Faculty of Computing and Information Technology

Assignment

OCT 2019 Semester

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Submission Date	:	**Week 12, Friday, before 12 noon**	

Members' Name	**Introduction**	**Coding & logic**	**I/O design**	**Leadership and teamwork**	**Total**
	(15marks)	**(40marks)**		**(5 marks)**	**(60 marks)**
1)					
2)					

3)					
Comment:					
Date of submission	**:**				
Date received **(to-be filled by the tutor received)**	**:**				

Semester: 2 Course Code & Title: AACS3064 Computer Systems Architecture

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Date: 3-January-2020

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Part 1 Introduction about the system

1.0 Industry Selected

Agriculture - Meat Producer Company

1.1 Company Background

1.1.1 Introduction

HOL Meat Company is a pork meat producer company headquartered and incorporated in Malaysia. It is one of the new participants in the market as a producer and seller of pork meat. HOL Meat Company employs 200 workers to handle its business processes such as slaughtering, cutting, and further processing.

1.1.2 Products

HOL Meat Company is one of the more prominent pork meat manufacturers in Malaysia. The company's main revenue source comes from selling processed pork meat to other distributors. Besides that, HOL Meat Company also offer direct sales to individual customers through its retail stores.

1.1.3 Company Outlook

As of 2018, HOL Meat Company grossed an annual income of MYR 300,000, netting a profit of RM100,000. HOL Meat Company company enjoys a high yearly growth due to the increased demand of pork meat, especially from the chinese restaurants where it is served as an exquisite dish. Besides that, by introducing good quality feed, and providing good amount of space for the pork to move around, HOL Meat Company has received positive feedbacks from its clients regarding the meat quality. HOL Meat Company, either directly, or indirectly, supplies pork meat for more than 40% of the restaurants and households in Malaysia.

1.1.4 Challenges

As of 2019, HOL Meat Company is still evaluating the weight and price of the pork meat using guesswork and weighing scale. This creates a problem in high volume sales has little to none surge capacity, which is especially limiting during holiday seasons. Besides that, as the company's popularity increases, the number of staff required also increases linearly. Therefore, the company is now looking for a solution to improve profits and efficiency in handling the evaluation part of pork sales.

1.2 Proposed Function

1.2.1 Login

One of the functions of the program is to allow the user to login/logout from the system. This system is in place to prevent unauthorized use of the system. Without this function in place, malicious customers can easily tamper with the operations of the weighing and calculating process, which can lead to a this system provides a degree of protection to serve as a deterrent for malicious acts.

1.2.2 Purchase function

One of the functions of the program is to allow the customer to purchase the meat. Firstly, the user will be prompted to select the desired type of meat (i.e pork ribs, pork loin, pork belly, etc). Then, the user is required to enter the weight (per packet) and quantity. The total weight of meat will immediately be calculated and displayed. After that, the program will ask the user whether he/she would want to edit the weight or quantity. If so, the new total weight of meat is recalculated and shown.

1.2.3 Billing function

The billing function is implemented to allow the user to make payment after purchasing and calculating the total weight of meat. In this module, the total price of meat is calculated by multiplying the total weight of meat and the price of meat (per Kilogram) that will be stored in an array. The program will multiply the total weight with the price (per kg) in respect of the type of meat selected. This is because different meat type will have different prices. Next, the user will need to choose to make payment in terms of RM, USD or SGD. The total payment will immediately be calculated and the user is required to enter the amount of payment. Lastly, the balance will be displayed if the user makes the payment successfully.

1.3 Proposed Formula

1.3.1 Login

- Password (default): P@ssw0rd
- Key (default): “e”
- Each character stored as hash. Hash = character XOR key
- To match the password, the program is required to compute the XOR hash of user input.

1.3.2 Purchase function

- Total weight of meat = Quantity of order * Weight of meat (per packet)

1.3.3 Billing function

- Price = Total weight of meat * Price of meat (per Kilogram)
- Conversion of Malaysia Ringgit (RM) to United States Dollar (USD) = Price / 4
- Conversion of Malaysia Ringgit (RM) to Singapore Dollar (SGD) = Price / 3

1.4 Assumptions

1.4.1 Login

- Password is hardcoded into the system, as the system is non-persistent.
- Users need to compute hash of the password themselves (using calculators/online tools) and store into the system.
- Password can only consist of alphabets, symbols, and numbers.
- Password maximum length is limited to 20 characters.

1.4.2 Purchase function

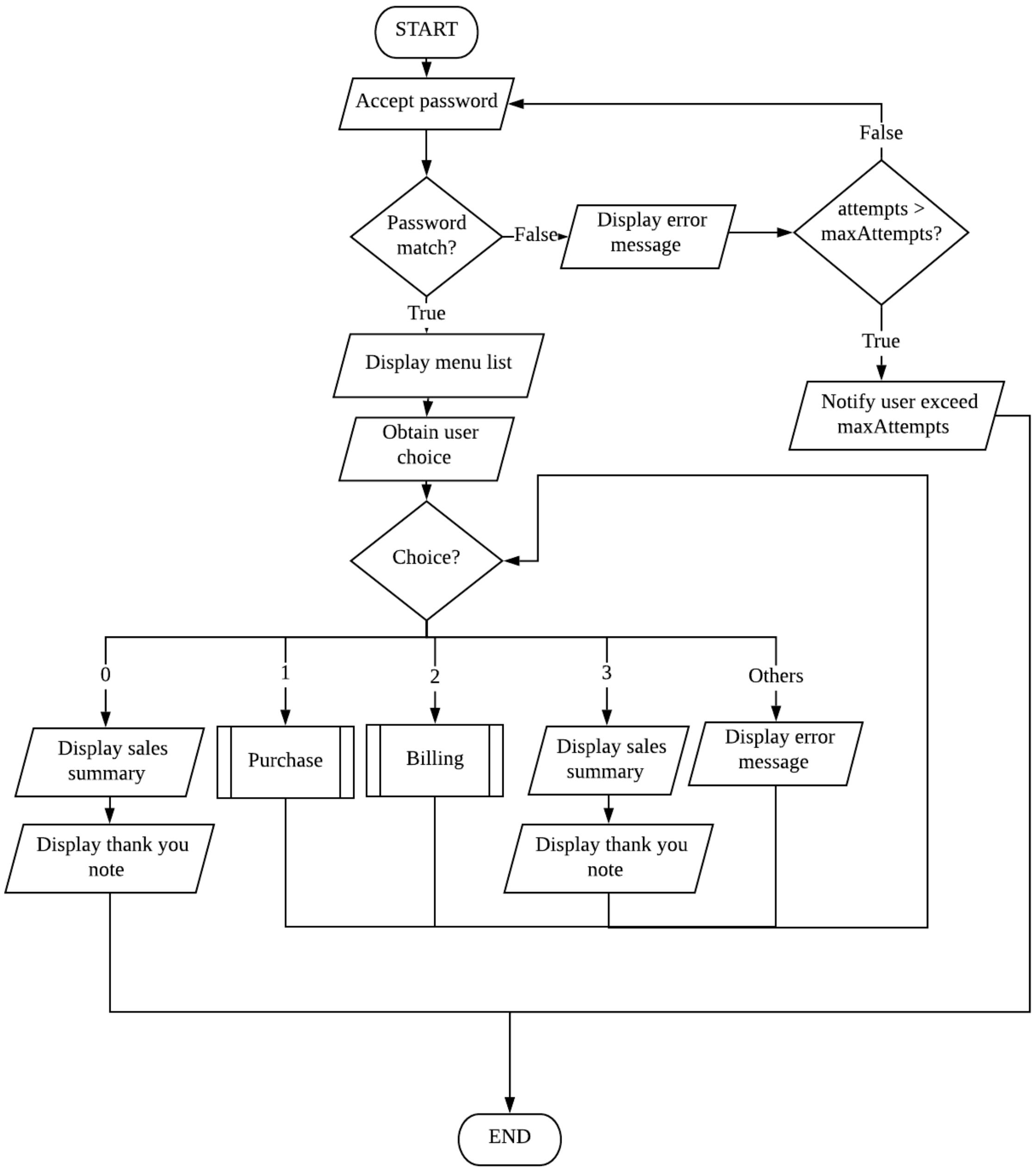
- The weight of each packet of meat is set to 1kg, 3kg and 5kg.
- The quantity of order must be a whole number.
- Each customer is limited to a maximum of 999 packets of meat
- Each customer can only purchase one kind of meat when entering the purchase function.

1.4.3 Billing function

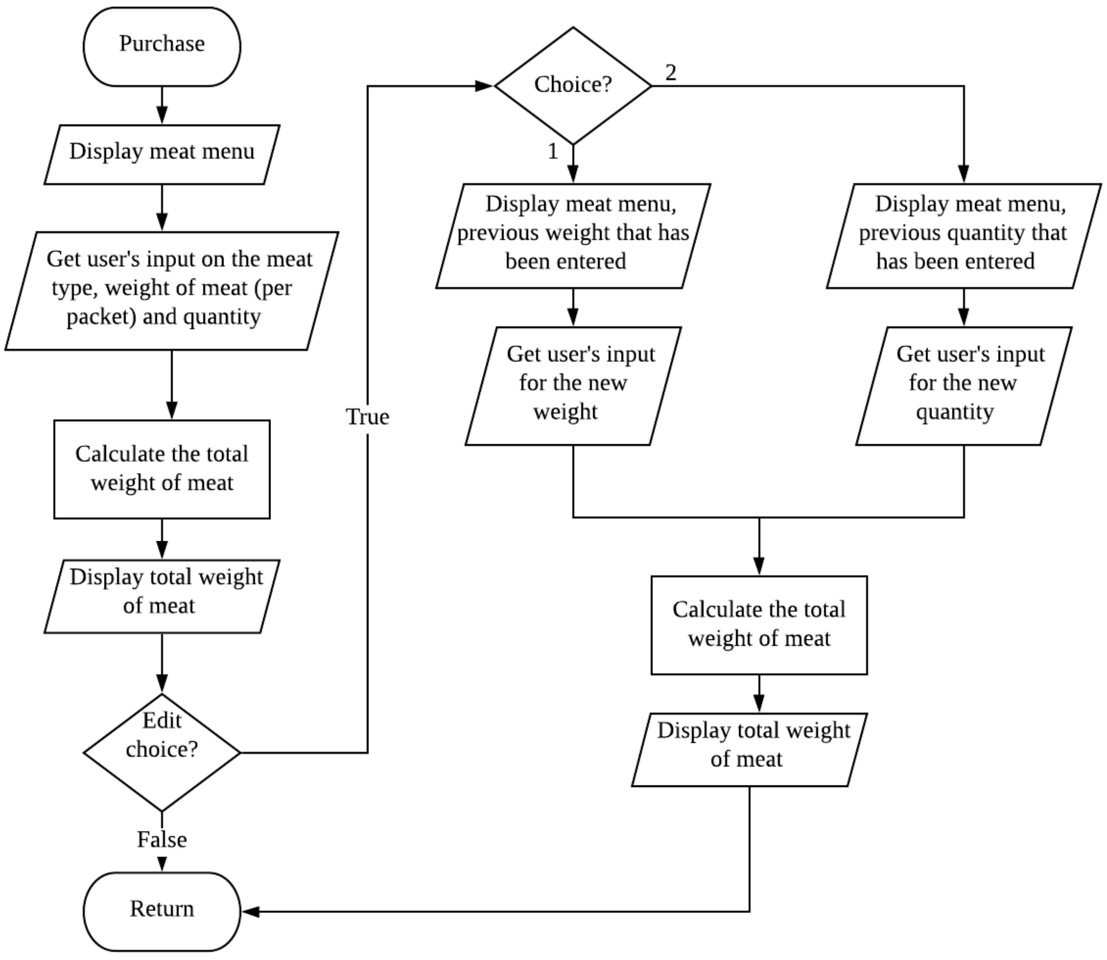
- Assume that the currency exchange rate from Malaysia Ringgit (RM) to United States Dollar (USD) is 4:1(RM 4 ≈ 1 US Dollar).
- Assume that the currency exchange rate from Malaysia Ringgit (RM) to Singapore Dollar (SGD) is 3:1 (RM 3 ≈ 1 SGD).

1.5 Flowchart

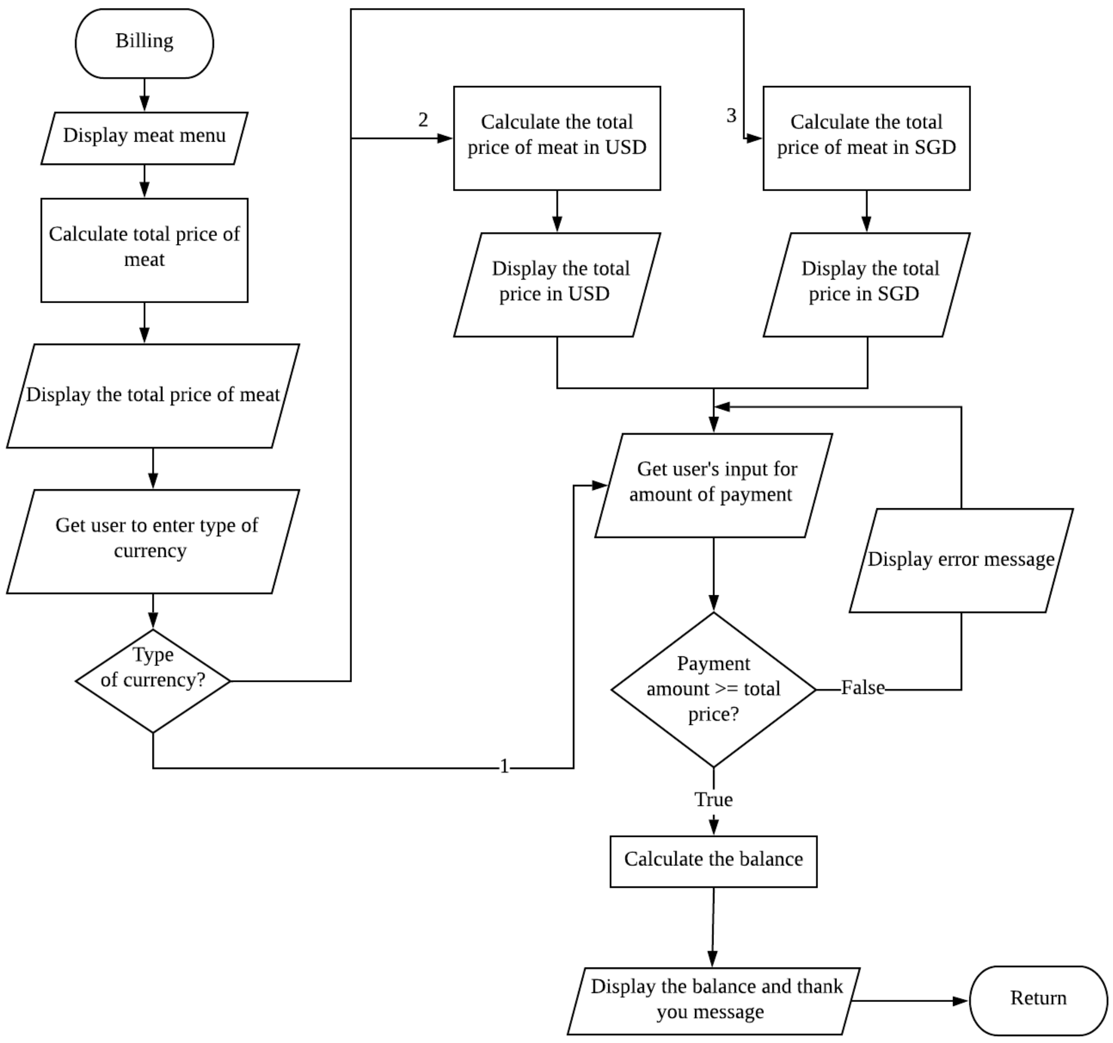
1.5.1 Overall program



1.5.2 Purchase Module


Purchase
Display meat menu
Get user's input on the meat type, weight of meat (per packet) and quantity
Calculate the total weight of meat
Display total weight of meat
Edit choice?
True
False
Return
Choice?
1
2
Display meat menu, previous weight that has been entered
Get user's input for the new weight
Display meat menu, previous quantity that has been entered
Get user's input for the new quantity
Calculate the total weight of meat
Display total weight of meat

1.5.3 Billing Module


Billing
Display meat menu
Calculate total price of meat
Display the total price of meat
Get user to enter type of currency
Type of currency?
1
2
3
Calculate the total price of meat in USD
Calculate the total price of meat in SGD
Display the total price in USD
Display the total price in SGD
Get user's input for amount of payment
Display error message
Payment amount >= total price?
False
True
Calculate the balance
Display the balance and thank you message
Return

Part 2 Coding & logic

2.1 Login Encryption Feature

One of the advanced features from the program is the login encryption & decryption feature. The main purpose of this feature is to prevent unauthorized users from accessing the system.

This feature encrypt the password by using a the XOR fucntion, and stores the password hash along with the key. This process makes the login system difficult to be bypassed through brute-force attacks.

When the user enters a password, each of their characters will have their password XOR-ed (eXclusive OR-ed) with the key for the hash. The output from the function is then compared with the character at the same location inside the password hash.

Besides that, this feature makes it harder for reverse-engineers to peek into the code and retrieve the plain-text password, as the actual password is not stored directly into the system. By doing so, the system's security is significantly increased.

2.1.1 Operation Example

When the password intended to be stored is **pass**, the ASCII representation of the password will be **112 97 115 115** in decimals. This translates to the following binary figures:

01110000 01100001 01110011 01110011

Instead of storing the actual binary representation, this feature will use a key provided to encrypt each binary figure by applying the XOR logical operation (refer to Appendix 1 to understand how XOR works given a set of inputs) using the key. As an example, **e**, in binary, is

01100101

When encrypted, the character will undergo the following calculation, and be stored as **21** in decimal inside the system:

```
      01110000 ← Input, Binary representation for p
XOR   01100101 ← Key, Binary representation for e
      --------------
      00010101 ← Output, In ASCII, this will be the 'NAK' special symbol, even if this cannot
                 be displayed on the screen, it still has a numerical value of 21 which will be
                 stored inside the system for comparison.
```

Therefore, the encrypted password will be stored as:

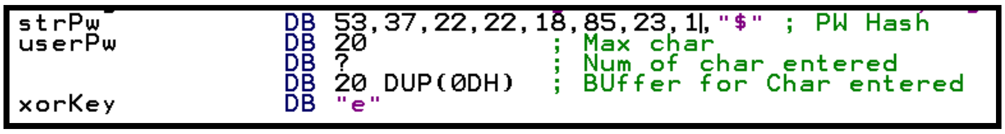
01110001 01110001 01110010 01110010

When the user attempts to login into the system, their input will undergo the same transformation with the key and be compared with the XORed password stored inside the system. Because XOR is a one-way function, it is very difficult to obtain the actual password from the password hash, thus hardening the system against unauthorized access.

2.1.2 Algorithm

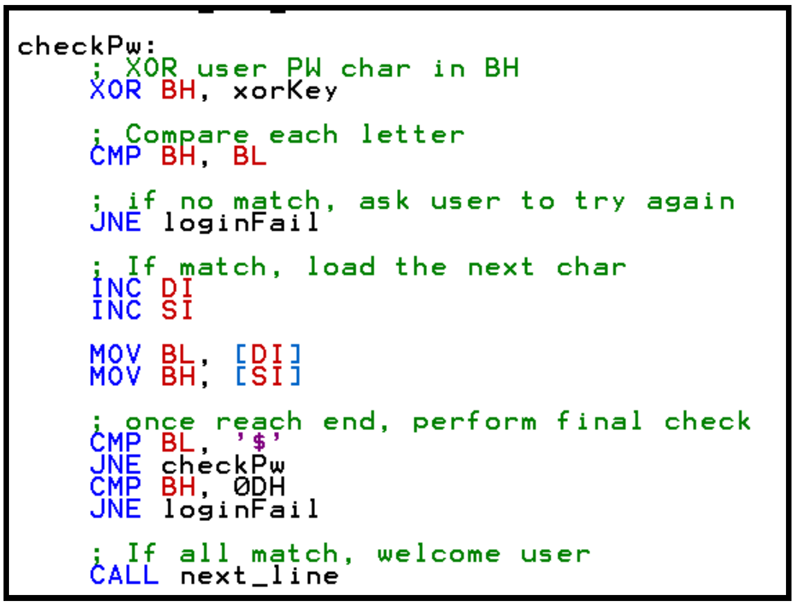
1. Obtain a character from user input inside `userPw`
2. XOR the character
3. Compare it with the character in the same location inside `strPw`
4. If matches,
    a. Check if the characters at the same location inside both `strPw` and `userPw` is "$"
        i. If yes, the password is valid, the user is authenticated
        ii. If not, the password is invalid, the user is denied access
    b. If not, compare the next character inside both `userPw` and `strPw`

2.1.3 Code snippet



```
strPw               DB 53,37,22,22,18,85,23,1, "$"  ; PW Hash
userPw              DB 20               ; Max char
                    DB ?                ; Num of char entered
                    DB 20 DUP(0DH)      ; BUffer for Char entered
xorKey              DB "e"
```

1. **strPw:** Stores the password hash of the actual password after being XOR-ed. The password is stored in decimals as some ASCII text cannot be displayed on screen.
2. **userPw:** A buffer for user string. Due to how assembly's string input (10H) does not allow for input over the maximum characters specified in the first field, no "overflow-checking" is required.
3. **xorKey:** The key used to perform the XOR encryption and decryption.



```
checkPw:
    ; XOR user PW char in BH
    XOR BH, xorKey

    ; Compare each letter
    CMP BH, BL

    ; if no match, ask user to try again
    JNE loginFail

    ; If match, load the next char
    INC DI
    INC SI

    MOV BL, [DI]
    MOV BH, [SI]

    ; once reach end, perform final check
    CMP BL, '$'
    JNE checkPw
    CMP BH, 0DH
    JNE loginFail

    ; If all match, welcome user
    CALL next_line
```

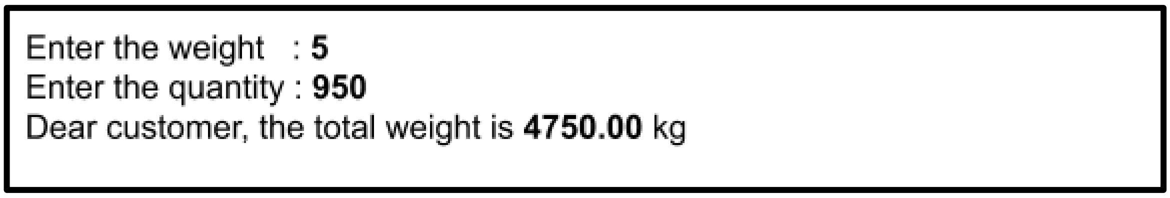
1. The code snippet above handles the XOR-ing of the user input and compares it with the characters stored inside strPw.

2.2 Four-digit number display

One of the advanced features from the program is the 4-digit display feature. The main purpose of this feature is to support for realistic, large numbers, at least enough to handle LOH's daily sales needs. For instance, some customers may buy the meats in bulk, and therefore total weight of the meat purchased can reach up to 4 digits. As a result, the total price of the meat will also be up to 5 digits.

2.2.1 Operation Example

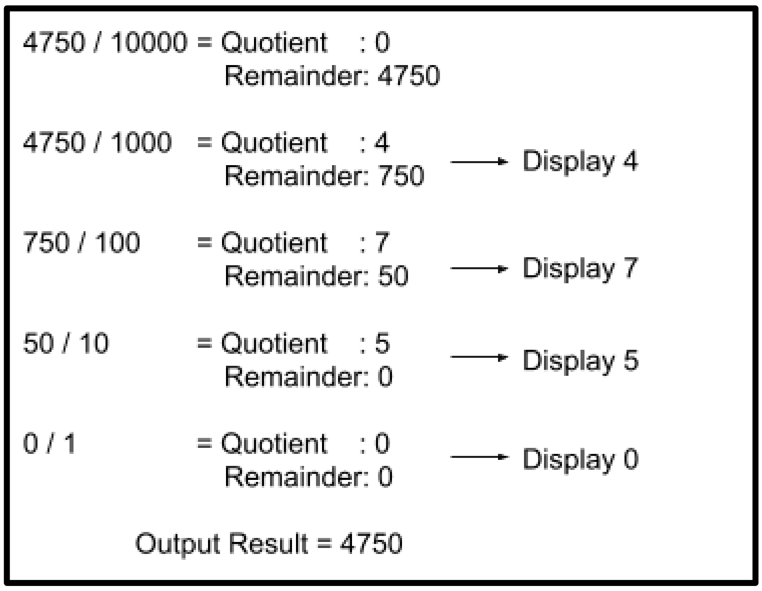
The user first enter the weight of meat (per packet) and quantity purchased. The total weight of meat (result) is then obtained through the multiplication of the weight of meat (per packet) and quantity.



```
Enter the weight   : 5
Enter the quantity : 950
Dear customer, the total weight is 4750.00 kg
```

Figure : Input data by the user and the display of output result

Suppose that the total weight of meat is 4750.00 kg. The result obtained will undergo a division process in order to be displayed.



```
4750 / 10000 = Quotient   : 0
               Remainder: 4750

4750 / 1000  = Quotient   : 4
               Remainder: 750    ──→ Display 4

750 / 100    = Quotient   : 7
               Remainder: 50     ──→ Display 7

50 / 10      = Quotient   : 5
               Remainder: 0      ──→ Display 5

0 / 1        = Quotient   : 0
               Remainder: 0      ──→ Display 0

          Output Result = 4750
```

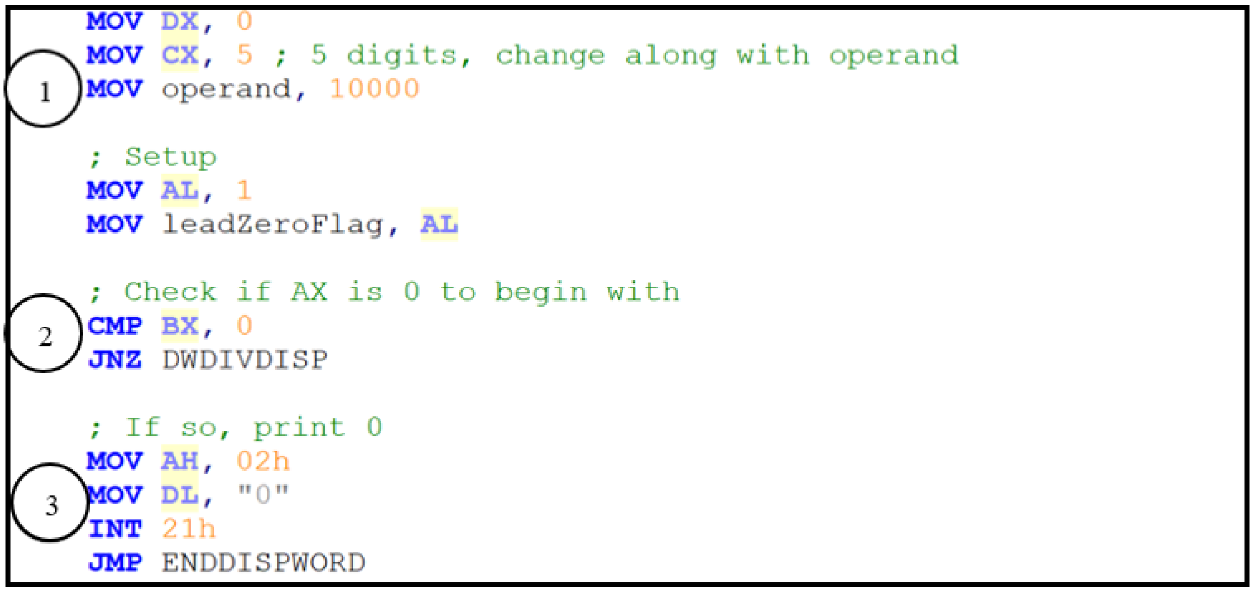
Figure : Division process that is involved in displaying 4-digit number

By applying the division process above, the 4-digit number can be displayed clearly and correctly to the user.

2.2.2 Algorithm

1. The number 10000 will first be assigned to a variable called "operand".
2. The program will then divide the result (total weight of meat) by "operand"
3. After the division, if the quotient consists of any non-zero number, the quotient will be displayed. At the same time, the remainder will be stored for further division process.
4. Each time after the division of total weight by operand, the operand will automatically be divided by 10 (10000 → 1000 → 100 → 10 → 1)
5. The remainder will then be used to divide by the new operand and the quotient obtained will be displayed to the user.
6. The same division process is repeated until the remainder obtained is 0.

2.2.3 Code Snippet

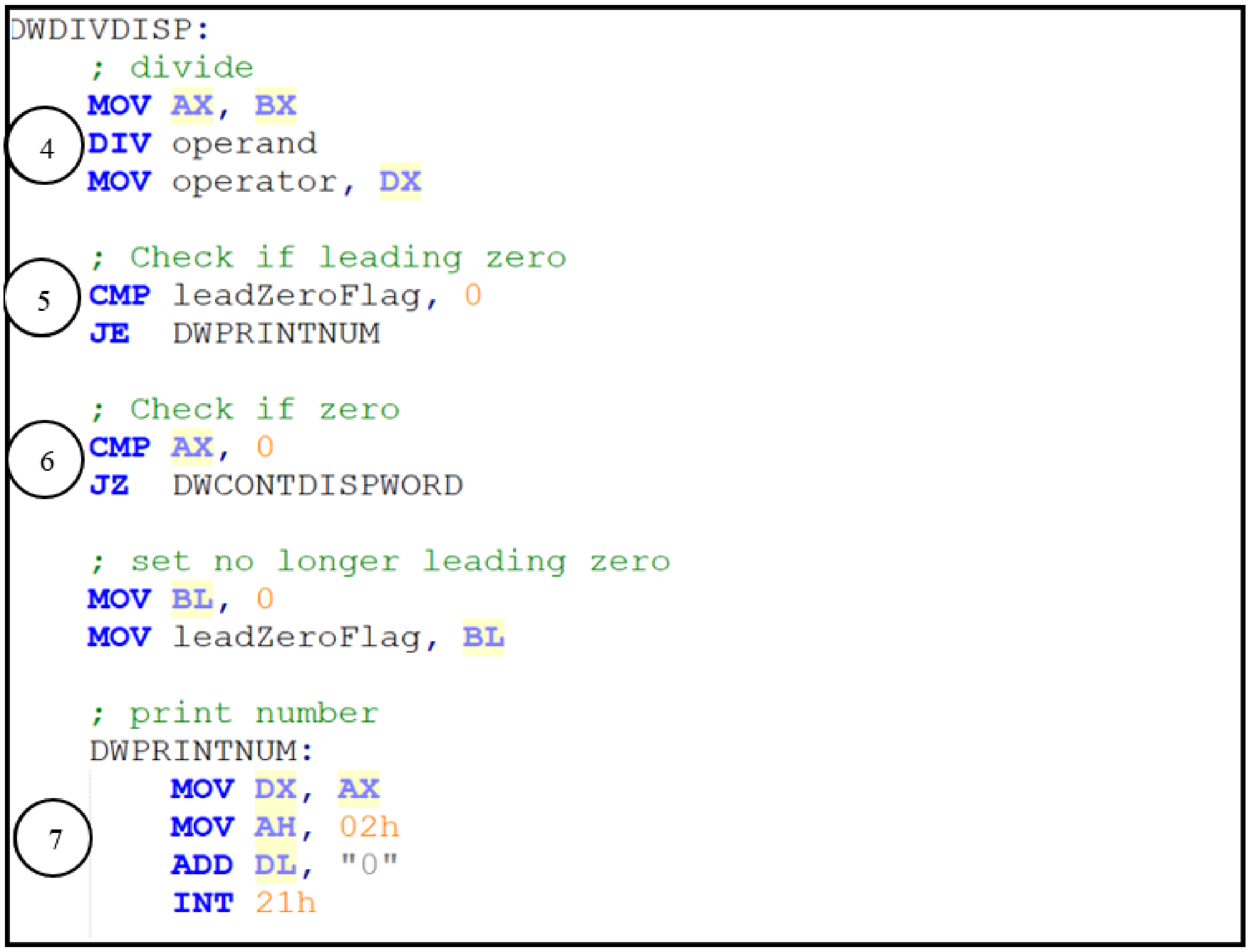


```
MOV DX, 0
MOV CX, 5 ; 5 digits, change along with operand
MOV operand, 10000

; Setup
MOV AL, 1
MOV leadZeroFlag, AL

; Check if AX is 0 to begin with
CMP BX, 0
JNZ DWDIVDISP

; If so, print 0
MOV AH, 02h
MOV DL, "0"
INT 21h
JMP ENDDISPWORD
```

1. **Operand**: This variable stores the initial value of 10000.

2. The program will check whether the total weight is 0kg or not.

3. If yes, the output result (total weight) will be displayed immediately without going through any complicated division process.



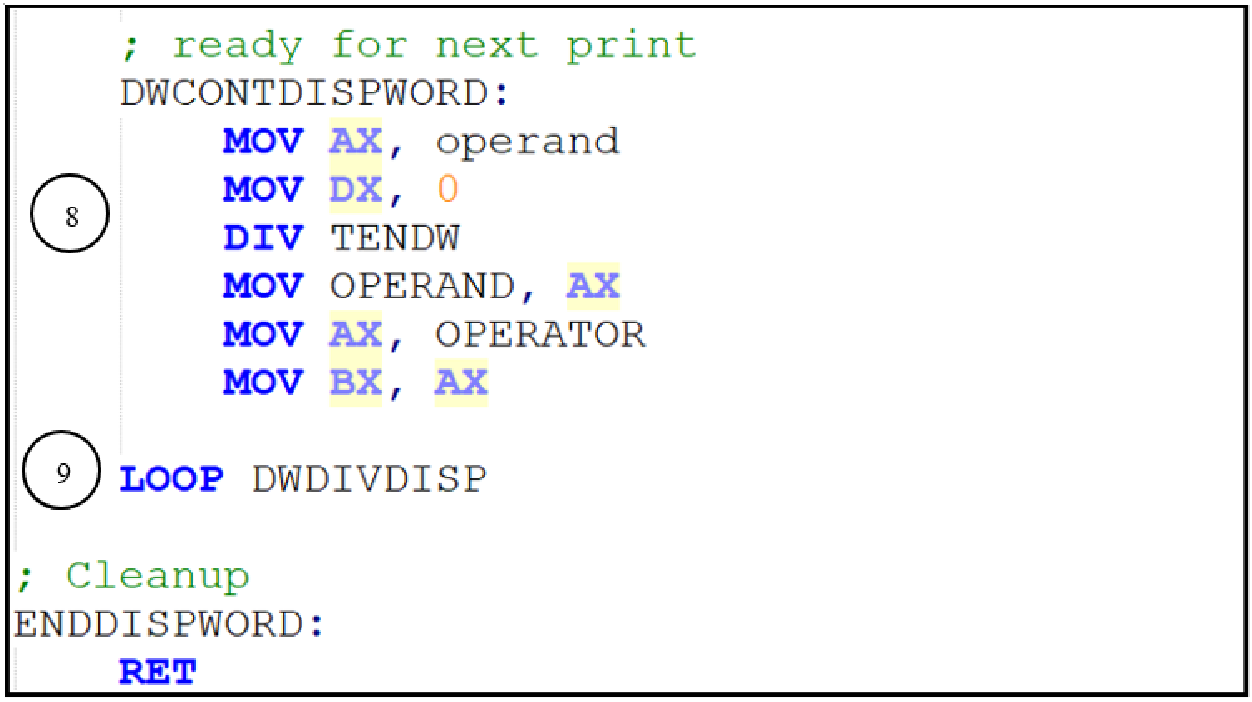
```
DWDIVDISP:
    ; divide
    MOV AX, BX
4   DIV operand
    MOV operator, DX

    ; Check if leading zero
5   CMP leadZeroFlag, 0
    JE  DWPRINTNUM

    ; Check if zero
6   CMP AX, 0
    JZ  DWCONTDISPWORD

    ; set no longer leading zero
    MOV BL, 0
    MOV leadZeroFlag, BL

    ; print number
    DWPRINTNUM:
        MOV DX, AX
7       MOV AH, 02h
        ADD DL, "0"
        INT 21h
```

4. The total weight is divided by the operand.

5. Check leading zero. If so, nothing will be displayed.

6. Compare the quotient with 0. If they are equal, the program will carry out another process (In the next screenshot).

7. If the quotient is not equal to 0, the number will be printed out and displayed.


```
    ; ready for next print
    DWCONTDISPWORD:
        MOV AX, operand
        MOV DX, 0
        DIV TENDW
        MOV OPERAND, AX
        MOV AX, OPERATOR
        MOV BX, AX

    LOOP DWDIVDISP

; Cleanup
ENDDISPWORD:
    RET
```

8. The operand will divide itself by ten (From initial value of 10000 to 1000, from 1000 to 100, etc) continuously. [Continue from 5]

9.The division process is repeated in which the remainder will continue to divide itself by the operand and display the number (quotient). It will then stop once the operand becomes ‘1’ and the remainder becomes ‘0’.

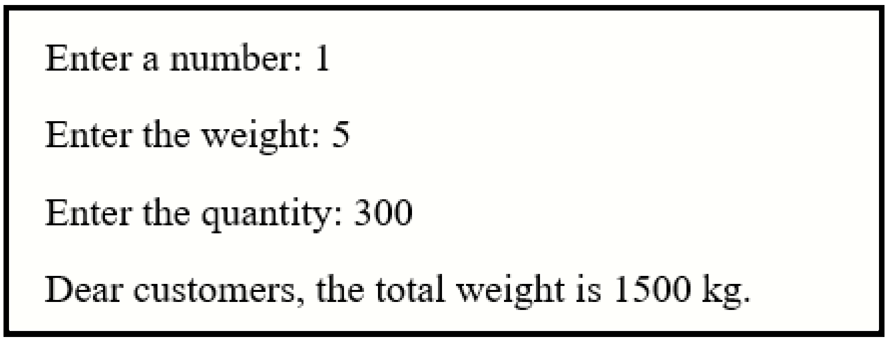
2.3 Five-digit number calculation

Another advanced function in the program is the 5-digits number calculation. The main purpose is to support large input number from the user and is able to calculate numbers up to 5-digits. For example, calculation such as total weight * price of meat and currency calculations such as total price/currency will involve calculations up to 5-digits but with a limitation of 2 byte which is 65535.

Therefore, calculations such as multiplication to obtain the total price of meat, subtraction to calculate the change for user and division to get a currency exchange can be done up to 5-digits.

2.3.1 Operation Example

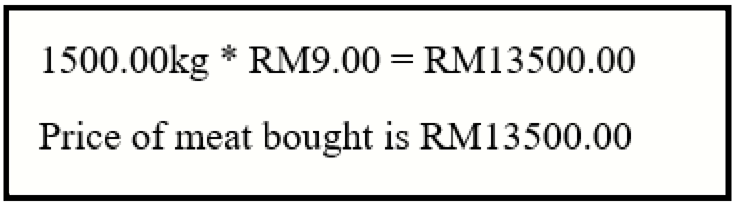
The user first enter the weight of meat (per packet) and quantity purchased. The total weight of meat (result) is then obtained through the multiplication of the weight of meat (per packet) and quantity.



```
Enter a number: 1

Enter the weight: 5

Enter the quantity: 300

Dear customers, the total weight is 1500 kg.
```

Figure : Input data by the user in the PURCHASE function

Next, when the user enters the BILLING function, it will display an equation of weight of meat(kg) * price of meat per kg(RM) = total price of meat purchased(RM). It will also display a statement “Price of meat bought is RM…...”.



```
1500.00kg * RM9.00 = RM13500.00

Price of meat bought is RM13500.00
```

Figure : Display of output result in BILLING function

The calculation of the figure are all done automatically after user input and it will be stored in the variable. For example,

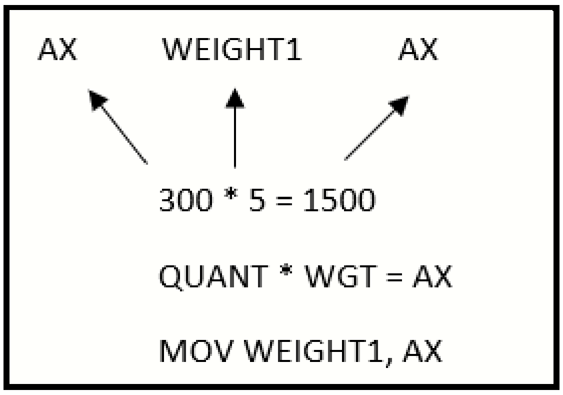
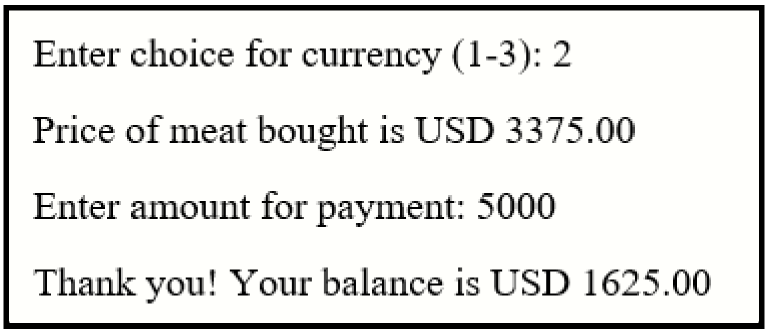


Figure : Multiplication calculation to obtain the total weight input by user

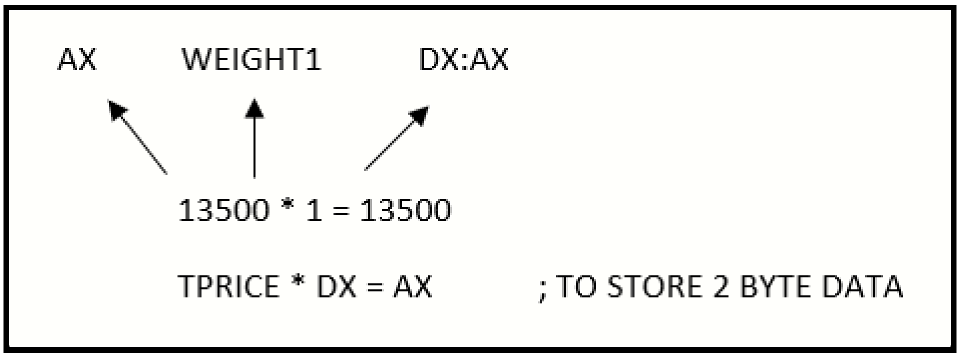
Next, the user will continue to input the choice for currency and the amount of meat bought after currency exchange will be displayed. After user enters the amount for payment, a message “Thank you! Your balance is USD…..”



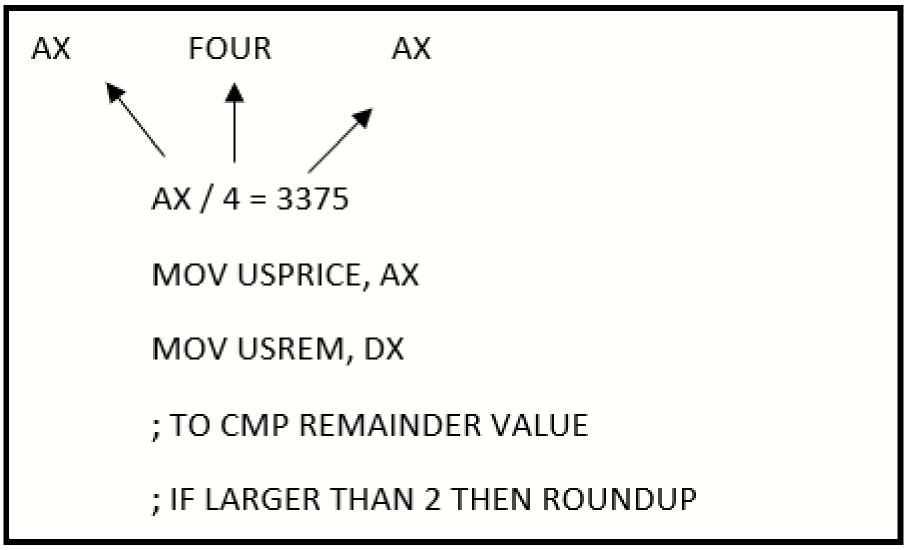
```
Enter choice for currency (1-3): 2

Price of meat bought is USD 3375.00

Enter amount for payment: 5000

Thank you! Your balance is USD 1625.00
```

Figure : Input data from user for payment and the result

The calculation of the figure are all done automatically after user input and it will be stored in the variable. For example,



```
AX        WEIGHT1        DX:AX

          13500 * 1 = 13500

          TPRICE * DX = AX          ; TO STORE 2 BYTE DATA
```



```
AX          FOUR          AX

          AX / 4 = 3375

          MOV USPRICE, AX

          MOV USREM, DX

          ; TO CMP REMAINDER VALUE

          ; IF LARGER THAN 2 THEN ROUNDUP
```

Figure : Division calculation to obtain the total price of meat bought after currency exchange

2.3.2 Algorithm

- Accept input string and convert it into digits

1. Accept input from the user
2. Check if it is 1 number, if it is one number it will store into BL and subtract 30H to get the real input value and lastly stored into the variable declared
3. If the input has more than 1 number, it will enter a loop.
4. The loop will store the 1st number into BL and subtract 30H then multiply with 10.
5. The loop will end when it reached the last number input.
6. After the loop calculation, the value will be stored in a variable declared.

- Multiplication calculation

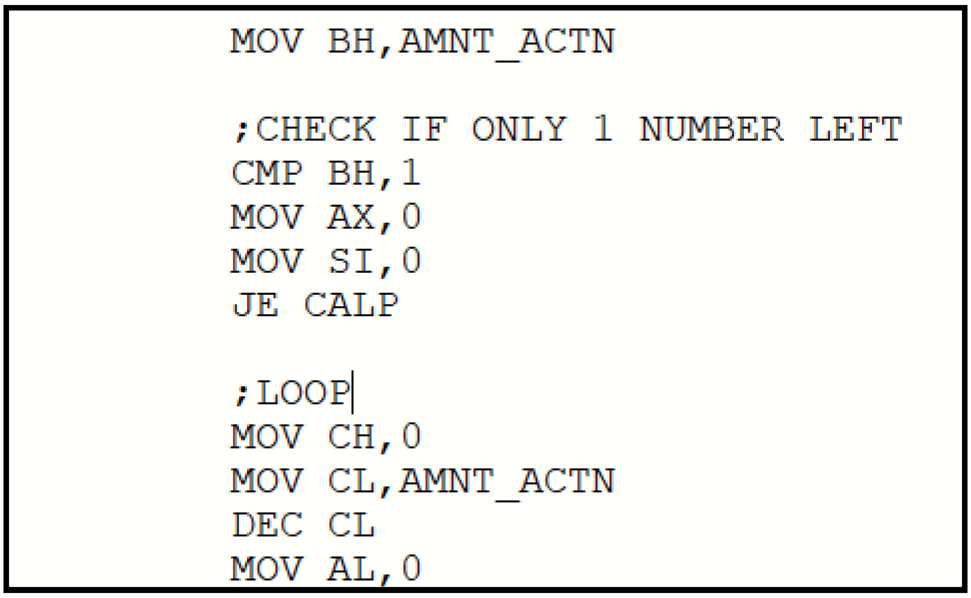
1. Move the multiplier into AX and multiply it with a multiplicand that must be a defined word to support 2 byte data.
2. Store the data into a defined word variable for display or continue with calculation

- Division calculation

1. Move the dividend into AX and move 1 into DX
2. Multiply AX with DX for calculation of 4 byte data to be divided with 2 byte data to obtain 2 byte data result.
3. After that, divide AX with divisor and obtain the quotient value from AX
4. Lastly, compare the remainder value from DX and compare it value and if it is bigger than the value, it will round up the quotient and store it in a variable

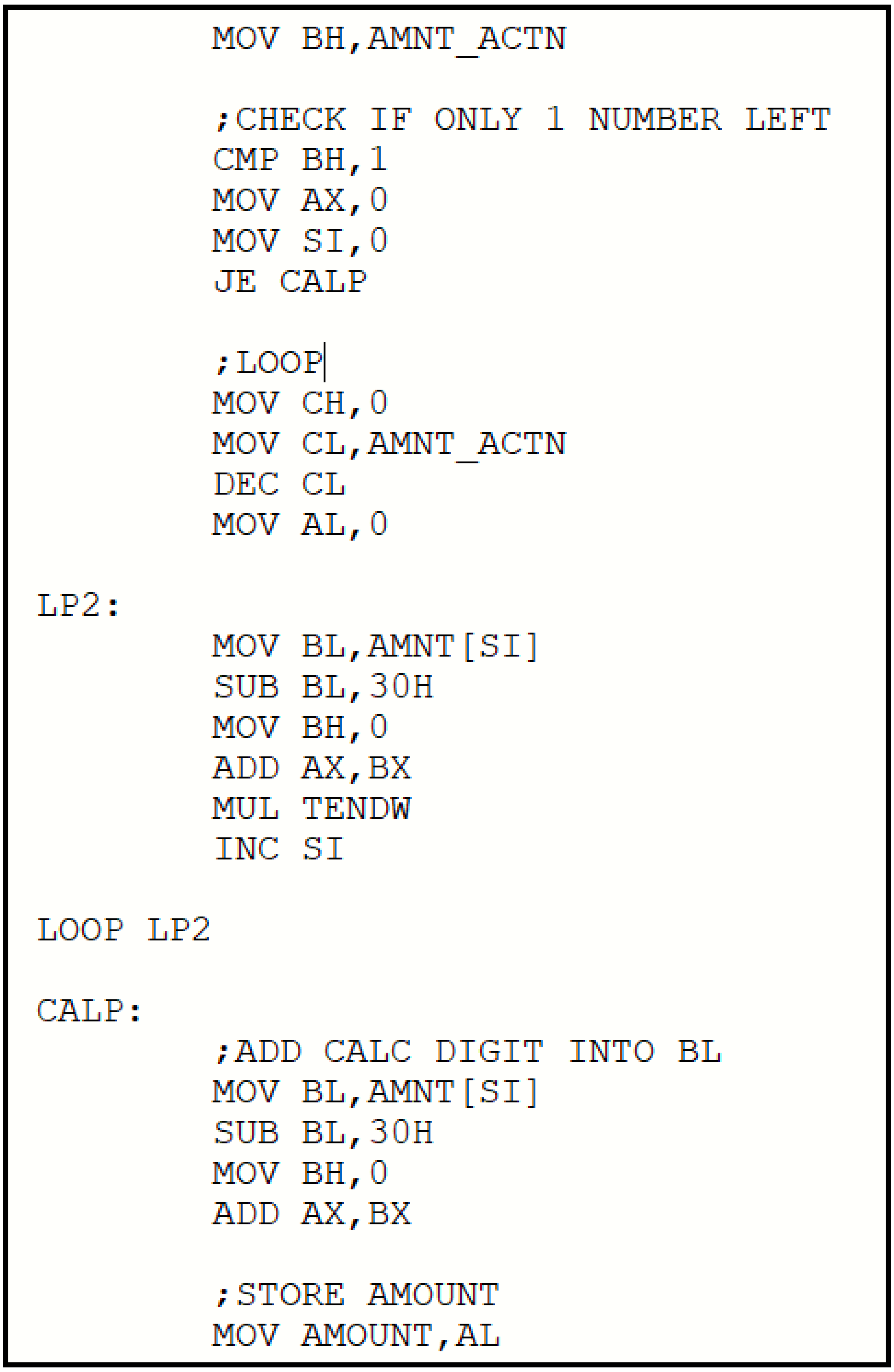
2.3.3 Code Snippet

When user inputs digits into the program, the program will accept the input as string and it will convert the input digit string into digit by using a formula.



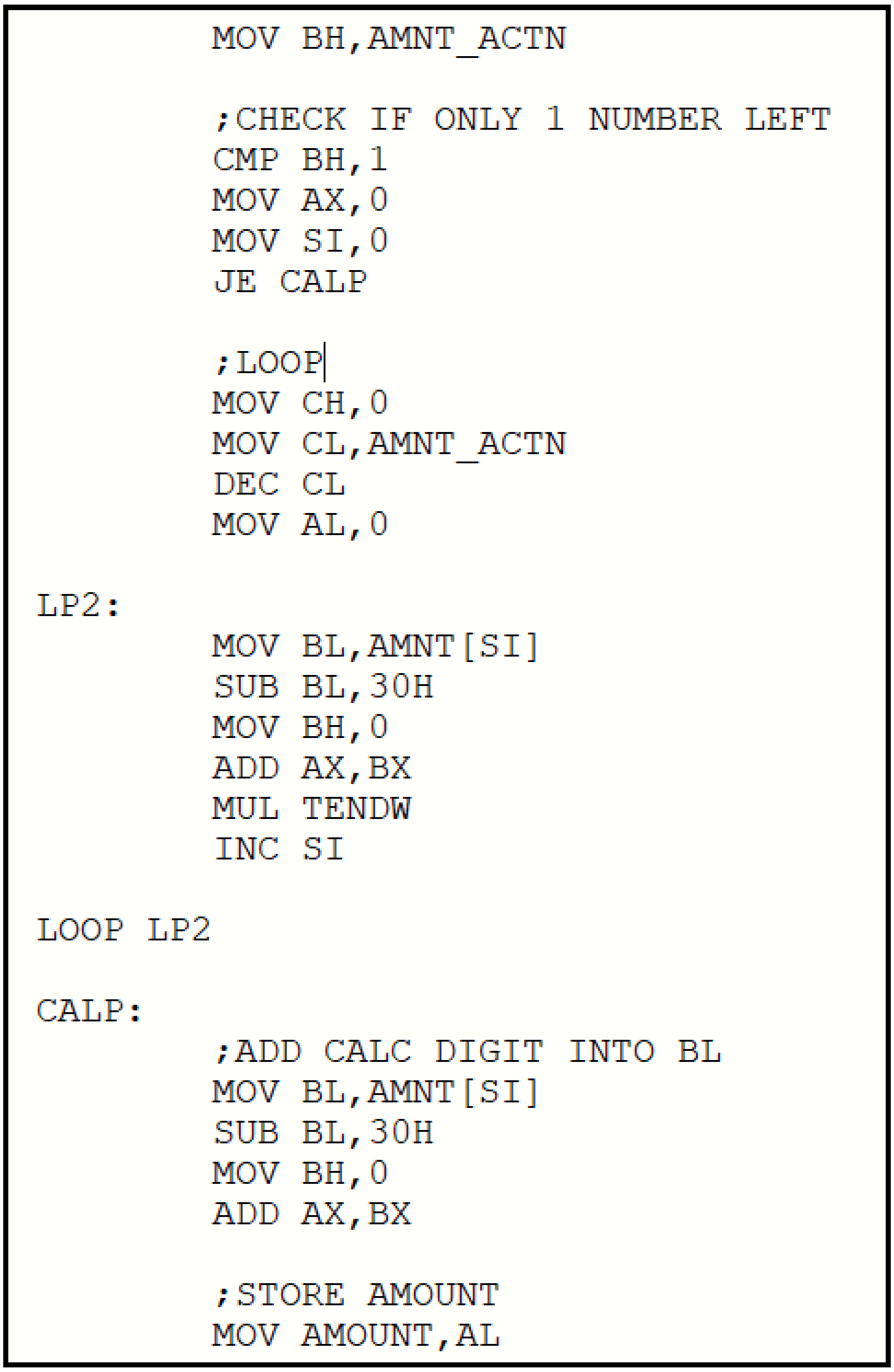
```
MOV BH,AMNT_ACTN

;CHECK IF ONLY 1 NUMBER LEFT
CMP BH,1
MOV AX,0
MOV SI,0
JE CALP

;LOOP
MOV CH,0
MOV CL,AMNT_ACTN
DEC CL
MOV AL,0
```

```
LP2:
        MOV BL,AMNT[SI]
        SUB BL,30H
        MOV BH,0
        ADD AX,BX
        MUL TENDW
        INC SI

LOOP LP2

CALP:
        ;ADD CALC DIGIT INTO BL
        MOV BL,AMNT[SI]
        SUB BL,30H
        MOV BH,0
        ADD AX,BX

        ;STORE AMOUNT
        MOV AMOUNT,AL
```



```
            MOV BH,AMNT_ACTN

            ;CHECK IF ONLY 1 NUMBER LEFT
            CMP BH,1
            MOV AX,0
            MOV SI,0
            JE CALP

            ;LOOP
            MOV CH,0
            MOV CL,AMNT_ACTN
            DEC CL
            MOV AL,0

LP2:
            MOV BL,AMNT[SI]
            SUB BL,30H
            MOV BH,0
            ADD AX,BX
            MUL TENDW
            INC SI

LOOP LP2

CALP:
            ;ADD CALC DIGIT INTO BL
            MOV BL,AMNT[SI]
            SUB BL,30H
            MOV BH,0
            ADD AX,BX

            ;STORE AMOUNT
            MOV AMOUNT,AL
```

1. The formula will first check the number of input, if it is one digit it will convert it to digit by subtracting 30H and store it in the variable declared.

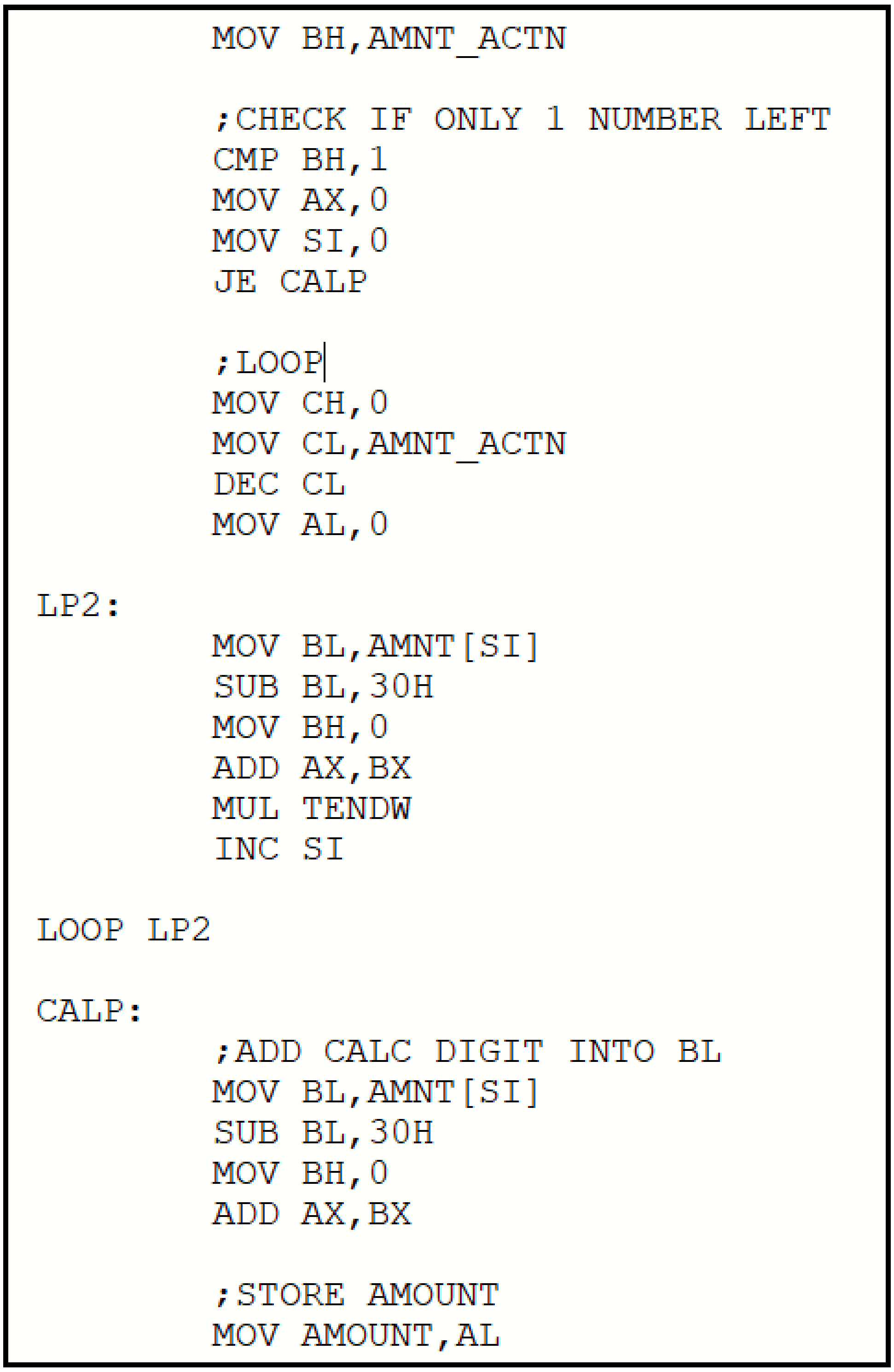


```
                MOV BH,AMNT_ACTN

                ;CHECK IF ONLY 1 NUMBER LEFT
                CMP BH,1
                MOV AX,0
                MOV SI,0
                JE CALP

                ;LOOP
                MOV CH,0
                MOV CL,AMNT_ACTN
                DEC CL
                MOV AL,0

LP2:
                MOV BL,AMNT[SI]
                SUB BL,30H
                MOV BH,0
                ADD AX,BX
                MUL TENDW
                INC SI

LOOP LP2

CALP:
                ;ADD CALC DIGIT INTO BL
                MOV BL,AMNT[SI]
                SUB BL,30H
                MOV BH,0
                ADD AX,BX

                ;STORE AMOUNT
                MOV AMOUNT,AL
```

2. But if the input digits are more than 1, it will enter a loop and it will looped based on the actual number of digits input.

3. The loop will first subtract 30H from the first digit and it will be stored in BX and the value will be moved to AX to be multiplied with 10.

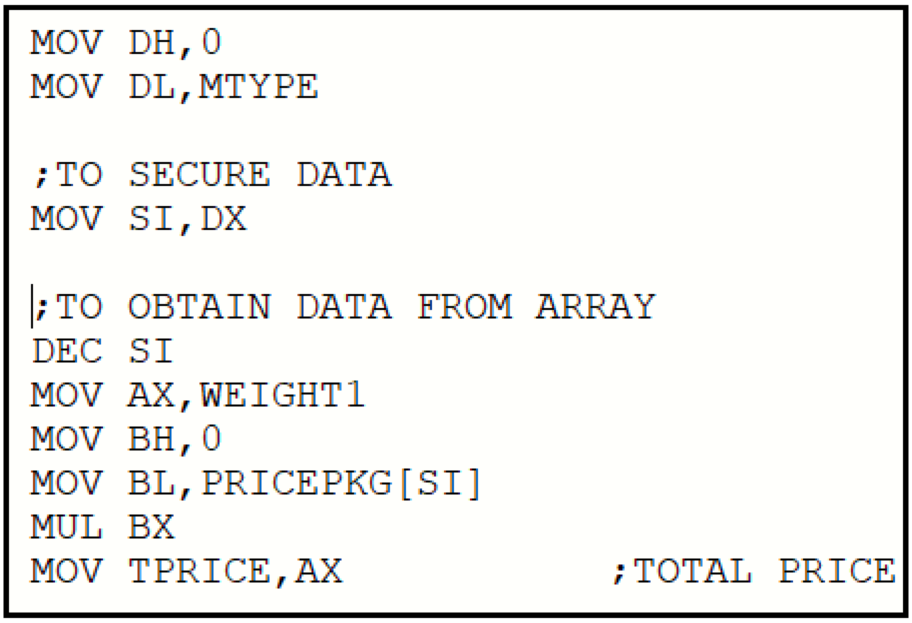
4. The loop will continue with the calculation until the digits are all stored in AX



```
        MOV BH,AMNT_ACTN

        ;CHECK IF ONLY 1 NUMBER LEFT
        CMP BH,1
        MOV AX,0
        MOV SI,0
        JE CALP

        ;LOOP
        MOV CH,0
        MOV CL,AMNT_ACTN
        DEC CL
        MOV AL,0

LP2:
        MOV BL,AMNT[SI]
        SUB BL,30H
        MOV BH,0
        ADD AX,BX
        MUL TENDW
        INC SI

LOOP LP2

CALP:
        ;ADD CALC DIGIT INTO BL
        MOV BL,AMNT[SI]
        SUB BL,30H
        MOV BH,0
        ADD AX,BX

        ;STORE AMOUNT
        MOV AMOUNT,AL
```

5. After converting the value to digits, the value will be stored in the variable declared for example AMOUNT.

After user entered data in the purchase function, it will continue with the calculation to print the total price of meat.



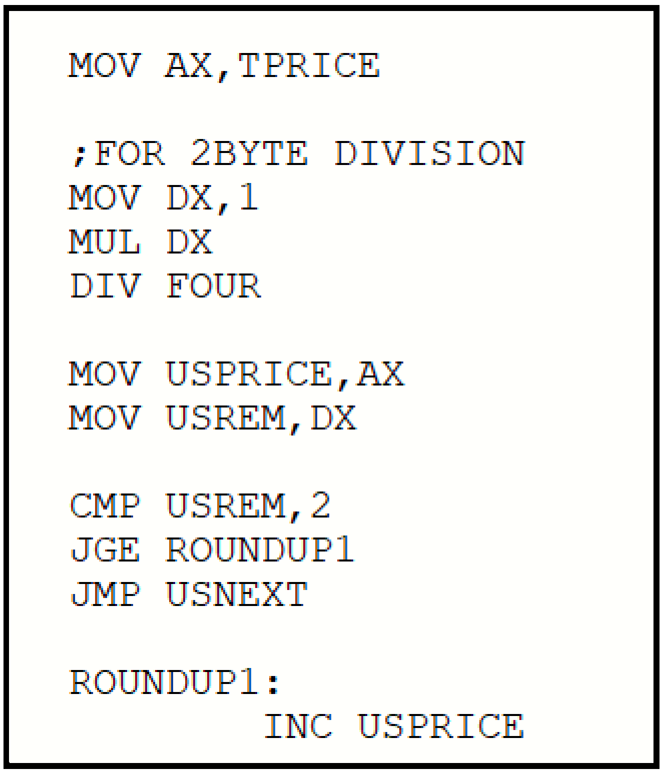
```
MOV DH,0
MOV DL,MTYPE

;TO SECURE DATA
MOV SI,DX

;TO OBTAIN DATA FROM ARRAY
DEC SI
MOV AX,WEIGHT1
MOV BH,0
MOV BL,PRICEPKG[SI]
MUL BX
MOV TPRICE,AX                ;TOTAL PRICE
```

1. Data is stored in MTYPE and WEIGHT1 when the user input data in the purchase function

2. The value in MTYPE will be moved to SI and the value in SI will be decreased to obtain the value of price of meat that is stored in the array.

3. The program will then multiply the WEIGHT1 and PRICEPKG[SI] to obtain the total price of meat which can be up to 2 bytes.

Currency exchange calculation if the user wish to pay with another currency such as USD or SGD.



```
MOV AX,TPRICE

;FOR 2BYTE DIVISION
MOV DX,1
MUL DX
DIV FOUR

MOV USPRICE,AX
MOV USREM,DX

CMP USREM,2
JGE ROUNDUP1
JMP USNEXT

ROUNDUP1:
        INC USPRICE
```

1. **TPRICE** which is the total price of meat bought is moved to **AX** to continue with the division.

2. **AX** is multiplied with **DX** to allocate enough space if **TPRICE** is a 2 byte number.

3. It is then divided by **FOUR** which is the currency rate for **USD**.

4. The quotient will be stored in **AX** and we move it to **USPRICE** to protect data while the remainder will be stored in **DX** and we move it to **USREM** to protect the data as well.

5. Comparison of **USREM** and 2 is to round up the **USPRICE** if the remainder is larger or equal to 2.

Part 3 I/O Design

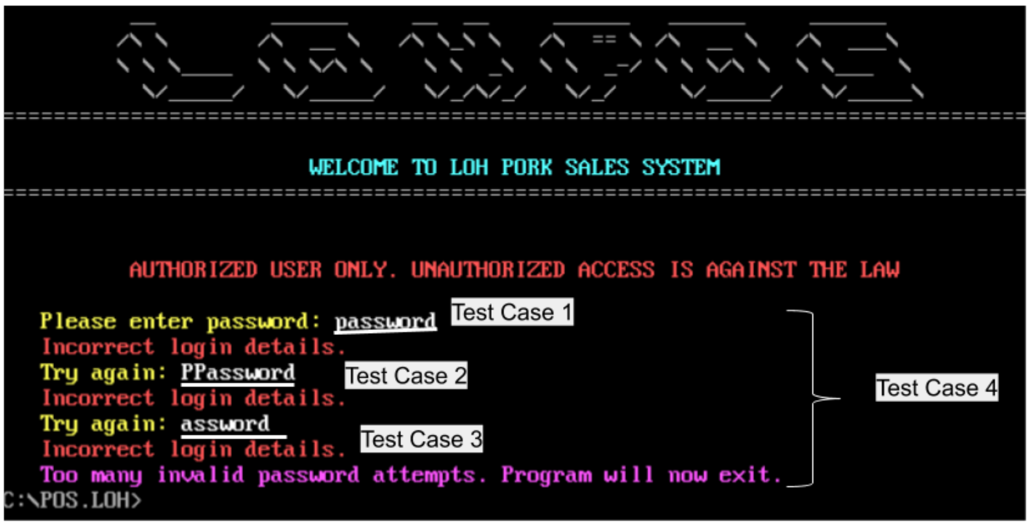
3.1 Login System

Purpose: Authenticates & verifies user before allowing access to the system.

3.1.1 Sample Data

Test Case	Condition	Input	Expected & Obtained Result
1	Did not match password completely (symbols, numbers, capitalization)	password	Deny user entry and reprompt for password
2	Password longer than stored	PPassword	Deny user entry and reprompt for password
3	Password shorter than stored	Passwor	Deny user entry and reprompt for password
5	Too many attempts (by default,exceed 3 attempts)	password PPassword assword	Program terminates.
4	Password matches the stored password exactly	P@ssw0rd	Allow user entry and redirect user to main menu

3.1.2 Screenshots & Program Execution



```
================================================================================
                        WELCOME TO LOH PORK SALES SYSTEM
================================================================================

          AUTHORIZED USER ONLY. UNAUTHORIZED ACCESS IS AGAINST THE LAW

  Please enter password: password
  Incorrect login details.
  Try again: PPassword
  Incorrect login details.
  Try again: assword
  Incorrect login details.
  Too many invalid password attempts. Program will now exit.
C:\POS.LOH>
```

***Screenshot**: Execution of the login function, and test cases associated (Login success not shown, user redirected to main menu screen immediately)*

3.2 Main Menu System

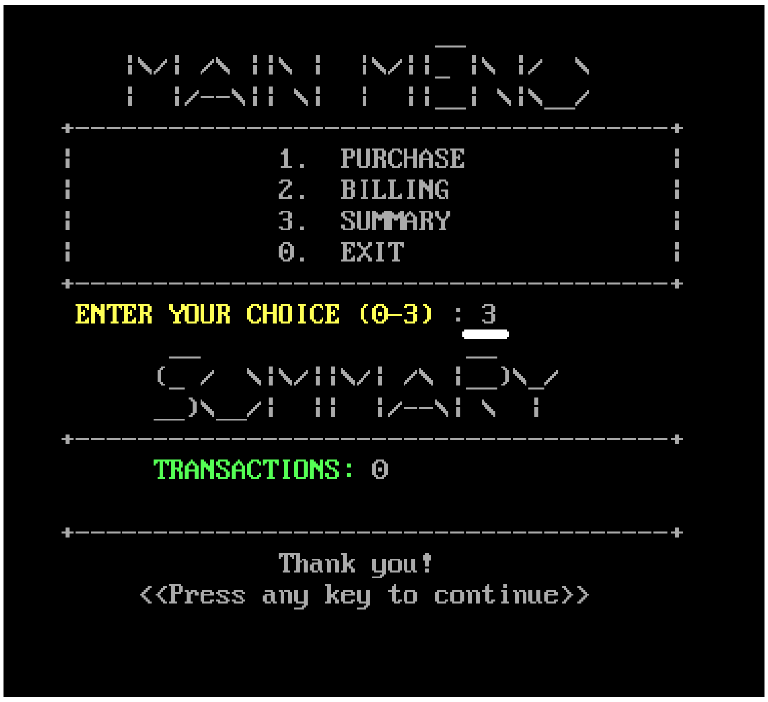
Purpose: Allow user to select the function they intend to use.

3.2.1 Sample Data

Test Case	Condition	List of inputs (separated by commas)	Expected & Obtained Result
1	Enters a valid choice	1,2,3,0	1-3 Redirects the user to the respective module. 0: Displays summary, then quit the program
2	Enters an invalid choice	-,4,5,a,!	Reprompt for valid choice

3.2.2 Screenshots & Program Execution

Note: On invalid choice, the screen automatically refreshes instead of filling the screen with error messages. Therefore, unless the user enters a valid choice, no visible feedback can be observed (except for occasional flashes of screen)



```
+---------------------------------------+
|             1.  PURCHASE              |
|             2.  BILLING               |
|             3.  SUMMARY               |
|             0.  EXIT                  |
+---------------------------------------+
 ENTER YOUR CHOICE (0-3) : 3

+---------------------------------------+
      TRANSACTIONS: 0

+---------------------------------------+
              Thank you!
       <<Press any key to continue>>
```

***Screenshot**: Operation when user enter '3', a valid input corresponding to summary function.*

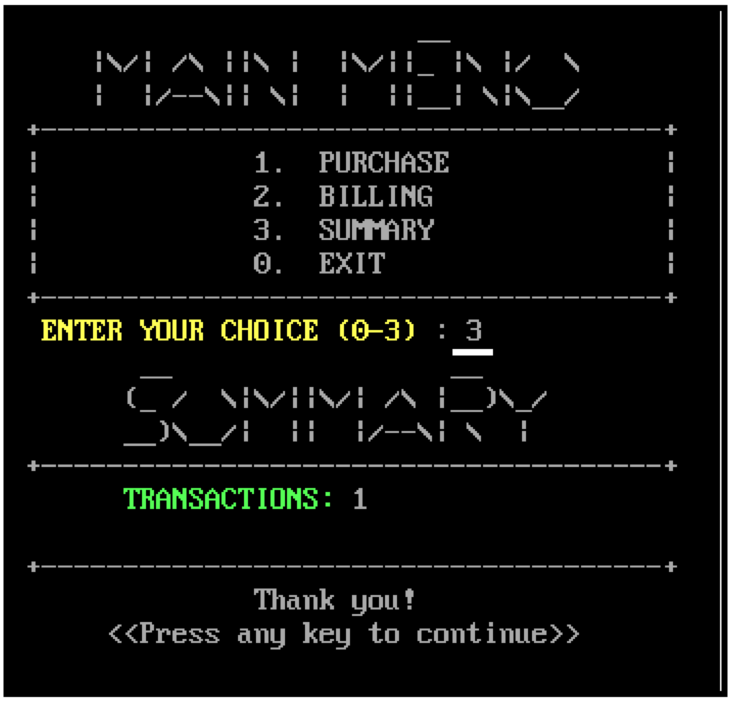
3.3 Summary System

Purpose: Allow user to view the successful transactions made during the operation of the system.

3.3.1 Sample Data

Test Case	Condition	Input steps (, separated by '→')	Expected & Obtained Result
1	User did not complete transaction	From main menu: Enter summary: 3 → [Enter] Enter purchase: → 1 → 1 → 1 → 1 → N → [Enter] Enter billing: Enter summary: → 3 → [Enter]	'Transactions' figure in summary do not change (because no valid transaction made yet)
2	User performs a valid transaction (Purchase + Billing), then enters summary	From main menu: Enter summary: 3 → [Enter] Enter purchase: → 1 → 1 → 1 → 1 → N → [Enter] Enter billing: → 2 → 1 → 10 → [Enter] Enter summary: → 3 → [Enter]	'Transactions' figure in summary increased by 1

3.3.2 Screenshots & Program Execution



```
                               __
     |\/|  /\  ||\ |   |\/||_  |\ ||/  \
     |  | |/--\|| \|   |  ||__| \|\__/
 +---------------------------------------+
 |              1.  PURCHASE             |
 |              2.  BILLING              |
 |              3.  SUMMARY              |
 |              0.  EXIT                 |
 +---------------------------------------+
  ENTER YOUR CHOICE (0-3) : 3
          __                 __
         (_ /  \|\/||\/| /\ |__)\_/
         __)\__/|  ||  ||/--\| \  |
 +---------------------------------------+
       TRANSACTIONS: 1

 +---------------------------------------+
              Thank you!
       <<Press any key to continue>>
```

Screenshot*: Operation when user enters ‘3’ in main menu, a valid input corresponding to summary function, after a successful transaction is made.*

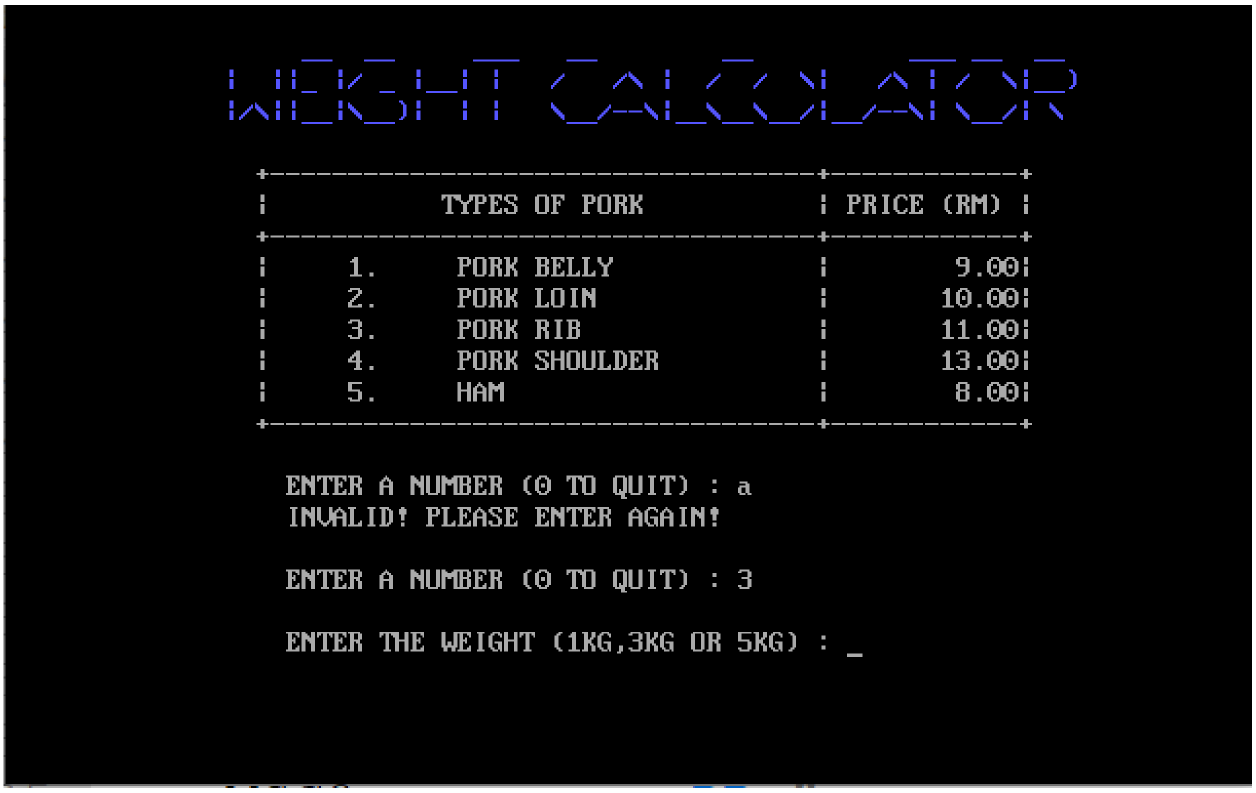
3.4 Purchase System

Purpose: To calculate the total weight of meat purchased by the customers. The program will first read the weight of meat (per packet) and quantity entered by the customer and perform calculation. The total weight of meat is obtained through the multiplication of weight of meat (per packet) and the quantity entered.

3.4.1 Sample Data

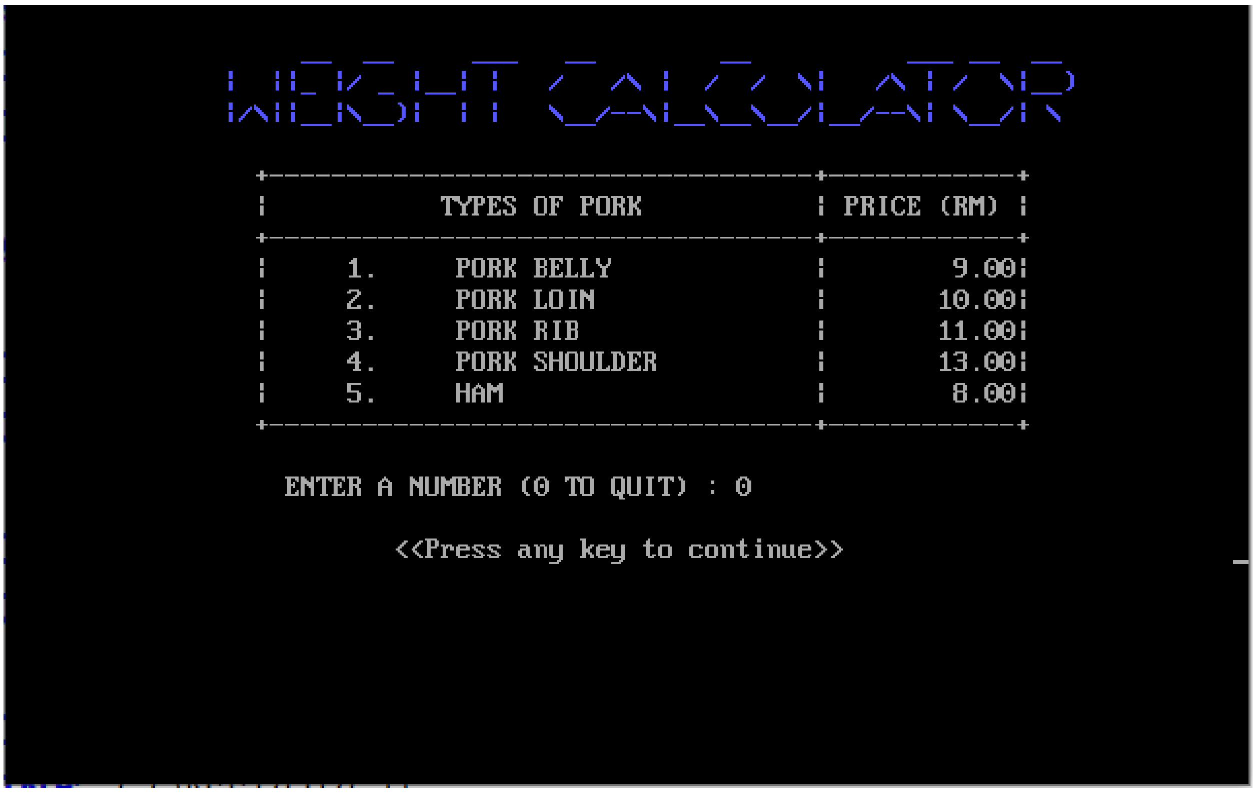
Test Case	Condition	Input data	Expected & Obtained Result
1	User provides an invalid input	Enter a number (0 to exit): **A, a, !, @, [Enter]**	An error message will be displayed and the user is required to re-enter a valid choice
2	User enters number '0'	Enter a number (0 to exit): **0**	User will quit the purchase function and will be redirected to the menu
3	User provides valid input	Enter a number (0 to exit): **1, 2, 3, 4, 5, 6**	The user will then be prompted to enter the weight of meat (per packet)
4	User provides an invalid input	Enter the weight: **2, 4, !, #, A, [Enter]**	An error message will be displayed and the user is required to re-enter a valid weight
5	User provides valid input	Enter the weight: **1, 3, 5**	The user will proceed to enter the quantity purchased
6	User provides an invalid input	Enter the quantity (max 3 digits): **A, 12A, !!@**	An error message will be displayed and the user is required to re-enter a valid quantity
7	User provides valid input	Enter the quantity (max 3 digits): **1, 99, 988**	The input data is accepted and the total weight of meat will also be displayed
8	User provides invalid input	Enter a number (1-2): **3, 5, @, A**	The user will be prompted to provide a valid data
9	User provides valid input	Enter a number (1-2): **1, 2**	The user can then edit the weight or quantity

3.4.2 Screenshots & Program Execution



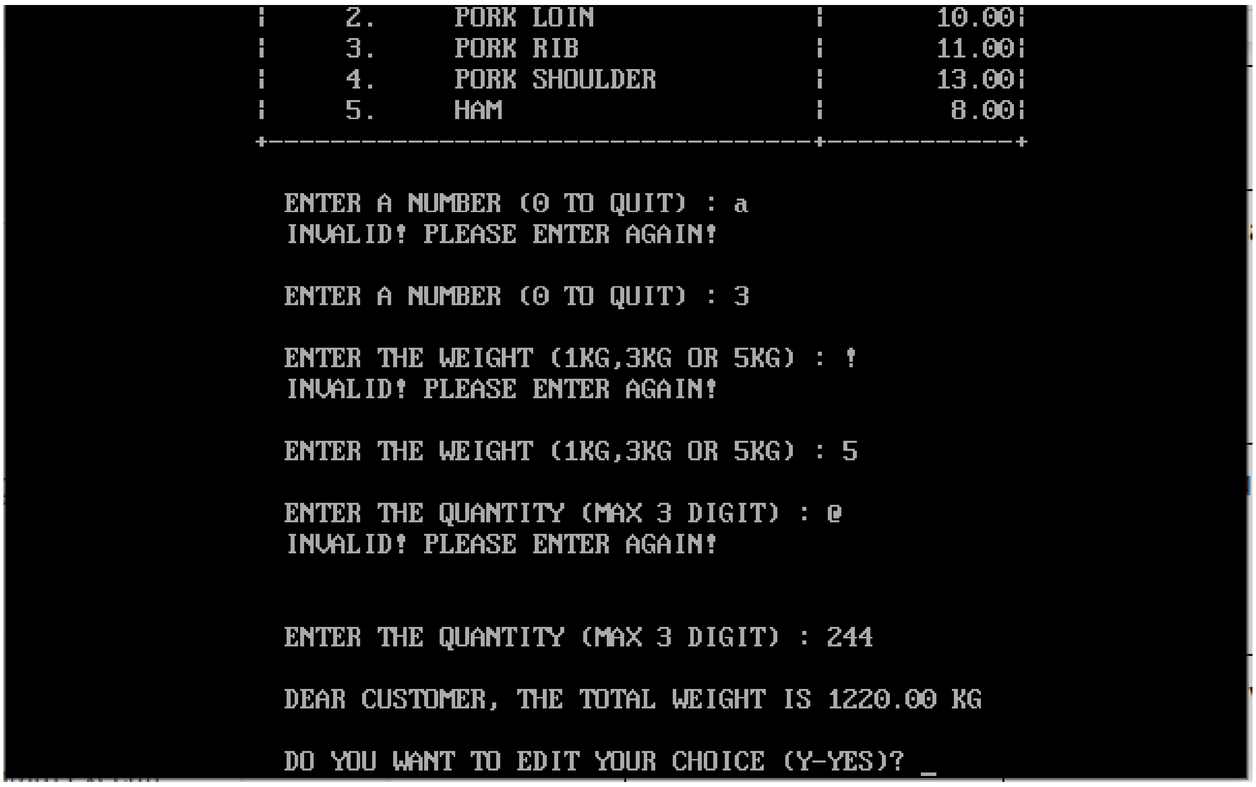
```
        +-----------------------------------+------------+
        |           TYPES OF PORK           | PRICE (RM) |
        +-----------------------------------+------------+
        |     1.      PORK BELLY            |        9.00|
        |     2.      PORK LOIN             |       10.00|
        |     3.      PORK RIB              |       11.00|
        |     4.      PORK SHOULDER         |       13.00|
        |     5.      HAM                   |        8.00|
        +-----------------------------------+------------+

          ENTER A NUMBER (0 TO QUIT) : a
          INVALID! PLEASE ENTER AGAIN!

          ENTER A NUMBER (0 TO QUIT) : 3

          ENTER THE WEIGHT (1KG,3KG OR 5KG) : _
```

***Screenshot**: Test Case 1, 3*



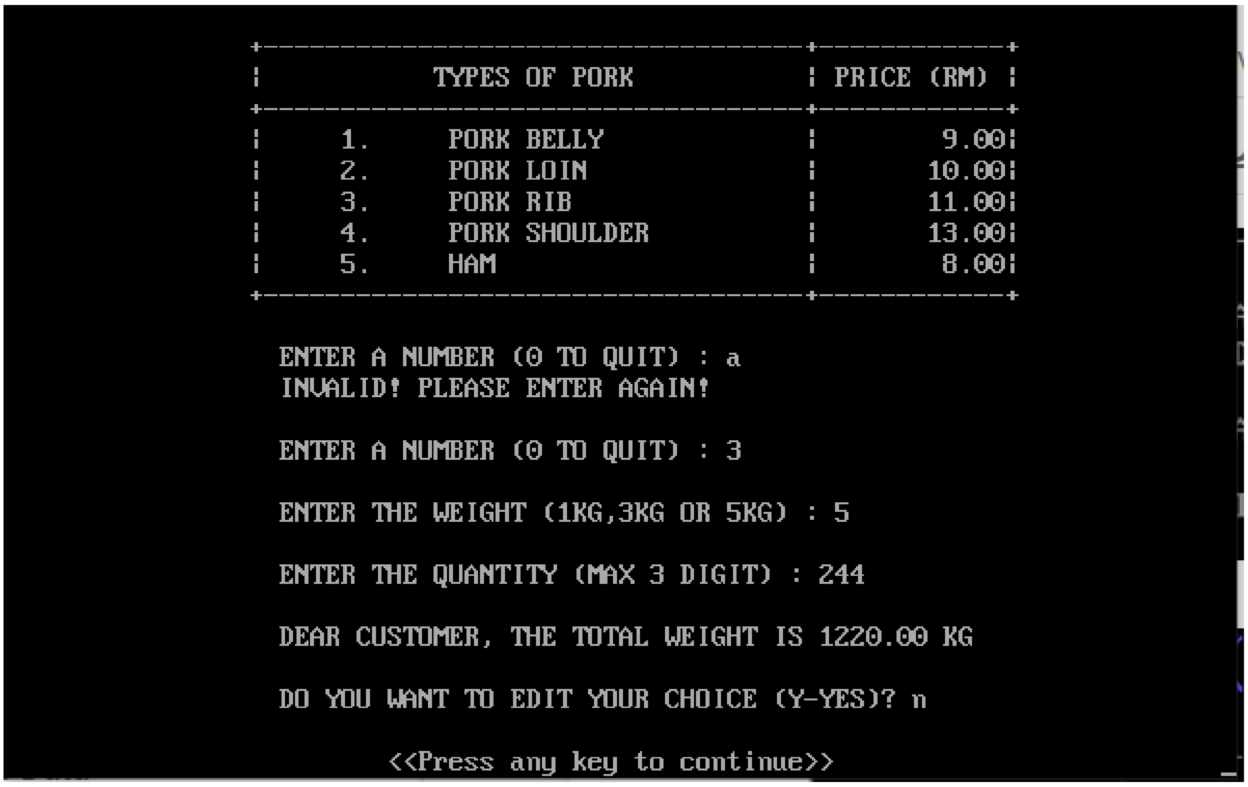
```
+------------------------------------+-------------+
|            TYPES OF PORK           | PRICE (RM)  |
+------------------------------------+-------------+
|     1.     PORK BELLY              |         9.00|
|     2.     PORK LOIN               |        10.00|
|     3.     PORK RIB                |        11.00|
|     4.     PORK SHOULDER           |        13.00|
|     5.     HAM                     |         8.00|
+------------------------------------+-------------+

  ENTER A NUMBER (0 TO QUIT) : 0

         <<Press any key to continue>>
```

***Screenshot**: Test Case 2*



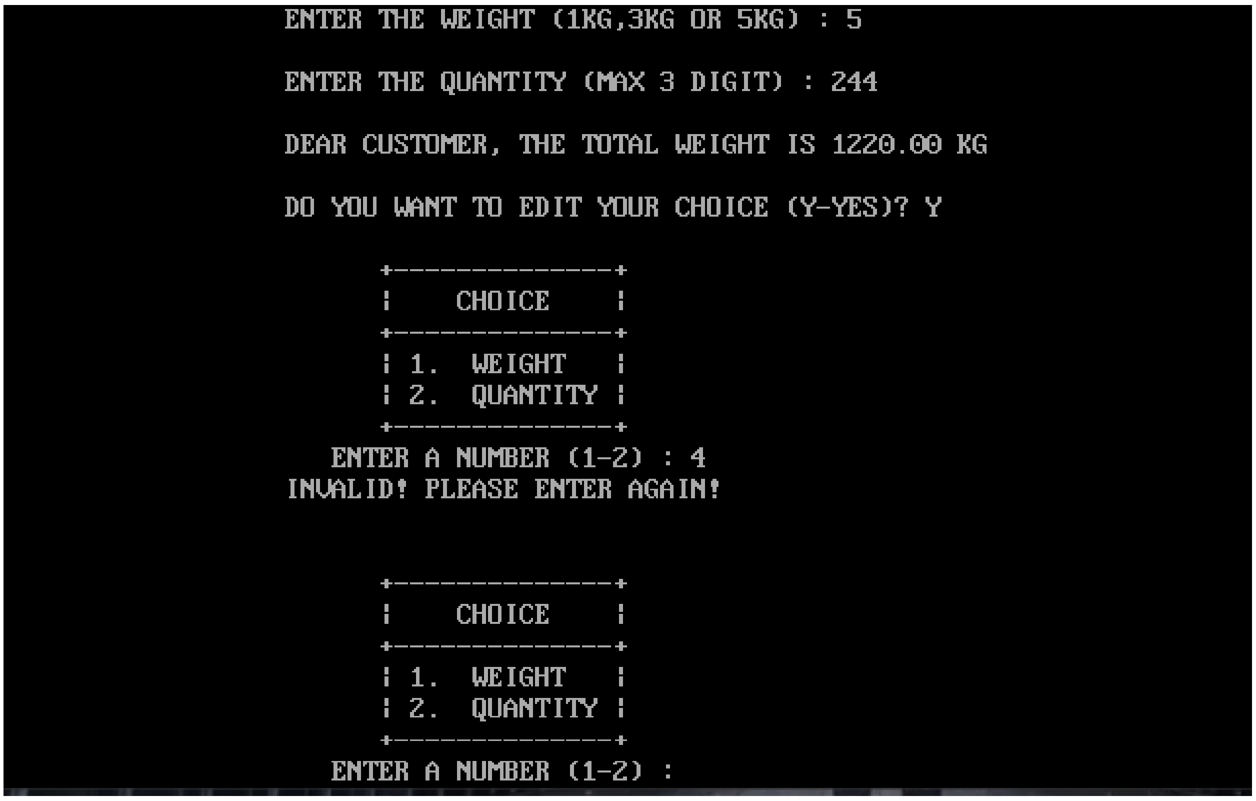
```
|     2.     PORK LOIN               |        10.00|
|     3.     PORK RIB                |        11.00|
|     4.     PORK SHOULDER           |        13.00|
|     5.     HAM                     |         8.00|
+------------------------------------+-------------+

  ENTER A NUMBER (0 TO QUIT) : a
  INVALID! PLEASE ENTER AGAIN!

  ENTER A NUMBER (0 TO QUIT) : 3

  ENTER THE WEIGHT (1KG,3KG OR 5KG) : !
  INVALID! PLEASE ENTER AGAIN!

  ENTER THE WEIGHT (1KG,3KG OR 5KG) : 5

  ENTER THE QUANTITY (MAX 3 DIGIT) : @
  INVALID! PLEASE ENTER AGAIN!


  ENTER THE QUANTITY (MAX 3 DIGIT) : 244

  DEAR CUSTOMER, THE TOTAL WEIGHT IS 1220.00 KG

  DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? _
```

***Screenshot**: Test Case 1, 4, 5, 6*



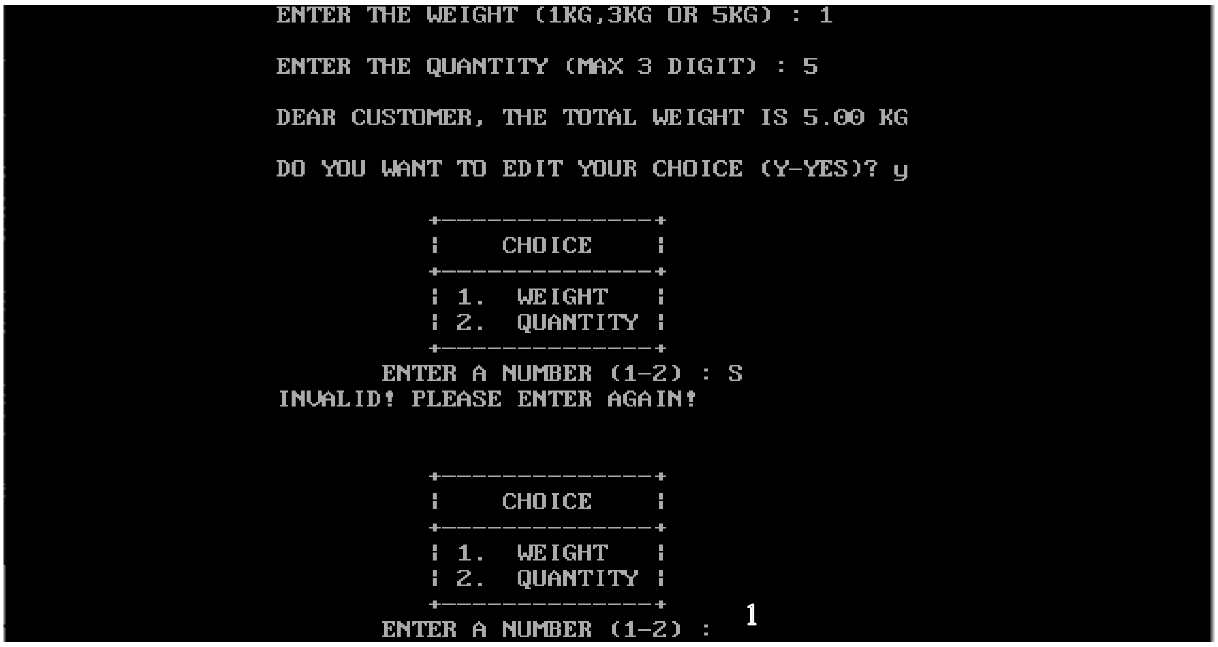
```
+------------------------------------+-------------+
|           TYPES OF PORK            | PRICE (RM)  |
+------------------------------------+-------------+
|     1.     PORK BELLY              |         9.00|
|     2.     PORK LOIN               |        10.00|
|     3.     PORK RIB                |        11.00|
|     4.     PORK SHOULDER           |        13.00|
|     5.     HAM                     |         8.00|
+------------------------------------+-------------+

  ENTER A NUMBER (0 TO QUIT) : a
  INVALID! PLEASE ENTER AGAIN!

  ENTER A NUMBER (0 TO QUIT) : 3

  ENTER THE WEIGHT (1KG,3KG OR 5KG) : 5

  ENTER THE QUANTITY (MAX 3 DIGIT) : 244

  DEAR CUSTOMER, THE TOTAL WEIGHT IS 1220.00 KG

  DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? n

         <<Press any key to continue>>
```

***Screenshot**: Test Case 7*

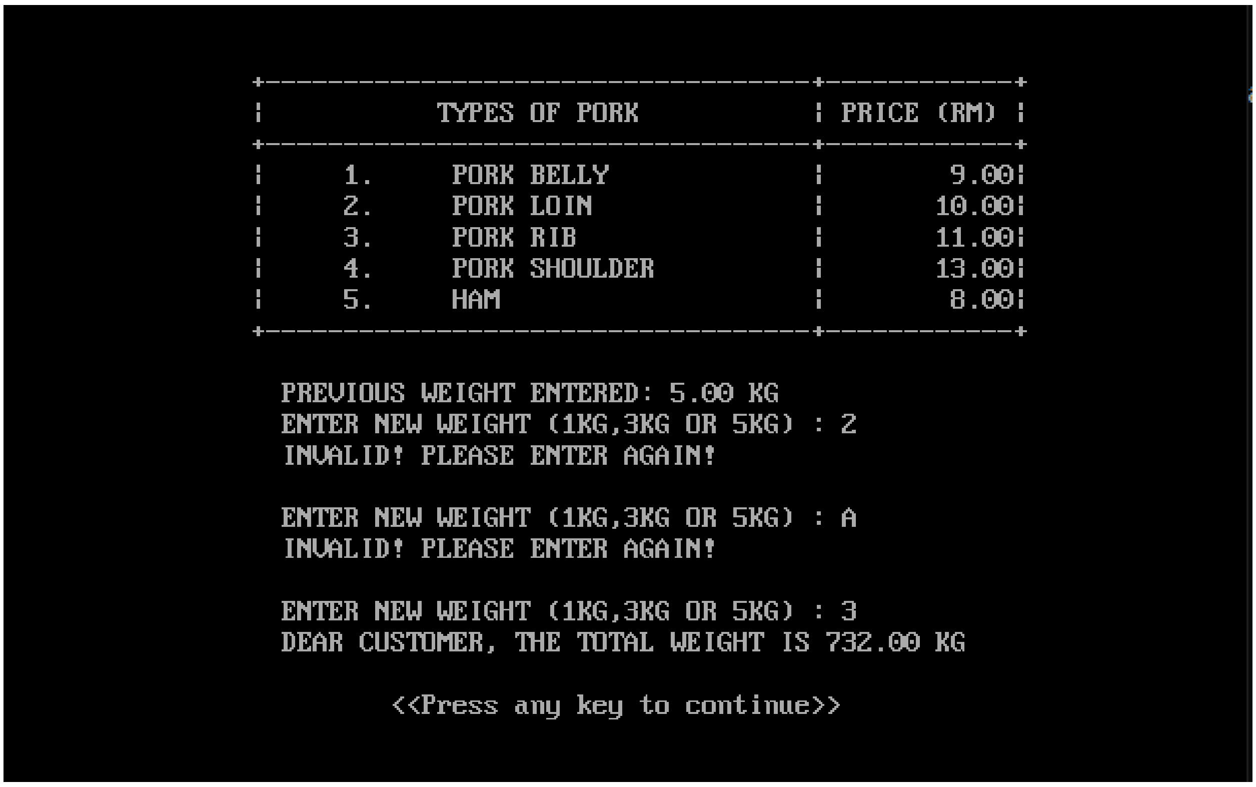


```
ENTER THE WEIGHT (1KG,3KG OR 5KG) : 5

ENTER THE QUANTITY (MAX 3 DIGIT) : 244

DEAR CUSTOMER, THE TOTAL WEIGHT IS 1220.00 KG

DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? Y

      +---------------+
      |    CHOICE     |
      +---------------+
      | 1.  WEIGHT    |
      | 2.  QUANTITY  |
      +---------------+
   ENTER A NUMBER (1-2) : 4
INVALID! PLEASE ENTER AGAIN!


      +---------------+
      |    CHOICE     |
      +---------------+
      | 1.  WEIGHT    |
      | 2.  QUANTITY  |
      +---------------+
   ENTER A NUMBER (1-2) :
```

***Screenshot**: Test Case 8*

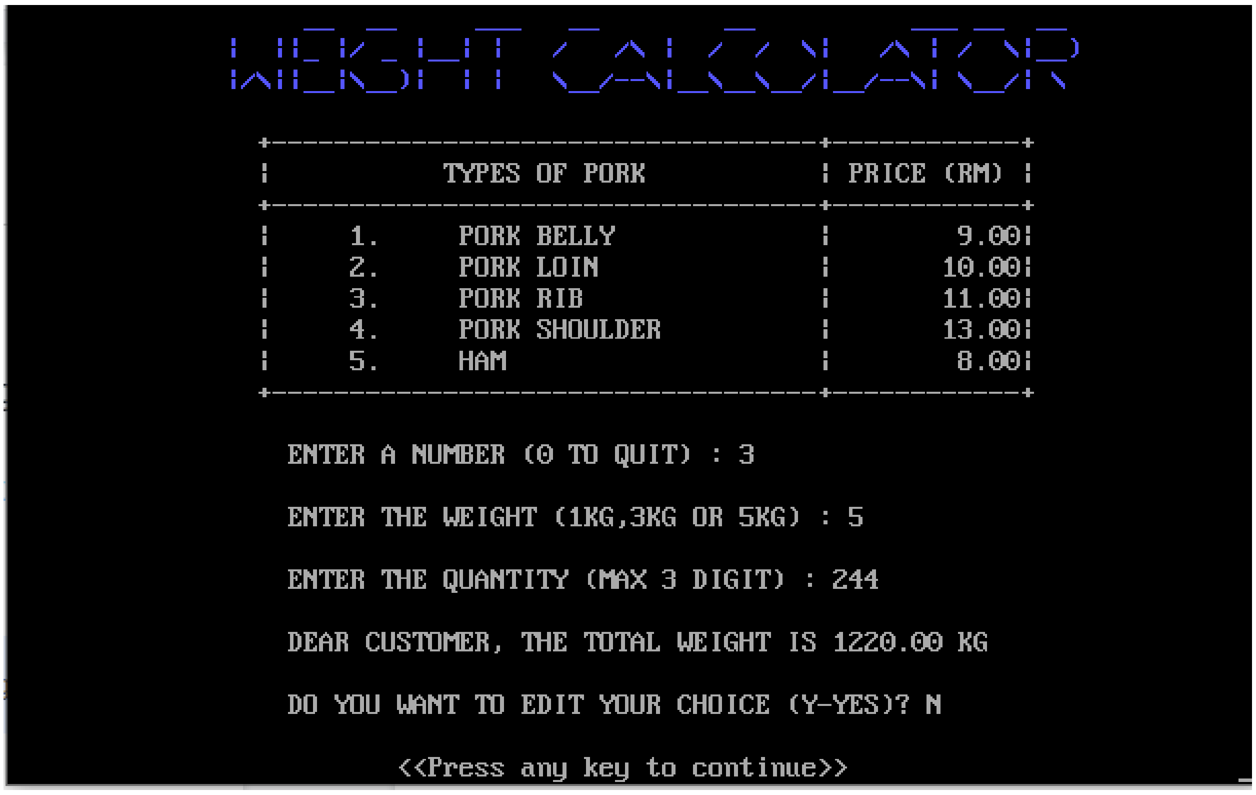


```
ENTER THE WEIGHT (1KG,3KG OR 5KG) : 1

ENTER THE QUANTITY (MAX 3 DIGIT) : 5

DEAR CUSTOMER, THE TOTAL WEIGHT IS 5.00 KG

DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? y

          +---------------+
          |    CHOICE     |
          +---------------+
          | 1.  WEIGHT    |
          | 2.  QUANTITY  |
          +---------------+
       ENTER A NUMBER (1-2) : S
INVALID! PLEASE ENTER AGAIN!


          +---------------+
          |    CHOICE     |
          +---------------+
          | 1.  WEIGHT    |
          | 2.  QUANTITY  |
          +---------------+
       ENTER A NUMBER (1-2) :  1
```



```
+-------------------------------------+-------------+
|           TYPES OF PORK             | PRICE (RM)  |
+-------------------------------------+-------------+
|     1.     PORK BELLY               |         9.00|
|     2.     PORK LOIN                |        10.00|
|     3.     PORK RIB                 |        11.00|
|     4.     PORK SHOULDER            |        13.00|
|     5.     HAM                      |         8.00|
+-------------------------------------+-------------+

  PREVIOUS WEIGHT ENTERED: 5.00 KG
  ENTER NEW WEIGHT (1KG,3KG OR 5KG) : 2
  INVALID! PLEASE ENTER AGAIN!

  ENTER NEW WEIGHT (1KG,3KG OR 5KG) : A
  INVALID! PLEASE ENTER AGAIN!

  ENTER NEW WEIGHT (1KG,3KG OR 5KG) : 3
  DEAR CUSTOMER, THE TOTAL WEIGHT IS 732.00 KG

         <<Press any key to continue>>
```

***Screenshot**: Test Case 9*



```
+------------------------------------+-------------+
|           TYPES OF PORK            | PRICE (RM)  |
+------------------------------------+-------------+
|     1.      PORK BELLY             |         9.00|
|     2.      PORK LOIN              |        10.00|
|     3.      PORK RIB               |        11.00|
|     4.      PORK SHOULDER          |        13.00|
|     5.      HAM                    |         8.00|
+------------------------------------+-------------+

   ENTER A NUMBER (0 TO QUIT) : 3

   ENTER THE WEIGHT (1KG,3KG OR 5KG) : 5

   ENTER THE QUANTITY (MAX 3 DIGIT) : 244

   DEAR CUSTOMER, THE TOTAL WEIGHT IS 1220.00 KG

   DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? N

          <<Press any key to continue>>
```

***Screenshot**: The user is able to view the total weight of meat if all the input data are valid*

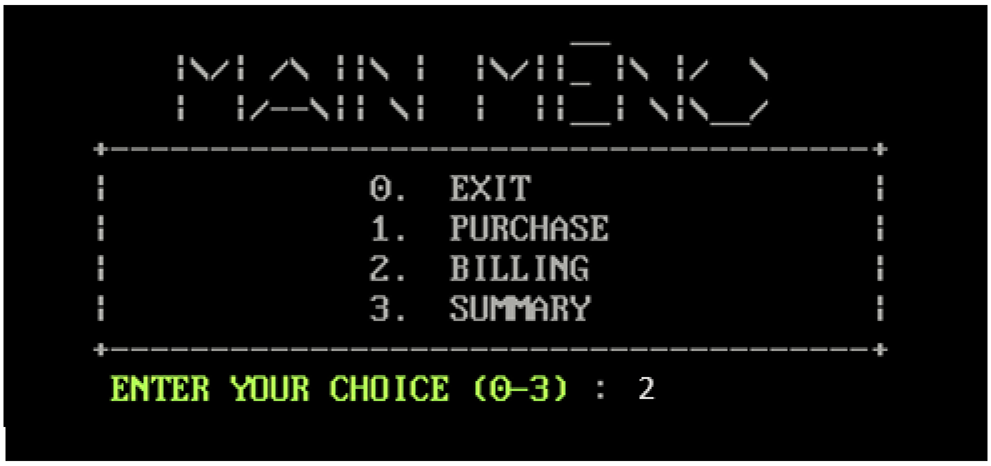
3.5 Billing System

Purpose: To calculate the total price of meat purchased by the customers. If user enters the billing system without entering data in the purchase system, the program will prompt a message to inform the user to perform weight calculation before entering the billing system. If all the data are entered in the purchase system, an equation of price of meat * weight of meat = total price of meat bought will be displayed. Lastly, the program will then prompt user for the currency they wished to continue with and the user will have to enter the amount for payment.

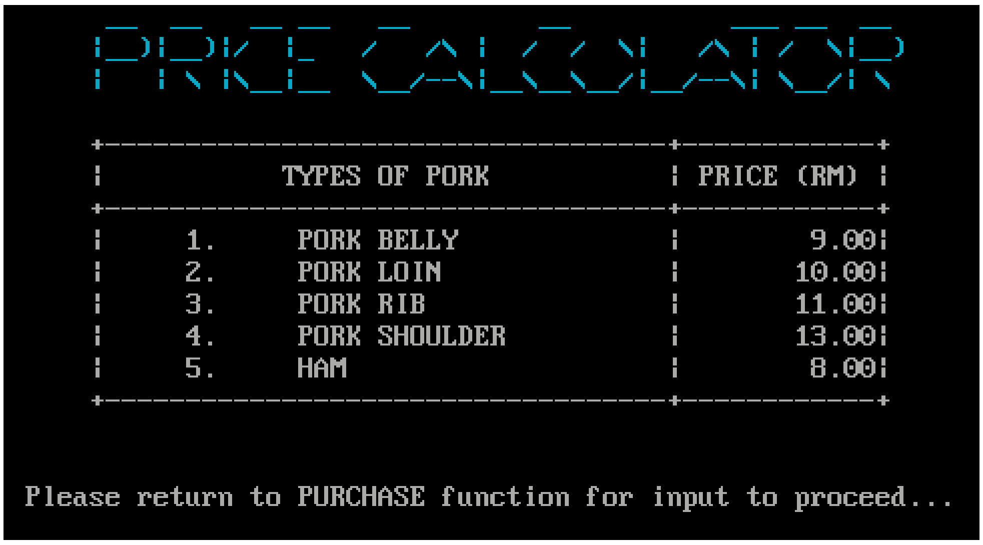
3.5.1 Sample Data

Test Case	Condition	Input data	Expected & Obtained Result
1	User did not enter data in the purchase system	From main menu: Enter billing: 2 → [Enter]	A prompt message "Please return to PURCHASE function for input to proceed" will be displayed
2	User provides an invalid input	Enter choice for currency(1-3): **A, - , !, @, [Enter]**	An error message will be displayed and the user is required to re-enter a valid choice
3	User provides valid input	Enter choice for currency(1-3): **1, 2, 3**	The price of meat will be displayed and the user will then be prompted to enter the amount for payment
4	User provides an invalid input	Enter amount for payment: **-, !, #, A, [Enter], Amount less than price**	An error message will be displayed and the user is required to re-enter a valid amount
5	User provides valid input	Enter amount for payment: **Amount more than price**	The system will automatically calculate the change and a message "Thank you! Your balance is …." will be displayed

3.5.2 Screenshots & Program Execution

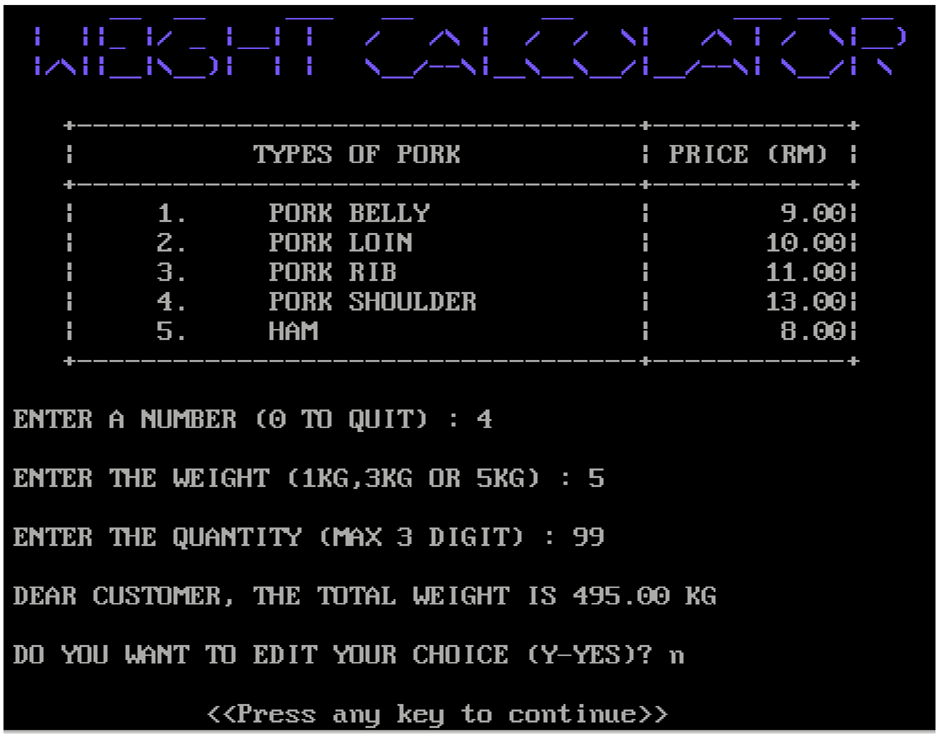


```
+--------------------------------------+
|          0.  EXIT                    |
|          1.  PURCHASE                |
|          2.  BILLING                 |
|          3.  SUMMARY                 |
+--------------------------------------+
 ENTER YOUR CHOICE (0-3) :  2
```

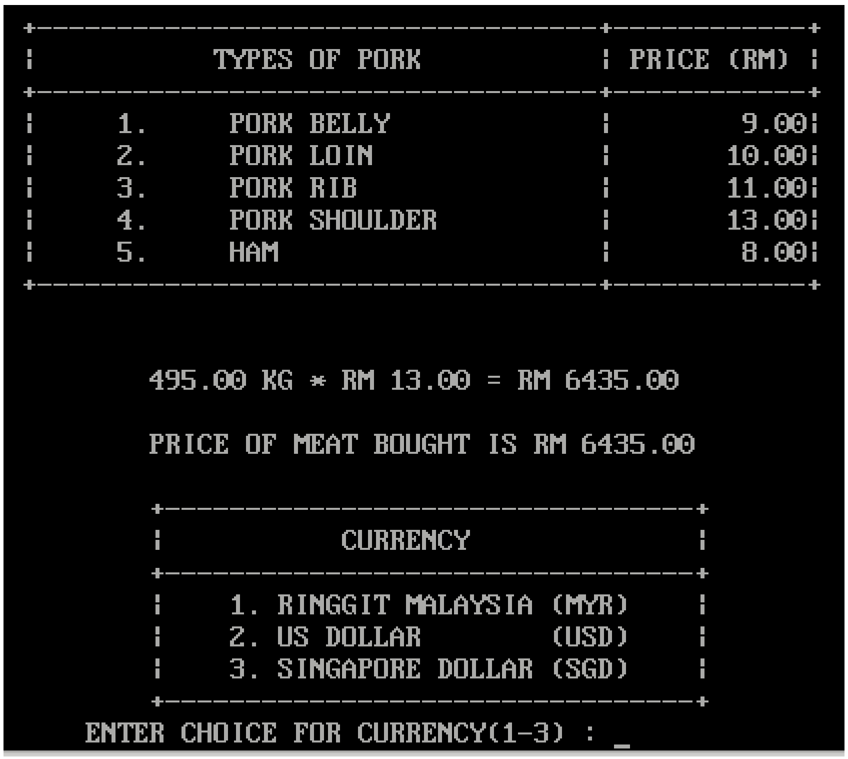


```
+----------------------------------------+------------+
|            TYPES OF PORK               | PRICE (RM) |
+----------------------------------------+------------+
|     1.      PORK BELLY                 |        9.00|
|     2.      PORK LOIN                  |       10.00|
|     3.      PORK RIB                   |       11.00|
|     4.      PORK SHOULDER              |       13.00|
|     5.      HAM                        |        8.00|
+----------------------------------------+------------+


 Please return to PURCHASE function for input to proceed...
```

***Screenshot**: Test Case 1*

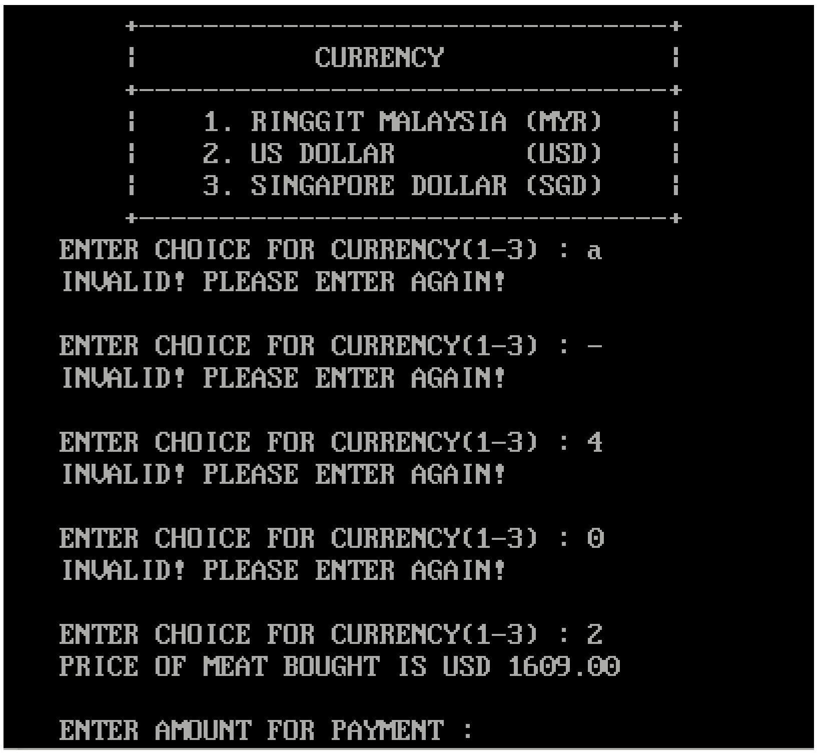


```
   +------------------------------------+-------------+
   |            TYPES OF PORK           | PRICE (RM)  |
   +------------------------------------+-------------+
   |      1.      PORK BELLY            |        9.00|
   |      2.      PORK LOIN             |       10.00|
   |      3.      PORK RIB              |       11.00|
   |      4.      PORK SHOULDER         |       13.00|
   |      5.      HAM                   |        8.00|
   +------------------------------------+-------------+

ENTER A NUMBER (0 TO QUIT) : 4

ENTER THE WEIGHT (1KG,3KG OR 5KG) : 5

ENTER THE QUANTITY (MAX 3 DIGIT) : 99

DEAR CUSTOMER, THE TOTAL WEIGHT IS 495.00 KG

DO YOU WANT TO EDIT YOUR CHOICE (Y-YES)? n

            <<Press any key to continue>>
```



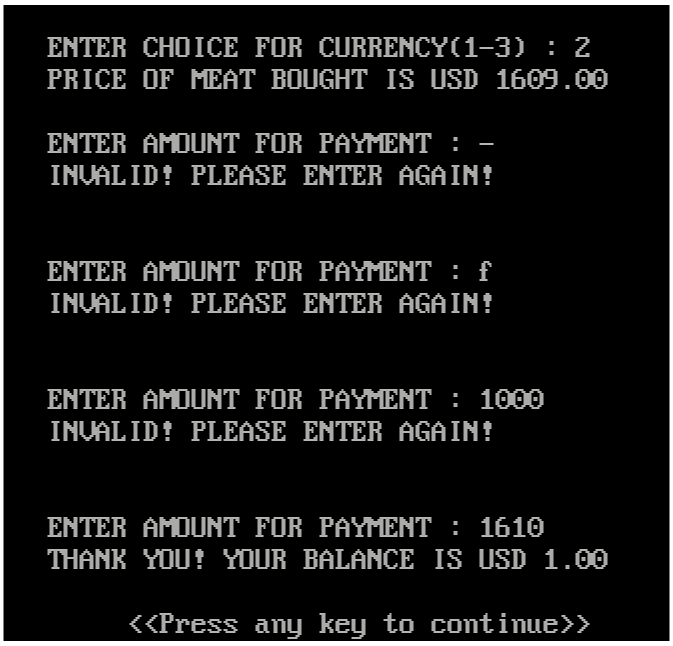
```
+------------------------------------+-------------+
|            TYPES OF PORK           | PRICE (RM)  |
+------------------------------------+-------------+
|      1.      PORK BELLY            |        9.00|
|      2.      PORK LOIN             |       10.00|
|      3.      PORK RIB              |       11.00|
|      4.      PORK SHOULDER         |       13.00|
|      5.      HAM                   |        8.00|
+------------------------------------+-------------+


         495.00 KG * RM 13.00 = RM 6435.00

         PRICE OF MEAT BOUGHT IS RM 6435.00

         +----------------------------------+
         |             CURRENCY             |
         +----------------------------------+
         |     1. RINGGIT MALAYSIA (MYR)    |
         |     2. US DOLLAR        (USD)    |
         |     3. SINGAPORE DOLLAR (SGD)    |
         +----------------------------------+
     ENTER CHOICE FOR CURRENCY(1-3) : _
```

Screenshot*: After user input data in the purchase function, they are able to view the weight, price of type of meat entered and the total price of meat bought in the billing function*



```
     +----------------------------------+
     |            CURRENCY              |
     +----------------------------------+
     |    1. RINGGIT MALAYSIA (MYR)     |
     |    2. US DOLLAR        (USD)     |
     |    3. SINGAPORE DOLLAR (SGD)     |
     +----------------------------------+
ENTER CHOICE FOR CURRENCY(1-3) : a
INVALID! PLEASE ENTER AGAIN!

ENTER CHOICE FOR CURRENCY(1-3) : -
INVALID! PLEASE ENTER AGAIN!

ENTER CHOICE FOR CURRENCY(1-3) : 4
INVALID! PLEASE ENTER AGAIN!

ENTER CHOICE FOR CURRENCY(1-3) : 0
INVALID! PLEASE ENTER AGAIN!

ENTER CHOICE FOR CURRENCY(1-3) : 2
PRICE OF MEAT BOUGHT IS USD 1609.00

ENTER AMOUNT FOR PAYMENT :
```

Screenshot: *Test Case 2,3*



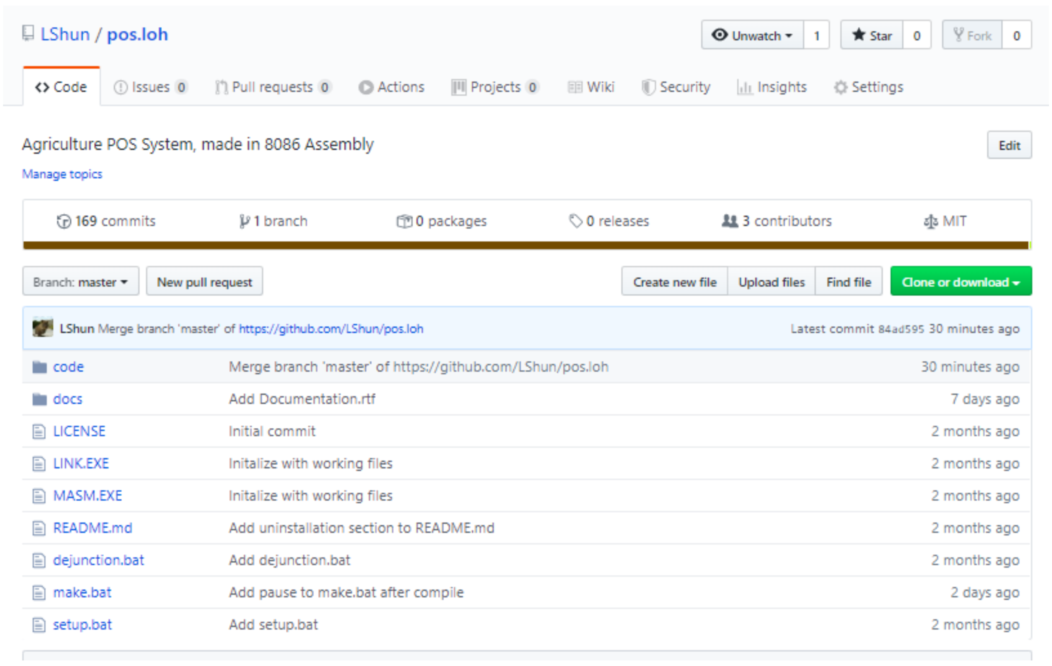
```
ENTER CHOICE FOR CURRENCY(1-3) : 2
PRICE OF MEAT BOUGHT IS USD 1609.00

ENTER AMOUNT FOR PAYMENT : -
INVALID! PLEASE ENTER AGAIN!


ENTER AMOUNT FOR PAYMENT : f
INVALID! PLEASE ENTER AGAIN!


ENTER AMOUNT FOR PAYMENT : 1000
INVALID! PLEASE ENTER AGAIN!


ENTER AMOUNT FOR PAYMENT : 1610
THANK YOU! YOUR BALANCE IS USD 1.00

     <<Press any key to continue>>
```

Screenshot: *Test Case 4,5*

Part 4 Leadership and Teamwork Software used

4.1 Git VCS

During the project period, our group shared & regularly communicated our progress using Git Version Control System (VCS) through an online platform known as GitHub. By using GitHub, we successfully eliminated the need for "combining work" and could instead focus on developing our own part while at the same time ensure our work can function correctly alongside other member's functions. Besides that, we can also monitor and help out each other through Git, and roll back unwanted changes if corruption, or mistakes occur.



LShun / pos.loh

Agriculture POS System, made in 8086 Assembly

169 commits | 1 branch | 0 packages | 0 releases | 3 contributors | MIT

LShun Merge branch 'master' of https://github.com/LShun/pos.loh — Latest commit 84ad595 30 minutes ago

code	Merge branch 'master' of https://github.com/LShun/pos.loh	30 minutes ago
docs	Add Documentation.rtf	7 days ago
LICENSE	Initial commit	2 months ago
LINK.EXE	Initalize with working files	2 months ago
MASM.EXE	Initalize with working files	2 months ago
README.md	Add uninstallation section to README.md	2 months ago
dejunction.bat	Add dejunction.bat	2 months ago
make.bat	Add pause to make.bat after compile	2 days ago
setup.bat	Add setup.bat	2 months ago

4.2 WhatsApp

During the project period, our group utilized WhatsApp to communicate regarding our project progress and request for help. We used WhatsApp to notify each other on deadlines, and communicate ideas on our project that does not involve code.

Part 5 References

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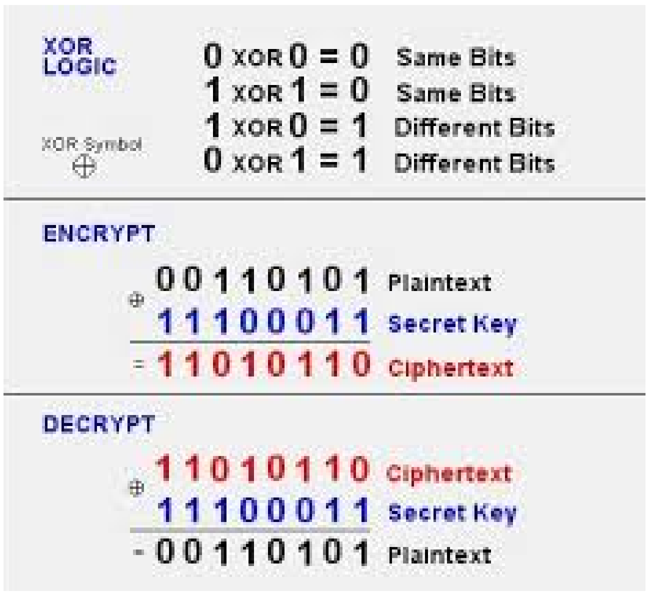
Part 6 Appendices

Appendix 6.1: How XOR cipher works by The Tech-FAQ


XOR LOGIC
0 XOR 0 = 0 Same Bits
1 XOR 1 = 0 Same Bits
1 XOR 0 = 1 Different Bits
0 XOR 1 = 1 Different Bits
XOR Symbol ⊕
ENCRYPT
00110101 Plaintext
⊕ 11100011 Secret Key
= 11010110 Ciphertext
DECRYPT
11010110 Ciphertext
⊕ 11100011 Secret Key
= 00110101 Plaintext