OS Project Report

- Madhav Sood (IMT2021009)

1. Architecture:

The application consists of several files including:

- Client.c: client-side code
- Server.c: server-side code
- inventory.txt: file stores information about available products
- carts.txt: file stores carts for each user
- customers.txt: file stores registered customers (ndx file for carts.txt)
- headers.h: file for utility to store structs
- receipt.txt: file shows the receipt for the user after payment is done
- adminReceipt.txt: file used to store modifications made by admin

2. Customer Functionalities:

- Register themselves as a new customer
- View available products in the store
- Add a product to their cart
- Edit the quantity of a product already in their cart
- Buying all the products in their cart leads to receipt generation (log file)

3. Admin Functionalities:

- Add a product to the store
- Update the quantity available of an existing product
- Update the price of an existing product
- Delete an existing product from the store
- View all the products (inventory) in the store

4. Server:

The server's functionality is to provide the above-listed services to the customer and admin.

5. headers.h:

The following structs are present in the file:

- struct product - stores product_id, name, quantity, and price of a product
- struct cart - stores customer_id and corresponding products
- struct index - stores the customer id and their cart offset in the carts.txt file

6. Client.C Implementation:

Initially, socket setup takes place following which the client tries to establish a connection with the Server.
After the connection is established, the user will be prompted to select either the userMenu (customerMenu) or the adminMenu.
All following implementations involve communication between the client and server.

6a. Customer function Implementations:

1) The customer selects the option to register themselves and a new customer will be created with the appropriate customerID.
2) To view available products, the customer chooses the appropriate option and all available products are displayed.
3) To add a product - customer id, product id, and quantity are taken as inputs. The cart either gets updated or an error is displayed.
4) To edit an existing product - customer id, product id, and quantity are taken as inputs. The cart either gets updated or an error is displayed.
5) To buy all the products in the cart, the payment process involves displaying the user's cart, calculating the total amount, and presenting it to the user. The user is then prompted to enter the amount to pay, and if the correct amount is provided, a receipt is generated. Else, the user is asked to enter the amount again.

6b. Admin Function Implementations:

1) In order to add a new product, the user is prompted to provide the productID, name, available quantity, and price. Once the user provides this information, it is sent to the server which then attempts to add the product to the inventory. If successful, the product is added to the inventory, else an error message is displayed.
2) To modify a product's quantity or price, the user enters the product ID along with the new quantity or price. If no errors occur, the changes are made and a message indicating success is displayed. If errors occur, appropriate error messages are displayed.
   Note: Updated values are not visible in the cart. They are visible at the time of payment.
3) To remove a product from the inventory, we prompt the user for the product ID. If the ID is valid, the product is deleted, otherwise, an error message is displayed. Note: After deletion, the product may still be visible in the cart until the customer reaches the payment page, where the updated inventory is displayed.
4) To view inventory, the admin chooses the appropriate option the inventory is displayed.

7. Server.C Implementation:

Initially, socket setup takes place following which the server waits for a connection request from the client.
It then reads the input from the client about the type of user (customer or admin) and the service required by them.

Following are the implementation details:

- readLockProduct(): Sets a mandatory lock on the inventory.txt file
- writeLockProduct(): Recordlocking for a product in the inventory.txt file
- cartRecordLock(): Record locking for a particular cart in the carts.txt for either reading or writing
- unlock(): used to unlock any type of lock
- getCartOffset(): It searches for the given customer id in the customers.txt file and retrieves the corresponding cart offset. If the cart offset is found, it is returned by the function. Otherwise, the function returns -1.

- generateAdminReceipt(): This function is called when the admin exits the program. It writes the inventory to the adminReceipt.txt file, documenting all changes made by the admin.
- To view available products, iterate through the products after calling readLockProduct() and write the available products, along with their information to the client. (Same for customer and admin)
- To register as a customer, customerID is generated by calculating the max of previous customer ids + 1. (customer)
- To view the cart, customerID is passed to the server from the client, the cart offset is calculated using getCartOffset(), and the cart is passed to the client. (customer)
- To add a product to the cart of a customer, client receives inputs from the client such as customer ID, product ID, and quantity. It validates the customer ID and checks if the product ID is already present in the cart, and if the requested quantity is in stock. If all conditions are met, the product is added to the customer's cart with a limit of MAX PROD on the number of products that can be added. (customer)
- To edit the quantity of product in the cart, the server reads customer id, product id and new quantity from the client. Checks for valid productID, and whether the requested quantity can be added are made. If all conditions are met, the quantity of the product is modified. (customer)
- To buy all products in the cart (payment), changes in quantity are not reflected in the inventory. The customer is shown the current stock of the products in their cart, and the payment amount is calculated accordingly. After the customer pays the correct amount, changes are recorded in the inventory, the cart is cleared, and the receipt is generated. (customer)
- To add a new product to the inventory, appropriate input is taken from the client. Checks for duplicate products are made. If checks are successful, the product is added. The log statement is written to the adminReceipt.txt file. (admin)
- To update the price/quantity of a product, appropriate input is taken from the client. Checks for valid product ID are made. If checks are successful, then modifications are made to the product’s quantity/price. The log statement is written to the adminReceipt.txt file. (admin)
- To delete an existing product from the inventory, appropriate input is taken from the client. Checks for valid product ID are made. If checks are successful, then product is deleted from the inventory. The log statement is written to the adminReceipt.txt file. (admin)

8. Instructions to Run the Code:

1. Code must be run in 2 terminal windows
2. In one terminal window, run the following commands to start up the server side:
    a. gcc server.c -o server
    b. ./server
3. In another terminal window, run the following commands to start up the client side:
    a. gcc client.c -o client
    b. ./client
4. Now proceed with the user/admin menus from the client side.

9. Some OS Concepts Used:

1. File Locking:

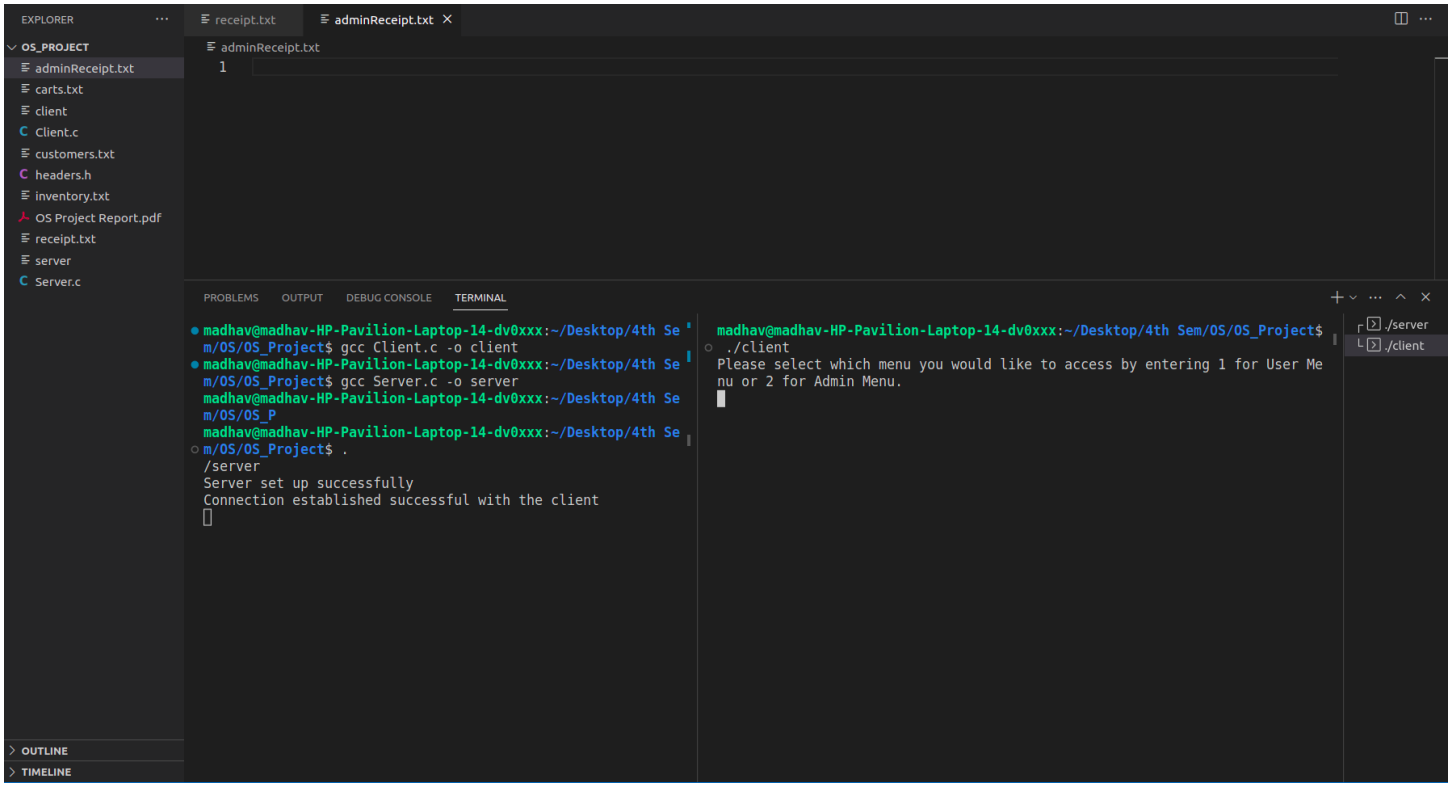
a. To read/write a cart, we use record locking.
b. To read the products in the inventory.txt, we lock the whole file for reading
c. To update the products in the inventory.txt, we perform record locking (write lock here) on the products to be updated

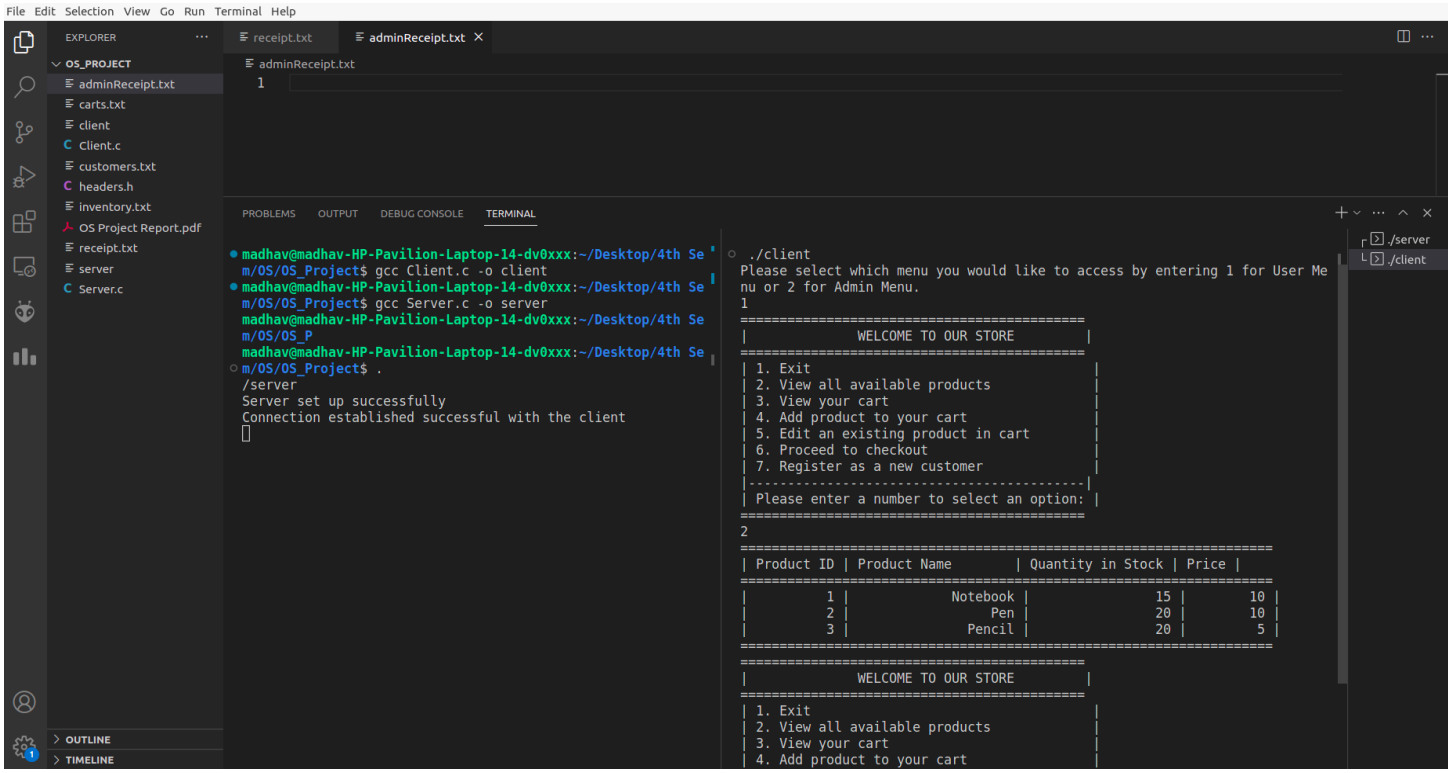
2. Socket Programming:

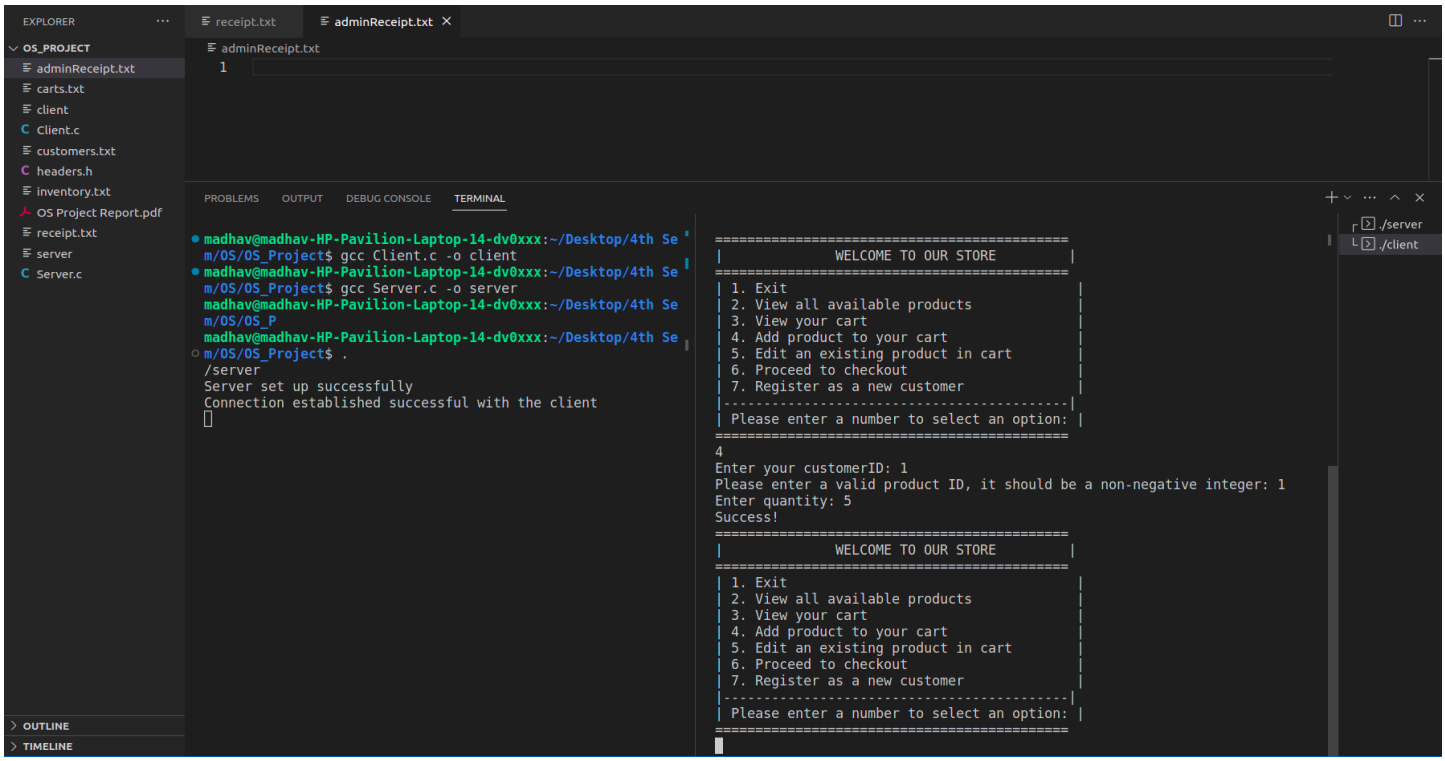
a. It is used to implement client/server architecture.
b. Concurrent server is implemented using fork() system call.

3. File Handling

9. Code Screenshots:


EXPLORER
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
receipt.txt
adminReceipt.txt
adminReceipt.txt
1
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$
./client
Please select which menu you would like to access by entering 1 for User Me
nu or 2 for Admin Menu.
./server
./client
OUTLINE
TIMELINE


File Edit Selection View Go Run Terminal Help
EXPLORER
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
receipt.txt
adminReceipt.txt
adminReceipt.txt
1
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
./client
Please select which menu you would like to access by entering 1 for User Me
nu or 2 for Admin Menu.
1
WELCOME TO OUR STORE
1. Exit
2. View all available products
3. View your cart
4. Add product to your cart
5. Edit an existing product in cart
6. Proceed to checkout
7. Register as a new customer
Please enter a number to select an option:
2
Product ID | Product Name | Quantity in Stock | Price
1 | Notebook | 15 | 10
2 | Pen | 20 | 10
3 | Pencil | 20 | 5
WELCOME TO OUR STORE
1. Exit
2. View all available products
3. View your cart
4. Add product to your cart
./server
./client
OUTLINE
TIMELINE


EXPLORER
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receipt.txt
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Server.c
OUTLINE
TIMELINE
receipt.txt
adminReceipt.txt
adminReceipt.txt
1
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
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madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
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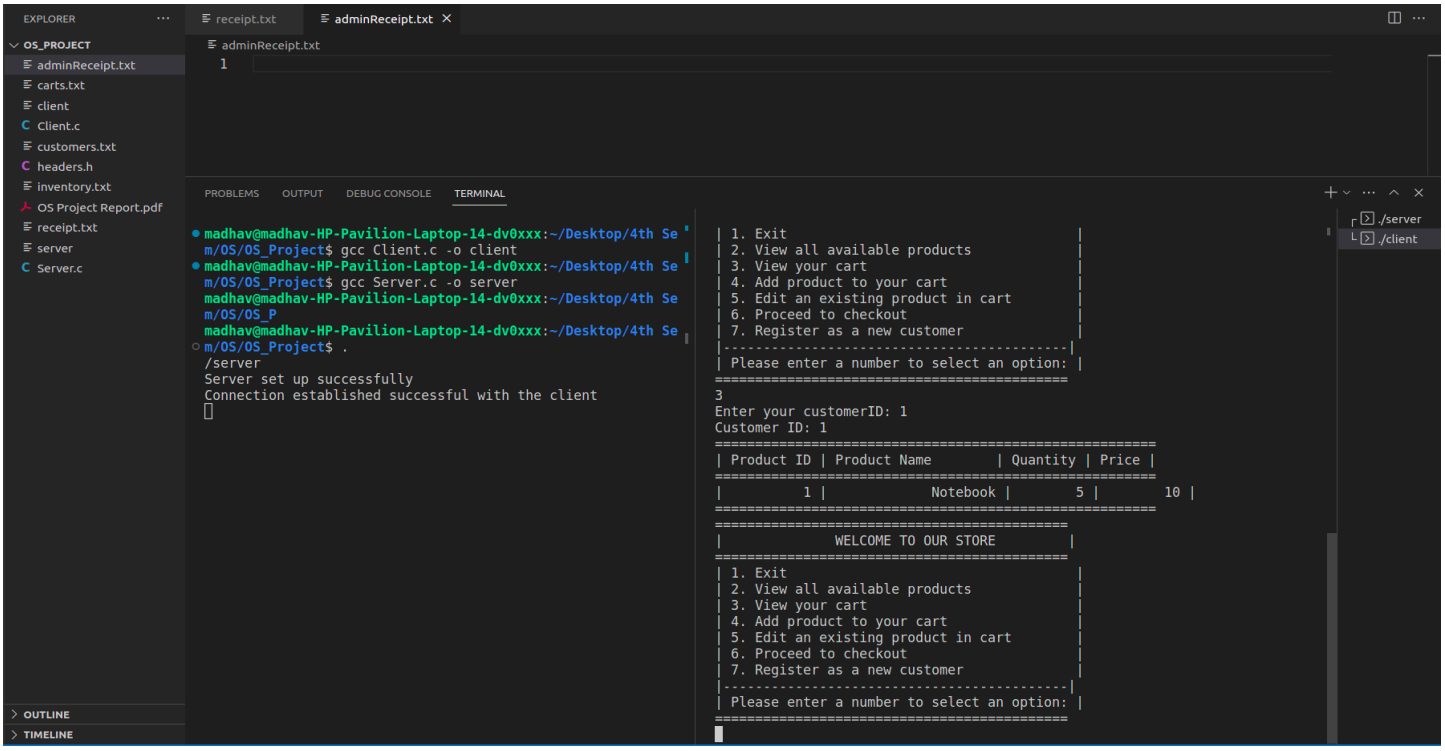
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
| WELCOME TO OUR STORE |
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
4
Enter your customerID: 1
Please enter a valid product ID, it should be a non-negative integer: 1
Enter quantity: 5
Success!
| WELCOME TO OUR STORE |
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
./server
./client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receipt.txt
adminReceipt.txt
adminReceipt.txt
1
PROBLEMS
OUTPUT
DEBUG CONSOLE
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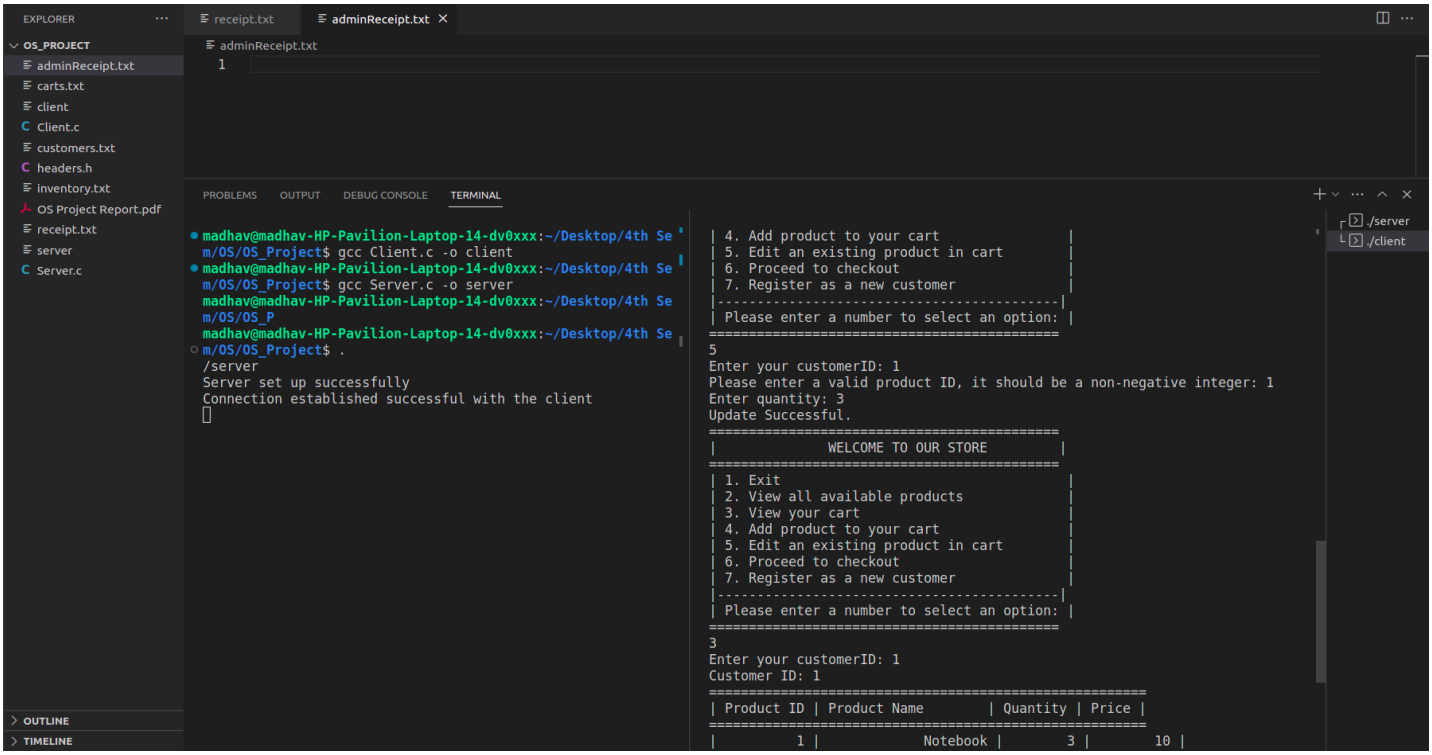
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
3
Enter your customerID: 1
Customer ID: 1
| Product ID | Product Name | Quantity | Price |
| 1 | Notebook | 5 | 10 |
| WELCOME TO OUR STORE |
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
./server
./client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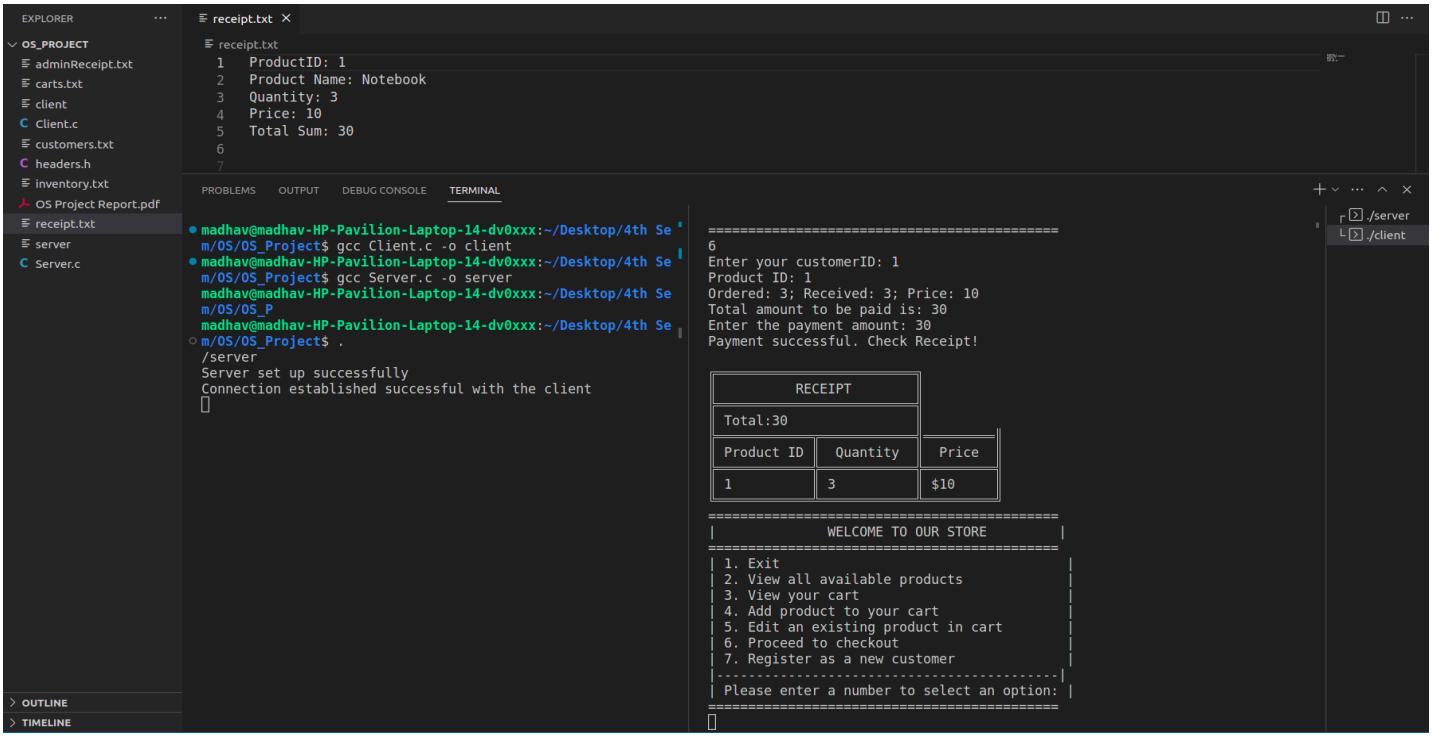
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
5
Enter your customerID: 1
Please enter a valid product ID, it should be a non-negative integer: 1
Enter quantity: 3
Update Successful.
| WELCOME TO OUR STORE |
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
3
Enter your customerID: 1
Customer ID: 1
| Product ID | Product Name | Quantity | Price |
| 1 | Notebook | 3 | 10 |
./server
./client


EXPLORER
receipt.txt
1 ProductID: 1
2 Product Name: Notebook
3 Quantity: 3
4 Price: 10
5 Total Sum: 30
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
OUTLINE
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PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
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m/OS/OS_Project$ gcc Client.c -o client
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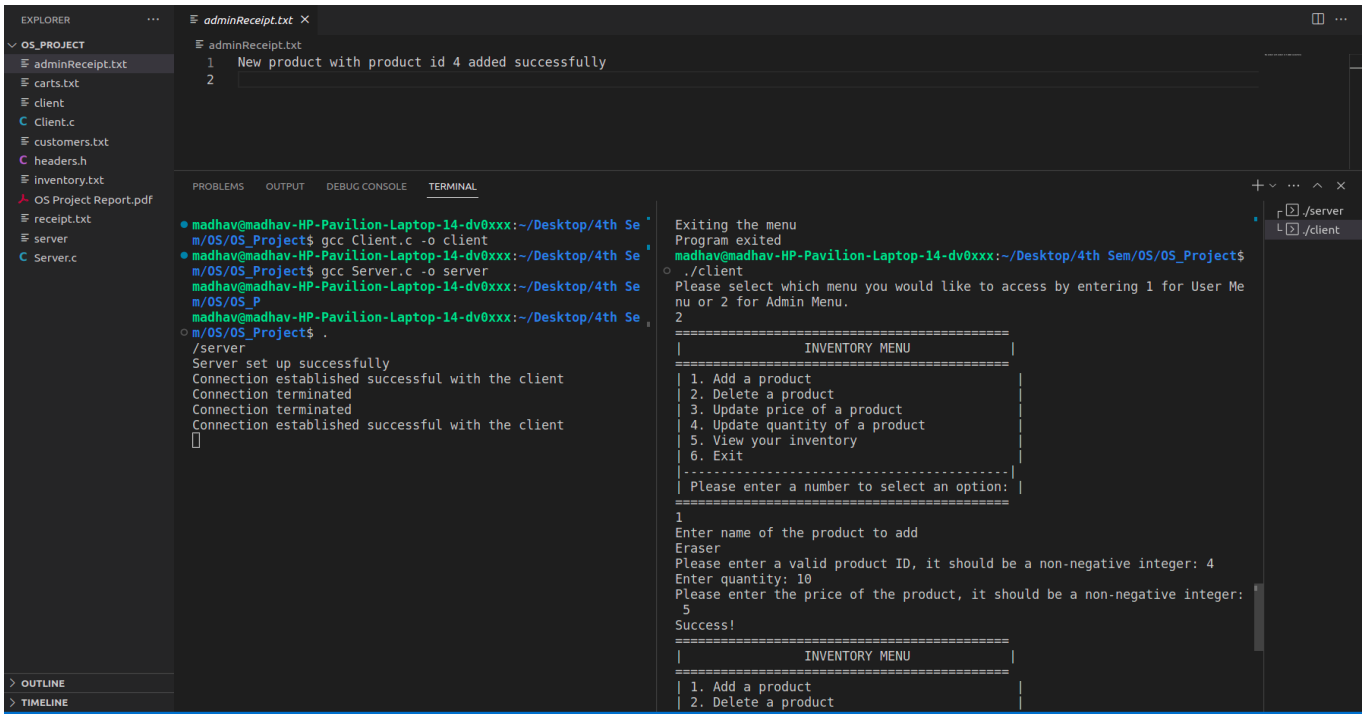
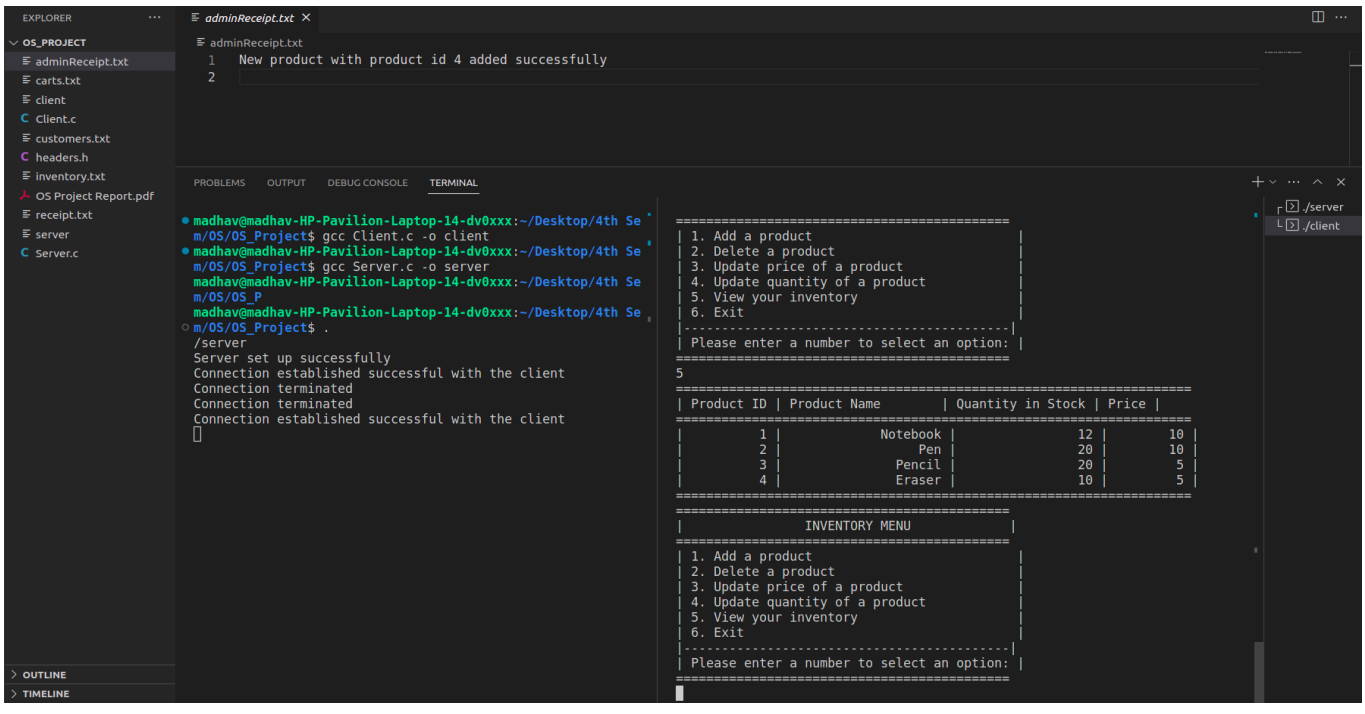
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
6
Enter your customerID: 1
Product ID: 1
Ordered: 3; Received: 3; Price: 10
Total amount to be paid is: 30
Enter the payment amount: 30
Payment successful. Check Receipt!
RECEIPT
Total:30
Product ID | Quantity | Price
1 | 3 | $10
| WELCOME TO OUR STORE |
| 1. Exit |
| 2. View all available products |
| 3. View your cart |
| 4. Add product to your cart |
| 5. Edit an existing product in cart |
| 6. Proceed to checkout |
| 7. Register as a new customer |
| Please enter a number to select an option: |
./server
./client


EXPLORER
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
OUTLINE
TIMELINE
adminReceipt.txt
1 New product with product id 4 added successfully
2
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
Exiting the menu
Program exited
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$
./client
Please select which menu you would like to access by entering 1 for User Me
nu or 2 for Admin Menu.
2
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
1
Enter name of the product to add
Eraser
Please enter a valid product ID, it should be a non-negative integer: 4
Enter quantity: 10
Please enter the price of the product, it should be a non-negative integer:
5
Success!
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
./server
./client


EXPLORER
OS_PROJECT
adminReceipt.txt
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customers.txt
headers.h
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OS Project Report.pdf
receipt.txt
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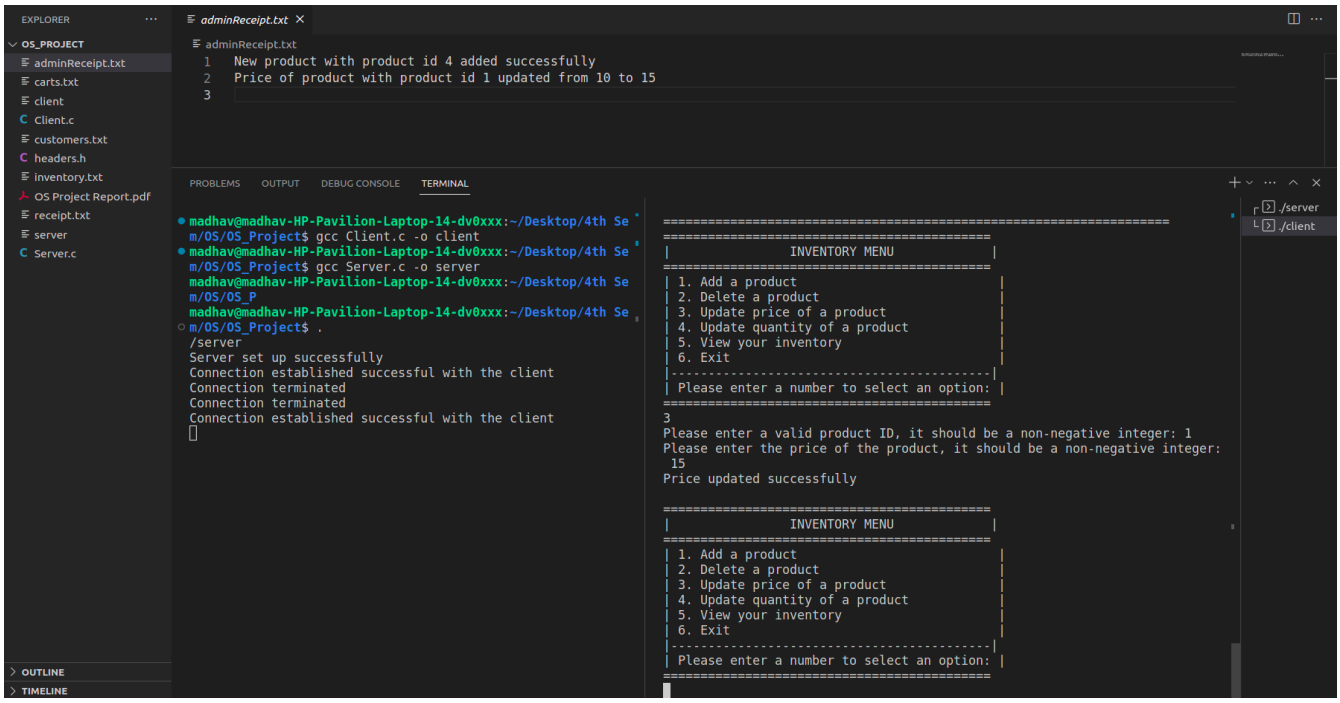
Server.c
OUTLINE
TIMELINE
adminReceipt.txt
1 New product with product id 4 added successfully
2
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
5
Product ID	Product Name	Quantity in Stock	Price
1	Notebook	12	10
2	Pen	20	10
3	Pencil	20	5
4	Eraser	10	5
INVENTORY MENU
1. Add a product
2. Delete a product
3. Update price of a product
4. Update quantity of a product
5. View your inventory
6. Exit
Please enter a number to select an option:
./server
./client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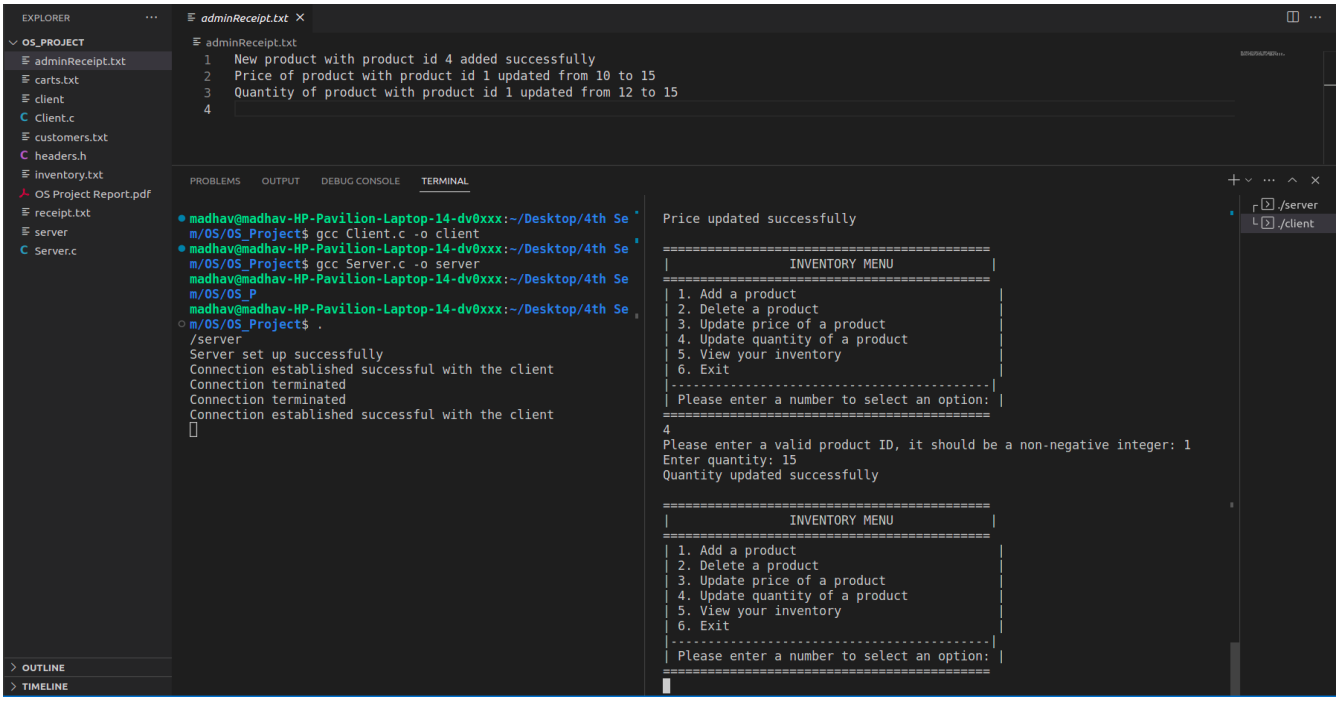
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
OUTLINE
TIMELINE
adminReceipt.txt
1 New product with product id 4 added successfully
2 Price of product with product id 1 updated from 10 to 15
3
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
3
Please enter a valid product ID, it should be a non-negative integer: 1
Please enter the price of the product, it should be a non-negative integer:
15
Price updated successfully
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
./server
./client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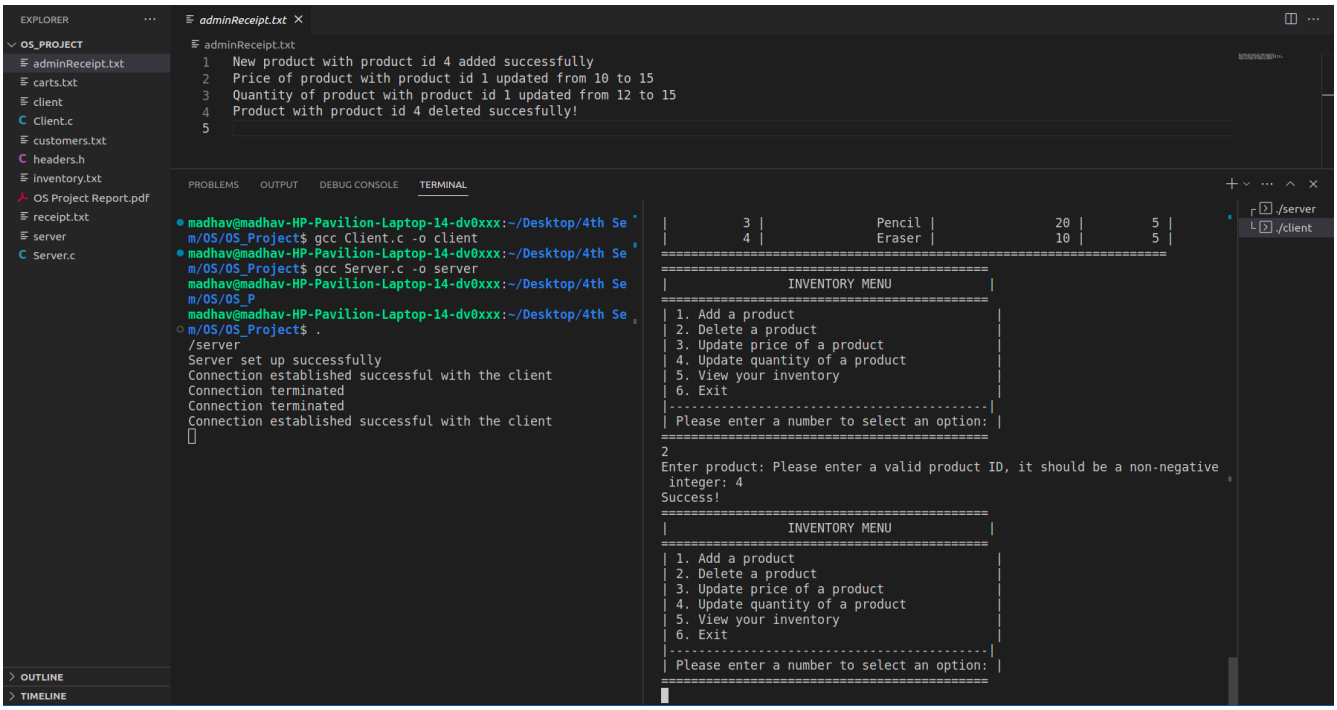
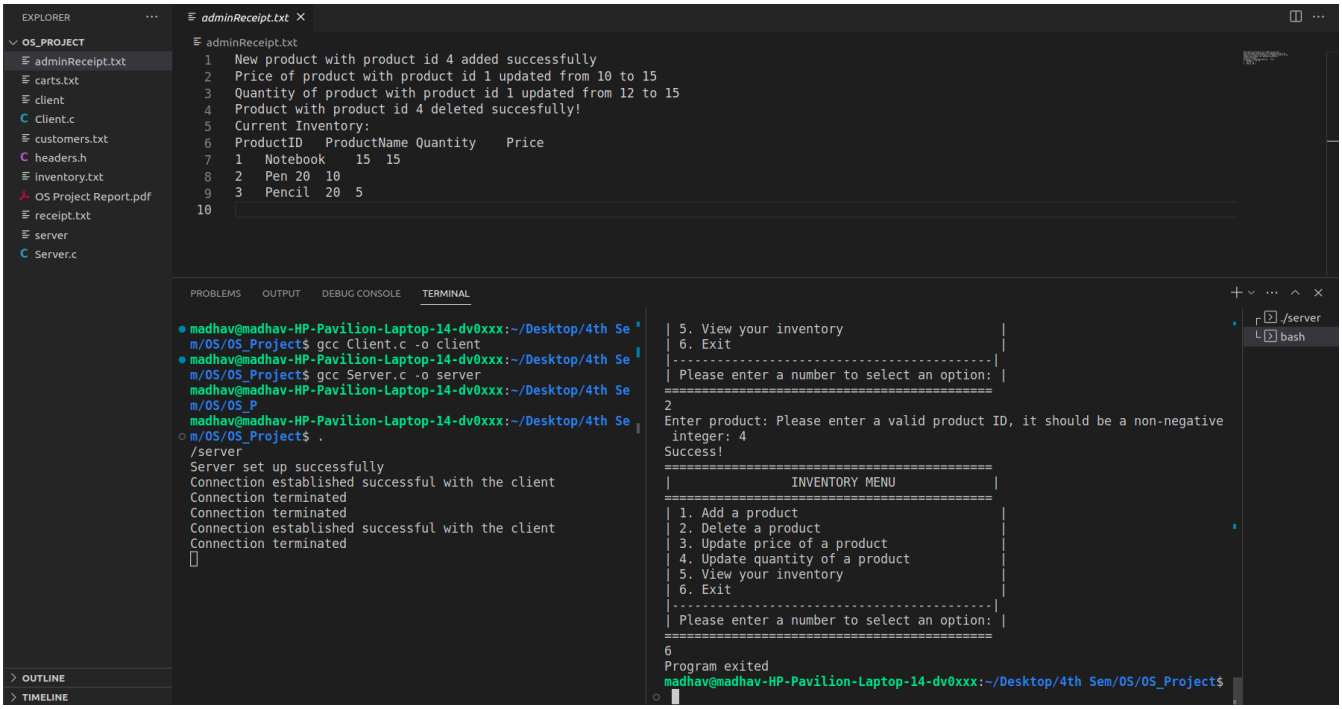
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
OUTLINE
TIMELINE
adminReceipt.txt
1 New product with product id 4 added successfully
2 Price of product with product id 1 updated from 10 to 15
3 Quantity of product with product id 1 updated from 12 to 15
4
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Se
m/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
Price updated successfully
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
4
Please enter a valid product ID, it should be a non-negative integer: 1
Enter quantity: 15
Quantity updated successfully
| INVENTORY MENU |
| 1. Add a product |
| 2. Delete a product |
| 3. Update price of a product |
| 4. Update quantity of a product |
| 5. View your inventory |
| 6. Exit |
| Please enter a number to select an option: |
./server
./client


EXPLORER
adminReceipt.txt
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
1 New product with product id 4 added successfully
2 Price of product with product id 1 updated from 10 to 15
3 Quantity of product with product id 1 updated from 12 to 15
4 Product with product id 4 deleted succesfully!
5
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
| 3 | Pencil | 20 | 5 |
| 4 | Eraser | 10 | 5 |
INVENTORY MENU
1. Add a product
2. Delete a product
3. Update price of a product
4. Update quantity of a product
5. View your inventory
6. Exit
Please enter a number to select an option:
2
Enter product: Please enter a valid product ID, it should be a non-negative integer: 4
Success!
INVENTORY MENU
1. Add a product
2. Delete a product
3. Update price of a product
4. Update quantity of a product
5. View your inventory
6. Exit
Please enter a number to select an option:
./server
./client
OUTLINE
TIMELINE


EXPLORER
adminReceipt.txt
OS_PROJECT
adminReceipt.txt
carts.txt
client
Client.c
customers.txt
headers.h
inventory.txt
OS Project Report.pdf
receipt.txt
server
Server.c
1 New product with product id 4 added successfully
2 Price of product with product id 1 updated from 10 to 15
3 Quantity of product with product id 1 updated from 12 to 15
4 Product with product id 4 deleted succesfully!
5 Current Inventory:
6 ProductID ProductName Quantity Price
7 1 Notebook 15 15
8 2 Pen 20 10
9 3 Pencil 20 5
10
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$ gcc Client.c -o client
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$ gcc Server.c -o server
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_P
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$.
/server
Server set up successfully
Connection established successful with the client
Connection terminated
Connection terminated
Connection established successful with the client
Connection terminated
| 5. View your inventory |
| 6. Exit |
Please enter a number to select an option:
2
Enter product: Please enter a valid product ID, it should be a non-negative integer: 4
Success!
INVENTORY MENU
1. Add a product
2. Delete a product
3. Update price of a product
4. Update quantity of a product
5. View your inventory
6. Exit
Please enter a number to select an option:
6
Program exited
madhav@madhav-HP-Pavilion-Laptop-14-dv0xxx:~/Desktop/4th Sem/OS/OS_Project$
./server
bash
OUTLINE
TIMELINE