CS 402 Project SPIM Calculator

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3.1 User's manual document:

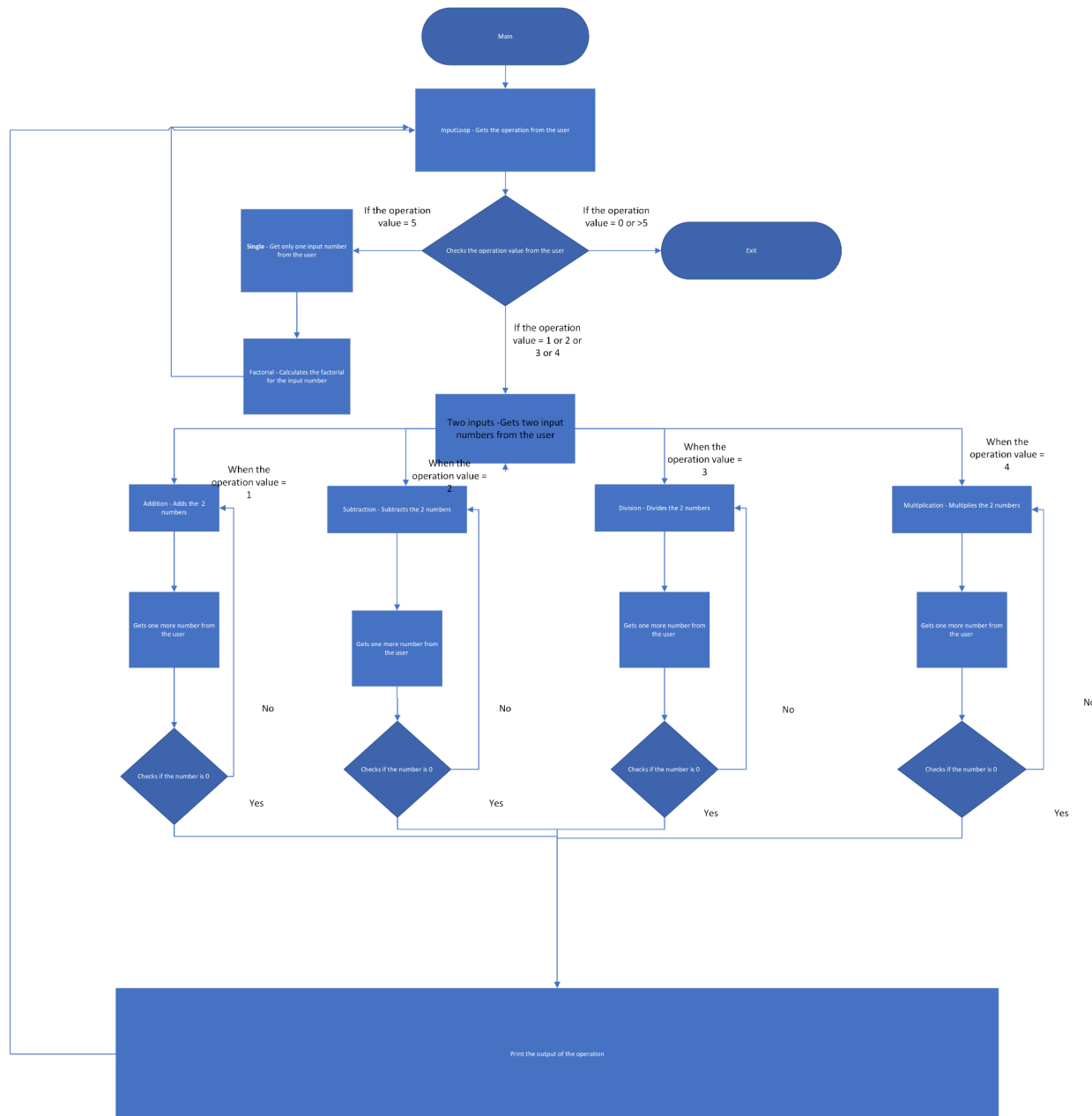The following steps are to be followed to run the program - asm file
1. your computer's QTSPIM simulator should now be open.
2. Click the "Load" or "Assemble/Load" button to load the software into the simulator.
3. The text part of the simulator will show the program's content.
4. In QTSPIM, select the "Run" button to launch the application. This will begin the program's execution.
5. When you input the desired procedure or number as instructed by the code, the simulator will display the outcome and prompt you.
6. Based on the menu selections shown in the simulator, enter the proper input.
7. The chosen operation will be carried out by the software, and the outcome will be shown.
8. Until you decide to end the program by inputting "0," you can resume the procedure by entering another operation or number.

3.2 Program analyzing document

Objective:
The objective of the program is to create a calculator using QTSPIM, an assembly language simulator, capable of performing various mathematical operations. The program allows the user to perform addition, subtraction, division, multiplication, and factorial calculations repeatedly until the user chooses to exit.

MIPS numerical calculator

```
                              Main

                    InputLoop - Gets the operation from the user

   If the operation                              If the operation
   value = 5                                     value = 0 or >5

Single - Get only one input number   Checks the operation value from the user        Exit
      from the user

                          If the operation
                          value = 1 or 2 or
                          3 or 4

Factorial - Calculates the factorial
      for the input number

                    Two inputs -Gets two input
                    numbers from the user

   When the              When the              When the              When the
 operation value =     operation value =     operation value =     operation value =
       1                   2                       3                     4

Addition - Adds the 2   Subtraction - Subtracts the 2 numbers   Division - Divides the 2 numbers   Multiplication - Multiplies the 2 numbers
      numbers

Gets one more number from   Gets one more number from   Gets one more number from   Gets one more number from
       the user                 the user                    the user                    the user

              No                       No                       No                       No

Checks if the number is 0   Checks if the number is 0   Checks if the number is 0   Checks if the number is 0

              Yes                      Yes                      Yes                      Yes

                         Print the output of the operation
```

Input:

The input to the program is provided by the user through the console while the program is running. The user is prompted with different messages and menus to make selections and enter numbers for

performing various operations. Here is a summary of the expected inputs:

1. Operation Selection:
   - The user is prompted to enter a number corresponding to the desired operation:
     - 1: Addition
     - 2: Subtraction
     - 3: Division
     - 4: Multiplication
     - 5: Factorial
     - 0: Exit
2. Number Inputs:
   - Depending on the chosen operation, the program expects the following number inputs:
     - For factorial (option 5): The user is prompted to enter a single number for which the factorial will be calculated.
     - For addition, subtraction, division, and multiplication (options 1, 2, 3, 4): The user is prompted to enter two numbers on separate occasions to perform the respective operation.
3. Continuing Calculations:
   - After completing an operation, the program gives the option to continue with another calculation or exit the program.
   - If the user chooses to continue, they can enter additional numbers to perform the same operation repeatedly until they decide to exit.

Output:

The program generates various outputs depending on the selected operation and user inputs. Here is a summary of the expected outputs:

1. Addition:
  - The program displays the result of the addition operation.
  - For example: "Addition: 10"

2. Subtraction:
  - The program displays the result of the subtraction operation.
  - For example: "Subtraction: -5"

3. Division:
  - The program displays the result of the division operation.
  - For example: "Division: 3"

4. Multiplication:
  - The program displays the result of the multiplication operation.
  - For example: "Multiplication: 24"

5. Factorial:
   - The program calculates the factorial of the entered number and displays the result.
  - For example: "Factorial: 120"

6. Prompt for Another Operation:
   - After completing an operation, the program prompts the user to enter the number corresponding to the desired operation, or to enter 0 to exit.
   - For example: "For add press 1, For sub press 2, For div press 3, For mult press 4, For factorial press 5, To exit press 0:"

7. Thank You Message:
   - When the user chooses to exit the program, the program displays a thank you message.
   - For example: "Thank you for using SPIM Calculator!"

Program Analysis:

The given program is a calculator implemented in MIPS assembly language using the QTSPIM simulator. It allows the user to perform various mathematical operations such as addition, subtraction, division, multiplication, and factorial. The program runs in a loop until the user chooses to exit.

The program begins by initializing the data section (` .data`) where strings for menu prompts, operation results, and end-of-line characters are defined. It also declares variables to store user inputs and results.

In the code section (` .text`), the program starts with a welcome message to greet the user. Then it enters an input loop (`inputLoop`) where the user can perform multiple calculations. Inside the loop, the program prompts the user to enter a number corresponding to the desired operation.

Based on the user's input, the program branches to different sections of code:
- If the user selects factorial (single-input operation) the program prompts the user to enter a number. It calculates the factorial using a loop and displays the result.
- If the user selects one of the addition, subtraction, division, multiplication operations, (two-input operation), the program prompts the user to enter two numbers. It performs the calculation using the

respective operation logic implemented in loops, accumulating the result.

After performing the operation, the program displays the result and prompts the user to select another operation or exit. If the user chooses to continue, the input loop continues. If the user selects the exit option, the program displays a thank you message and exits.

The program utilizes branching instructions (`beq`, `beqz`, `bgt`, `bne`, `j`) to control the flow of execution based on the user's input. It also employs looping constructs (`j`, `j label`, `beqz`) to repeat calculations or to iterate until the user enters a specific input.

Overall, the program provides a user-friendly calculator experience, allowing the user to perform multiple calculations and providing feedback on the results.