Vu Duc Tran 104175614

Task 1:

For each arithmetic operators, there are two possible incorrect uses of it:

- Incorrect use of + as - or *
- Incorrect use of * as + or -
- Incorrect use of - as + or *

And with all combinations of incorrect uses, we will have 26 (3*3*3-1) incorrect possibilities and 1 correct operation. Here is a list:

Possibilities	Operation	Description
P1_Correct	A = (A + B) * B, C = A - 5	Correct operation
P2	A = (A - B) * B, C = A - 5	Incorrect + as -
P3	A = (A * B) * B, C = A - 5	Incorrect + as *
P4	A = (A + B) + B, C = A - 5	Incorrect * as +
P5	A = (A + B) - B, C = A - 5	Incorrect * as -
P6	A = (A + B) * B, C = A + 5	Incorrect - as +
P7	A = (A + B) * B, C = A * 5	Incorrect - as *
P8	A = (A - B) * B, C = A + 5	Incorrect + as -, - as +
P9	A = (A - B) * B, C = A * 5	Incorrect + as -, - as *
P10	A = (A * B) * B, C = A + 5	Incorrect + as *, - as +
P11	A = (A * B) * B, C = A * 5	Incorrect + as *, - as *
P12	A = (A + B) + B, C = A + 5	Incorrect * as +, - as +
P13	A = (A + B) + B, C = A * 5	Incorrect * as +, - as *
P14	A = (A + B) - B, C = A + 5	Incorrect * as -, - as +
P15	A = (A + B) - B, C = A * 5	Incorrect * as -, - as *

P16	A = (A - B) + B, C = A - 5	Incorrect + as -, * as +
P17	A = (A * B) * B, C = A * 5	Incorrect + as *, * as +, - as *
P18	A = (A * B) - B, C = A + 5	Incorrect + as *, * as -, - as +
P19	A = (A * B) - B, C = A * 5	Incorrect + as *, * as -, - as *
P20	A = (A - B) * B, C = A + 5	Incorrect + as -, * as +, - as +
P21	A = (A - B) * B, C = A * 5	Incorrect + as -, * as +, - as *
P22	A = (A - B) - B, C = A + 5	Incorrect + as -, * as -, - as +
P23	A = (A - B) - B, C = A * 5	Incorrect + as -, * as -, - as *
P24	A = (A + B) + B, C = A + 5	Incorrect * as +, - as +
P25	A = (A + B) + B, C = A * 5	Incorrect * as +, - as *
P26	A = (A + B) - B, C = A + 5	Incorrect * as -, - as +
P27	A = (A - B) + B, C = A * 5	Incorrect * as +, + as -, - as *

Since the output of any input can be verified, test oracle exists, we can use traditional testing. Therefore, the chosen test cases should illustrate the noticeably change of output C if any operator is used incorrectly.

For instance, the correct operation: A = (A + B) * B, C = A – 5

Test Case	Operation	Input	Expected Output	Actual Output
P7	A = (A + B) * B, C = A * 5	A = 2, B = 3	C = 10	C = 75
P8	A = (A - B) * B, C = A + 5	A = 5, B = 2	C = 9	C = 11

Task 2:

A=10, B=0 => The correct output of C is -5.

The given test case (A=10, B=0) is not good, it is not enough to achieve the required testing objective. For **24 of 26 incorrect possibilities**, it conducts the outputs different from -5. But with P2 (A = (A - B) * B, C = A – 5) and P3 (A = (A * B) * B, C = A – 5) the output is -5.

This means that these two incorrect operations produce the same result as the correct operation when B is 0. Hence, this test case **cannot distinguish** between the correct and these specific incorrect operations. An additional test is needed.

Task 3:

As I have analysed above, test cases should help distinguish the correct implementation from the incorrect ones across most of the 26 possibilities. Here are my two concrete test cases:

Test case 1:
A = 0, B = -4
⇨ The correct output is 11
While P15 and P27's result is 0. We can eliminate P11 and P27

Test case 2:
A = 2, B = 3
⇨ The correct output is 10

Incorrect Possibility	Output C	Incorrect Possibility	Output C
P2	-8	P14	7
P3	13	P16	23
P4	3	P17	90
P5	-3	P18	8
P6	20	P19	15
P7	75	P20	2
P8	2	P21	-15
P9	-15	P22	1
P10	23	P23	-20
P11	90	P24	13
P12	13	P25	40
P13	40	P26	7

We can eliminate others.

Task 4:

- From the corect program: A = (A + B) * B, C = A – 5 ,Given B = 2.

⇨ C = (A + 2) * 2 – 5

 I do a similar with the other 26 possibilities.
 For example, P10: A = (A * B) * B, C = A + 5

⇨ C = (A * 2) * 2 + 5

- Any concrete test case (A, B), that cannot achieve the testing objective, will produce the same outputs in the correct program and the wrong arithmetic operations.

- Let the C in the correct program equal to C in each possibility. The value A, that satisfies the equation, is the value we are looking for. For example:

⇨ C(p1) = C(p10)

⇨ (A + 2) * 2 – 5 = (A * 2) * 2 + 5 => A = -3.
 Then (-3,2) is the required case.

- Repeating similarly for the remaining possibilities from P2 to P27.

All the possible values of A so that the concrete test case (A, B) cannot achieve the above testing objective when given B = 2 are -11, -7, -4, -3, 0, 2, 6, 9, 10, 13.