assignment operator (box3 and box6 will share memory)
    box6.setBoxSize(70);                                                                    // Modify box6
    cout << "Box3 Size: " << box3.getBoxSize() << endl;                                     // Should be 70 (shared memory with box6)
    cout << "Box6 Size: " << box6.getBoxSize() << endl << endl;                             // Should be 70

    return 0;                                                                               // End of Program
}

```



```
---- Deep Copy Example ----
Box Created with size 10
Box1 (Initial) Size: 10
Box Created by copying with size 10
Box2 (After Deep Copy) Size: 10
Box1 Size (After Box2 Change): 10
Box2 Size (After Change): 20

---- Shallow Copy Example ----
Box Created with size 30
Box3 (Initial) Size: 30
Box Created by shallow copying with size 30
Box4 (After Shallow Copy) Size: 30
Box3 Size (After Box4 Change): 40
Box4 Size (After Change): 40

---- Copy Assignment Example (Deep Copy) ----
Box Created with size 50
Box Assigned with size 10
Box5 Size (After Deep Copy Assignment): 10
Box1 Size (After Change): 40
Box5 Size (After Changing Box1 Size): 10

---- Copy Assignment Example (Shallow Copy) ----
Box Created with size 60
Box Assigned by shallow copy with size 40
Box3 Size (After Shallow Copy Assignment): 70
Box6 Size (After Change): 70

Box Destroyed
Box Destroyed

--------------------------------
Process exited after 4.084 seconds with return value 3221226356
Press any key to continue . . .
```