BangBangBank Documentation

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System Introduction

1. Introduction

In the banking and finance industry, where transaction speed and data integrity are paramount, leveraging assembly language can lead to optimized solutions. Assembly language programming offers a unique opportunity to develop high-performance applications by providing direct control over hardware resources. Therefore, we propose to build a user-friendly, robust and secure banking system using MASM 32-bit assembly language.

2. Objectives

- Performance Optimization: Develop critical components that require high-speed processing, such as transaction validation and real-time data analysis.
- System Integration: Create interfaces with existing banking systems to enhance functionality without compromising security.
- Security Enhancement: Implement low-level security features to protect sensitive financial data during processing.

3. Justification

While high-level languages are prevalent, assembly language remains relevant for tasks demanding precise hardware interaction and performance. In finance, certain operations benefit from the efficiency that assembly language offers. For instance, some financial institutions still utilize assembly language for specific applications due to its reliability and performance

4. Methodology

- **System Analysis**: Identify performance-critical modules within the banking system that could benefit from assembly language optimization.
- **Development**: Write 32-bit assembly code targeting processors using MASM with Visual Studio 2022 and Irvine32 Library.
- **Integration**: Ensure seamless communication between assembly modules and Windows console output through well-defined interfaces and API function calls.
- **Testing**: Perform rigorous testing to validate functionality, performance gains, and security measures.

5. Expected Outcomes

- **Enhanced Performance**: Achieve measurable improvements in transaction processing speeds and system responsiveness.
- **System Compatibility**: Ensure that assembly modules integrate smoothly with existing banking software and hardware.
- **Security Improvements**: Provide robust protection against potential security threats through low-level security implementations.

System Functionalities / Modules

The program will include the following functionalities:

1. Security login

   Functionality: Authenticate and authorize the user to ensure the security of the banking system. It prevents unauthorized access to the banking system.

   Approach:

   - Utilizes simple data encryption with XOR operation
   - Uses different encryption key for different users
   - Stores the username and password in hash

2. Process deposit

   Functionality: Process the money deposited by user's into their account. The user can deposits money via bank teller or automated teller machine (ATM).

   Mathematical formula:

   New Balance = Previous Balance + Deposit Amount

3. Process transaction / transfer

   Functionality: Process the transaction requested by user, to allow them to transfer money to others or their own bank accounts. It also ensures that the transfer amount and recipient are correct.

   Mathematical formula:

   New Sender Balance = **Previous Sender Balance - Transfer Amount**

   New Receiver Balance = **Previous Receiver Balance** + **Transfer Amount**

4. OTP generation and timeout

   Functionality: One-Time Passwords (OTPs) are temporary, single-use codes designed to enhance security by ensuring that each authentication attempt is unique. They prevent unauthorized access by making intercepted passwords useless for future authentication.

   Mathematical formula:

   Elapsed Time = **Current Time - Start Time**

Elapsed Time in Seconds = Elapsed Time / 1000

Where time is obtained with GetMseconds function

5. Formatting date and time

   Functionality: Accurate date and time formatting are essential for various banking operations, such as transaction timestamps, interest accrual and OTP validity periods.

   Approach: Utilize Window APIs and system functions to handle date and time operations, ensuring correct handling of time zones, daylight saving changes and leap years.

   Mathematical formula:

   Date = GetLocalTime

   Day = EDX = EAX / 10

   Month = EDX = EAX / 10

   Year 1st Digit = EDX = EAX / 1000

   Year 2nd Digit = EDX = EAX / 100

   Year 3rd Digit = EDX = EAX / 10

   Year 4th Digit = EDX

6. Data persistence with file system

   Functionality: File system preserves the data and changes from each session into files to ensure its availability across system restarts and crashes. In the context of a banking system, this includes securely storing customer account information, transaction histories and other critical data.

   Approach: Implement secure storage mechanisms that protect data integrity and confidentiality. This includes using data encryption with XOR hashing and access controls.

7. Calculate total credit and total debit

   Functionality: Determine the total credit and total debit of a customer's account.

   Mathematical formula:

   Total Credit = Σ(**Deposits**)

   Total Debit = Σ(**Withdrawals**)

8. Calculate interest

Functionality: Compute interest earned on a customer's account based on the applicable interest rate and time period.

Mathematical formula:

Interest = (Balance * 3 + 50) /100

9. Calculate remaining free transactions

   Functionality: Track the availability of free transactions a user has left. After exceeding the limit,the system will charge fees for additional transactions.

   Mathematical formula:

   Remaining Free Transactions = **Initial Free Transactions -** Σ(**Transactions Made**)

10. Input validation

    Functionality: Determine whether the input is valid or invalid. Shows an error message to the user when the input is invalid, suggest recoverability options and prompts for a new input.

    Approach:

    - Define acceptable input formats and ranges for each data field (account numbers, transaction amounts etc.).
    - Implement checks to validate that inputs conform to these definitions.
    - Provide error messages and prompts for re-entry when invalid inputs are detected.

11. Provide avenues for user to input values for program processing

    Functionality: Enables users to enter necessary data through forms and keyboard input for program execution and processing.

12. Produce account monthly statement

    Functionality: Generates a detailed monthly statement summarizing account activities, transactions, and balances for user review.

    Approach:

    - Aggregate all transactions and activities for the month.

- Calculate the opening and closing balances.
- Apply interest calculations as applicable.
- Format the information into a readable statement for the user.

Mathematical formula:

Average Account Balance = (Sum of Daily Ending Balances) / (Number of Days in Billing Period)

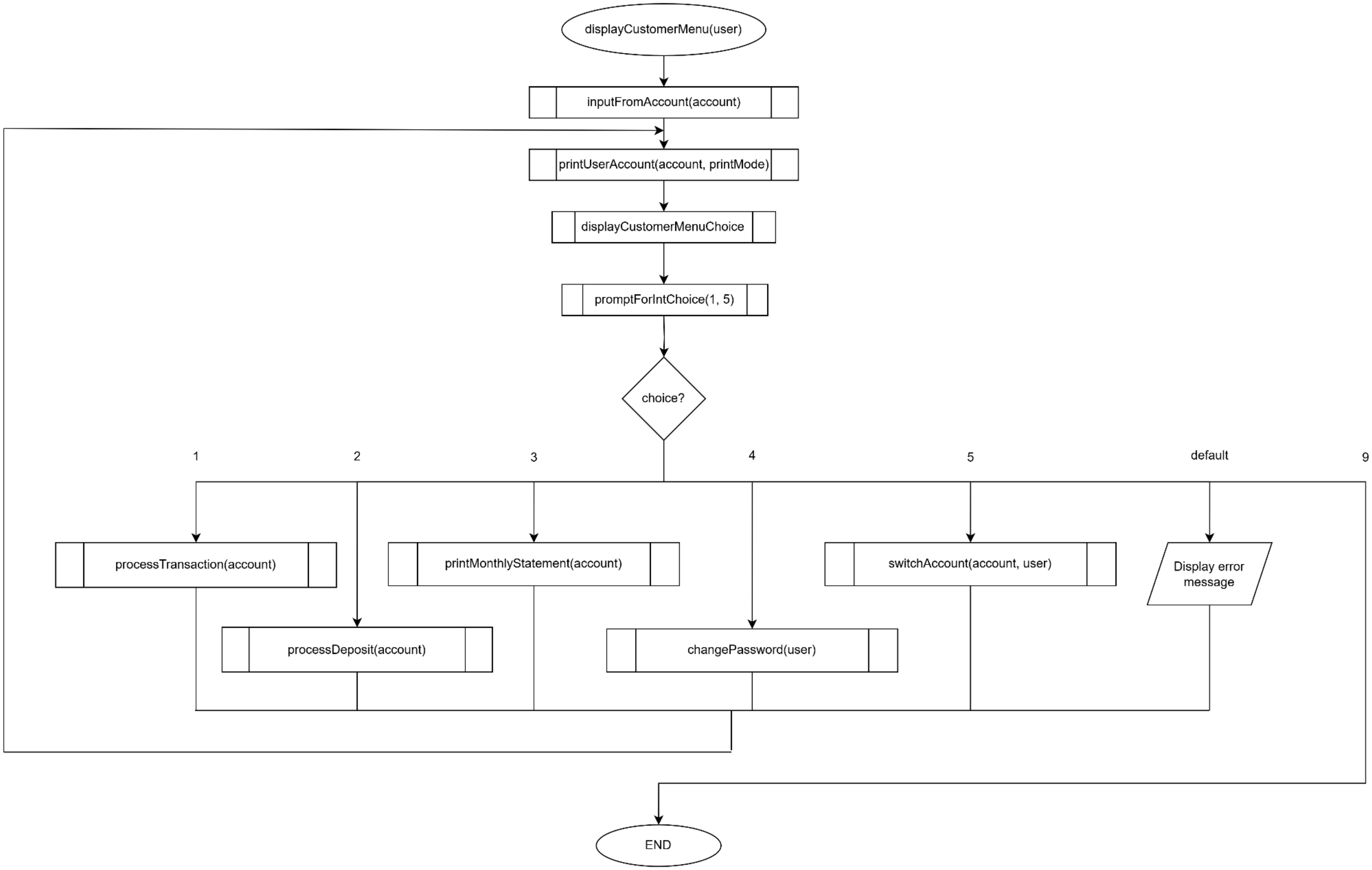
13. Logout

Functionality: Ends the user session securely, ensuring account data protection and preventing unauthorized access.

Approach:

- Terminate active sessions upon user logout.
- Ensure that session data is not accessible after logout.
- Implement timeouts for inactivity to automatically log out users after a specified period.

Main Flowchart


displayCustomerMenu(user)
inputFromAccount(account)
printUserAccount(account, printMode)
displayCustomerMenuChoice
promptForIntChoice(1, 5)
choice?
1
2
3
4
5
default
9
processTransaction(account)
printMonthlyStatement(account)
switchAccount(account, user)
Display error message
processDeposit(account)
changePassword(user)
END

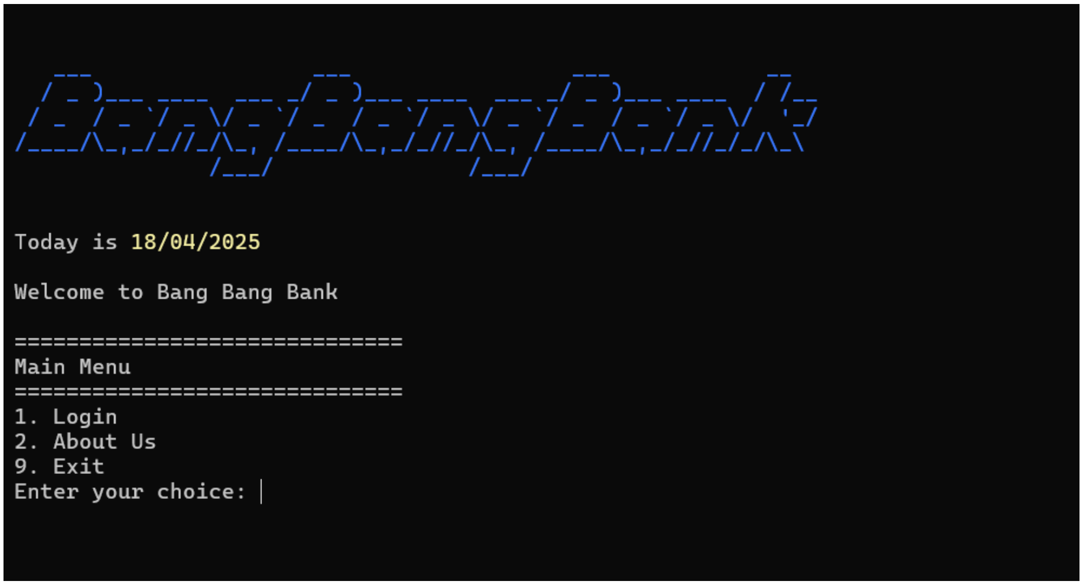
User Manual

File name	Involved files	Description
Main.asm	BangBangBank.inc printString.asm displayLogo.asm displayMainMenu.asm utility.asm	● Set console title ● Call program driver ● Display exit message
displayMainMenu.asm	BangBangBank.inc printString.asm helper.asm (Line 8 - 229) setTxtColor.asm displayLogo.asm promptForIntChoice.asm login.asm aboutUs.asm	● Print logo ● Print menu design ● Prompt menu choice
login.asm	BangBangBank.inc printString.asm utility.asm promptForUsername.asm promptForPassword.asm inputFromFile.asm validateLoginTime.asm validatePassword.asm updateFile.asm displayCustomerMenu.asm helper.asm (Line 273 - 463)	● Print login design ● Prompt for username ● Prompt for password ● Validate login time (> 24 hours if account is locked) ● Validate Password ● Clear loginAttempt and firstLoginAttemptTimestamp if password is valid ● Update loginAttempt and firstLoginAttemptTimestamp if password is invalid ● Clear user credential structure on logout
displayCustomerMenu.asm	BangBangBank.inc utility.asm helper.asm (Line 8 - 229) inputFromAccount.asm checkInterest.asm displayLogo.asm printString.asm setTxtColor.asm printUserAccount.asm promptForIntChoice.asm processTransaction.asm processDeposit.asm printMonthlyStatement.asm changePassword.asm switchAccount.asm	● Check Interest (Check user apply interest date is more than 1 year or not, if more than 1 year, apply interest to the user, if not display no interest) ● Print login design ● Print customer menu design ● Prompt customer menu choice
processTransa	BangBangBank.inc	● Print process transaction page title

ction.asm	utility.asm helper.asm printString.asm promptForRecipientAccNo.asm validateRecipientAcc.asm inputFromFile.asm promptForTransactionAmount.asm validateTransactionAmount.asm promptForTransactionDetail.asm generateTransactionId.asm setTxtColor.asm promptForIntChoice.asm generateOTP.asm verifyOTP.asm updateFile.asm	● Prompt for recipient account number ● Validate recipient account number ● Input data from account log by account number ● Prompt for transaction amount ● Validate transaction amount (account’s balance > transaction amount) ● If not sufficient balance, display error message and skip to done ● Prompt for transaction detail ● If empty input, use default message ● Display transaction information ● Show extra fee charge message (if fee flag = 1) ● Prompt for transaction confirmation ● Generate OTP ● Prompt and verify OTP (> 60 seconds or failure > 3, display transaction fail) ● Update user and recipient account ● Store transaction information
processDeposit.asm	BangBangBank.inc printString.asm helper.asm promptForTransactionMethod.asm promptForTransactionAmount.asm promptForTransactionDetail.asm promptForIntChoice.asm setTxtColor.asm promptForPassword.asm validatePassword.asm updateFile.asm	● Print process deposit page title ● Prompt for transaction method ● Validate input transaction method (if input = 9, skip to done) ● Prompt for transaction amount ● Validate transaction amount ● Prompt for transaction detail ● Display transaction information ● Prompt for transaction confirmation ● Prompt for user’s PIN ● Validate user’s PIN ● Update user account ● Store transaction information
printMonthlyStatement.asm	BangBangBank.inc printString.asm setTxtColor.asm inputFile.asm helper.asm utility.asm calculation.asm	● Print monthly statement page header ● Print account details ● Input from transaction file ● Print transactions’ information ● Count and print totalTransfer ● Count and print totalDeposit ● Count totalBalance (by each date last balance value) ● Count and display averageDailyBalance (totalBalance / DateCount) ● Count averageDailySpent (totalTransfer / DateCount) ● Print reminderNotes ● Prompt and get selectedMonth (null value then return CustomerMenu) ● Validate format of selectedMonth ● Rerun the program for the selectedMonth

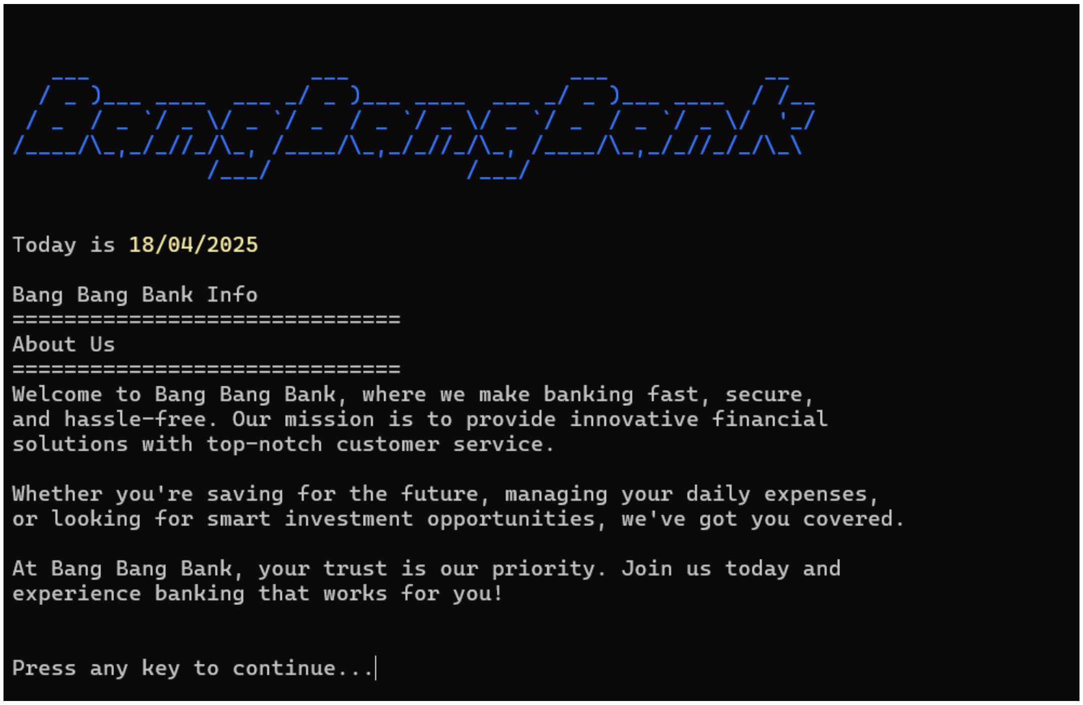
changePassword.asm	BangBangBank.inc printString.asm setTxtColor.asm promptForPassword.asm validatePasswordComplexity.asm updateFile.asm helper.asm	● Print change password design ● Prompt and get current password ● Prompt and get new password ● Compare new password with current password (Cannot same with current password) ● Validate new password complexity ● Prompt and get confirm password ● Compare confirm password with new password (Must same with new password)
switchAccount.asm	BangBangBank.inc printString.asm helper.asm utility.asm promptForPassword.asm inputFile.asm validatePassword.asm	● Check if user has any other account ● Display a message to inform the user they have no other account if there's no other account, return to customer menu ● Display a list of available account and related information if there's other account ● Prompt for account choice ● Validate PIN number ● Switch account if PIN number is valid ● Display an error message if PIN number is invalid ● Return to customer menu

<table>
<tr><td>Pages</td><td>Expected output</td></tr>
<tr><td>Main Menu</td><td>



```
   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


Today is 18/04/2025

Welcome to Bang Bang Bank

==============================
Main Menu
==============================
1. Login
2. About Us
9. Exit
Enter your choice:
```

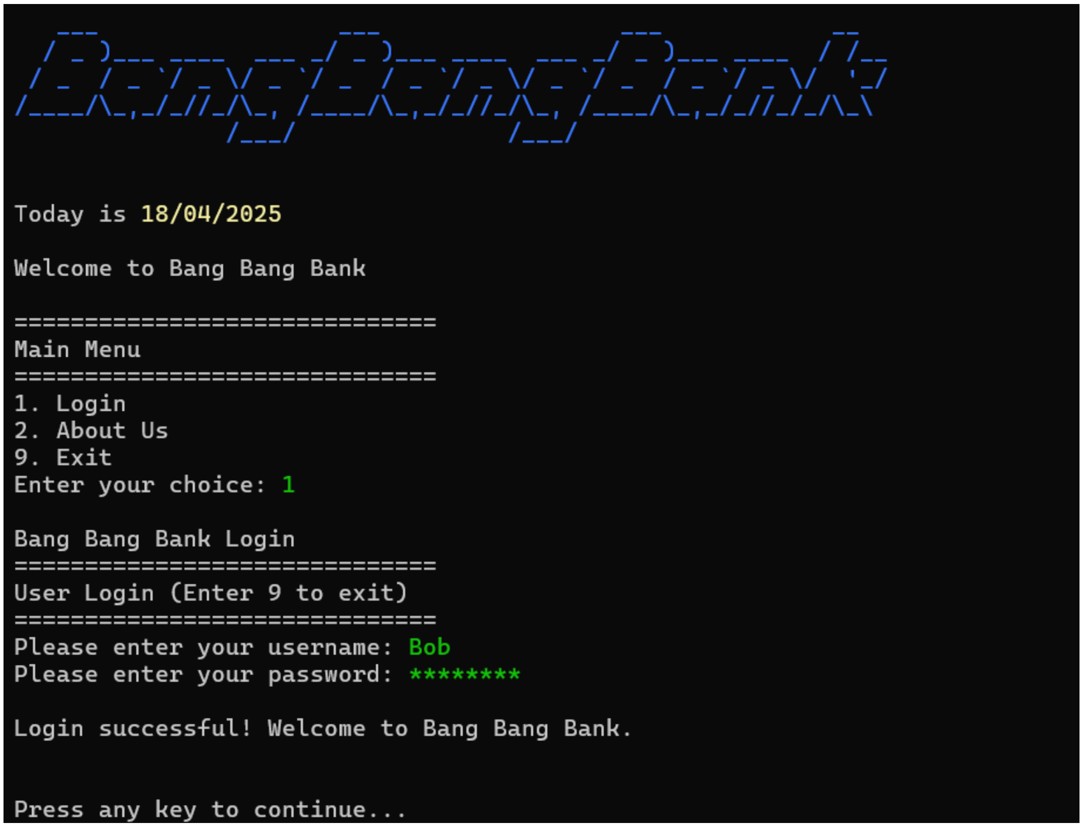
</td></tr>
<tr><td>About Us</td><td>



```
   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


Today is 18/04/2025

Bang Bang Bank Info
==============================
About Us
==============================
Welcome to Bang Bang Bank, where we make banking fast, secure,
and hassle-free. Our mission is to provide innovative financial
solutions with top-notch customer service.

Whether you're saving for the future, managing your daily expenses,
or looking for smart investment opportunities, we've got you covered.

At Bang Bang Bank, your trust is our priority. Join us today and
experience banking that works for you!


Press any key to continue...
```

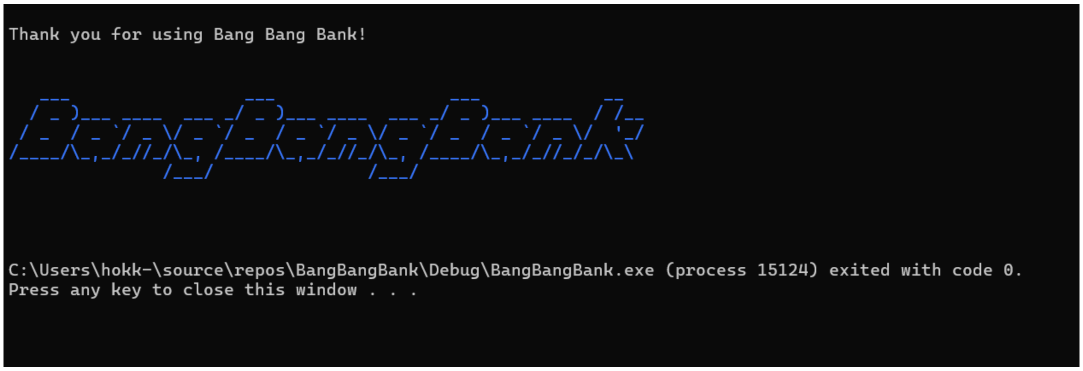
</td></tr>
</table>

Login



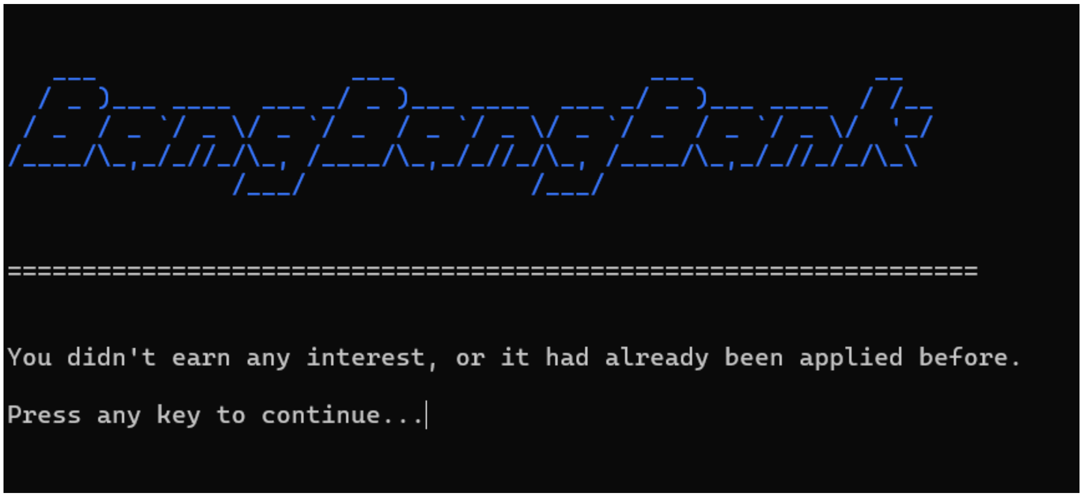
```
   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


Today is 18/04/2025

Welcome to Bang Bang Bank

==============================
Main Menu
==============================
1. Login
2. About Us
9. Exit
Enter your choice: 1

Bang Bang Bank Login
==============================
User Login (Enter 9 to exit)
==============================
Please enter your username: Bob
Please enter your password: ********

Login successful! Welcome to Bang Bang Bank.


Press any key to continue...
```

Exit

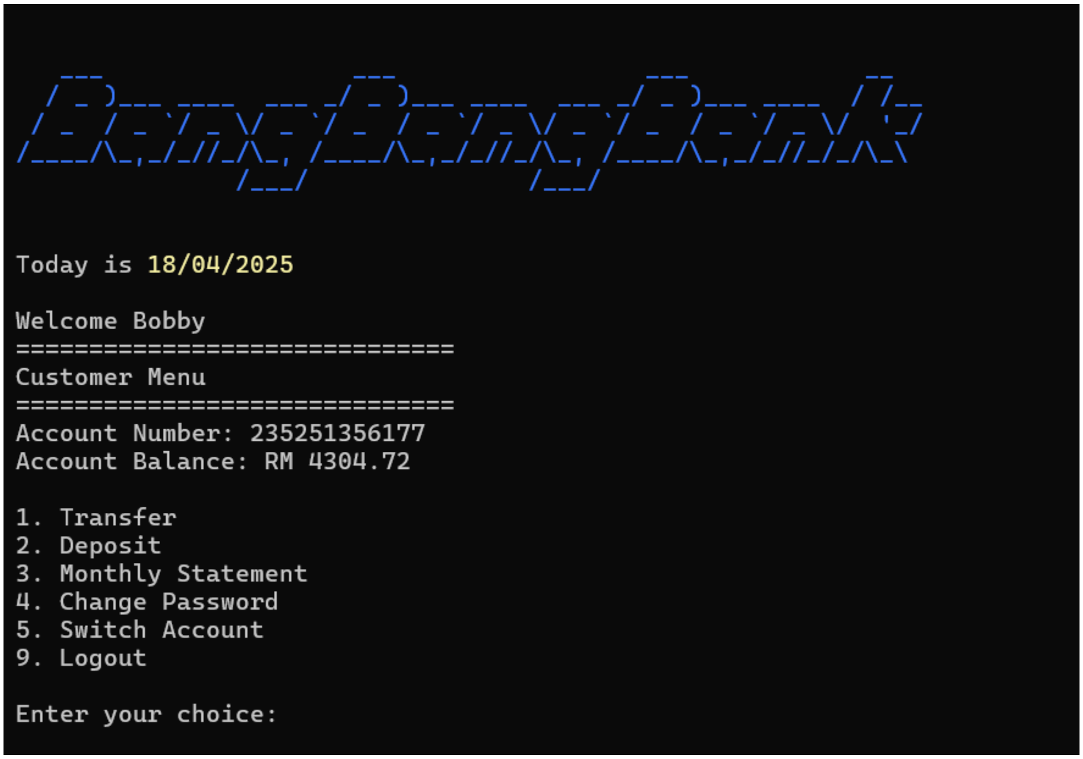
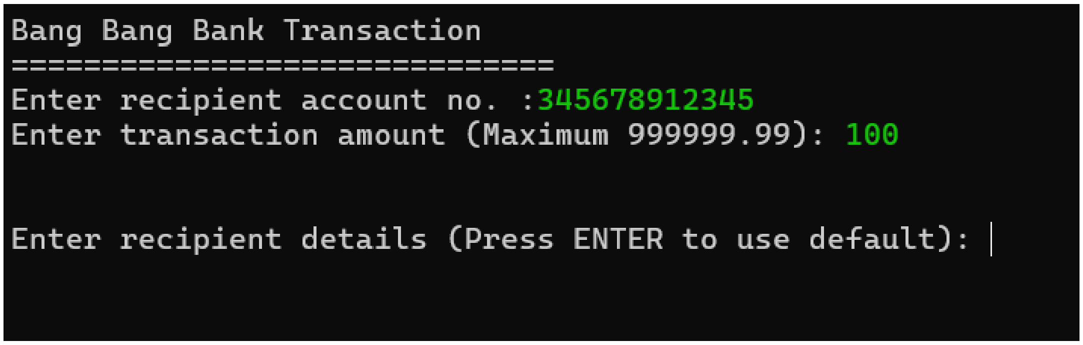
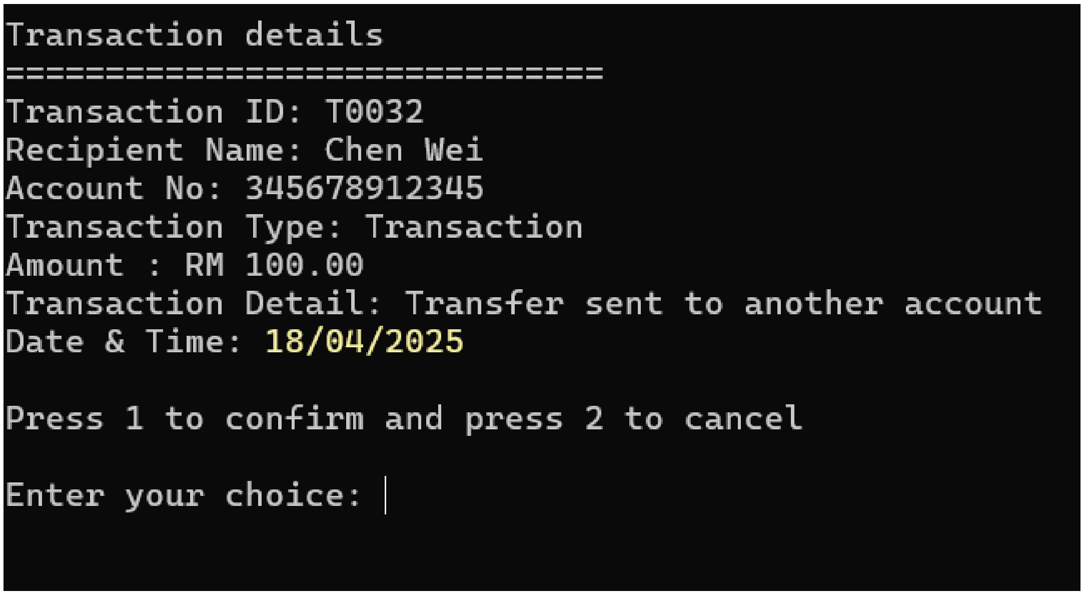


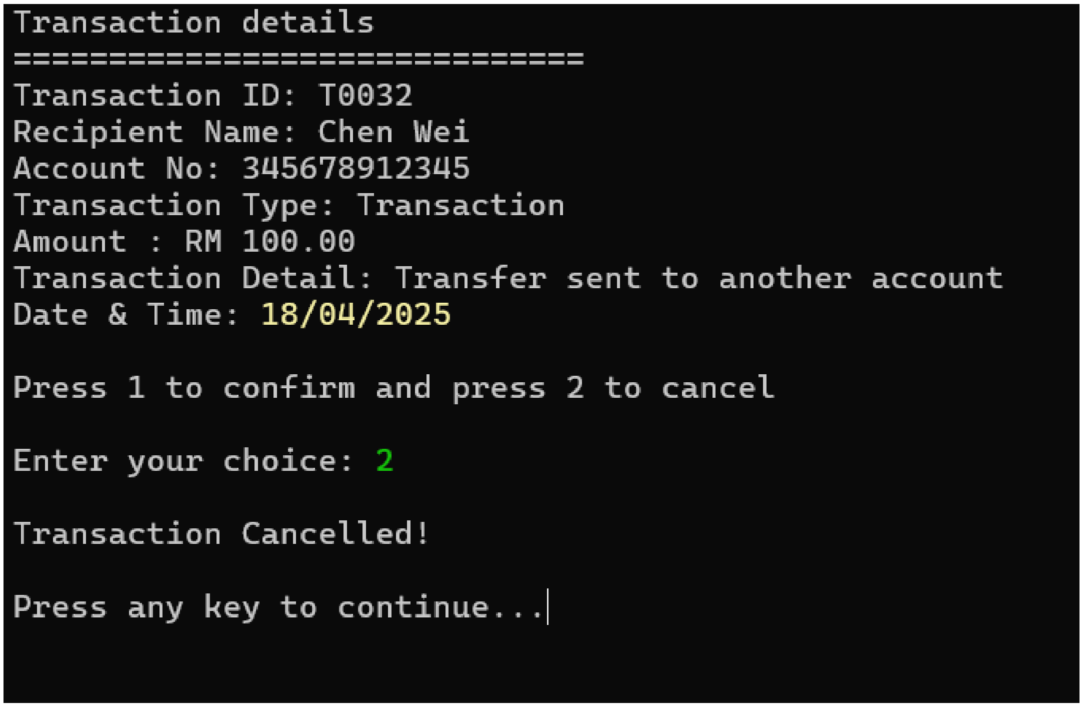
```
Thank you for using Bang Bang Bank!


   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/



C:\Users\hokk-\source\repos\BangBangBank\Debug\BangBangBank.exe (process 15124) exited with code 0.
Press any key to close this window . . .
```

Check interest

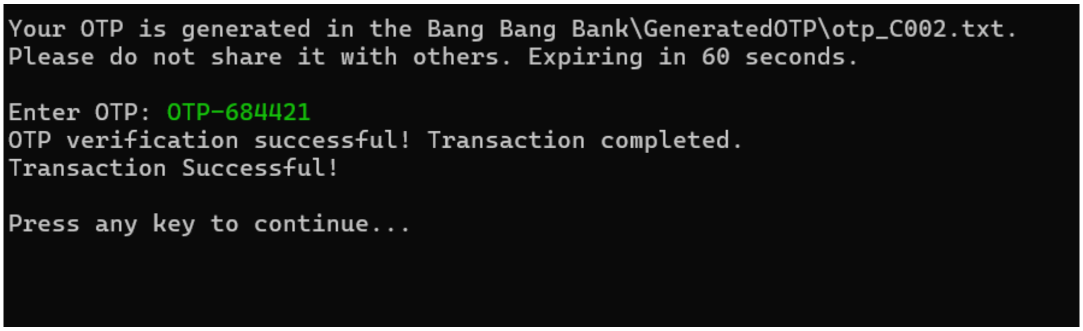


```
   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


=================================================================


You didn't earn any interest, or it had already been applied before.

Press any key to continue...
```

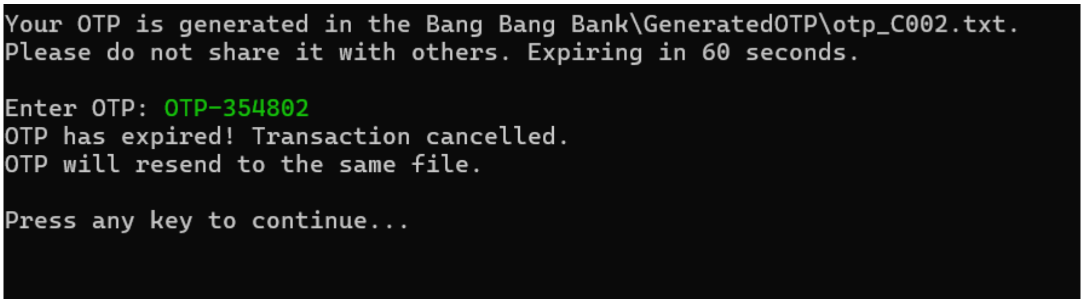
Customer menu	 Today is 18/04/2025 Welcome Bobby ============================== Customer Menu ============================== Account Number: 235251356177 Account Balance: RM 4304.72 1. Transfer 2. Deposit 3. Monthly Statement 4. Change Password 5. Switch Account 9. Logout Enter your choice:
Process Transaction	Bang Bang Bank Transaction ============================== Enter recipient account no. :345678912345 Enter transaction amount (Maximum 999999.99): 100 Enter recipient details (Press ENTER to use default):
	Transaction details ============================== Transaction ID: T0032 Recipient Name: Chen Wei Account No: 345678912345 Transaction Type: Transaction Amount : RM 100.00 Transaction Detail: Transfer sent to another account Date & Time: 18/04/2025 Press 1 to confirm and press 2 to cancel Enter your choice:



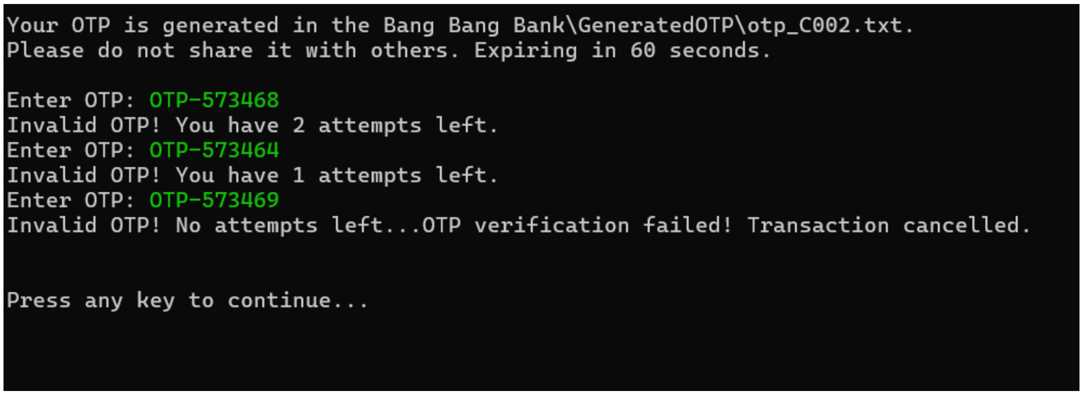
```
Transaction details
================================
Transaction ID: T0032
Recipient Name: Chen Wei
Account No: 345678912345
Transaction Type: Transaction
Amount : RM 100.00
Transaction Detail: Transfer sent to another account
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice: 2

Transaction Cancelled!

Press any key to continue...
```



```
Your OTP is generated in the Bang Bang Bank\GeneratedOTP\otp_C002.txt.
Please do not share it with others. Expiring in 60 seconds.

Enter OTP: OTP-684421
OTP verification successful! Transaction completed.
Transaction Successful!

Press any key to continue...
```

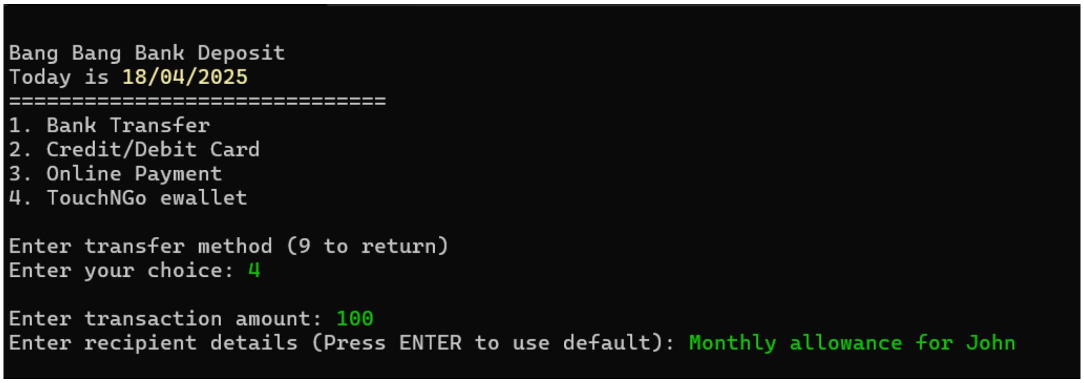


```
Your OTP is generated in the Bang Bang Bank\GeneratedOTP\otp_C002.txt.
Please do not share it with others. Expiring in 60 seconds.

Enter OTP: OTP-354802
OTP has expired! Transaction cancelled.
OTP will resend to the same file.

Press any key to continue...
```

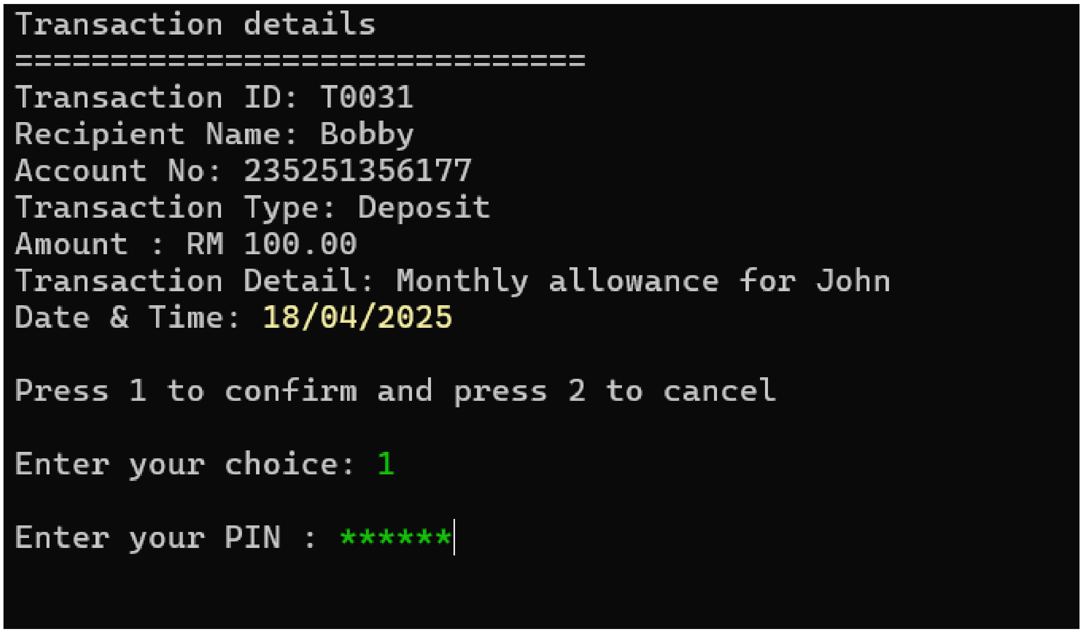


```
Your OTP is generated in the Bang Bang Bank\GeneratedOTP\otp_C002.txt.
Please do not share it with others. Expiring in 60 seconds.

Enter OTP: OTP-573468
Invalid OTP! You have 2 attempts left.
Enter OTP: OTP-573464
Invalid OTP! You have 1 attempts left.
Enter OTP: OTP-573469
Invalid OTP! No attempts left...OTP verification failed! Transaction cancelled.


Press any key to continue...
```

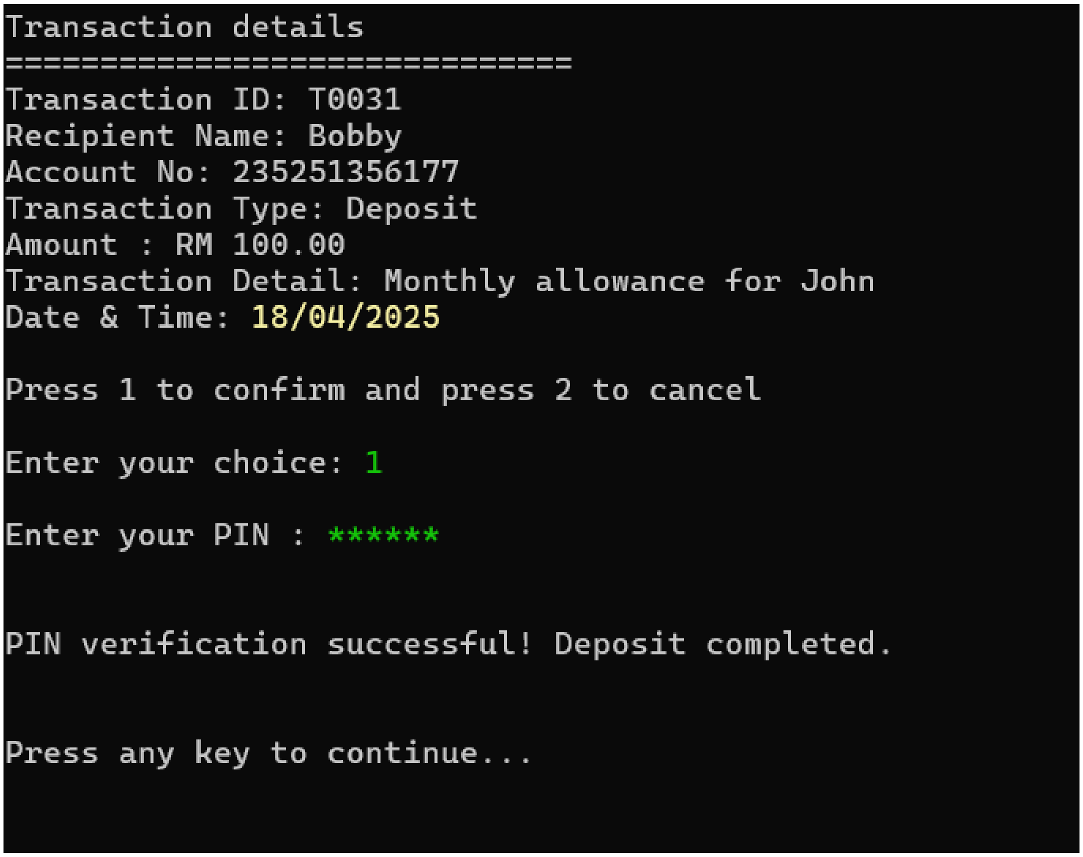
Process Deposit



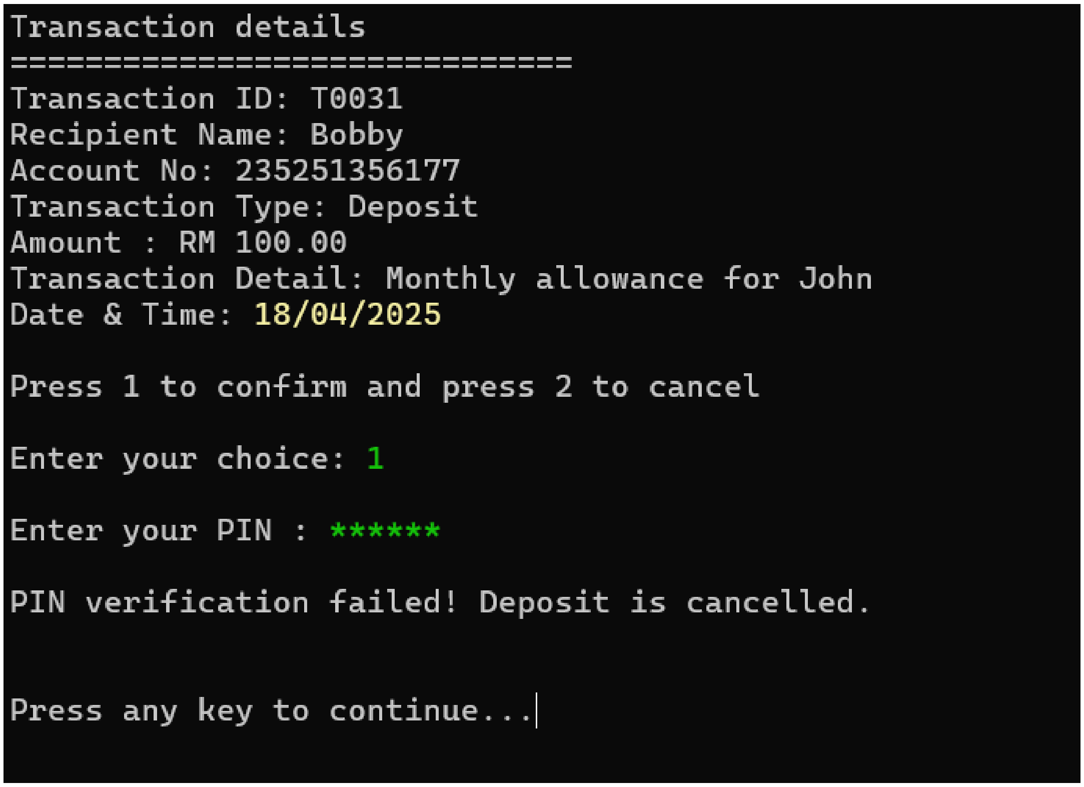
```
Bang Bang Bank Deposit
Today is 18/04/2025
==============================
1. Bank Transfer
2. Credit/Debit Card
3. Online Payment
4. TouchNGo ewallet

Enter transfer method (9 to return)
Enter your choice: 4

Enter transaction amount: 100
Enter recipient details (Press ENTER to use default): Monthly allowance for John
```



```
Transaction details
==============================
Transaction ID: T0031
Recipient Name: Bobby
Account No: 235251356177
Transaction Type: Deposit
Amount : RM 100.00
Transaction Detail: Monthly allowance for John
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice: 1

Enter your PIN : ******
```

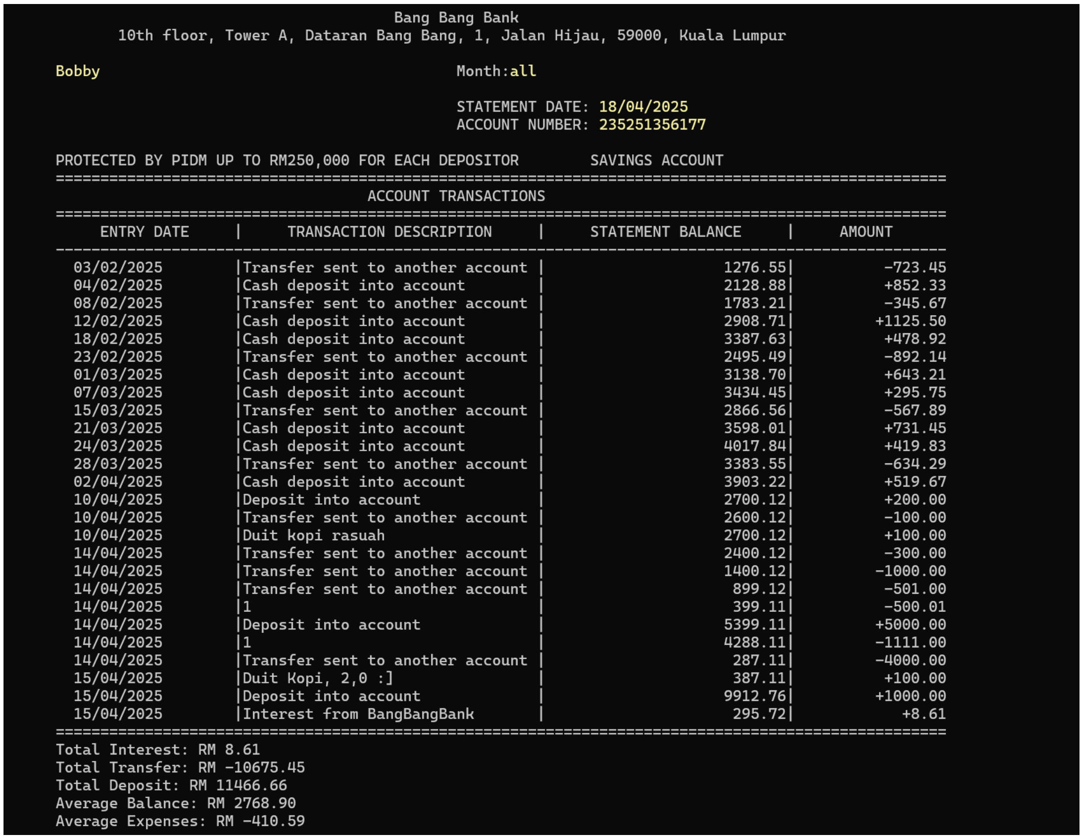


```
Transaction details
================================
Transaction ID: T0031
Recipient Name: Bobby
Account No: 235251356177
Transaction Type: Deposit
Amount : RM 100.00
Transaction Detail: Monthly allowance for John
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice: 1

Enter your PIN : ******


PIN verification successful! Deposit completed.


Press any key to continue...
```

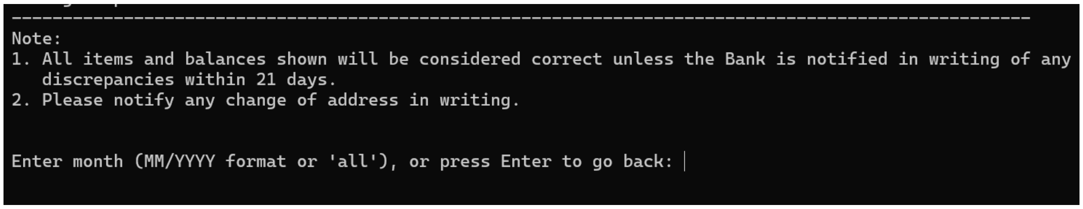


```
Transaction details
================================
Transaction ID: T0031
Recipient Name: Bobby
Account No: 235251356177
Transaction Type: Deposit
Amount : RM 100.00
Transaction Detail: Monthly allowance for John
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice: 1

Enter your PIN : ******

PIN verification failed! Deposit is cancelled.


Press any key to continue...
```

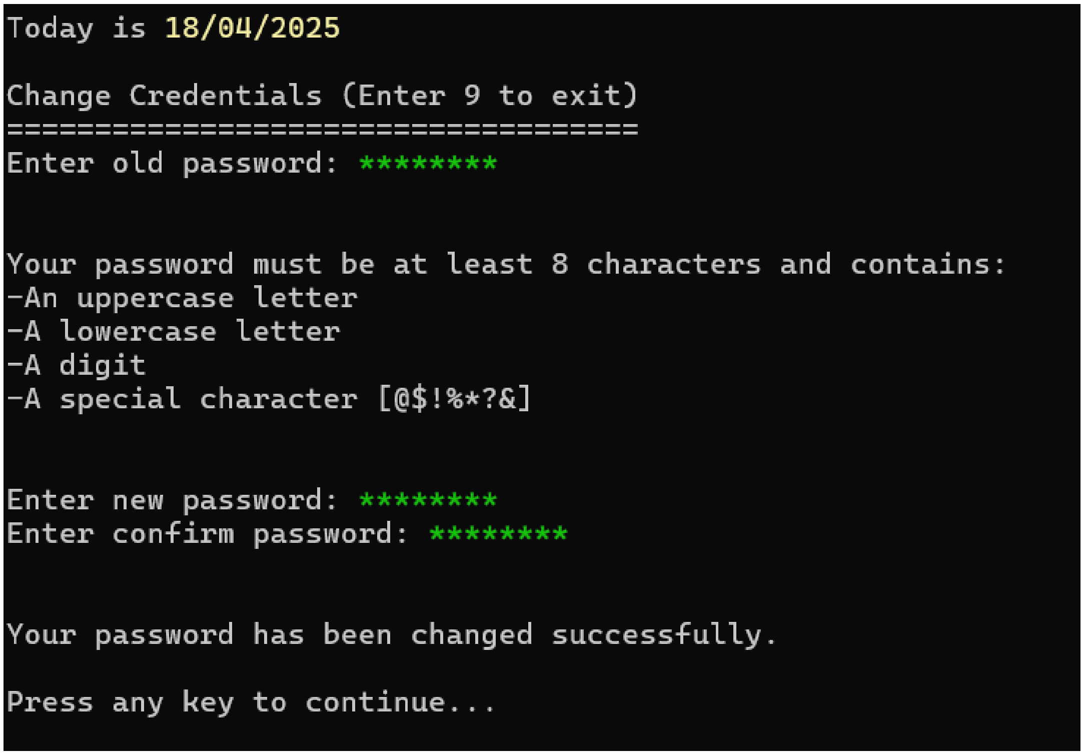
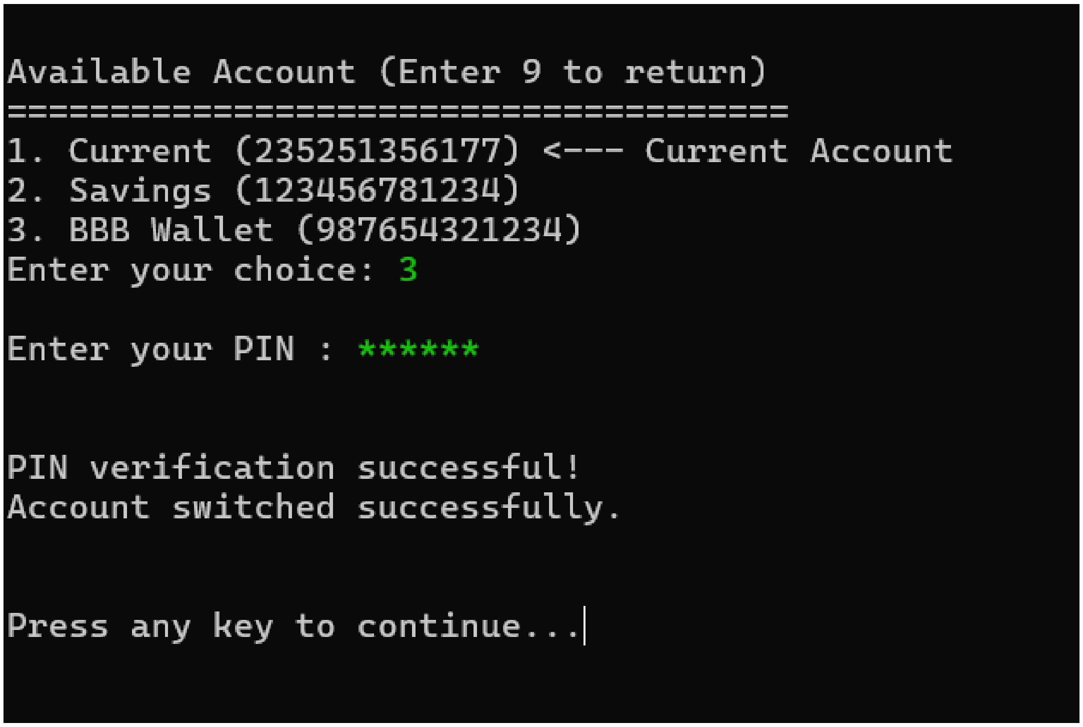
Monthly Statement

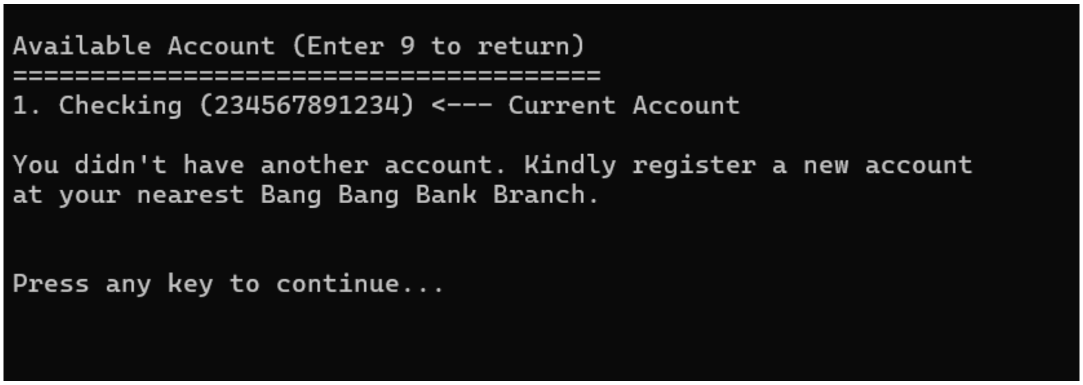


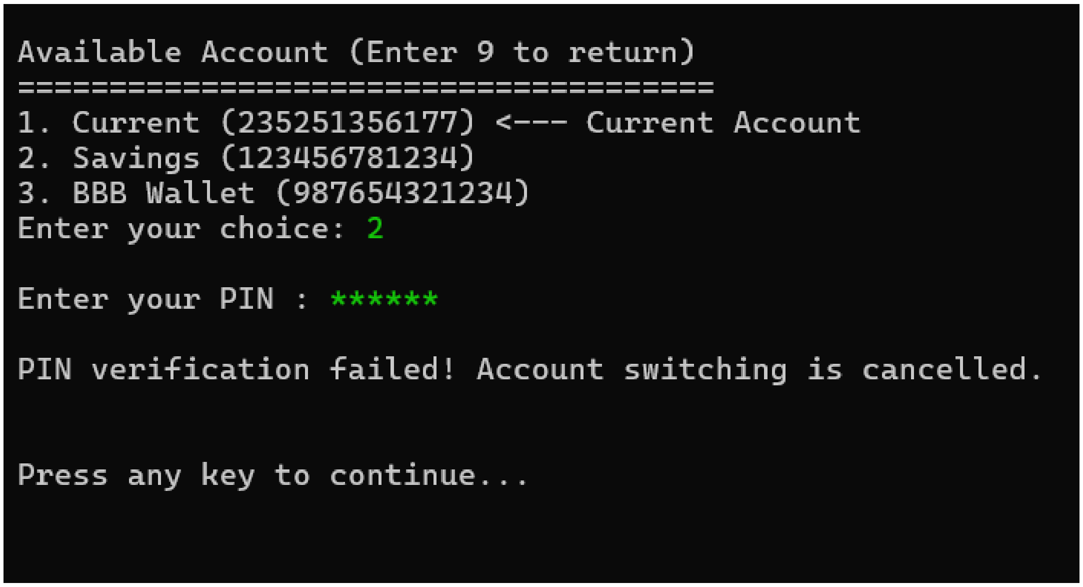
```
                                      Bang Bang Bank
             10th floor, Tower A, Dataran Bang Bang, 1, Jalan Hijau, 59000, Kuala Lumpur

      Bobby                                        Month:all

                                                   STATEMENT DATE: 18/04/2025
                                                   ACCOUNT NUMBER: 235251356177

      PROTECTED BY PIDM UP TO RM250,000 FOR EACH DEPOSITOR        SAVINGS ACCOUNT
      ====================================================================================================
                                         ACCOUNT TRANSACTIONS
      ====================================================================================================
           ENTRY DATE      |     TRANSACTION DESCRIPTION      |     STATEMENT BALANCE      |     AMOUNT
      ----------------------------------------------------------------------------------------------------
        03/02/2025         |Transfer sent to another account |                     1276.55|         -723.45
        04/02/2025         |Cash deposit into account        |                     2128.88|         +852.33
        08/02/2025         |Transfer sent to another account |                     1783.21|         -345.67
        12/02/2025         |Cash deposit into account        |                     2908.71|        +1125.50
        18/02/2025         |Cash deposit into account        |                     3387.63|         +478.92
        23/02/2025         |Transfer sent to another account |                     2495.49|         -892.14
        01/03/2025         |Cash deposit into account        |                     3138.70|         +643.21
        07/03/2025         |Cash deposit into account        |                     3434.45|         +295.75
        15/03/2025         |Transfer sent to another account |                     2866.56|         -567.89
        21/03/2025         |Cash deposit into account        |                     3598.01|         +731.45
        24/03/2025         |Cash deposit into account        |                     4017.84|         +419.83
        28/03/2025         |Transfer sent to another account |                     3383.55|         -634.29
        02/04/2025         |Cash deposit into account        |                     3903.22|         +519.67
        10/04/2025         |Deposit into account             |                     2700.12|         +200.00
        10/04/2025         |Transfer sent to another account |                     2600.12|         -100.00
        10/04/2025         |Duit kopi rasuah                 |                     2700.12|         +100.00
        14/04/2025         |Transfer sent to another account |                     2400.12|         -300.00
        14/04/2025         |Transfer sent to another account |                     1400.12|        -1000.00
        14/04/2025         |Transfer sent to another account |                      899.12|         -501.00
        14/04/2025         |1                                |                      399.11|         -500.01
        14/04/2025         |Deposit into account             |                     5399.11|        +5000.00
        14/04/2025         |1                                |                     4288.11|        -1111.00
        14/04/2025         |Transfer sent to another account |                      287.11|        -4000.00
        15/04/2025         |Duit Kopi, 2,0 :]                |                      387.11|         +100.00
        15/04/2025         |Deposit into account             |                     9912.76|        +1000.00
        15/04/2025         |Interest from BangBangBank       |                      295.72|           +8.61
      ====================================================================================================
      Total Interest: RM 8.61
      Total Transfer: RM -10675.45
      Total Deposit: RM 11466.66
      Average Balance: RM 2768.90
      Average Expenses: RM -410.59
```



```
--------------------------------------------------------------------------------------------------------
Note:
1. All items and balances shown will be considered correct unless the Bank is notified in writing of any
   discrepancies within 21 days.
2. Please notify any change of address in writing.


Enter month (MM/YYYY format or 'all'), or press Enter to go back:
```

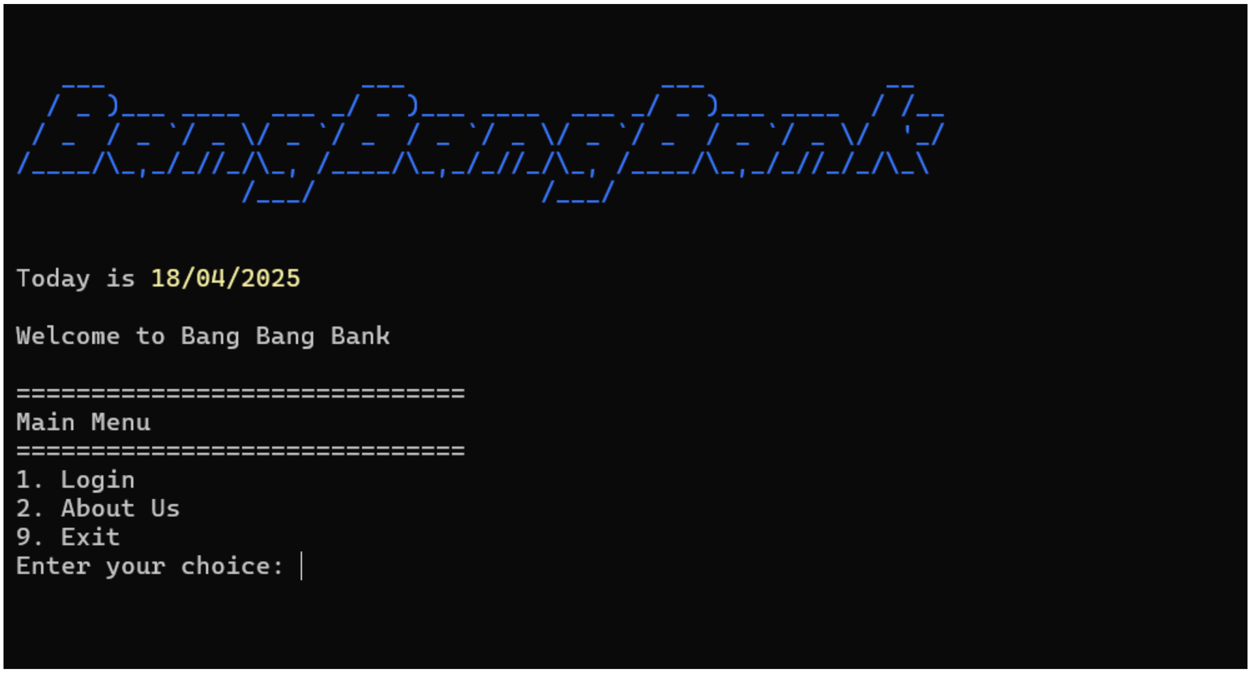
Change Credentials	 Today is 18/04/2025 Change Credentials (Enter 9 to exit) ==================================== Enter old password: ******** Your password must be at least 8 characters and contains: -An uppercase letter -A lowercase letter -A digit -A special character [@$!%*?&] Enter new password: ******** Enter confirm password: ******** Your password has been changed successfully. Press any key to continue...
Switch Account	 Available Account (Enter 9 to return) ===================================== 1. Current (235251356177) <--- Current Account 2. Savings (123456781234) 3. BBB Wallet (987654321234) Enter your choice: 3 Enter your PIN : ****** PIN verification successful! Account switched successfully. Press any key to continue...

<table>
<tr>
<td></td>
<td>


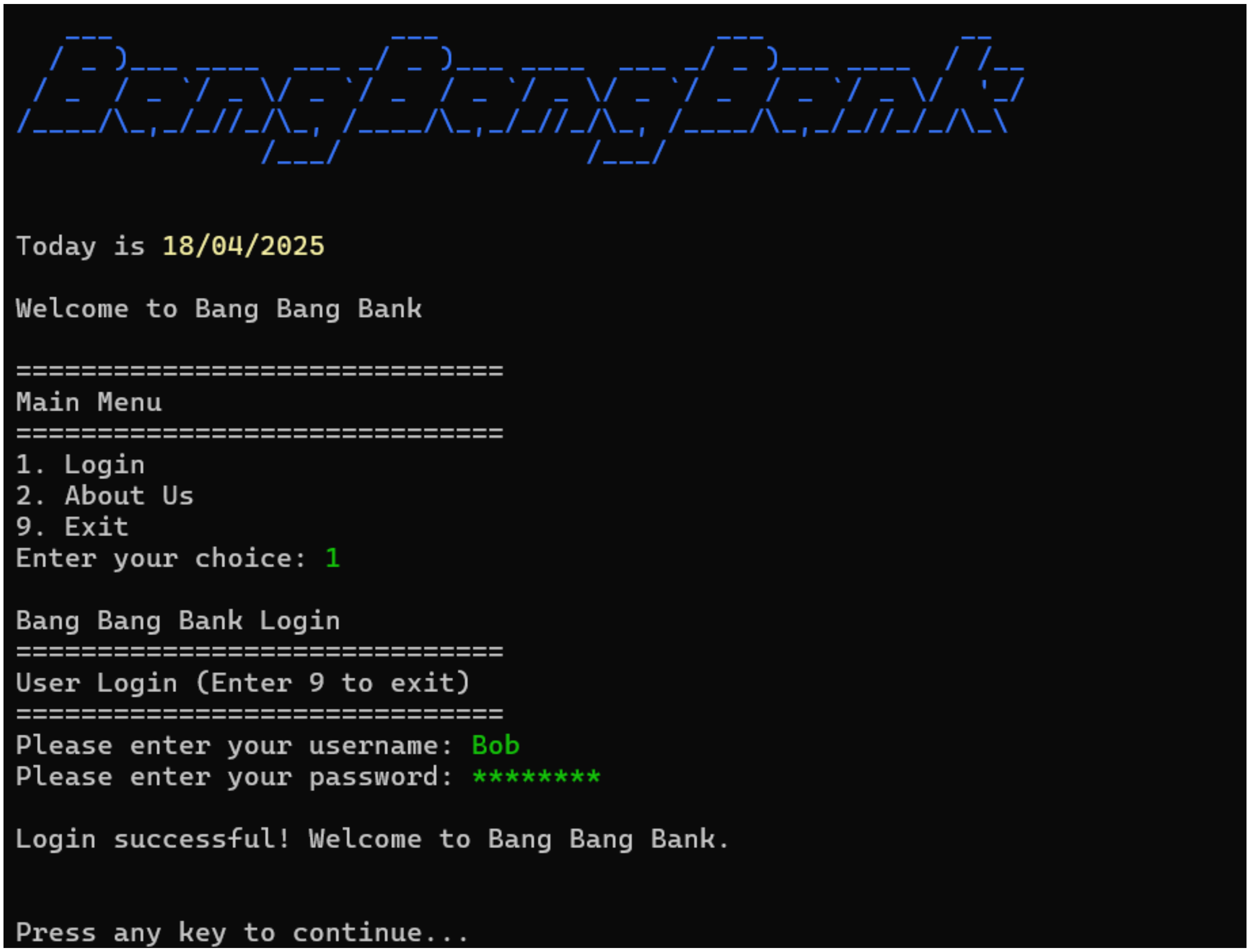
```
Available Account (Enter 9 to return)
======================================
1. Checking (234567891234) <--- Current Account

You didn't have another account. Kindly register a new account
at your nearest Bang Bang Bank Branch.


Press any key to continue...
```
</td>
</tr>
<tr>
<td></td>
<td>


```
Available Account (Enter 9 to return)
======================================
1. Current (235251356177) <--- Current Account
2. Savings (123456781234)
3. BBB Wallet (987654321234)
Enter your choice: 2

Enter your PIN : ******

PIN verification failed! Account switching is cancelled.


Press any key to continue...
```
</td>
</tr>
</table>

Possible option and outcomes

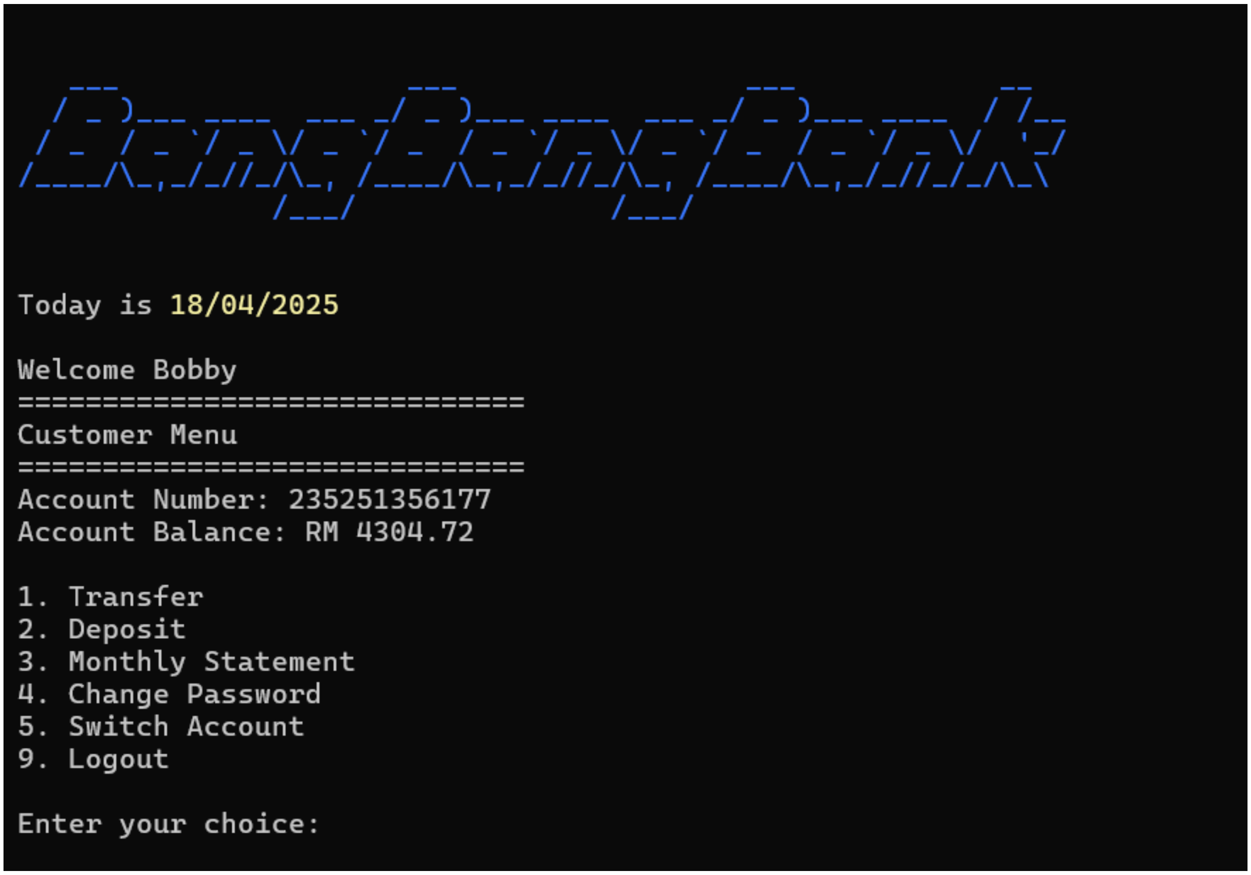
Pages	Possible option	Outcomes
		
Main Menu	1	Proceed to Login page
	2	Proceed to About us page
	9	Display “Thank you for using Bang Bang Bank!” Exit
	Non-numeric	Display “Please enter a number within the range.”
	Other input	Display “ Invalid option. Please try again.”
About us	Any key	Exit About us page Return to Main Menu

```
   ___                 ___                 ___              __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


Today is 18/04/2025

Welcome to Bang Bang Bank

==============================
Main Menu
==============================
1. Login
2. About Us
9. Exit
Enter your choice:
```



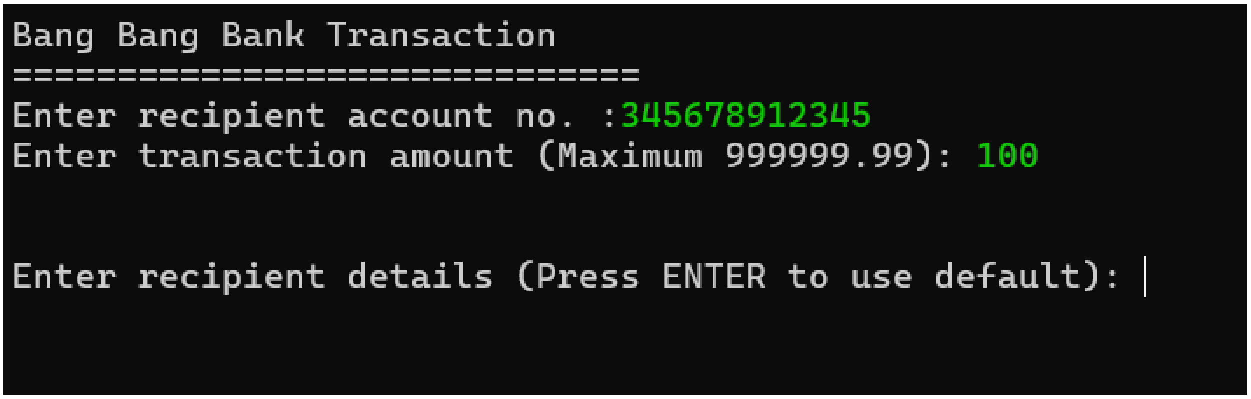
```
   ___                 ___                 ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/               /___/


Today is 18/04/2025

Welcome to Bang Bang Bank

==============================
Main Menu
==============================
1. Login
2. About Us
9. Exit
Enter your choice: 1

Bang Bang Bank Login
==============================
User Login (Enter 9 to exit)
==============================
Please enter your username: Bob
Please enter your password: ********

Login successful! Welcome to Bang Bang Bank.


Press any key to continue...
```

Login	username:9 or password:9	Return to Main Menu
	username or password is empty	Display “Username and password cannot be empty.” Prompt and get username and password again.
	Invalid username or password	Display “ Login failed. Incorrect username or password.” If the user exists, increment the loginAttempt Display “You have [3 - loginAttempt] attempts remaining.” Prompt and get username and password again.
	Reached login attempt limit	Display “You have reached your login attempt limit. Please try again at” Display the remaining waiting time.
	Valid username and correct password Example: username: Bob, password: Pass123@	Display “Login successful! Welcome to Bang Bang Bank.” Proceed to the Customer menu page.

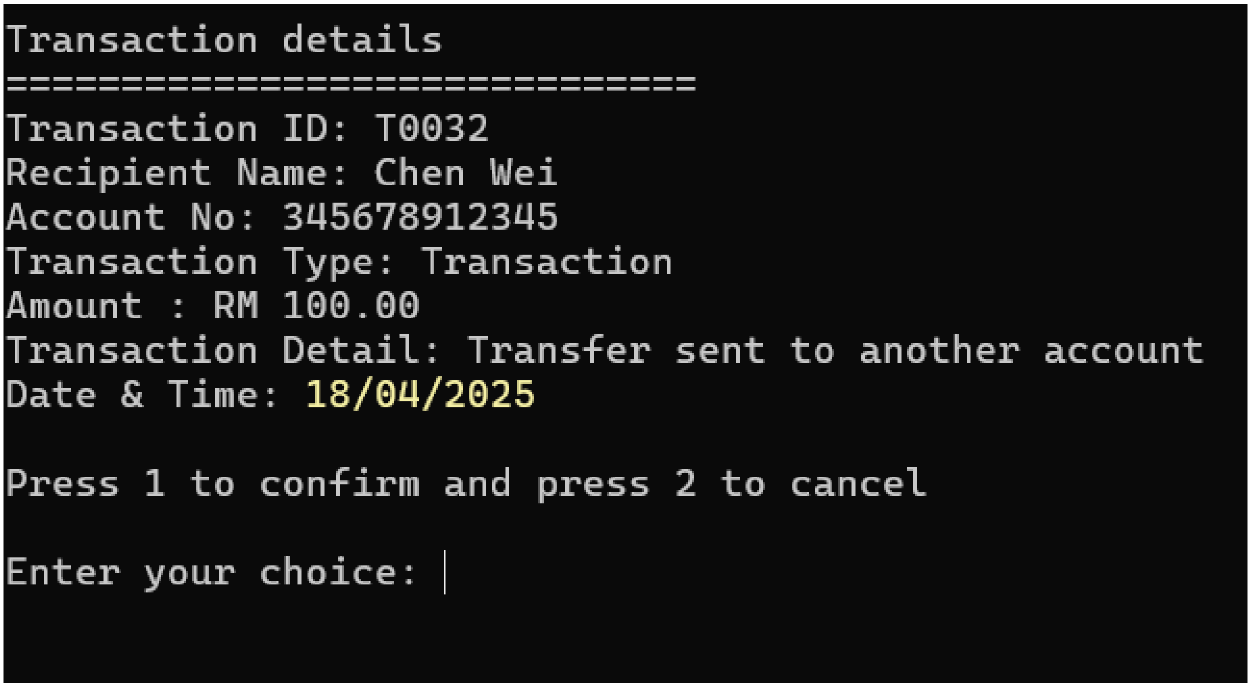


```
   ___                ___                ___            __
  / _ )___ ____  ___ _/ _ )___ ____  ___ _/ _ )___ ____  / /__
 / _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/ _ `/ _  / _ `/ _ \/  '_/
/____/\_,_/_//_/\_, /____/\_,_/_//_/\_, /____/\_,_/_//_/_/\_\
               /___/              /___/


Today is 18/04/2025

Welcome Bobby
==============================
Customer Menu
==============================
Account Number: 235251356177
Account Balance: RM 4304.72

1. Transfer
2. Deposit
3. Monthly Statement
4. Change Password
5. Switch Account
9. Logout

Enter your choice:
```

Customer Menu	1	Proceed to Transfer page
	2	Proceed to Deposit page
	3	Proceed to Monthly Statement page
	4	Proceed to Change Password page
	5	Proceed to Switch Account page
	9	Logout. Return to Main menu
	Non-numeric	Display “Please enter a number within the range.”
	Other input	Display “ Invalid option. Please try again.”



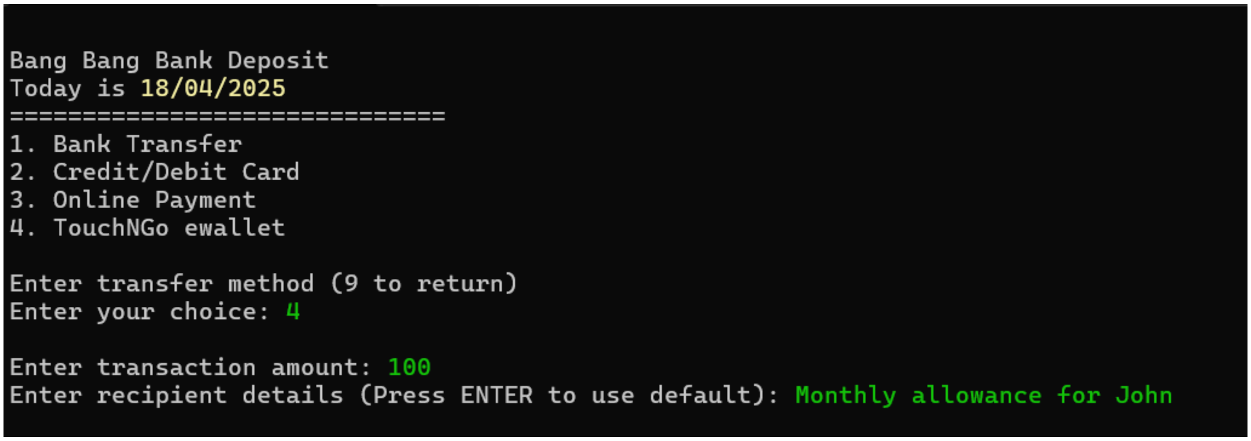
```
Bang Bang Bank Transaction
==============================
Enter recipient account no. :345678912345
Enter transaction amount (Maximum 999999.99): 100


Enter recipient details (Press ENTER to use default):
```



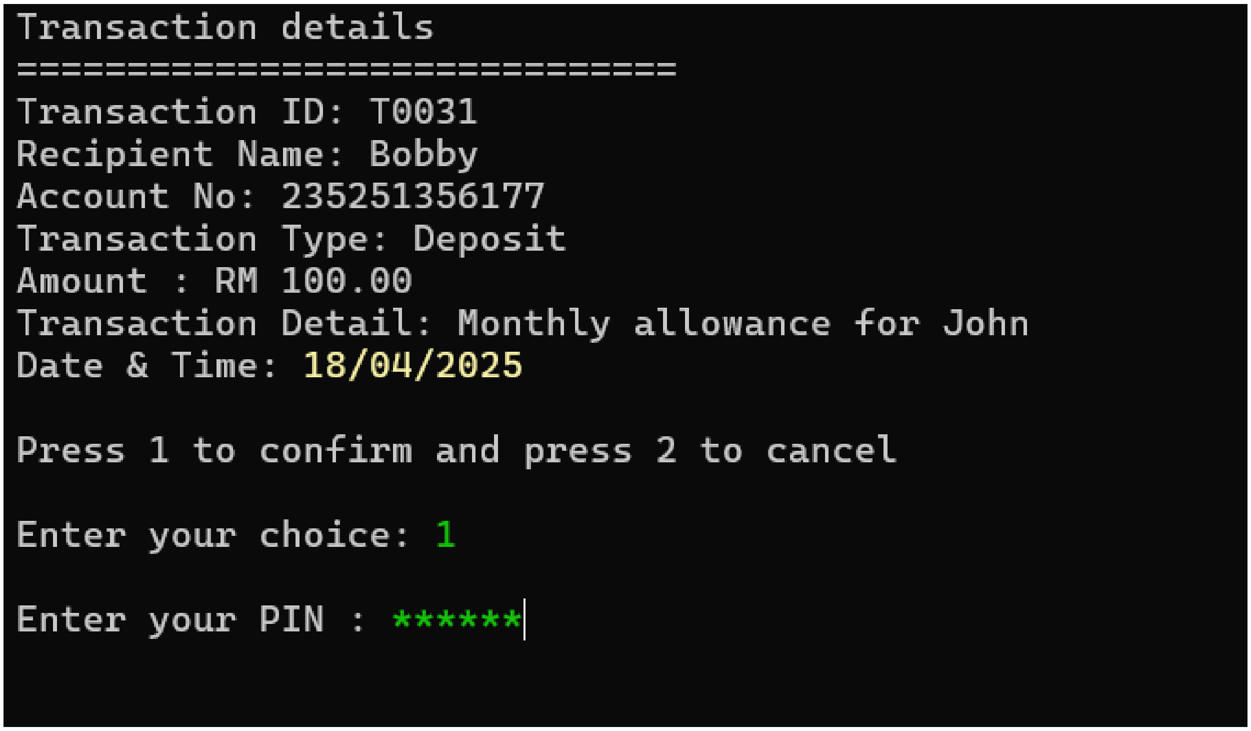
```
Transaction details
==============================
Transaction ID: T0032
Recipient Name: Chen Wei
Account No: 345678912345
Transaction Type: Transaction
Amount : RM 100.00
Transaction Detail: Transfer sent to another account
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice:
```

Process Transaction	Empty account number	Display " Recipient account cannot be empty."
	Invalid account number	Display " Recipient account not found..."
	Own account number	Display " You cannot enter your own account number as recipient."
	Valid account number	Prompt and get transaction amount.
	Enter transaction amount : -100 Enter transaction amount : bla bla bla	Display " Invalid amount. Please enter a positive number."
	Enter transaction amount : 5000000 (exceed balance)	Display "Not sufficient balance..."
	Enter transaction amount : 300 (if exceeded daily transaction limit)	Display "Exceed transaction limit! Will charge extra RM 1 for this transaction." Display "Extra Fee: RM 1.00 (exceeded daily limit)" in transaction details

	Transaction amount :1000	Prompt and get transaction details. Prompt and get transaction confirmation.
	1 (confirm)	Generate and send OTP to file. Prompt and get OTP number.
	2 (cancel)	Abort transaction Display “Transaction Cancelled!” Return to the Customer menu.
	Other input	Display “Invalid option. Please try again.”. Prompt and get transaction confirmation.
	Invalid OTP	Decrement otpAttemptCount Display “Invalid OTP! You have” + otpAttemptCount + “ attempts left.” Prompt and get OTP number.
	More than 3 attempts	Display “Invalid OTP! No attempts left...” Abort transaction Return to the Customer menu.
	More than 1 minute	Display “OTP has expired! Transaction cancelled.” Generate and send OTP to file. Prompt and get OTP number.
	Valid OTP	Display “OTP verification successful! Transaction completed. Transaction Successful!” Perform transaction. Display account balance.



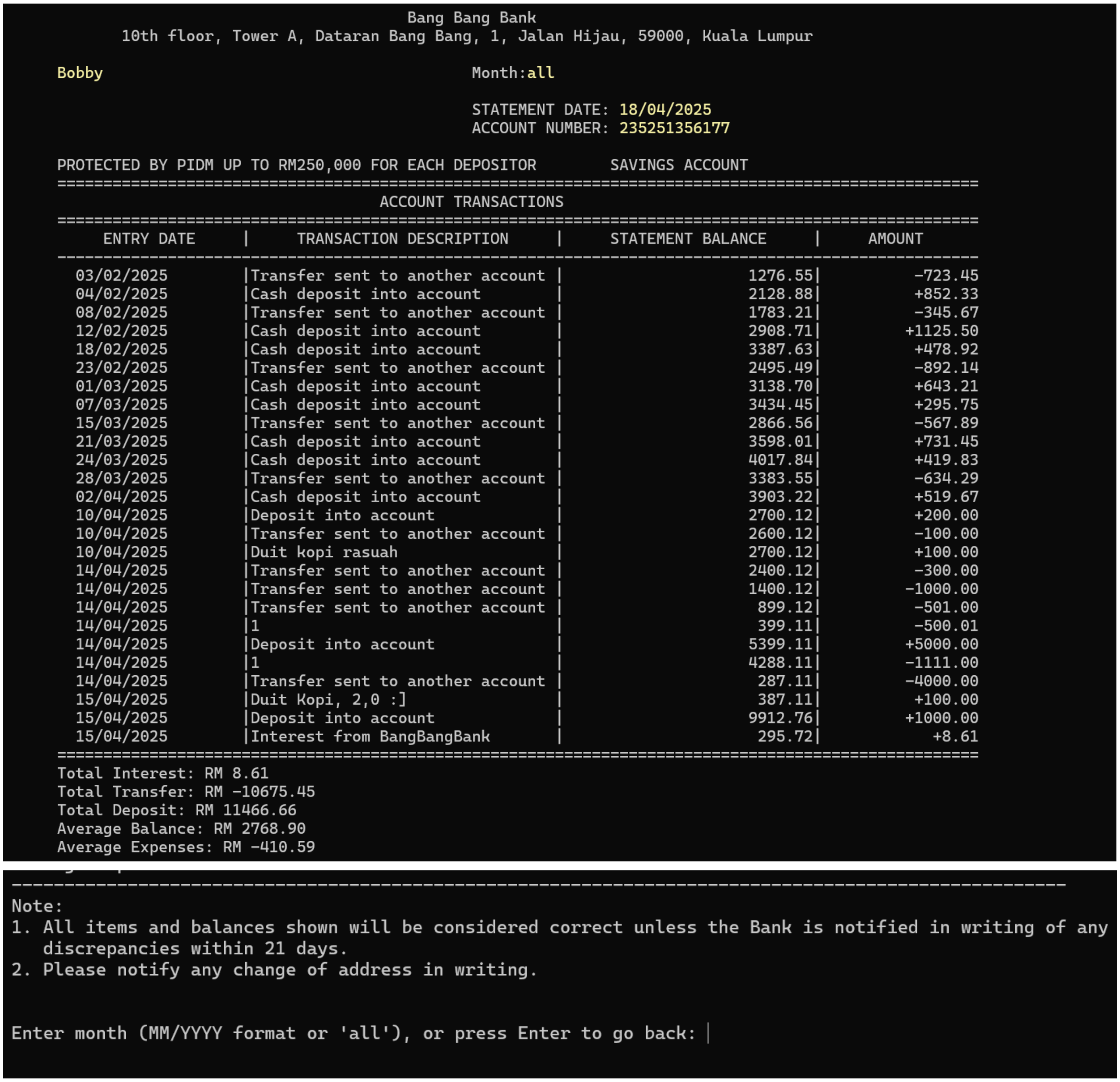
```
Bang Bang Bank Deposit
Today is 18/04/2025
==============================
1. Bank Transfer
2. Credit/Debit Card
3. Online Payment
4. TouchNGo ewallet

Enter transfer method (9 to return)
Enter your choice: 4

Enter transaction amount: 100
Enter recipient details (Press ENTER to use default): Monthly allowance for John
```



```
Transaction details
==============================
Transaction ID: T0031
Recipient Name: Bobby
Account No: 235251356177
Transaction Type: Deposit
Amount : RM 100.00
Transaction Detail: Monthly allowance for John
Date & Time: 18/04/2025

Press 1 to confirm and press 2 to cancel

Enter your choice: 1

Enter your PIN : ******
```

Process Deposit	Deposit amount: 300	Prompt and get transfer method
	Transfer method: (1 or 2 or 3 or 4)	Prompt and get deposit amount
	Transfer method: 9	Return to Customer Menu
	Transfer method: other input	Display “Invalid option. Please try again.” Prompt and get the transfer method again.
	Enter deposit amount: (Empty input)	Display “Invalid amount. Please enter a positive number..”
	Enter deposit amount: bla bla bla Enter deposit amount: ‘’’’’’’’’’ Enter deposit amount: -900 Enter deposit amount: 900.000	Display “Invalid decimal format. Please use format like 9999.99”
	Enter recipient details (Press ENTER to use default): Monthly allowance for John	Set the carry flag to use custom message “Monthly allowance for John”
	Enter recipient details (Press ENTER to use default): (enter)	Clear the carry flag to use default message
	Confirm : 1	Prompt for PIN Return to Customer Menu
	Confirm : (Other input)	Abort transaction Display “ Transaction cancelled.” Return to Customer Menu

	Enter your PIN number: 123456 (Correct PIN)	Display “PIN verification successful! Deposit completed.” Process transaction
	Enter your PIN number: 111111 (Wrong PIN)	Display “PIN verification failed! Deposit is cancelled.” Return to Customer Menu

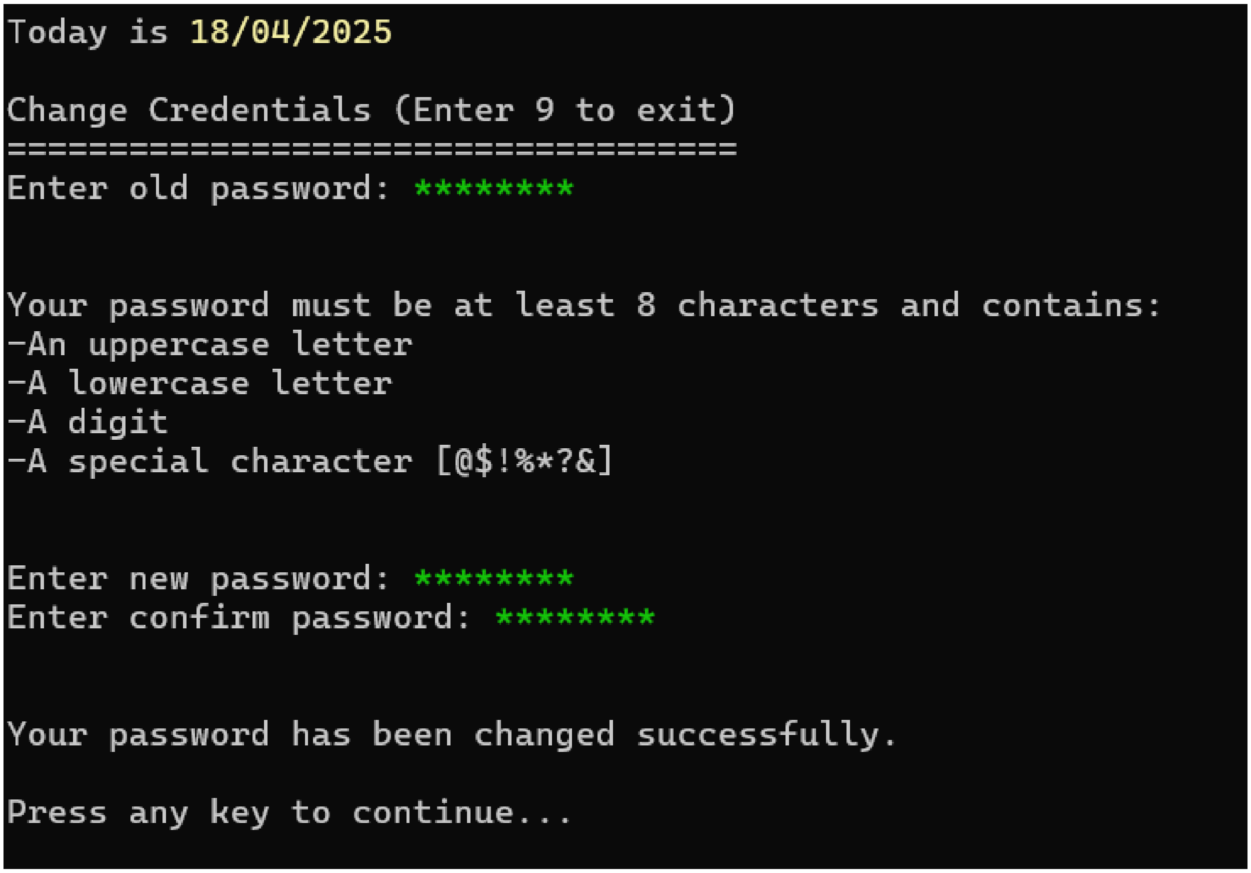


```
                                 Bang Bang Bank
          10th floor, Tower A, Dataran Bang Bang, 1, Jalan Hijau, 59000, Kuala Lumpur

     Bobby                                       Month:all

                                                 STATEMENT DATE: 18/04/2025
                                                 ACCOUNT NUMBER: 235251356177

     PROTECTED BY PIDM UP TO RM250,000 FOR EACH DEPOSITOR        SAVINGS ACCOUNT
     ====================================================================================================
                                         ACCOUNT TRANSACTIONS
     ====================================================================================================
          ENTRY DATE     |     TRANSACTION DESCRIPTION     |     STATEMENT BALANCE     |     AMOUNT
     ----------------------------------------------------------------------------------------------------
       03/02/2025        |Transfer sent to another account |                    1276.55|         -723.45
       04/02/2025        |Cash deposit into account        |                    2128.88|         +852.33
       08/02/2025        |Transfer sent to another account |                    1783.21|         -345.67
       12/02/2025        |Cash deposit into account        |                    2908.71|        +1125.50
       18/02/2025        |Cash deposit into account        |                    3387.63|         +478.92
       23/02/2025        |Transfer sent to another account |                    2495.49|         -892.14
       01/03/2025        |Cash deposit into account        |                    3138.70|         +643.21
       07/03/2025        |Cash deposit into account        |                    3434.45|         +295.75
       15/03/2025        |Transfer sent to another account |                    2866.56|         -567.89
       21/03/2025        |Cash deposit into account        |                    3598.01|         +731.45
       24/03/2025        |Cash deposit into account        |                    4017.84|         +419.83
       28/03/2025        |Transfer sent to another account |                    3383.55|         -634.29
       02/04/2025        |Cash deposit into account        |                    3903.22|         +519.67
       10/04/2025        |Deposit into account             |                    2700.12|         +200.00
       10/04/2025        |Transfer sent to another account |                    2600.12|         -100.00
       10/04/2025        |Duit kopi rasuah                 |                    2700.12|         +100.00
       14/04/2025        |Transfer sent to another account |                    2400.12|         -300.00
       14/04/2025        |Transfer sent to another account |                    1400.12|        -1000.00
       14/04/2025        |Transfer sent to another account |                     899.12|         -501.00
       14/04/2025        |1                                |                     399.11|         -500.01
       14/04/2025        |Deposit into account             |                    5399.11|        +5000.00
       14/04/2025        |1                                |                    4288.11|        -1111.00
       14/04/2025        |Transfer sent to another account |                     287.11|        -4000.00
       15/04/2025        |Duit Kopi, 2,0 :]                |                     387.11|         +100.00
       15/04/2025        |Deposit into account             |                    9912.76|        +1000.00
       15/04/2025        |Interest from BangBangBank       |                     295.72|           +8.61
     ====================================================================================================
     Total Interest: RM 8.61
     Total Transfer: RM -10675.45
     Total Deposit: RM 11466.66
     Average Balance: RM 2768.90
     Average Expenses: RM -410.59
```

```
----------------------------------------------------------------------------------------------------
Note:
1. All items and balances shown will be considered correct unless the Bank is notified in writing of any
   discrepancies within 21 days.
2. Please notify any change of address in writing.


Enter month (MM/YYYY format or 'all'), or press Enter to go back:
```

Monthly Statement	Enter month: (no input just Enter)	Return to Customer Menu
	Enter month: all	Display all result of that account
	Enter month: 03/2025 (or other valid month in format of	Display result of 03/2025 monthly statement of that account

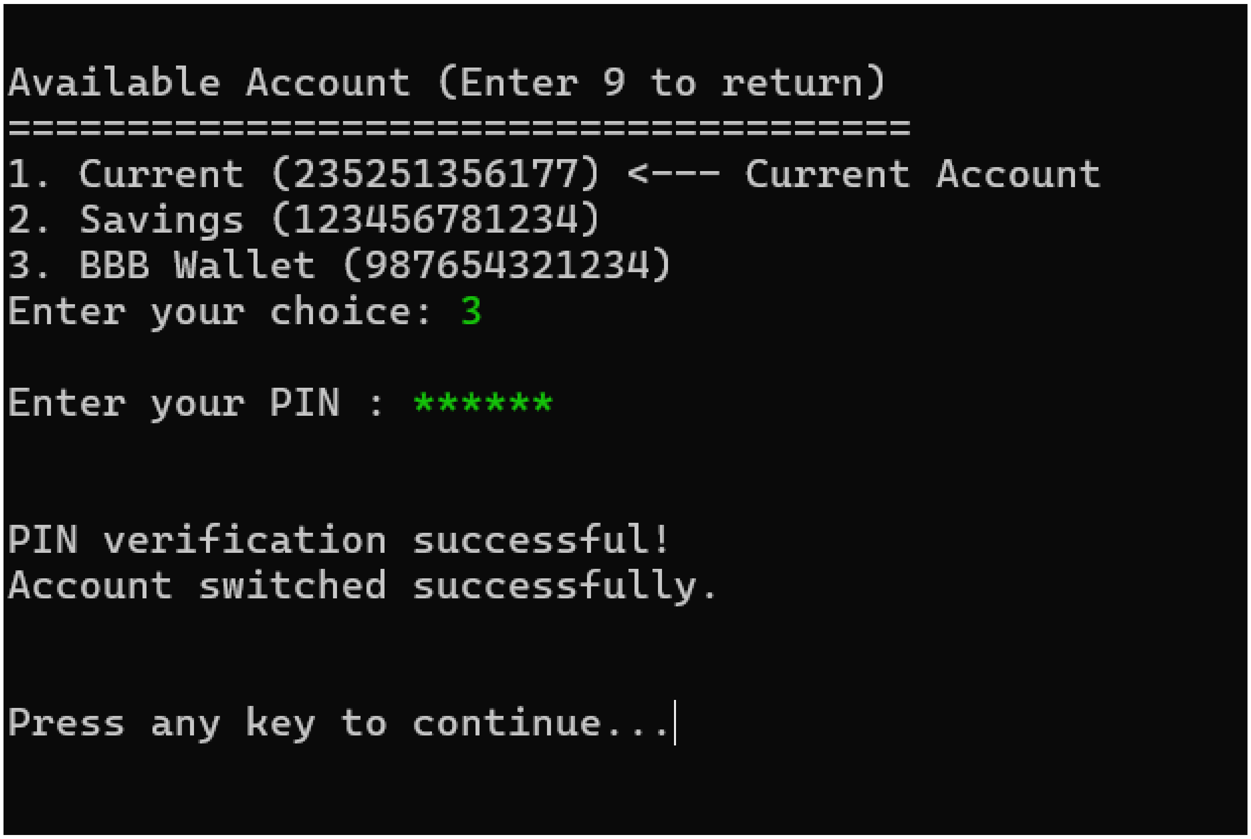
	MM/YYYY)	
	Enter month: bla bla bla (other invalid input)	Display “Invalid format! Please use MM/YYYY format (e.g., 03/2025) or 'all'.”



```
Today is 18/04/2025

Change Credentials (Enter 9 to exit)
====================================
Enter old password: ********


Your password must be at least 8 characters and contains:
-An uppercase letter
-A lowercase letter
-A digit
-A special character [@$!%*?&]


Enter new password: ********
Enter confirm password: ********


Your password has been changed successfully.

Press any key to continue...
```

Change Password	Enter old password: Pass123@ Enter new password: Pass123$ Enter confirm password: Pass123$	Display “Your password has been changed successfully ” Update user file Return to Customer Menu
	Enter old password: Pass123@ Enter new password: Pass123@	Display “Your new password cannot be the same with your old password. Please try again.” Prompt for new password
	Enter old password: Pass123@ Enter new password: (Pass123 or pass123 or passabcD or pas123@)	Display “Password must be at least 8 characters long.” Display “Your password must be at least 8 characters and contains: -An uppercase letter -A lowercase letter -A digit -A special character [@$!%*?&]” Prompt for new password
	Enter old password: Pass123@	Display “Your confirm password is not the

	Enter new password: Pass123# Enter confirm password: Pass123$	same as your new password. Please try again." Prompt for confirm password
	Enter old password: 9	Return to Customer Menu
	Enter new password: 9	Return to Customer Menu
	Enter confirm password: 9	Return to Customer Menu
	Enter old password: (Empty input)	Display "Input cannot be empty." Prompt and get old password
	Enter new password: (Empty input)	Display "Input cannot be empty." Prompt and get new password
	Enter confirm password: (Empty input)	Display "Input cannot be empty." Prompt and get confirm password



```
Available Account (Enter 9 to return)
======================================
1. Current (235251356177) <--- Current Account
2. Savings (123456781234)
3. BBB Wallet (987654321234)
Enter your choice: 3

Enter your PIN : ******


PIN verification successful!
Account switched successfully.


Press any key to continue...
```

Switch Account	No other account	Display "You didn't have another account. Kindly register a new account at your nearest Bang Bang Bank Branch." Return to Customer Menu
	Enter your choice: 7 (out of range)	Display "Invalid option. Please try again."
	Non-numeric	Display "Please enter a number within the range."

	Account Choice: 9	Return to Customer Menu
	Account Choice: 2	Prompt and get PIN number
	Enter your PIN number: 123456 (Correct PIN)	Display “PIN verification successful! Account switched successfully.” Switch into the account Return to Customer Menu
	Enter your PIN number: 111111 (Wrong PIN)	Display “PIN verification failed! Account switching is cancelled.” Return to Customer Menu
	Enter your PIN number: (Empty input)	Display “Please enter your PIN number.” Prompt and get PIN number

Sample Customer Credential File

```
username,hashed_password,hashed_PIN,customer_id,encryption_key, loginAttempt, firstLoginAttemptTimestamp

Bob,35 0D 16 03 59 53 5D 34,54 5E 56 44 5D 57,C001,elephant,0,-

asmith,37 0C 0D 1A 01 04 25 32 17 1A,56 5A 5A 5A 45 56,C002,dinosaur,0,-

bwhite, 33 23 1D 1D 0A 56 79 51, 44 4C 4B 5E 5C 54, C003, strongKey, 3,27/03/2025 19:15:30
```

Sample Customer Account File

```
account_number,customer_id,full_name,phone_number,email,account_balance,opening_date,transaction_limit,branch_name,branch_address,account_type,currency,interest_apply_date,beneficiaries

987654321234,C001,Bobby,012-555-1234,jdoe@gmail.com,4430.24,02/04/2024,5000.00,Main Branch,123 Main St,BBB Wallet,RM,02/04/2025,[Sarah Jones]

234567891234,C002,Alice Smith,013-535-5678,asmith@gmail.com,2500.00,20/02/2025,3000.00,East Branch,456 East Rd,Checking,RM,20/02/2025,[Bob White]

765498764321,C003,Bob White,016-354-8765,bwhite@gmail.com,3600.50,05/03/2025,7000.00,West Branch,789 West Ave,Savings,RM,05/03/2025,[Alice Smith]
```

Sample Customer Transaction Log File

```
transaction_id,customer_id,sender_account_number,transaction_type,recipient_id,recipient_account_number,amount,balance,transaction_detail,date,time

T0001,C001,235251356177,Transfer,C003,765498764321,-723.45,1276.55,Transfer sent to another account,03/02/2025,14:35:22

T0002,C002,234567891234,Transfer,C003,765498764321,-189.99,810.01,Transfer sent to another account,15/01/2025,09:47:18

T0003,C003,765498764321,Transfer,C004,345678912345,-1250.75,749.25,Transfer sent to another account,27/01/2025,16:12:54
```

Explanation on Program Logic

List of additional functions

1. BangBangBank.inc file
2. OTP generation
3. OTP timeout
4. Change color and title
5. Password masking
6. Data encryption
7. Validate login time, user account locking / unlocking
8. Change password with complexity validation
9. Extra fee for transactions exceeded daily transaction limit
10. File functions
11. Advanced account management, no need to logout to manage multiple accounts under the same customer_id
12. Usage of STRUCT to create user-defined type

1. Encryption

This module implements XOR encryption on data

Receives: Data array to be encrypted and the encryption key array

Returns: Encrypted data array's address in EAX

The program utilizes XOR operations to provide symmetric encryption on the user's password and PIN. It uses modulus operation to calculate the key character to be used for encryption. We make use of the DIV behaviour that stores the remainder in EDX and quotient in EAX to compute the next key index to be used for encryption.

For example:

data = “Pass12345@”

key = “elephant”

Data	P	a	s	s	1	2	3	4	5	@
Key	e	l	e	p	h	a	n	t	e	l
Key index	0 % 8 = 0	1 % 8 = 1	2 % 8 = 2	3 % 8 = 3	4 % 8 = 4	5 % 8 = 5	6 % 8 = 6	7 % 8 = 7	8 % 8 = 0	9 % 8 = 1

	01010000b	01100001b	01110011b	01110011b	00110001b	00110010b	00110011b	00110100b	00110101b	01000000b
XOR	01100101b	01101100b	01100101b	01110000b	01101000b	01100001b	01101110b	01110100b	01100101b	01101100b
Bin	00110101b	00001101b	00010110b	00000011b	01011001b	01010011b	01011101b	01000000b	01010000b	00101100b
Hex	35H	0DH	16H	03H	59H	53H	5DH	40H	50H	2CH

2. Daily Transaction Limit Handling

This module implements validateTransactionAmount to check if the transaction exceeds the daily limit (for Current accounts)the daily transaction limit and verify that the account has sufficient balance.

Receives: User input transaction amount and the user account array

Returns: Set carry flag or fee flag if invalid

Step 1: Account Type Checking

- Load user's account type from the userAccount structure.
- Compare the account type with the string "Current".
- If is current proceed to step 2, else continue with step 5.

Step 2: Setup Data For Validate Transaction Limit

- Load the user's transaction limit from userAccount structure and remove the decimal point.
- Load the user's account number into the senderTransaction structure.
- Get current system date with GetLocalTime and store the value in timeDate

Step3: Parse Transaction Limit of The Day

- The inputTotalTransactionFromTransaction procedure extracts sender's account number from the transaction log and compares it with the user's account number.
- If the account number is the same then extract all data from the transaction. (transaction_id,customer_id,sender_account_number,transaction_type,recipient_id,recipient_account_number,amount,balance,transaction_detail,date,time)
- Then compare the transaction date with current date (transaction date = = current date).
- If it is the same then add the amount into the daily total transaction.
- Repeat the procedure until the transaction log is empty.

Step 4: Transaction Limit Validation

- Remove the decimal point for the input transaction amount before calculation using removeDecimalPoint.
- Add the formatted input transaction amount to the daily total transaction (input transaction amount + daily total transaction) and store in totalWithCurrentTransaction.
- Compare the transaction limit with the total with current transaction amount (transaction limit + total with current transaction). "+" is used because the total with the current transaction is a negative value.
- Check if the value is negative. If it is positive, skip to step 5, else display over limit message and set fee flag to 1.

Step 5: Setup Data For Validate Account Balance

- Load user's account balance from userAccount structure.
- Remove decimal points for the input transaction amount.

Step 6: Balance Check

- Subtract the formatted input transaction amount from the account balance (account balance - input transaction amount).
- Check if the value is negative.
- If the value is negative, skip to step 7, else clear carry flag to indicate success and skip to step 8.

Step 7: Display and update

- Display insufficient balance message.
- Set carry flag to indicate failure.

Step 8: Done

- Restore register value and return to previous procedure.

3. Interest calculation and dispatch

   This module implements checkInterest to determine whether the user is eligible to receive interest or not. If eligible, it applies interest to the user account and updates the new interest apply date in the user's account file.

   Step 1. Initial Setup

   - Load user's account balance and convert the string value into numeric value.
   - Accesses the last interest apply date from the user's account record.

   Step 2. Date Parsing

   - The parseInterestDate procedure extracts day, month, and year from the user's last interest date.
   - The parsecurrentDate procedure extracts day, month, and year from the current system date.

   Step 3. Date Comparison

   - The code compares years first (If current year is more than 1 year after interest year, interest is applied)
   - If exactly 1 year difference, it checks month (Current month must be >= interest month)
   - If same month, it checks days (current day must be >= interest day)

   Step 4. Interest Calculation

   - If eligible, the code calculates interest (balance * 0.03)
   - Implemented as (balance * 3 / 100) with 50 before division for rounding
   - Result is stored in tempInterest

   Step 5. Balance Update

   - Adds the calculated interest to the current balance
   - Stores result in newBalance

   Step 6. Format Conversion

   - Converts the interest amount and new balance into formatted strings with RM and cents
   - Handles special cases like adding leading zeros for cents less than 10

   Step 7. Display and update

   - Displays the interest amount and new balance to the user
   - Updates the account structure with the new balance
   - Sets the interest application date to the current date
   - Updates the user account file with new information

   Step 8. Transaction Recording

   - Generates a new transaction ID
   - Creates a transaction record with:
     - Transaction ID
     - Customer ID
     - Account number
     - Transaction type: "Interest"
     - Amount (with "+" prefix)
     - Updated balance
     - Transaction description: "Interest from BangBangBank"

    - Current date
- Inserts the transaction into the transaction log

4. Decimal calculation

    This module implements ADD, to add up both input decimal

    Receives: 2 Decimal in string and a result destination

    Returns: Final result stored in the result destination

Before doing calculation, removeDecimalPoint module is used to remove the decimal point in the string to carry out calculation.

The decimalArithmetic module is used to handle both addition and subtraction operations on decimal numbers provided as strings.

Step 1, It first processes each input number by checking for sign characters ('+' or '-'), skipping them if present, and then converting the string representations to integer values using the StringToInt function.
Step 2, For negative inputs, it sets a flag and later negates the numeric value.
Step 3, After conversion, it performs either addition or subtraction based on the operation parameter. (ADD or SUB)
Step 4, The procedure then formats the result by checking if it's negative, prepending a minus sign if necessary
Step 5, Converting the integer result back to a string using the IntToString function.

This function is designed to work with decimal numbers represented as strings, supporting signed arithmetic operations while handling all necessary string-to-integer and integer-to-string conversions.

The decimalDivide module will handle division operations between two decimal numbers represented as strings.

Repeat Step 1 and Step 2 in decimalArithmetic.
Step 3, The code carefully validates the divisor to prevent division by zero—if detected, it writes an "Error" message to the result buffer and returns an error code of 1 in EAX.
Step 4, When the division is valid, it performs the operation using the DIV instruction, which places the quotient in EAX and the remainder in EDX.
Step 5, The procedure stores both values in local variables, applying any necessary sign adjustment to the result.
Step 6, Finally, it converts the integer quotient back to a string representation using IntToString.
This function handles all aspects of decimal division including sign management, zero divisor checking, and proper integer-to-string conversion for the result.

To display the result, the addDecimalPoint module is used to add back the decimal point that removed from removeDecimalPoint module

decimalArithmetic

Example Steps	removeDecimalPoint	positive/negative sign handler	Calculation (decimalArithmetic)	addDecimalPoint

“-9999.00”	“-999900”	“999900” isNegative = 1 -> -999900		
“8888.00”	“888800”	“888800” isNegative=0 -> 888800		
+	+	+	-111100 -> “-111100”	“-1111.00”

decimalDivide

Example Steps	removeDecimalPoint	positive/negative sign handler	Calculation (decimalDivide)	addDecimalPoint
“-9999.00”	“-999900”	“999900” isNegative = 1 -> -999900		
“11”		11	-90900 -> “-90900”	“-909.00”

References

Choy, L. F. (2023, September 12). *BACS1113 Computer Organisation and Architecture* [Slide show; Portable Document Format]. https://drive.google.com/drive/folders/1HsxHpZTAcrulED7oIRB4oAWRrjAJuPxP

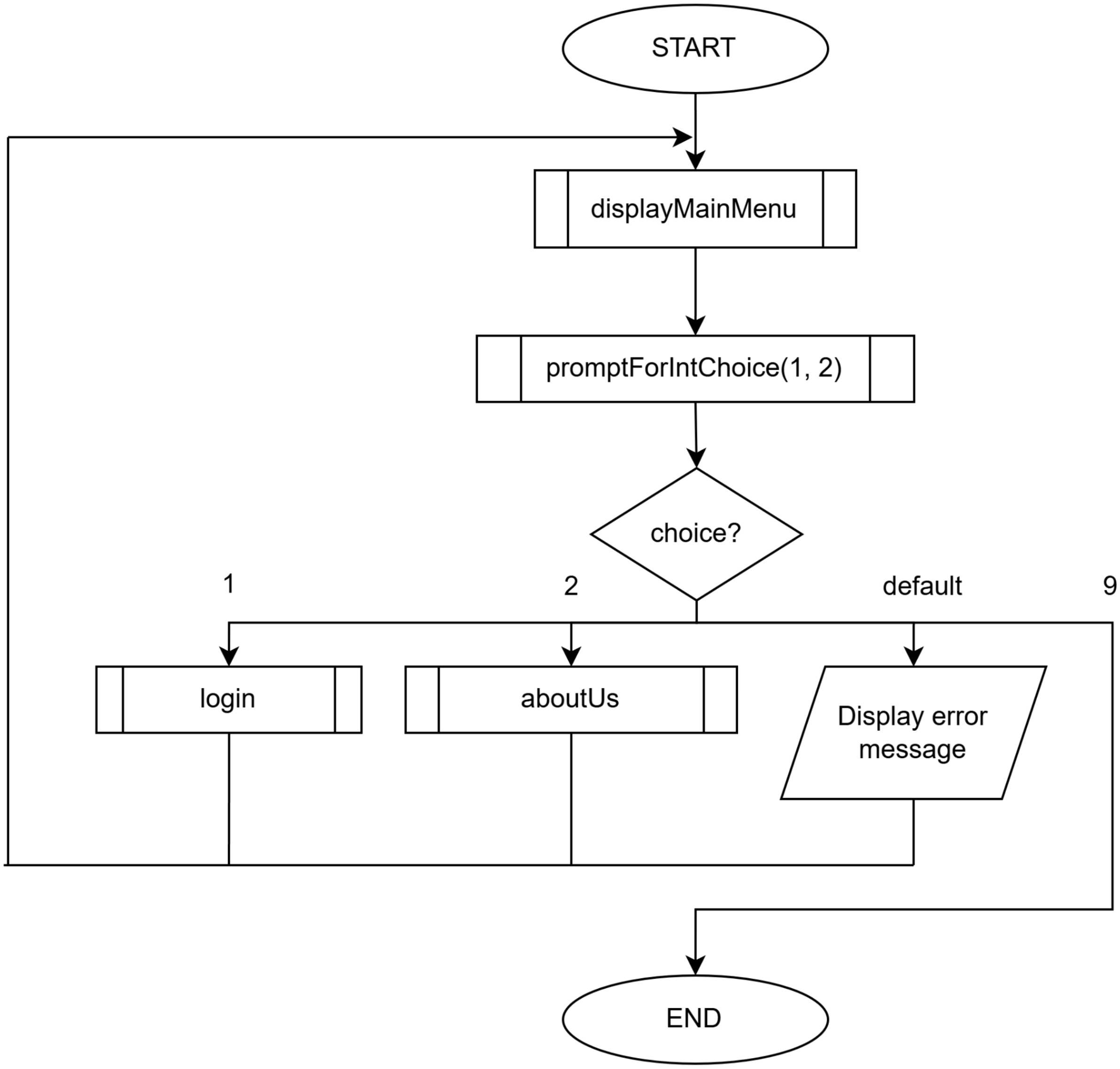
Irvine, K. (n.d.). *Assembly language for x86 processors*. http://kipirvine.com/asm/

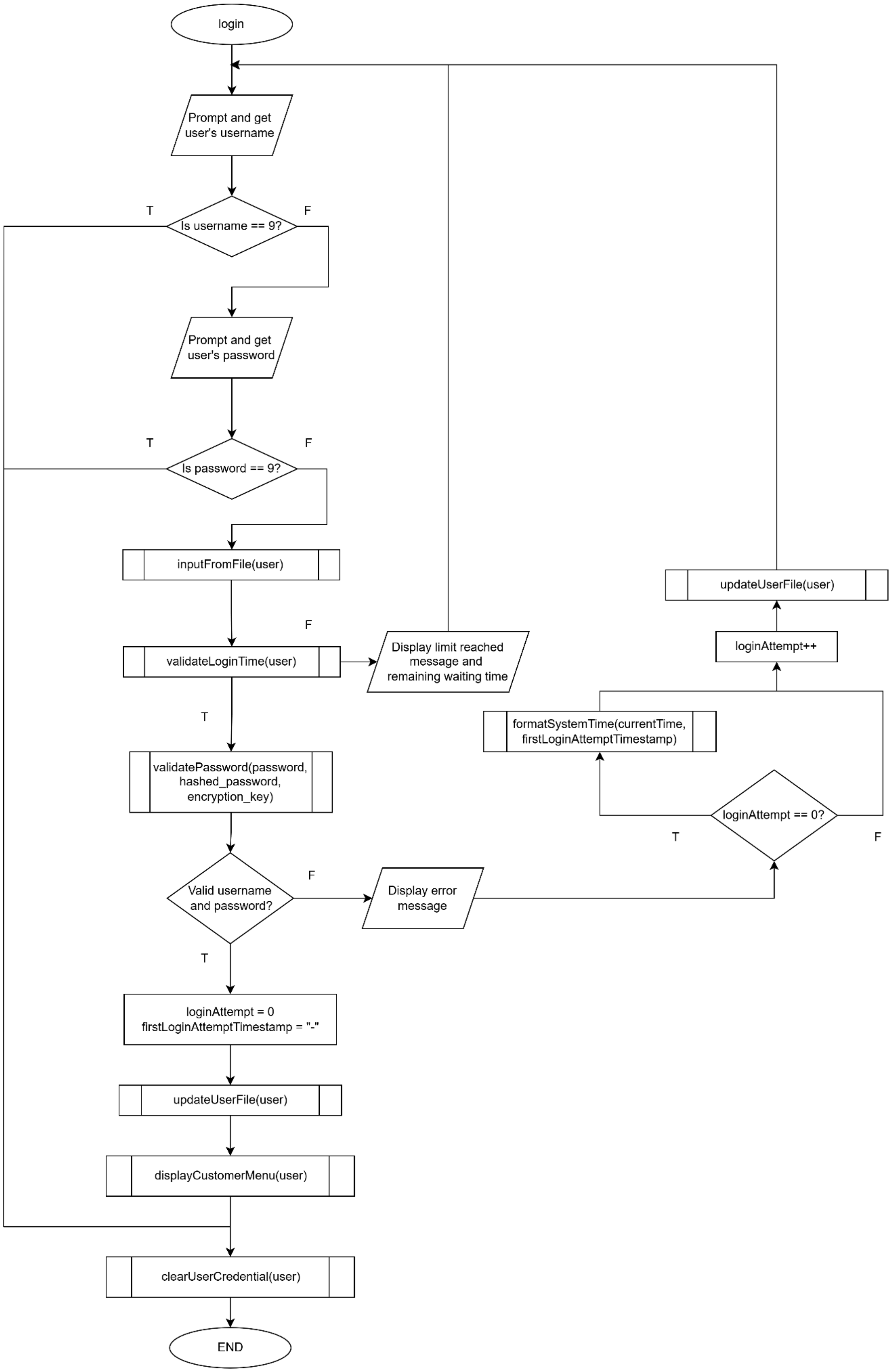
Ledin, J. (2022). *Modern computer architecture and organization: Learn x86, ARM, and RISC-V architectures and the design of smartphones, PCs, and cloud servers* (2nd ed.). Packt.

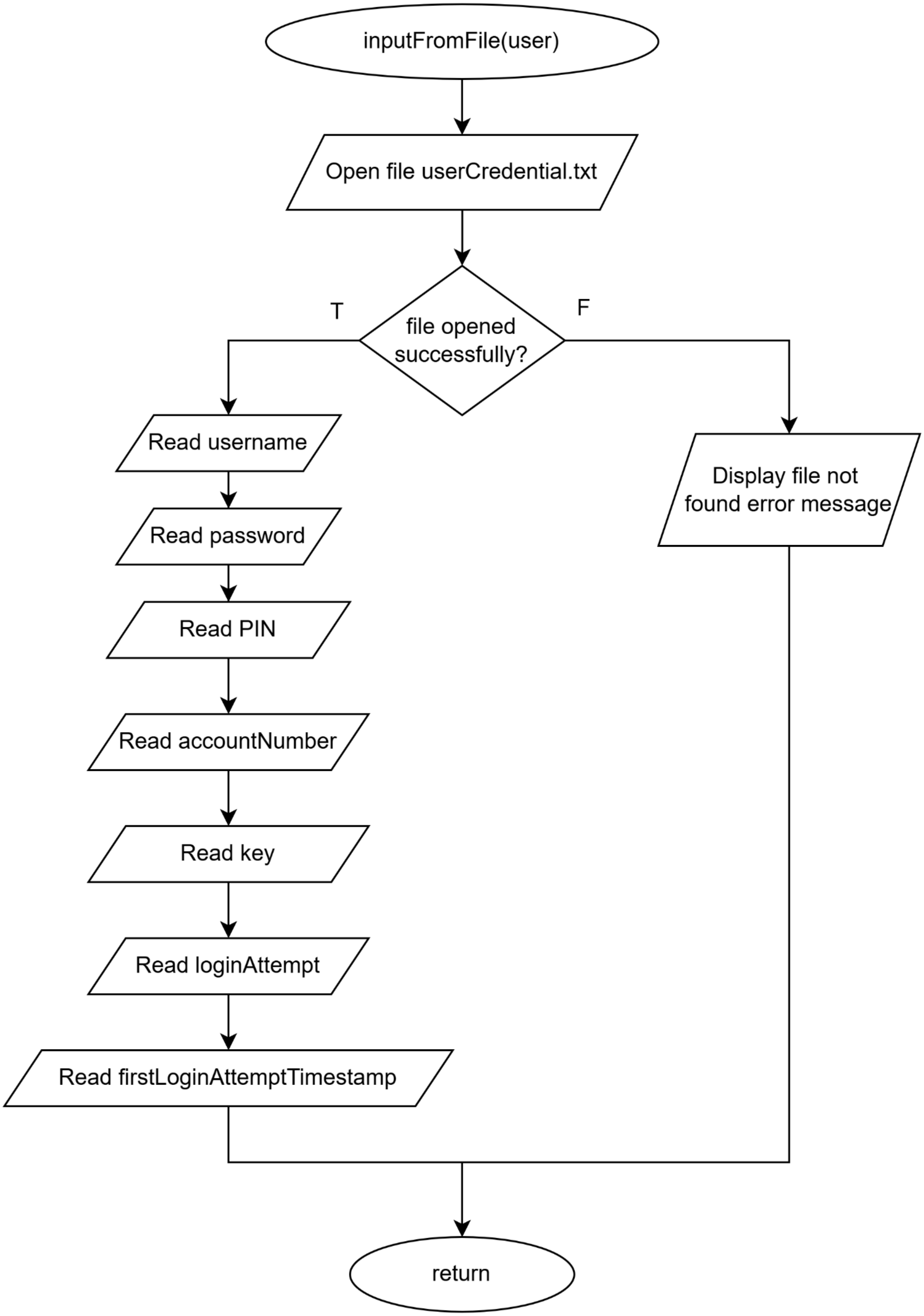
Flowchart link:

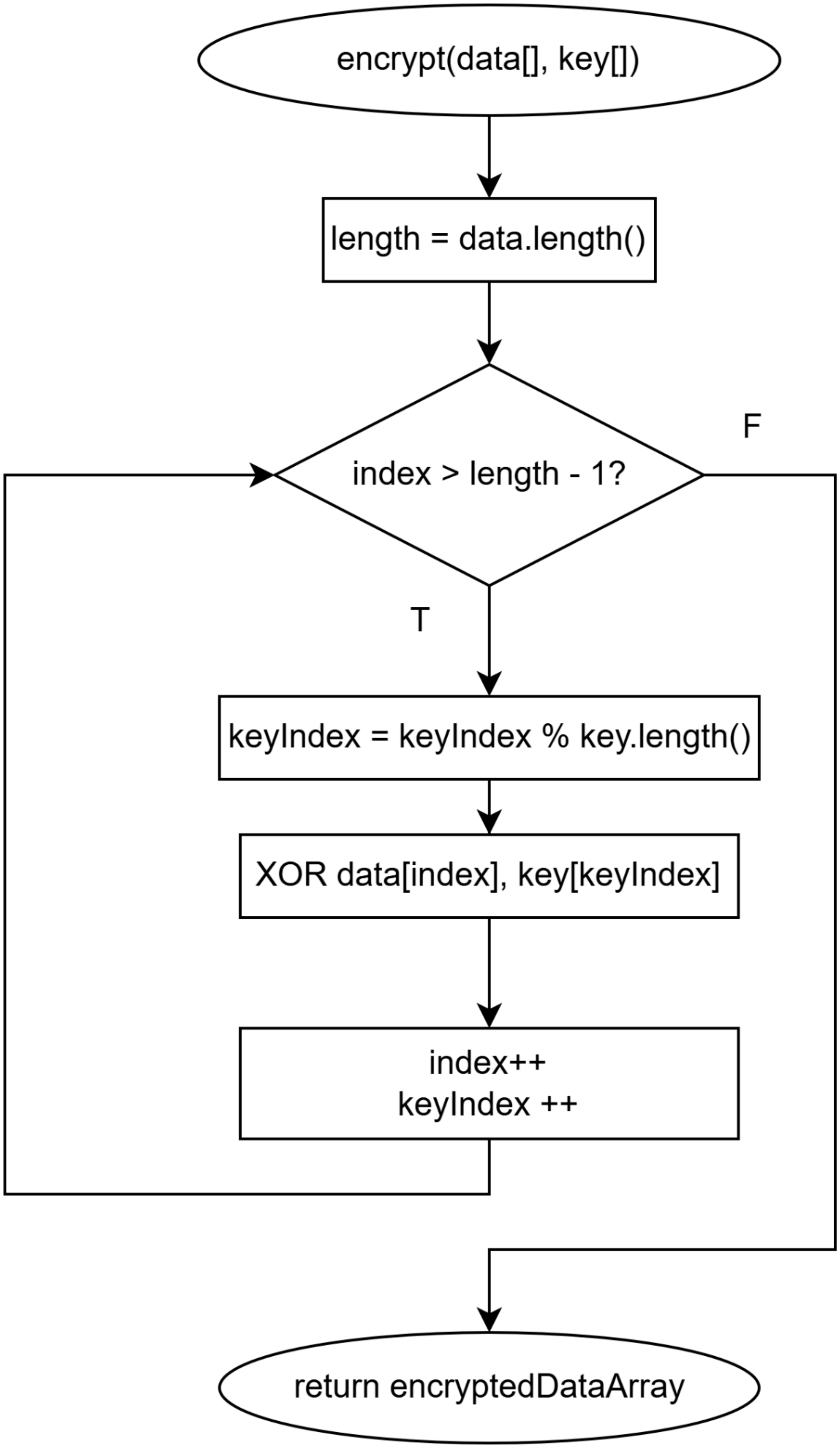
https://drive.google.com/file/d/1eonLOCw4hMhe4ZtsbDRywrrU8ZENhbt_/view?usp=sharing

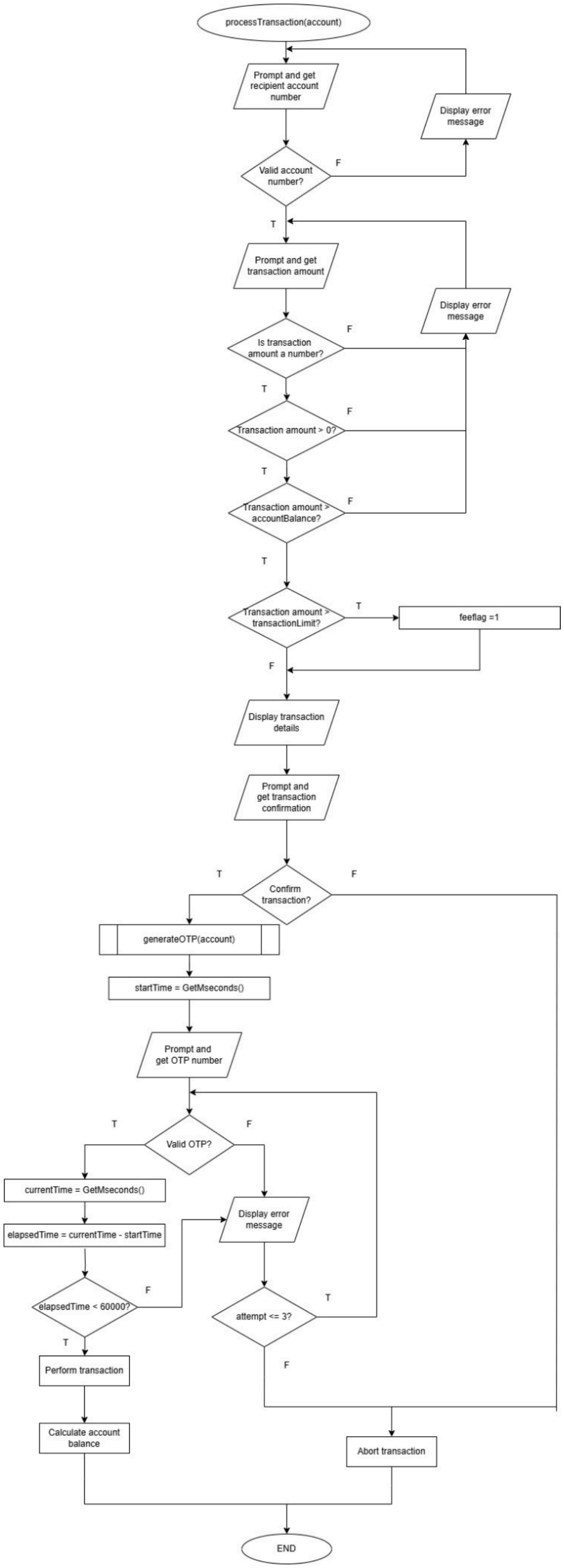
Appendix A: Flowchart

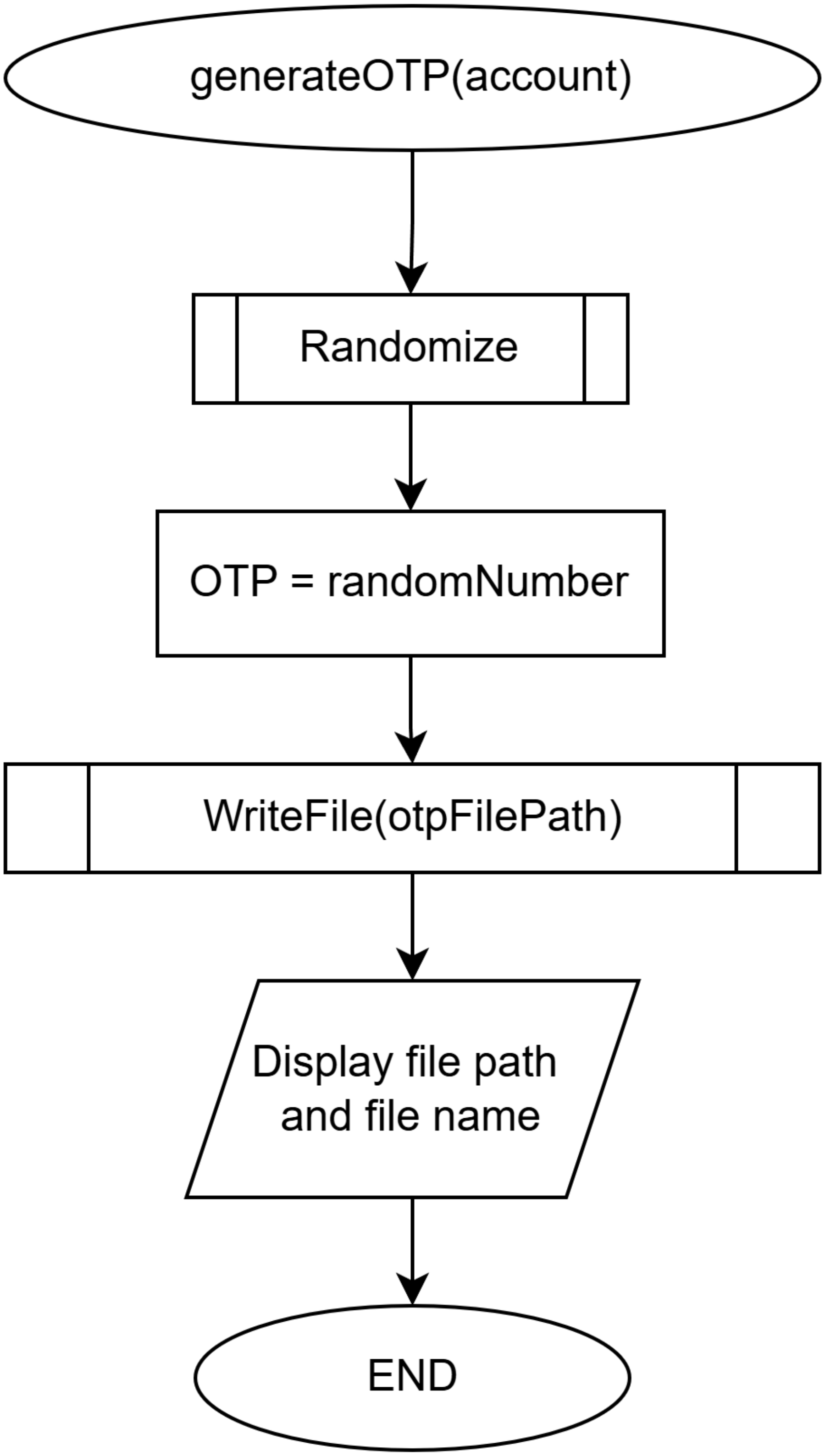


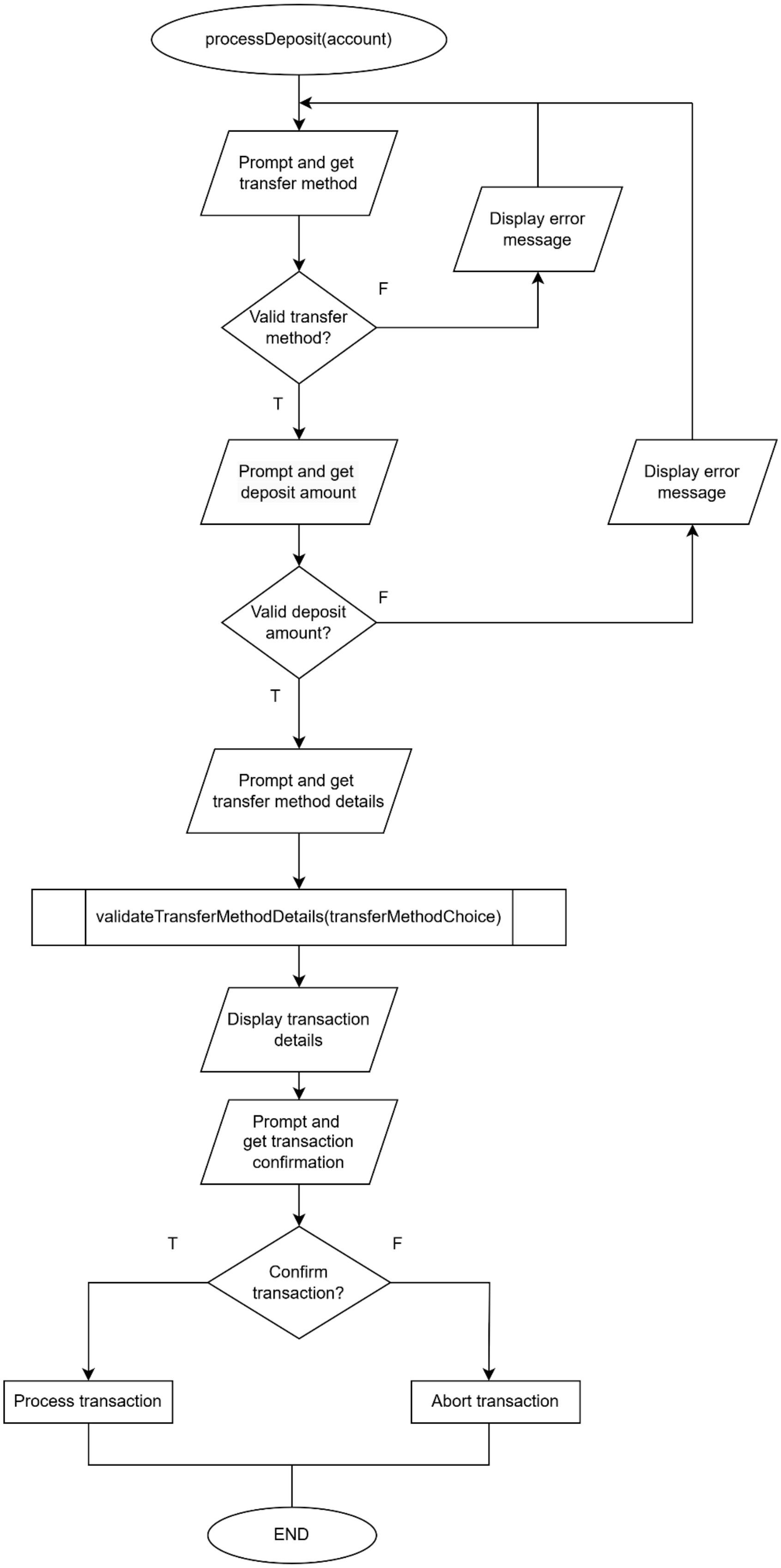

login
Prompt and get user's username
T
Is username == 9?
F
Prompt and get user's password
T
Is password == 9?
F
inputFromFile(user)
F
validateLoginTime(user)
Display limit reached message and remaining waiting time
T
validatePassword(password, hashed_password, encryption_key)
Valid username and password?
F
Display error message
T
loginAttempt = 0
firstLoginAttemptTimestamp = "-"
updateUserFile(user)
displayCustomerMenu(user)
clearUserCredential(user)
END
updateUserFile(user)
loginAttempt++
formatSystemTime(currentTime, firstLoginAttemptTimestamp)
T
loginAttempt == 0?
F

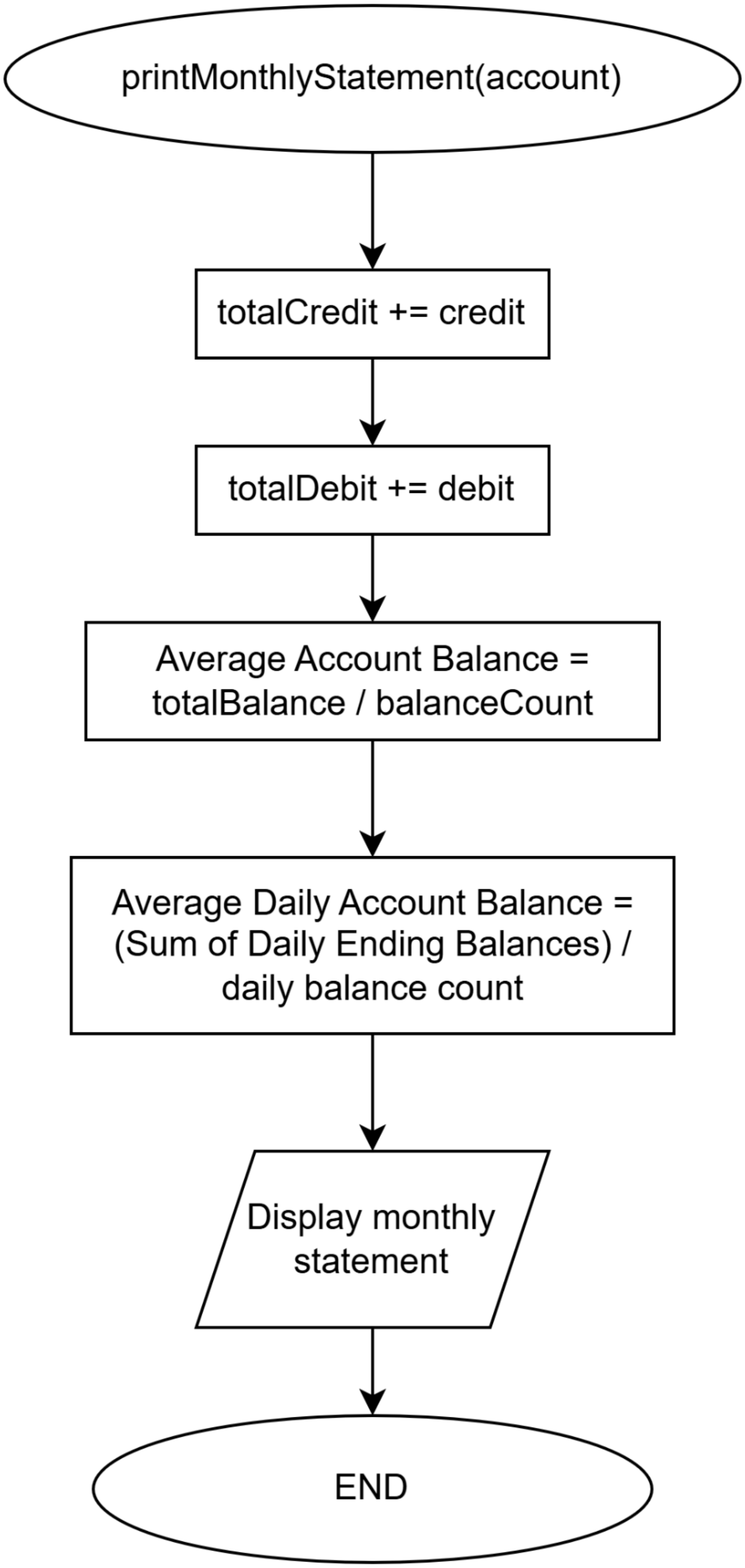

inputFromFile(user)
Open file userCredential.txt
file opened successfully?
T
F
Read username
Read password
Read PIN
Read accountNumber
Read key
Read loginAttempt
Read firstLoginAttemptTimestamp
Display file not found error message
return

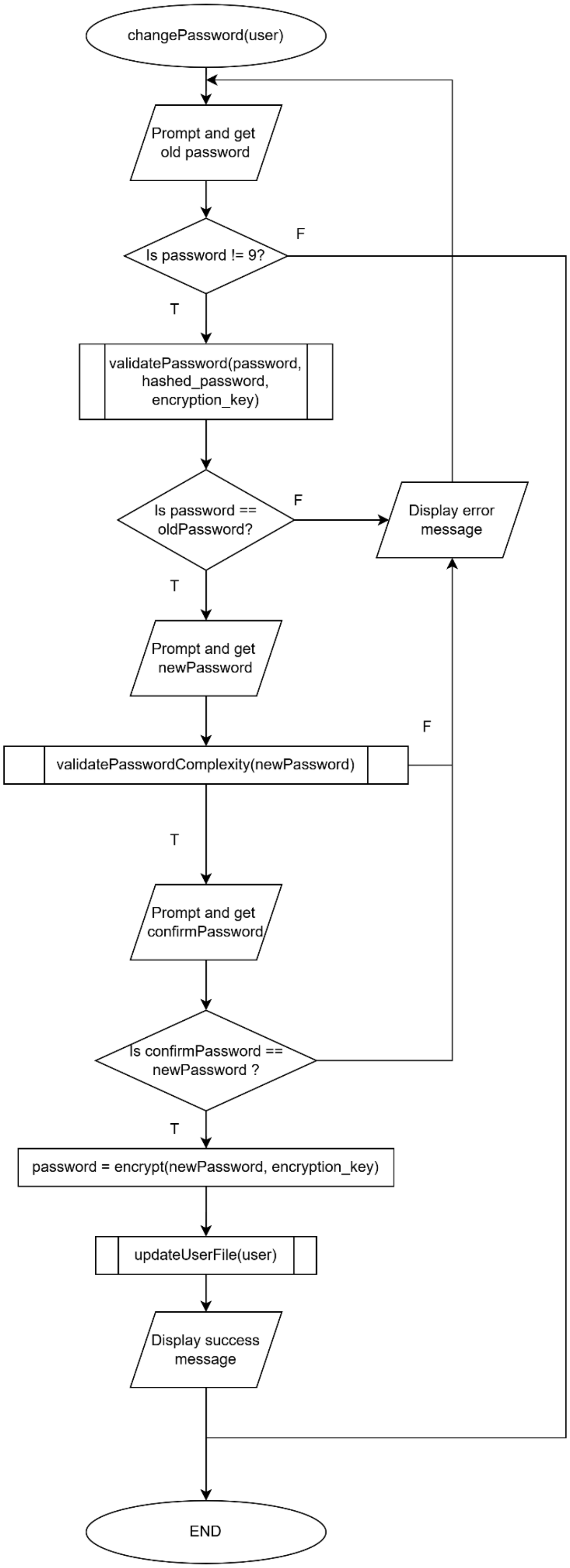

encrypt(data[], key[])
length = data.length()
index > length - 1?
F
T
keyIndex = keyIndex % key.length()
XOR data[index], key[keyIndex]
index++
keyIndex ++
return encryptedDataArray

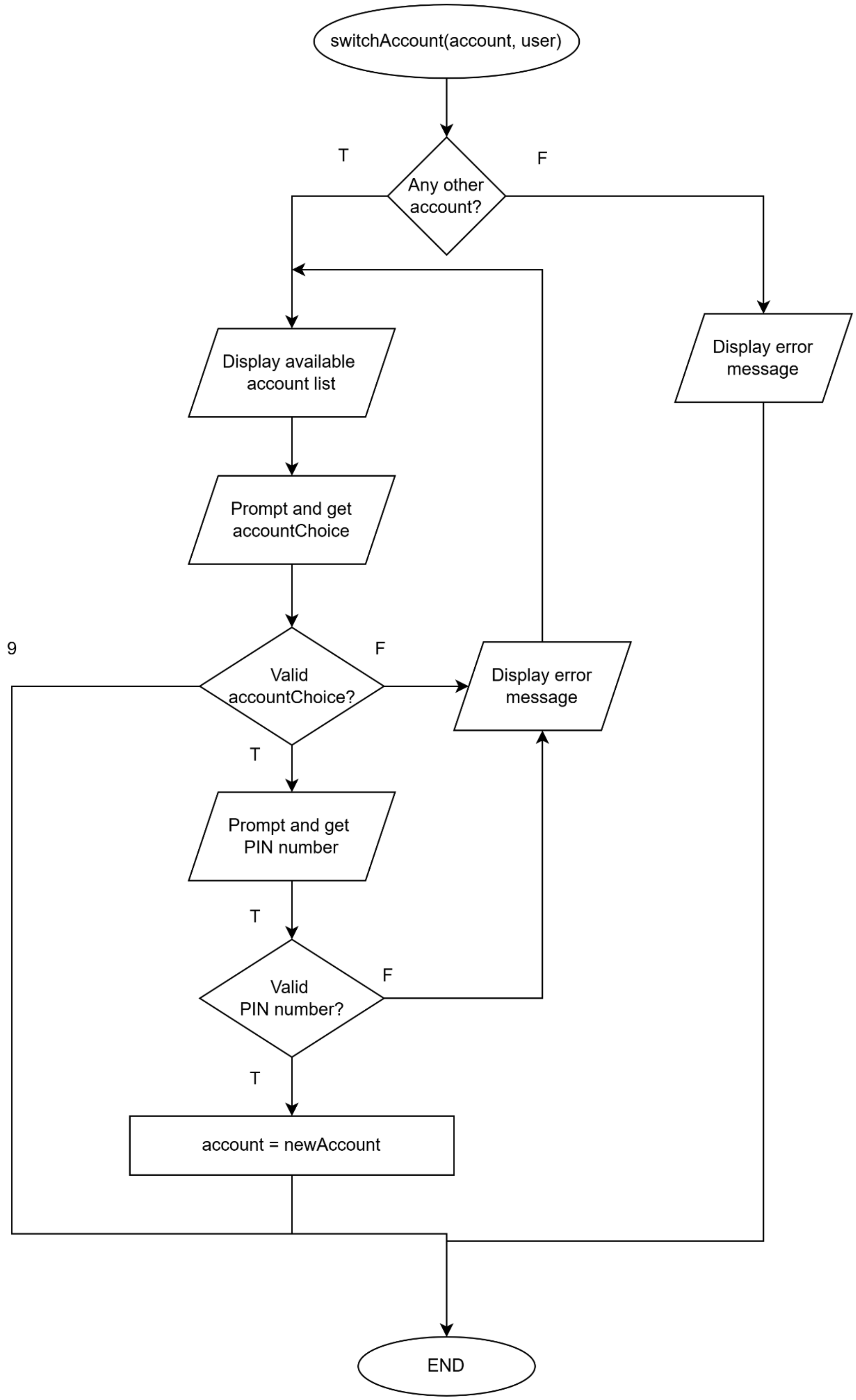

processTransaction(account)
Prompt and get recipient account number
Valid account number?
F
Display error message
T
Prompt and get transaction amount
Is transaction amount a number?
F
Display error message
T
Transaction amount > 0?
F
T
Transaction amount > accountBalance?
F
T
Transaction amount > transactionLimit?
T
feeflag =1
F
Display transaction details
Prompt and get transaction confirmation
T
Confirm transaction?
F
generateOTP(account)
startTime = GetMseconds()
Prompt and get OTP number
T
Valid OTP?
F
currentTime = GetMseconds()
elapsedTime = currentTime - startTime
Display error message
elapsedTime < 60000?
F
attempt <= 3?
T
T
F
Perform transaction
Calculate account balance
Abort transaction
END


generateOTP(account)
Randomize
OTP = randomNumber
WriteFile(otpFilePath)
Display file path and file name
END


processDeposit(account)
Prompt and get transfer method
Valid transfer method?
F
Display error message
T
Prompt and get deposit amount
Valid deposit amount?
F
Display error message
T
Prompt and get transfer method details
validateTransferMethodDetails(transferMethodChoice)
Display transaction details
Prompt and get transaction confirmation
T
Confirm transaction?
F
Process transaction
Abort transaction
END


printMonthlyStatement(account)
totalCredit += credit
totalDebit += debit
Average Account Balance = totalBalance / balanceCount
Average Daily Account Balance = (Sum of Daily Ending Balances) / daily balance count
Display monthly statement
END


changePassword(user)
Prompt and get old password
Is password != 9?
F
T
validatePassword(password, hashed_password, encryption_key)
Is password == oldPassword?
F
Display error message
T
Prompt and get newPassword
F
validatePasswordComplexity(newPassword)
T
Prompt and get confirmPassword
Is confirmPassword == newPassword ?
T
password = encrypt(newPassword, encryption_key)
updateUserFile(user)
Display success message
END


switchAccount(account, user)
T
F
Any other account?
Display available account list
Display error message
Prompt and get accountChoice
9
F
Valid accountChoice?
Display error message
T
Prompt and get PIN number
T
F
Valid PIN number?
T
account = newAccount
END

Appendix B: File Data

Users\userCredential.txt

```
username,hashed_password,hashed_PIN,customer_id,encryption_key, loginAttempt, firstLoginAttemptTimestamp
Bob,35 0D 16 03 59 53 5D 34,54 5E 56 44 5D 57,C001,elephant,0,-
asmith,37 0C 0D 1A 01 04 25 32 17 1A,56 5A 5A 5A 45 56,C002,dinosaur,0,-
bwhite,33 23 1D 1D 0A 56 79 51,44 4C 4B 5E 5C 54,C003,strongKey,0,-
Chen,3E 0A 1C 13 1D 27 01,7F 5D 41 40 5D 78,C004,North,0,-
Sarah,23 0E 06 07 1F 3C 1D 11,65 5A 41 47 5A 62,C005,South,0,-
```

Users\userAccount.txt

```
account_number,customer_id,full_name,phone_number,email,account_balance,opening_date,transaction_limit,branch_name,branch_address,account_type,currency,interest_apply_date,beneficiaries
235251356177,C001,Bobby,012-555-1234,jdoe@gmail.com,5404.72,15/01/2025,7000.00,Main Branch,123 Main St,Current,RM,17/04/2025,[Chen Wei. Sarah Jones]
123456781234,C001,Bobby,012-555-1234,jdoe@gmail.com,9912.76,15/01/2025,5000.00,Main Branch,123 Main St,Savings,RM,15/01/2025,[Chen Wei. Sarah Jones]
987654321234,C001,Bobby,012-555-1234,jdoe@gmail.com,4430.24,02/04/2024,5000.00,Main Branch,123 Main St,BBB Wallet,RM,02/04/2025,[Sarah Jones]
234567891234,C002,Alice Smith,013-535-5678,asmith@gmail.com,2300.00,20/02/2025,3000.00,East Branch,456 East Rd,Checking,RM,20/02/2025,[Bob White]
765498764321,C003,Bob White,016-354-8765,bwhite@gmail.com,3600.50,05/03/2025,7000.00,West Branch,789 West Ave,Savings,RM,05/03/2025,[Alice Smith]
```

```
345678912345,C004,Chen Wei,017-654-3210,cwei@gmail.com,4950.25,12/03/2025,6500.00,North Branch,321 North Blvd,Checking,RM,12/03/2025,[Bobby. Sarah Jones]
456789123456,C005,Sarah Jones,019-765-4321,sjones@gmail.com,980.50,04/06/2024,250.00,South Branch,654 South St,Savings,RM,04/06/2024,[Chen Wei. Bobby]
```

Users\transactionLog.txt

```
transaction_id,customer_id,sender_account_number,transaction_type,recipient_id,recipient_account_number,amount,balance,transaction_detail,date,time
T0001,C001,235251356177,Transfer,C003,765498764321,-723.45,1276.55,Transfer sent to another account,03/02/2025,14:35:22
T0002,C002,234567891234,Transfer,C003,765498764321,-189.99,810.01,Transfer sent to another account,15/01/2025,09:47:18
T0003,C003,765498764321,Transfer,C004,345678912345,-1250.75,749.25,Transfer sent to another account,27/01/2025,16:12:54
T0004,C001,235251356177,Deposit,,,+852.33,2128.88,Cash deposit into account,04/02/2025,10:23:41
T0005,C001,235251356177,Transfer,C005,456789123456,-345.67,1783.21,Transfer sent to another account,08/02/2025,13:19:05
T0006,C001,235251356177,Deposit,,,+1125.50,2908.71,Cash deposit into account,12/02/2025,08:52:37
T0007,C001,235251356177,Deposit,,,+478.92,3387.63,Cash deposit into account,18/02/2025,11:45:29
T0008,C001,235251356177,Transfer,C004,345678912345,-892.14,2495.49,Transfer sent to
```

another account,23/02/2025,15:31:46

T0009,C001,235251356177,Deposit,,,+643.21,3138.70,Cash deposit into account,01/03/2025,09:05:12

T0010,C001,235251356177,Deposit,,,+295.75,3434.45,Cash deposit into account,07/03/2025,12:39:58

T0011,C001,235251356177,Transfer,C002,234567891234,-567.89,2866.56,Transfer sent to another account,15/03/2025,14:28:33

T0012,C001,235251356177,Deposit,,,+731.45,3598.01,Cash deposit into account,21/03/2025,10:17:24

T0013,C001,235251356177,Deposit,,,+419.83,4017.84,Cash deposit into account,24/03/2025,16:42:19

T0014,C001,235251356177,Transfer,C003,765498764321,-634.29,3383.55,Transfer sent to another account,28/03/2025,11:09:47

T0015,C001,235251356177,Deposit,,,+519.67,3903.22,Cash deposit into account,02/04/2025,13:54:36

T0016,C001,,Deposit,,,+200.00,2700.12,Deposit into account,10/04/2025,15:24:38

T0017,C001,235251356177,Transfer,C003,765498764321,-100.00,2600.12,Transfer sent to another account,10/04/2025,15:25:54

T0018,C001,,Deposit,,,+100.00,2700.12,Duit kopi rasuah,10/04/2025,15:39:38

T0019,C001,235251356177,Transfer,C001,123456781234,-300.00,2400.12,Transfer sent to another account,14/04/2025,16:53:19

T0020,C001,235251356177,Transfer,C001,123456781234,-1000.00,1400.12,Transfer sent to another account,14/04/2025,16:57:23

T0021,C001,235251356177,Transfer,C001,123456781234,-501.00,899.12,Transfer sent to another account,14/04/2025,17:17:24

```
T0022,C001,235251356177,Transfer,C001,123456781234,-500.01,399.11,1,14/04/2025,17:18:30
T0023,C001,,Deposit,,,+5000.00,5399.11,Deposit into account,14/04/2025,17:18:53
T0024,C001,235251356177,Transfer,C001,123456781234,-1111.00,4288.11,1,14/04/2025,17:30:32
T0025,C001,235251356177,Transfer,C001,123456781234,-4000.00,287.11,Transfer sent to another account,14/04/2025,21:03:31
T0026,C001,,Deposit,,,+100.00,387.11,Duit Kopi. 2.0 :],15/04/2025,17:44:16
T0027,C001,,Deposit,,,+1000.00,9912.76,Deposit into account,15/04/2025,20:35:18
T0028,C001,235251356177,Interest,,,+8.62,295.84,Interest from BangBangBank,17/04/2025,00:57:01
T0029,C001,235251356177,Interest,,,+8.88,304.72,Interest from BangBangBank,17/04/2025,00:59:33
T0030,C001,,Deposit,,,+4000.00,4304.72,Deposit into account,18/04/2025,09:08:54
T0031,C002,234567891234,Transfer,C004,345678912345,-100.00,2400.00,Transfer sent to another account,18/04/2025,20:31:03
T0032,C002,234567891234,Transfer,C004,345678912345,-100.00,2300.00,Transfer sent to another account,18/04/2025,20:37:06
T0033,C001,235251356177,Transfer,C001,235251356177,-7000.00,304.72,Transfer sent to another account,18/04/2025,20:53:33
T0034,C001,,Deposit,,,+100.00,4404.72,Deposit into account,18/04/2025,21:10:24
T0035,C001,,Deposit,,,+1000.00,5404.72,Deposit into account,18/04/2025,21:10:36
```

Original\plainTextCredentials.txt

```
username    |    password    |    PIN
=============================================
```

Bob	Pass123@	123456
asmith	SecureP@ss	234567
bwhite	@Word124	789123
Chen	penguin	123456
Sarah	password	654321

Put 54 at Bob’s password field for debugging purpose, password = 1