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Practical Lab Report

Submitted By: Sumayta Shama
Roll No**:** 200639
Dept. of Information and Communication Engineering
Pabna University of Science and Technology
Pabna-6600, Bangladesh

Submitted To: Md. Anwar Hossain
Professor
Dept. of Information and Communication Engineering.
Pabna University of Science and Technology
Pabna-6600, Bangladesh

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Problem No: 01

Problem Name: Write a program in "JAVA" or "C" to develop a simple calculator that would be able to take a number, an operator (addition/subtraction/multiplication/ division/modulo) and another number consecutively as input and the program will display the output after pressing "=" sign. Sample input: 1+2; 8%4; Sample output: 1+2=3; 8%4=0.

Objective:

- To create a simple calculator using C programming.
- To take an arithmetic expression as input in the form of: number operator number.
- To perform operations like addition, subtraction, multiplication, division, and modulo.
- To display the result after evaluating the expression.

Theory: A simple calculator is a basic program that processes mathematical operations between two operands using a specified operator. The user inputs a complete expression (e.g., 5*4), and the program parses the input to identify the operands and operator. Based on the operator, it performs the appropriate arithmetic operation. Handling characters and integer parsing is essential. The calculator must also include basic validation, such as checking for division by zero or invalid operators.

Algorithm:

1. Start the program.
2. Prompt the user to enter a simple arithmetic expression in the format operand1 operator operand2 (e.g., 3+5).
3. Prompt the user to:
    - First operand (operand1)
    - Operator (op)
    - Second operand (operand2)
4. Check the operator using a switch or if-else structure:
    - If +, perform addition.
    - If -, perform subtraction.
    - If *, perform multiplication.
    - If /, check for division by zero, then perform division.
    - If %, check for modulo by zero, then perform modulo.
    - Else, display an error for an invalid operator.
5. Display the result in the format operand1 operator operand2 = result.
6. End the program.

Code:

```
#include <stdio.h>

int main() {
    double num1, num2, result;
    char op, equal;
    printf("Enter expression: ");
    scanf("%lf %c %lf", &num1, &op, &num2);
    printf("Press '=' to get result: ");
    scanf(" %c", &equal);

    if (equal == '=') {
        switch (op) {
            case '+':
                result = num1 + num2;
                printf("%.0lf%c%.0lf=%.2lf\n", num1, op, num2, result);
                break;
            case '-':
                result = num1 - num2;
                printf("%.0lf%c%.0lf=%.2lf\n", num1, op, num2, result);
                break;
            case '*':
                result = num1 * num2;
                printf("%.0lf%c%.0lf=%.2lf\n", num1, op, num2, result);
                break;
            case '/':
                if (num2 != 0)
                    printf("%.0lf%c%.0lf=%.2lf\n", num1, op, num2, num1 / num2);
                else
                    printf("Error: Division by zero!\n");
                break;
            case '%':
                if ((int)num2 != 0)
                    printf("%d%%%d=%d\n", (int)num1, (int)num2, (int)num1 %
(int)num2);
                else
                    printf("Error: Modulo by zero!\n");
                break;
            default:
                printf("Invalid operator!\n");
        }
    } else {
        printf("You did not press '='. No result displayed.\n");
    }
    return 0;
}
```

Input:

Enter expression: 5+3

Press '=' to get result: =

Output:

5+3=8.00

Problem No: 02

Problem Name: Write a program in "JAVA" or "C" that will take two 'n' integers as input until a particular operator and produce 'n' output.

Sample input: 4 5 7 8 20 40 +; Sample output: 9 15 60.

Objective:

- ❖ Read pairs of integers and an operator from input.
- ❖ To perform element-wise arithmetic operations based on a specified operator.
- ❖ Display the results or handle errors like division by zero.

Theory: This program demonstrates array-based arithmetic operations in programming. The user provides two groups of numbers, a sequence of 2n integers. each containing n integers, followed by an arithmetic operator like +, -, *, /, or %. The program then performs the specified operation between corresponding elements of the two sequences (e.g., A[i] + B[i]) and prints each result. This helps build understanding of array handling, loop iteration, and basic arithmetic operations in C or Java.

Algorithm:

1. Start the program.
2. Declare arrays to store the two sets of n integers.
3. Prompt the user to enter 2n integers followed by a single operator character.
4. Read the values into two arrays: the first n numbers go into the first array, the next n into the second.
5. Store the operator entered after the numbers.
6. Using a loop, perform the operation between corresponding elements of both arrays:
    - If +, add A[i] + B[i].
    - If -, subtract A[i] - B[i].
    - If *, multiply A[i] * B[i].
    - If /, divide A[i] / B[i] (check for zero).
    - If %, perform A[i] % B[i] (check for zero).
7. Print the result of each operation.
8. End the program.

Code:

```
#include <stdio.h>

int main() {
   int numbers[100], count = 0;
   char op;
```

```
printf("Enter even number of integers followed by an operator :\n");

while (scanf("%d", &numbers[count]) == 1) {
    count++;
    if (count >= 100) break; // prevent overflow
}

// Read the operator
scanf(" %c", &op);

if (count % 2 != 0) {
    printf("Error: Please enter an even number of integers.\n");
    return 1;
}

printf("Output:\n");
for (int i = 0; i < count; i += 2) {
    int a = numbers[i];
    int b = numbers[i + 1];

    switch (op) {
        case '+':
            printf("%d ", a + b);
            break;
        case '-':
            printf("%d ", a - b);
            break;
        case '*':
            printf("%d ", a * b);
            break;
        case '/':
            if (b != 0)
                printf("%d ", a / b);
            else
                printf("ERR ");
            break;
        case '%':
            if (b != 0)
                printf("%d ", a % b);
            else
                printf("ERR ");
            break;
        default:
            printf("Invalid operator\n");
            return 1;
```

```
            }
        }

        printf("\n");
        return 0;
    }
```

Input:

Enter even number of integers followed by an operator :

4 5 7 8 20 40 +

Output:

9 15 60

Problem No: 03

Problem Name: Write a program in "JAVA" or "C" to check weather a number or string is palindrome or not.

N.B: your program must not take any test case number such as 1 or 2 for the desired cases from the user. Program user will insert a number or string as input directly and the program will display the exact result in the output console.

Objective:

- To develop a program that checks if a given number or string is a palindrome.
- To determine whether the input reads the same forward and backward
- To accept user input directly without requiring the number of test cases.
- To display accurate results indicating whether the input is a palindrome or not.

Theory: A palindrome is a word, phrase, or number that remains the same when reversed. Common examples include “madam”, “121”, or “racecar”. This program takes a single input (string or number, treated as a string), and checks if it is identical to its reverse. This involves reversing the input and comparing it to the original. If both are equal, it's a palindrome; otherwise, it’s not. This exercise reinforces understanding of string manipulation and conditional logic in programming.

Algorithm:

1. **Start the program.**
2. **Prompt the user** to enter a string or number (as a string input).
3. **Store the input** in a variable.
4. **Create a reversed version** of the input using a loop or built-in function.
5. **Compare** the original input with the reversed version:
    - If they match, display “Palindrome”.
    - If they don’t match, display “Not Palindrome”.
6. **End the program.**

Code:

```
#include <stdio.h>
#include <string.h>

int main() {
   char input[1000];
   int start, end, isPalindrome = 1;

   printf("Enter a number or string: ");
```

```
    scanf("%s", input);

    start = 0;
    end = strlen(input) - 1;

    while (start < end) {
        if (input[start] != input[end]) {
            isPalindrome = 0;
            break;
        }
        start++;
        end--;
    }

    if (isPalindrome) {
        printf("Palindrome\n");
    } else {
        printf("Not Palindrome\n");
    }

    return 0;
}
```

Input:

madam

Output:

Palindrome

Problem No: 04

Problem Name: Write down the ATM system specifications and report the various bugs.

Objective:

- To understand and document the functional specifications of an ATM system.
- To analyze the ATM workflow and identify potential faults or vulnerabilities.
- To report and categorize the various bugs found during system analysis.

Theory:

An Automated Teller Machine (ATM) is an electronic banking device that enables customers to perform basic financial transactions without the need for a human teller. These transactions include withdrawing cash, checking account balances, depositing funds, transferring money between accounts, and printing mini statements. ATMs are accessible 24/7 and are connected to banking networks, allowing users to access their bank accounts using a debit or ATM card and a Personal Identification Number (PIN) for secure authentication.

ATM System Specifications:

- **Hardware Components:**
  - Card Reader: Reads data from ATM/debit cards using magnetic stripe or chip.
  - Keypad: For PIN entry and transaction inputs.
  - Display Screen: Provides user interface to display messages and instructions.
  - Cash Dispenser: Dispenses requested cash denominations.
  - Receipt Printer: Prints transaction receipts for users.
  - Security Camera: Monitors user activity for security.
  - Communication Module: Connects ATM to banking network over secure channels.

- **Software Components**
  - Operating System: Embedded OS (e.g., Windows Embedded, Linux).
  - ATM Application Software:
    - ✓ User authentication (PIN verification)
    - ✓ Transaction processing (withdrawal, deposit, balance inquiry)
    - ✓ Communication with bank server
  - Encryption Module: For secure PIN entry and data transmission.
  - Logging Module: For maintaining audit trails and error logs.

- **Functional Specifications:**

- **User Authentication:** The ATM system verifies user identity through a card number and PIN, allowing only a limited number of incorrect attempts before blocking access to prevent unauthorized use.
- **Account Management:** It provides users with the ability to view account balances and manage multiple accounts linked to their card within a single session.
- **Transactions:** The system supports cash withdrawals with daily limits, deposits with immediate balance updates, fund transfers between accounts, and generating mini statements showing recent transactions.
- **User Interface:** The ATM offers clear prompts and error messages to guide users smoothly, sometimes including multilingual support to cater to diverse users.
- **Security:** Sensitive data is encrypted, sessions time out after inactivity, and measures are in place to prevent unauthorized access or tampering.
- **Receipt Generation:** After transactions, the ATM can print or display detailed receipts confirming the transaction details for the user's reference.
- **Error Handling:** The system detects hardware issues like card reader or cash dispenser failures and informs users of transaction errors or failures to ensure transparency.

Common Bugs in ATM Systems:

Incorrect PIN Handling: Some ATMs fail to lock accounts after multiple incorrect PIN entries or allow weak PINs, compromising security.

Transaction Errors: Errors occur when withdrawals exceed balances or limits without blocking, or when balances do not update correctly after transactions.

Concurrency Issues: Simultaneous transactions can cause race conditions, leading to inconsistent or incorrect account balances.

User Interface Glitches: Misleading or unclear error messages and poor input validation can confuse users or cause system crashes.

Security Flaws: Sensitive data like PINs may be stored in plain text, and sessions might not timeout properly, exposing user accounts to risk.

Hardware Failure Handling: ATMs sometimes fail to detect or properly handle card reader or cash dispenser malfunctions, leading to lost transactions.

Receipt Errors: The system may print incorrect transaction details or fail to generate receipts, causing confusion or disputes.

Conclusion

This lab helped in understanding the internal working of ATM systems from both a functional and user experience perspective. By identifying common bugs, we learned the importance of edge-case handling, UI responsiveness, and robust error management in software systems.

Problem No: 05

Problem Name: Write a program in "JAVA" or "C" to find out the factorial of a number using while or for loop. Also verify the results obtained from each case.

Objective:

- To calculate the factorial of a given number using iterative looping methods such as while or for.
- To understand the logic for computing the factorial of a number.
- To ensure the correctness of the result by applying the logic to various sample inputs.
- To verify the consistency and accuracy of the outcome obtained through different loop implementations.

Theory:

The factorial of a non-negative integer n is the product of all positive integers less than or equal to n. It is denoted as n!.

Mathematically,

$n! = n \times (n-1) \times (n-2) \times ... \times 1$

For example, $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$. In programming, we can compute factorial using iteration (for or while) or recursion. This lab focuses on iterative approaches. In each iteration, the program multiplies the current result with the loop variable until it reaches the input number. The result can then be verified by comparing it with a known factorial value or using different loop structures to ensure correctness. This program helps in understanding loop control and the concept of iterative computation in programming.

Algorithm:

- Start the program and take a positive number as input.
- Initialize a variable to store the factorial result and a counter for iterations.
- Use a loop (either for or while) to iterate from the input number down to 1.
- In each iteration, print the current multiplication step and update the result.
- After completing the loop, print the final factorial result.
- End the program.

Code:

```
#include <stdio.h>

int main() {
    int number;
    long long int fact = 1;
    int j = 1;
```

```
    printf("Enter a number to find factorial: ");
    scanf("%d", &number);

    for (int i = number; i > 0; i--) {
        printf("Factorial in iteration %d is : %lld * %d = %lld\n", j, fact, i, fact);
        fact = fact * i;
        j++;
    }

    printf("\n%d! = %lld\n", number, fact);

    return 0;
}
```

Input:

Enter a number to find factorial: 5

Output:

Factorial in iteration 1 is : 1 * 5 = 1

Factorial in iteration 2 is : 5 * 4 = 5

Factorial in iteration 3 is : 20 * 3 = 20

Factorial in iteration 4 is : 60 * 2 = 60

Factorial in iteration 5 is : 120 * 1 = 120

5! = 120

Problem No: 06

Problem Name: Write a program in "JAVA" or "C" that will find sum and average of array using do while loop and 2 user defined function.

Objective:

- To implement logic for calculating the sum and average of elements stored in an array.
- To use a do-while loop for array traversal and processing.
- To organize the program using two user-defined functions for modularity and clarity.

Theory:

An array is a collection of elements stored in contiguous memory locations.
To compute the sum of its elements, we add each value during iteration. The average is calculated as:

$$\text{Average} = \text{Sum} / \text{Number of Elements}$$

The program takes input from the user to populate the array, then processes the data using a do-while loop, which ensures that the loop runs at least once. This approach reinforces the use of loops, functions, and array manipulation, encouraging modular and structured programming practices.

Algorithm:

- Start the program.
- Take input for the size of the array.
- Read all elements of the array from the user.
- Call a user-defined function to calculate the sum:
  - Initialize sum to 0 and index to 0.
  - Use a do-while loop to iterate through each array element.
  - Add each element to the sum and increment the index.
  - Continue until all elements are processed.
- Call another user-defined function to calculate the average:
  - Divide the calculated sum by the number of elements.
- Display both sum and average.
- End the program.

Code:

```
#include <stdio.h>

int calculateSum(int arr[], int n) {
    int sum = 0, i = 0;
    do {
        sum += arr[i];
        i++;
```

```
    } while(i < n);
    return sum;
}

float calculateAverage(int sum, int n) {
    return (float)sum / n;
}

int main() {
    int arr[100], n, i;
    int sum;
    float avg;
    printf("Enter number of elements: ");
    scanf("%d", &n);
    printf("Enter %d elements:\n", n);
    for(i = 0; i < n; i++) {
        scanf("%d", &arr[i]);
    }
    sum = calculateSum(arr, n);
    avg = calculateAverage(sum, n);
    printf("Sum = %d\n", sum);
    printf("Average = %.2f\n", avg);

    return 0;
}
```

Input:

Enter number of elements: 3

Enter 3 elements:

1 2 3

Output:

Sum = 6

Average = 2.00

Problem No: 07

Problem Name: Write a simple "JAVA" program to explain classNotFound Exception and endOfFile(EOF) exception.

Objective:

- To understand and demonstrate the use of exception handling in Java.
- To illustrate the working of:
- ClassNotFoundException when trying to load a class dynamically.
- EOFException when reading beyond the end of a file.
- To develop a simple Java program that handles these exceptions gracefully.

Theory: In Java, ClassNotFoundException and EOFException are two common exceptions that occur during runtime under specific conditions. ClassNotFoundException is thrown when the Java ClassLoader tries to load a class at runtime using its name (often through reflection) and the class cannot be found in the classpath. This usually happens in programs that use dynamic class loading. On the other hand, EOFException (End-Of-File Exception) is a checked exception that occurs when an input operation is attempted beyond the end of a file, typically when reading from a file or stream using classes like ObjectInputStream or DataInputStream. These exceptions help in identifying problems related to class availability and file reading boundaries, ensuring more reliable and controlled program execution.

Algorithm:

- Import necessary I/O and utility classes.
- Begin the program execution.
- Attempt to load a class at runtime.
  Handle exception if the class is not found.
- Open a stream to read data.
- Read data in a loop until the end is reached.
  Handle exception when end of data is encountered.
- Close the stream and end the program.

Code:

```
package Study;
import java.io.*;
public class CEException {
   public static void main(String args[]) throws Exception {
      try {
    Class.forName("Study.ExistClass");
    System.out.println("Class Found inside package.\n---------");
          }        catch(ClassNotFoundException e) {
         System.out.println("CLassNotFoundException");
          }
```

```
        System.out.println("EOF exception for output ");
        DataInputStream dis = new DataInputStream(new FileInputStream("input.txt"));
        while(true) {
            try{
                    byte ch;
                    ch = dis.readByte();
                    System.out.print((char)ch);
            } catch(EOFException e) {
                    System.out.println("\nEnd of file reached");
                    break;
            }
        }
        dis.close();
            }
    }
    package Study;
    public class ExistClass
    {
        public static void getDepartmentName()
        {
            System.out.println("Information and Communication Engineering");
        }
    }
```

Output:

Problem No: 08

Problem Name: Write a program in "JAVA" or "C" that will read a input.txt file containing n positive integers and calculate addition, subtraction, multiplication and division in separate output.txt file.

Sample input: 5 5 9 8; Sample output: Case-1:10 0 25 1; Case-2: 17 1 72 1.

Objective:

- To read a series of positive integers from a file.
- To perform basic arithmetic operations addition, subtraction, multiplication, and division on each pair of integers.
- To write the results into an output file in a structured format.
- To understand file handling and arithmetic operations in C.

Theory: File handling in programming allows reading from and writing to external files, enabling data persistence and I/O operations beyond standard input/output.

In this lab, the program will use **file input/output (I/O)** operations to read n positive integers from a file named input.txt. These integers will be processed to perform the following arithmetic operations:

1. **Addition**: Sum all the integers.
2. **Subtraction**: Subtract each subsequent number from the first.
3. **Multiplication**: Multiply all the integers together.
4. **Division**: Perform successive division starting from the first number.

The calculated results will then be written to another file named output.txt. This process involves:

- Opening the input file in **read mode**.
- Parsing the content to extract integers.
- Performing the four operations using loops or accumulators.
- Opening the output file in **write mode** and writing the results.

Algorithm:

- Start the program.
- Open the input file in read mode and the output file in write mode.
- Check if files opened successfully.
- Read two integers at a time from the input file.
- For each pair:
  - Perform addition, subtraction, multiplication, and division.
  - Write the results to the output file with proper formatting.

- Repeat steps 4–5 until all data is processed.
- Close both files.
- End the program.

Code:

```
#include <stdio.h>
#include <stdlib.h>

int main() {
    FILE *fin, *fout;
    int a, b, caseNum = 1;

    fin = fopen("input.txt", "r");
    fout = fopen("output.txt", "w");

    if (fin == NULL || fout == NULL) {
        printf("Error opening file.\n");
        return 1;
    }

    while (fscanf(fin, "%d %d", &a, &b) == 2) {
        int sum = a + b;
        int diff = a - b;
        int prod = a * b;
        int div = (b != 0) ? a / b : 0; // Prevent division by zero

        fprintf(fout, "Case-%d: %d %d %d %d\n", caseNum, sum, diff, prod, div);
        caseNum++;
    }

    // Close files
    fclose(fin);
    fclose(fout);

    printf("Results written to output.txt successfully.\n");
    return 0;
}
```

Input: 5 5 9 8

Output:

Case-1: 10 0 25 1

Case-2: 17 1 72 1

Problem No: 09

Problem Name: Explain the role of software engineering in Biomedical Engineering and in the field of Artificial Intelligence and Robotics.

Objective:

- To explore how software engineering principles support innovation in biomedical engineering applications.
- To understand the integration of software systems in artificial intelligence and robotics.
- To highlight the impact of reliable software design on the development of intelligent and automated technologies.

Theory:

Role of Software Engineering in Biomedical Engineering

1. Development of Medical Device Software: Software engineering is essential for creating the software that controls medical devices such as MRI machines, pacemakers, and diagnostic equipment. This software must be precise and reliable to ensure patient safety and accurate medical results.

2. Healthcare Data Management Systems: Managing electronic health records and medical databases requires robust software systems. Software engineering enables the design of secure and efficient platforms that store, retrieve, and analyze patient data, helping improve diagnosis and treatment.

3. Automation and Patient Monitoring: Software engineering helps build automated patient monitoring systems that continuously track vital signs and health metrics. These systems provide real-time alerts to medical staff, enhancing patient care and response times.

Role of Software Engineering in Artificial Intelligence and Robotics

1. AI Algorithm Design and Implementation: Software engineering develops the algorithms that power artificial intelligence, enabling machines to learn from data, make decisions, and solve complex problems. This forms the core of AI applications like speech recognition, recommendation systems, and more.

2. Robotics Control and Navigation: In robotics, software engineering is responsible for creating control systems that guide robot movement and interactions. It ensures that robots can operate autonomously in various environments, from industrial floors to medical settings.

3. System Integration and Maintenance: Software engineers integrate AI and robotic software with hardware components and develop maintainable, scalable solutions. They focus on ensuring the long-term reliability and adaptability of intelligent systems as technology evolves.

Problem No: 10

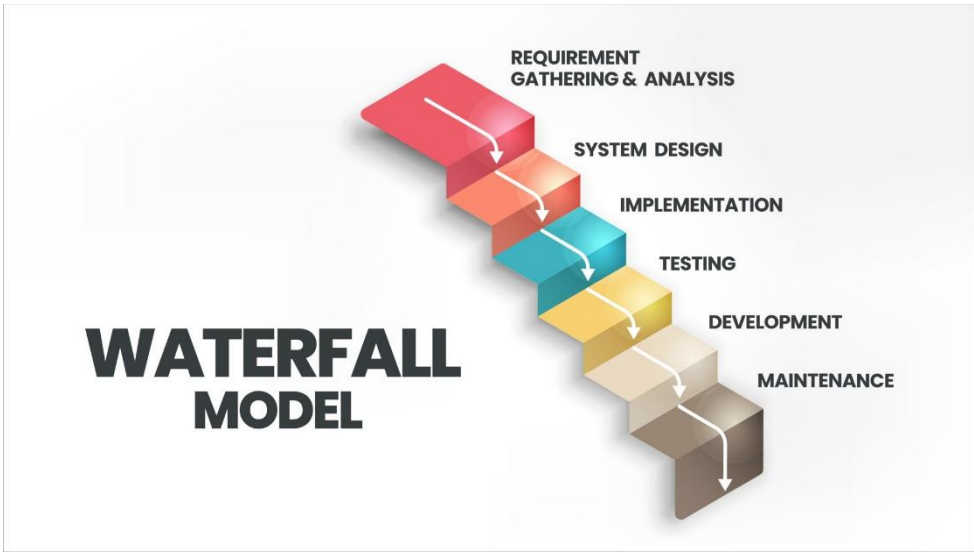
Problem Name: Study the various phases of Water-fall model. Which phase is the most dominated one?

Objective:

- To understand the working of the Waterfall model in software development.
- To study the various sequential phases involved in the Waterfall model.
- To identify and analyze the most dominant phase of the Waterfall model.
- To learn how each phase depends on the completion of the previous phase.

Theory: The Waterfall Model is one of the earliest and most widely known models in software engineering. It follows a sequential design process, where progress is seen as flowing steadily downwards (like a waterfall) through several distinct phases.

Each phase must be completed before the next begins, and there is typically no overlapping or iteration between the phases.



1. **Requirement Analysis:** This phase involves collecting and documenting all software requirements from the client. It defines what the system should do and ensures clarity for the development process.
2. **System Design:** Based on the gathered requirements, system architecture and module-level designs are created. This serves as a blueprint for coding.
3. **Implementation (Coding):** The design is translated into source code using suitable programming languages. Each module is developed and tested individually.
4. **Integration and Testing:** All modules are combined and tested as a complete system. This phase checks for defects and ensures the software meets requirements.

5. **Deployment:** The fully tested software is delivered and installed in the user environment. It becomes operational for end users.
6. **Maintenance:** Post-deployment, the software is monitored, bugs are fixed, and updates or enhancements are applied as needed.

Most Dominant Phase:

The most important phase is **Requirement Analysis** because it sets the foundation for the entire project. If requirements are unclear or incorrect, the following phases will be affected, often leading to costly errors. Since the Waterfall Model is sequential, mistakes in this phase are hard to fix later, making it the most critical stage.

Conclusion: The Waterfall model provides a clear and structured approach to software development. While each phase has its importance, the **Requirement Analysis phase** is the most dominant, as it lays the groundwork for the entire project. Success in this phase often determines the success of the final software product.

Problem No: 11

Problem Name: Using COCOMO model estimate effort for specific problem in industrial domain

Objective:

- To estimate software development effort using the COCOMO model.
- To identify key parameters from an industrial problem for accurate estimation.
- To calculate effort, time, and cost based on the model's formulas.

Theory:

Effort Estimation Using COCOMO Model

COCOMO (Constructive Cost Model) is a widely used software cost estimation model that predicts effort (person-months), development time, and required workforce based on the size of the software project (measured in Kilo Lines of Code, KLOC).

Steps to Estimate Effort for an Industrial Project

1. **Determine the project size:** Estimate the total lines of code (LOC) expected for the project and convert it to KLOC (1 KLOC = 1000 LOC).
2. **Identify the project type:** COCOMO defines three categories:

    i. **Organic:** Small, simple projects with experienced teams.
    ii. **Semi-detached:** Medium complexity projects with mixed experience levels.
    iii. **Embedded:** Complex projects with tight constraints, typical in industrial or embedded systems.

3. **Apply the COCOMO basic formula:**

$$\text{Effort (person-months)} = a \times (\text{KLOC})^b$$

where coefficients a and b depend on the project type.

For organic type, a= 2.4 and b= 1.05

For Semi-detached type, a= 3.0 and b= 1.12

For Embedded type, a= 3.6 and b= 1.20

4. **Calculate effort:**
   Substitute the KLOC and corresponding a, b values into the formula.

Example: Industrial Domain Project

- Estimated size: 50,000 LOC → 50 KLOC
- Project type: Embedded (industrial system with strict requirements)
- Using Embedded coefficients: a=3.6, b=1.20

$$\text{Effort} = 3.6 \times (50)^{1.20}$$

$$= 3.6 \times 109.65 = 394.74 \text{ person-months}$$

Conclusion: By applying COCOMO, industrial software development teams can better estimate the required effort and avoid underestimation or overestimation, leading to improved project management and resource allocation.

Problem No: 12

Problem Name: Identify the reasons behind software crisis and explain the possible solutions for the following scenario:

Case 1: "Air ticket reservation software was delivered to the customer and was installed in an airport 12.00 AM (mid night) as per the plan. The system worked quite fine till the next day 12.00 PM (noon). The system crashed at 12.00 PM and the airport authorities could not continue using software for ticket reservation till 5.00 PM. It took 5 hours to fix the defect in the software".

Case 2: "Software for financial systems was delivered to the customer. Customer conformed the development team about a mal-function in the system. As the software was huge and complex, the development team could not identify the defect in the software".

Objective:

- To investigate the root causes of the software crisis in real-world system deployments.
- To analyze critical failures in case studies related to air ticket reservation and financial systems.
- To propose effective software engineering solutions to prevent similar issues in future projects.

Theory: The Software Crisis refers to the challenges faced in software development, especially in the areas of reliability, maintainability, cost, complexity, and delayed delivery. It emerged when demand for software outgrew the ability to develop and maintain it effectively.

Reasons Behind Software Crisis

Software crisis refers to the difficulties and challenges faced during software development, such as delayed delivery, cost overruns, low-quality products, and maintenance problems. Common reasons include:

- **Complexity:** Software systems have grown large and complex, making them hard to understand, develop, and maintain.
- **Poor Requirements:** Incomplete, ambiguous, or changing requirements lead to faulty design and implementation.

- **Inadequate Testing:** Insufficient testing can result in undetected bugs, causing failures in real-world use.
- **Poor Project Management:** Lack of proper planning, estimation, and resource management often causes delays and overruns.
- **Lack of Skilled Personnel:** Shortage of experienced developers affects software quality and delivery.
- **Inadequate Maintenance:** Difficulty in locating and fixing defects in large, complex software systems.

Case 1: Air Ticket Reservation Software Crash at Noon

Reason for the Problem: The system crashed exactly at 12:00 PM, possibly due to a time-dependent bug (e.g., date/time rollover issue, memory leak, or resource exhaustion) that appeared after running continuously for 12 hours. This indicates insufficient stress testing and failure to test the system under real operating conditions for extended periods.

Possible Solutions:

- Conduct thorough stress and boundary testing**,** especially focusing on time-related scenarios (midnight transitions, date/time rollover).
- Implement robust error handling to avoid system crashes and allow graceful recovery.
- Use monitoring tools to detect resource leaks and performance bottlenecks during testing.
- Schedule regular maintenance windows and develop failover mechanisms to minimize downtime.
- Employ incremental deployment with fallback plans rather than big-bang installations.

Case 2: Defect in Complex Financial Software Not Identified

Reason for the Problem: The development team struggled to identify the defect due to the size and complexity of the software, highlighting poor modularity, lack of documentation, or inadequate debugging tools and processes.

Possible Solutions:

- Adopt modular design and component-based development to isolate and localize defects more easily.
- Maintain comprehensive documentation to help understand and navigate complex codebases.
- Use automated testing and debugging tools such as static analyzers, profilers, and logging frameworks.
- Implement version control and issue tracking systems to trace changes and defect reports effectively.

- Encourage code reviews **and** pair programming to catch defects early and spread knowledge across the team.
- Invest in training and skill development for the development team.

Conclusion: The software crisis in both cases emerged due to lack of robust testing, code modularity, and real-world scenario handling. By applying engineering principles, modular design, and automated testing, such failures can be minimized. This experiment shows the importance of proactive development and testing strategies in critical software systems like airline reservations and financial applications.