
SN²ARK CO.

**Arithmetic Parser
Test Case Document**

Version 1.3

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| Arithmetic Parse | Version: 1.2 |
| Test Case Document | Date: 11/29/2023 |
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Revision History

| Date | Version | Description | Author |
|------------|---------|--|---|
| 11/20/2023 | 1.0 | Team members started the Test Case Document. They started working on the individual's 10 test cases. | Sophia Jacob, Reeny Huang, Navya Nittala, Kusuma Murthy, Anna Lin, Nimra Syed |
| 11/26/2023 | 1.1 | Each team member completed their 10 individual Test Cases. This will have robust examples that will test the software and code in various ways. | Sophia Jacob, Reeny Huang, Navya Nittala, Kusuma Murthy, Anna Lin, Nimra Syed |
| 11/29/2023 | 1.2 | The team members went through all 61 test cases and explained the purpose of each test case and validated the test cases. | Sophia Jacob, Reeny Huang, Navya Nittala, Kusuma Murthy, Anna Lin, Nimra Syed |
| 12/01/2023 | 1.3 | Removed blue instructions text from the document, added more required details in the needed areas, and finalized this document to be submitted after reviewing all the sections. | Sophia Jacob, Reeny Huang, Navya Nittala, Kusuma Murthy, Anna Lin, Nimra Syed |

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Test Case

1. Purpose

The purpose of this project is for SN²ARK to develop a multifunctional arithmetic expression evaluator utilizing C++. The objective is to create a simulation of a calculator, through a program, that can handle expressions as input and calculate the result using mathematical operations like (PEMDAS). Furthermore, SN²ARK will fully integrate the Software Development Process through timely deliverables within the semester. These deliverables include a detailed project plan, a requirements document, a design document aligned with the requirements, a set of test cases, and a fully developed product. As part of the scope of this project, each iteration should be timely and in line with the functionality of the requirements.

This **Test Case Specification Document** for the Arithmetic Parser defines a test case for an item that should be tested. The sections of the test case specification shall be ordered in the specified sequence. Additional sections may be included at the end. The Document will validate the user's functionality in the various features that are offered by SN²ARK's project. Section 2 of the **Test Case Specification Document** contains the various test cases procured by each team member. This Document displays the functionality of regression testing, allowing the team to test different scenarios, then refactor and debug the source code. This was done throughout the process of creating modules and the Implementation Phase. Finally, in Section 2, the different headers include a Test Case Identifier, which is the number of the Test Case. The Test Item is a brief description of the Test Case. The Input Specification is what expression/input will be tested. The Expected Output Specification and Actual Output Specification will show what the user expects to see versus what is actually shown. The Test Case is validated by a Pass/Fail column. Section 6 will cover any other requirements or Test Cases.

2. Test cases

Refer to *Table 1*

3. Test item

Refer to *Table 1*.

4. Input specifications

All input values are specified in *Table 1*.

Databases: None

Files: None

Terminal Messages: "Enter your Expression:", "Missing or misplaced operands/operator", "Division by Zero Error", "Invalid Character", "Bad Input", "Modulus operator requires integers.", "Bad Input.

Unary operators must be separated by parentheses.", "Parentheses Error."

Memory Resident Areas: None

Values Passed by Operating System: the return value of expression

5. Output specifications

Table 1.

| Test Case Identifier | Test Item | Input Specification | Expected Output Specification | Actual Output Specification | Pass/Fail |
|----------------------|---|---------------------|-------------------------------|-----------------------------|-----------|
| 001 | Test to validate if the program handles invalid input of letters through the isValidCharacter | abcdefg | Invalid Character Error. | Invalid Character Error. | Pass |

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| | <p>method of the Parser module. It also tests the Error Handling Module to see if it will take in the Error and handle the output and exiting of the code gracefully.</p> <p>This test case ensures the error-handling requirement.</p> | | | | |
| 002 | <p>Test to validate if the program handles expressions with missing operators through the isMathValid method of the Parser module.</p> <p>This test case ensures the error-handling requirement.</p> | (10+30)(40*50) | Missing or misplaced operands/operators. | 2000 | Pass |
| 003 | <p>Test to validate if the program can handle unary operators not separated by parentheses at the beginning of the expression through the try-catch block in the Main module.</p> <p>This test case ensures that the error-handling requirement is met.</p> | --5+2 | Bad Input. Unary operators must be separated by parentheses. | Bad Input. Unary operators must be separated by parentheses. | Pass |
| 004 | <p>Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in the Main module.</p> <p>This test case ensures that the error-handling requirement is met.</p> | 5--5 | Bad Input. Unary operators must be separated by parentheses. | Bad Input. Unary operators must be separated by parentheses. | Pass |

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| 005 | <p>Test to validate if the program will handle a single operand through the evaluateRemainding method in the Evaluate module.</p> <p>This test case ensures that the evaluation of valid expression requirements is met.</p> | 1 | 1 | 1 | Pass |
| 006 | <p>Test to validate that the program can handle unbalanced parentheses through the isBalancedParentheses method in the Parser module.</p> <p>This test case ensures that the combination of extraneous and necessary parentheses and error-handling requirements are met.</p> | (((((5)+7)))) | Parentheses Error. | Parentheses Error. | Pass |
| 007 | <p>Test to validate that the program follows operator precedence through the evaluateExpression method in the Evaluate module.</p> <p>This test case ensures that evaluation according to operator precedence requirement is met.</p> | (10+2-4*5%10/20^2) | 12 | 12 | Pass |
| 008 | <p>Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in</p> | 5^(--2) | Bad Input. Unary operators must be separated by parentheses. | Bad Input. Unary operators must be separated by parentheses. | Pass |

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| | <p>the Main module.</p> <p>This test case ensures that the valid expression and error-handling requirements are met.</p> | | | | |
| 009 | <p>Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in the Main module.</p> <p>This test case ensures that the valid expression and error-handling requirements are met.</p> | 5+-2 | Bad Input. Unary operators must be separated by parentheses. | Bad Input. Unary operators must be separated by parentheses. | Pass |
| 010 | <p>Test to validate if the program is able to catch extraneous decimal points through the isValidCharacter method in the Parser module.</p> <p>This test case ensures that the valid expression and error-handling requirements are met.</p> | 0.9.9+1 | Invalid Character Error. | Invalid Character Error. | Pass |
| 011 | <p>Test to validate nested negative signs within parenthesis. This test case is purposefully designed to check the Evaluate and Tokenizer Module. Tokenizer should give input of -1* when it sees these nested negatives and Evaluate should be able to read and</p> | 5^(-(-2)) | 25 | 25 | Pass |

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| | <p>evaluate it.</p> <p>This test case validates the unary operators and parentheses requirements.</p> | | | | |
| 012 | <p>Test to validate that the program handles Division by Zero Errors. This tests to see if the Evaluate Module can successfully catch and handle DivisionByZero errors and if it will exit the code gracefully when computing.</p> <p>This test case validates the bad input handling requirement.</p> | $5/(3*2+3-4-5)$ | Division by Zero Error. | Division by Zero Error. | Pass |
| 013 | <p>Test to validate combining unary operators with arithmetic operators and negated parenthesis. This is to wholly test if the Evaluate Module can parse through the expression given by the user, with complex expressions. Tokenizer should successfully give input where the negative unary operator is concatenated with the digit it is associated with, for Evaluate to work properly.</p> <p>This is to validate the unary operator and arithmetic operator requirement.</p> | $+(-7)^{-3+2}*(+5)-(-(-2*7))+1$ | 14.2857 | 14.2857 | Pass |

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| 014 | <p>Test to validate that the program handles modulus by floating point error, since C++ Compilers cannot handle the modulus operator for anything other than integers. This Test Case validates the Evaluate Module to see if it can gracefully catch floating point modulus error and respond by going to the Error Handling Module.</p> <p>This is in accordance with the bad input handling requirement.</p> | $5/7\%9+11*3+2^5$ | Modulus Operator requires integers. | Modulus Operator requires integers. | Pass |
| 015 | <p>Test unary operators inside and outside parentheses. This is testing the Evaluate and Tokenizer Module to identify if unary and arithmetic operators are separated in terms of their capabilities.</p> <p>This tests the operator and evaluation requirement.</p> | $-(+2+(3+5)*9)+10$ | -64 | -64 | Pass |
| 016 | <p>Test a negative exponent with other operator precedence. This wholly tests the Evaluate Module by seeing if it can handle negative exponents in its expression and output, not an integer, but a decimal value.</p> <p>It also tests the functionality and requirement of</p> | $5^{-4} + 11 * 10 - 9 / 33$ | 109.729 | 109.729 | Pass |

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| | operator precedence by removing any parenthesis. | | | | |
| 017 | Test a misplaced operator nested inside of an expression. This tests the goodInput function for the Parser Module and the Error Handling Module. Before going to the Evaluate Class, it must check if the user has inputted a good expression that can be evaluated. If the Parser Module parses through the expression and sees that there is an error in the user input, then it must go to the Error Handling module to exit the code gracefully. This tests the bad input functionality. | $((2*)5/3+9+7)$ | Missing or misplaced operands/operators. | Missing or misplaced operands/operators. | Pass |
| 018 | Test that has all valid operators and extraneous and nested parentheses. This tests the parenthesis-handling requirement from the Evaluate Module and sees if it returns a decimal value when necessary. It tests for unnecessary parenthesis in the expression to check if Evaluate can handle this. | $(5+3)-(2\%10)+((2^{(7-6)})/7)*3$ | 6.85714 | 6.85714 | Pass |
| 019 | Test to see if a number modulus 0 results in an error (since you cannot divide by 0 to get a remainder). This tests the Evaluate Module and if it can | $(3\%0)+(10*7)$ | Division by Zero Error. | Division by Zero Error. | Pass |

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| | gracefully handle errors while calculating. It should go to the Error Module that will help it gracefully exit the code. This checks the bad input handling requirement. | | | | |
| 020 | Test to validate if an error message occurs when there is a missing operand. This tests the Error Handling Module and the Parser Module. Again, a user must put good input for it to go to the Evaluate Module by checking with Parser. If there is a misplaced operator, there is an error and must go to the Error Module from Parser. This tests the bad input handling requirement. | $(5*2)+(9-3)+7-(7-)$ | Missing or misplaced operands/operators. | Missing or misplaced operands/operators. | Pass |
| 021 | Test to validate if an error message occurs when an expression ends with an operator that is not just a closing parenthesis. This tests the Error Handling Module and the Parser Module. Again, a user must put good input for it to go to the Evaluate Module by checking with Parser. If there is a misplaced operator, there is an error and must go to the Error Module from Parser. This tests the bad input handling requirement. | $(5/7)*(3+2)-$ | Missing or misplaced operands/operators. | Missing or misplaced operands/operators. | Pass |

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| 022 | <p>Test to validate if the program catches the error due to invalid character '#'. This utilizes the Parser Module that checks if the expression is valid such as invalid characters. It also tests whether or not the Error Handling module can output this expression and exit gracefully.</p> <p>This tests the bad input handling requirement.</p> | 8+(6#3) | Invalid Character Error. | Invalid Character Error. | Pass |
| 023 | <p>Test to validate if the program catches the operator error when it attempts to divide by 0. This tests the evaluate expression in the Evaluate Module. This tests to see if the Evaluate Module can successfully catch and handle DivisionByZero errors and if it will exit the code gracefully when computing.</p> <p>This test case validates the bad input handling requirement.</p> | (9+7)/((5*1)+(-5)) | Division by Zero Error. | Division by Zero Error. | Pass |
| 024 | <p>Test to validate if the unary '+' works in the Evaluate Module.</p> <p>This is in accordance with the unary operator and subtraction operator of the Evaluate Module.</p> | +(+4-7) | -3 | -3 | Pass |
| 025 | Test to validate if the | 9--(1225) | Bad Input. Unary | Bad Input. Unary | Pass |

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| | <p>program correctly evaluates this equation with the unary '-' works. Having consecutive unary operators together is bad input because it needs to specify whether or not we want subtraction or unary operators by parenthesis. This tests the Main Module to see if it will catch such errors accordingly and exit gracefully.</p> <p>This test case validates the bad input handling requirement.</p> | | Operators must be separated by parentheses. | Operators must be separated by parentheses. | |
| 026 | <p>Test to validate if the program catches the error of dividing by 0. This tests the evaluate expression in the Evaluate Module.</p> <p>This tests to see if the Evaluate Module can successfully catch and handle DivisionByZero errors and if it will exit the code gracefully when computing.</p> <p>This test case validates the bad input handling requirement.</p> | $(9)\%(1+1-2)$ | Division by Zero Error. | Division by Zero Error. | Pass |
| 027 | Test to validate combining unary operators with arithmetic operators and negated parenthesis. Test getPrecedence, isBalancedParenthes, and evaluate | $+(-2) * (-3) - ((-4) ^ (+5))$ | 1030 | 1030 | Pass |

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| | function in both the Parser and Evaluate modules. | | | | |
| 028 | Test to validate nested parentheses with exponent and modulo. Tests the getPrecedence and isBalanced Parentheses function in the Parser and Evaluate Module. | $2^{(8\%(79-45-9-2))}$ | 256 | 256 | Pass |
| 029 | Test to validate unary negation and addition in parentheses Test unary signs in the Evaluate Module | $-(+2) + (+2)$ | 0 | 0 | Pass |
| 030 | Test to validate exponentiation and addition/subtraction. Test the exponential requirement in the evaluate module. | 2^5+3-9 | 26 | 26 | Pass |
| 031 | Test to validate precedence and multiplication and subtraction. Test precedence with getPrecedence in the Evaluate module. The input should be evaluated following PEMDAS and the Evaluate module should parse through the input without parenthesis by solely following operator precedence rules. | $92/5-4+9*2$ | 32.4 | 32.4 | Pass |
| 032 | Test to validate parentheses without operators. This is to validate missing operators or operands. Test the isMathValid in the Parser Module. It also checks to ensure that the module checks that valid | $(5-6(5))$ | Missing or misplaced operands/operators. | Missing or misplaced operands/operators. | Pass |

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| | input contains operators or parentheses between unary operators. | | | | |
| 033 | Test to validate exponential by 0 and operator precedence. This is to validate unary operators with exponents. | $(5-4+-1^0)$ | Bad Input. Unary Operators must be separated by parentheses. | Bad Input. Unary Operators must be separated by parentheses. | Pass |
| 034 | Test to validate operator precedence. This is to check the functionality of the | $(1+5)^2/3/-2$ | -6 | -6 | Pass |
| 035 | Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in the Main module. This test case ensures that the error-handling requirement is met. | $-1--(-90)$ | Bad Input. Unary Operators must be separated by parentheses. | Bad Input. Unary Operators must be separated by parentheses. | Pass |
| 036 | Test to validate error message when missing operands between operators. This is to validate the missing operators or operands within the parser module. Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in the Main module. This test case ensures that the error-handling requirement is met. | $(5--5(+12)))$ | Bad Input. Unary Operators must be separated by parentheses. | Bad Input. Unary Operators must be separated by parentheses. | Pass |

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| 037 | Test to validate invalid exponential operator. This is to validate the missing operators or operands within the parser module. This tests the Error Handling Module and the Parser Module. Again, a user must put good input for it to go to the Evaluate Module by checking with Parser. If there is a misplaced operator, there is an error and must go to the Error Module from Parser. This tests the bad input handling requirement. | 5-1**2 | Missing or misplaced operands/operator s. | Missing or misplaced operands/operator s. | Pass |
| 038 | Test to validate if spacing still provides good input This is to validate the Tokenizer and Evaluate module. This tests the subtraction, parenthesis, and good input requirements. | ((5-1)) | 4 | 4 | Pass |
| 039 | Test to validate nested operators with modulo. This is to validate the Parser module and ensure that unary operators are separated by an operand or parenthesis. Test to validate if the program can handle unary operators not separated by parentheses in the middle of the expression through the try-catch block in the Main module. | -(5(2%(5+1--4))) | Bad Input. Unary Operators must be separated by parentheses. | Bad Input. Unary Operators must be separated by parentheses. | Pass |

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| | This test case ensures that the error-handling requirement is met. | | | | |
| 040 | <p>Test to validate nested operators within the Parser module.</p> <p>This test case ensures that the unary operator and nested parentheses requirement is met.</p> | $-(-(+(-(50-11)))))$ | -39 | -39 | Pass |
| 041 | <p>Test to validate division by 0. This is to validate the isMathValid in the Parser module.</p> <p>This tests to see if the Evaluate Module can successfully catch and handle DivisionByZero errors and if it will exit the code gracefully when computing.</p> <p>This test case validates the bad input handling requirement.</p> | $(5^2+1)/(12*2-6*4)$ | Division by Zero Error. | Division by Zero Error. | Pass |
| 042 | <p>Tests to see if equations with variables are valid input.</p> <p>Tests the isMathValid method in the Parser module.</p> <p>Test to validate if the program handles invalid input of letters through the isValidCharacter method of the Parser module. It also tests the Error Handling Module to see if it will take in the Error</p> | $-(5x)^3$ | Invalid Character Error. | Invalid Character Error. | Pass |

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| | <p>and handle the output and exiting of the code gracefully.</p> <p>This test case ensures the error-handling requirement.</p> | | | | |
| 043 | <p>Test to see if '++ is invalid.</p> <p>Tests the try and catch in the mian is catching the consecutive '++' and "--".</p> <p>Having consecutive unary operators together is bad input because it needs to specify whether or not we want subtraction or unary operators by parenthesis. This tests the Main Module to see if it will catch such errors accordingly and exit gracefully.</p> <p>This test case validates the bad input handling requirement.</p> | $-(-5++3))$ | <p>Bad Input. Unary Operators must be separated by parentheses.</p> | <p>Bad Input. Unary Operators must be separated by parentheses.</p> | Pass |
| 044 | <p>Checks if large floats are valid inputs, and they return a scientific number</p> <p>Test the Evaluate module to see if floats are valid inputs.</p> | $200/0.000001*3$ | $6e+08$ | $6e+08$ | Pass |
| 045 | <p>Checks if it accounts for a zero as a float and identifies it</p> <p>Tests the evaluateExpression method's division by zero section of the code, this is in the</p> | $200*3+4/0.000000$ | Division by Zero Error. | Division by Zero Error. | Pass |

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| | Evaluate module | | | | |
| 046 | tests to see if the negative and positive signs are getting paired with the numbers properly Tests to see if the Tokens module is tokenizing the user input appropriately. | $40 * -(3/2) + 12 * +5$ | 0 | 0 | Pass |
| 047 | Tests to see if numbers/equations evaluated to zero and This evaluated expression is in the denominator of the equation it throws an error First it tests the Evaluate module's evaluateExpression and evaluateRemainder methods to see if the operations are evaluated accurately according to precedence, then it Tests if the Parser module's isMathValid method is valid and if not then the division by zero section of the code is evaluated accurately. | $2 / ((30 \% 20) - 10)$ | Division by Zero Error. | Division by Zero Error. | Pass |
| 048 | Tests to see if the order in which the multiplication operator is computed is valid This tests the isMathValid method in the Parser module as the order of certain consecutive symbols is invalid input. | $36 + * 45$ | Missing or misplaced operands/operator s. | Missing or misplaced operands/operator s. | Pass |

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| 049 | <p>Tests to see if just a '.' point before a number is considered as/converted successfully into '0.'</p> <p>Tests Evaluate module evaluateExpression method which checks if the input "[any number]" is valid input</p> | 100.3/.46 | 218.043 | 218.043 | Pass |
| 050 | <p>Checks to see if two or more consecutive operators is valid</p> <p>Tests the try and catch in the mian is catching more than one consecutive '+++' and '---'.</p> | 3 - - 6 + + + 8 | Bad Input. Unary Operators must be separated by parentheses. | Bad Input. Unary Operators must be separated by parentheses. | Pass |
| 051 | <p>Tests to see if the order of the operators imputed are in a valid order</p> <p>This tests the isMathValid method the in the Parser module as the order of certain consecutive symbols is invalid input</p> | 3+ / 6-3 | Missing or misplaced operands/operator s. | Missing or misplaced operands/operator s. | Pass |
| 052 | <p>Tests to evaluate a complex arithmetic expression.</p> <p>This tests the tokens module which breaks down the string into a vector that can be evaluated further. Also checks the Parser module for valid characters, balanced parentheses, and correct math expressions.</p> | $((5 * 3) - (12 / 4)) * 2 + 8 / 2$ | 28 | 28 | Pass |

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| | If there are any errors detected(such as invalid characters), the error module will be invoked to handle and display errors. | | | | |
| 053 | <p>Tests to evaluate a complex arithmetic expression involving nested operations.</p> <p>Functions tested: ‘tokenzierInput()’- this is used to convert the string to vector for further evaluation.</p> <p>isDigit(), isFloat(), isExpr()- these functions are also tested to check if these actually detect/determine if a string token is a digit, float, etc.</p> | $2 * (3 + (7 - 4) * 5) - 12 / 2$ | 30 | 30 | Pass |
| 054 | <p>Tests to Calculate a complex arithmetic expression with multiple operations.</p> <p>Checks modules like Parser and Evaluate:</p> <p>Functions tested in these modules: isValidCharacter: checks if the content in the vector is valid(digits, float, operators).</p> <p>isMathValid(): Verifies if the math is carried validly.</p> | $(10 + 5) * (2 + 6) / 4 - (18 / 3)$ | 24 | 24 | Pass |

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| 058 | <p>Tests to evaluate a deeply nested arithmetic expression with extra opening parenthesis. Test to validate that the program can handle unbalanced parentheses through the isBalancedParentheses method in the Parser module.</p> <p>This test case ensures that the combination of extraneous and necessary parentheses and error-handling requirements are met.</p> | $((((((((((((((30 / 6) * (((((4 + 2) - (12 - 8) * (15 / 5))$ | Parentheses Error. | Parentheses Error. | Pass |
| 059 | <p>Tests to verify an invalid arithmetic expression due to syntax error (multiple decimal points). Tests the isMathValid method in the Parser module.</p> <p>Test to validate if the program handles invalid input of letters through the isValidCharacter method of the Parser module. It also tests the Error Handling Module to see if it will take in the Error and handle the output and exiting of the code gracefully.</p> | 0.99+..*0 | Invalid Character Error. | Invalid Character Error. | Pass |
| 060 | Tests to check if there is an invalid arithmetic expression due to division by zero. | 0.0000000+0.11111 1/0 | Division by Zero Error. | Division by Zero Error. | Pass |

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| | First it tests the Evaluate module's evaluateExpression and evaluateRemainding methods to see if the operations are evaluated accurately according to precedence, then it Tests if the Parser module's isMathValid method is valid and if not then the division by zero section of the code is evaluated accurately | | | | |
| 061 | Test to calculate a complex arithmetic expression with multiple operations. This tests the Evaluate Module and operator precedence and parentheses handling requirements. | $(18 / 3) * (9 - 3) + (24 / 4) - (6 * 2)$ | 30 | 30 | Pass |

6. Environmental needs

6.1.1 Hardware - NA

6.1.2 Software - NA

6.1.3 Other

A requirement to run the code for the Arithmetic Parser Project is to have a laptop or functioning device that allows for a Linux-based environment or can connect to Cycle Servers. This will allow one to run the executable from the code to test various Arithmetic Expressions from the terminal.

7. Special procedural requirements - NA

8. Intercase dependencies - NA