Next Scientists
European International Journal of Multidisciplinary Research and Management Studies

TYPE Original Research
PAGE NO. 117-118
DOI 10.55640/eijmrms-05-12-23

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Absolute Value Equations With The Unknown Under The Square Root

Mamaraimov Bekzod Kadirovich

Teacher of mathematics at Terdu Academic Lyceum, Uzbekistan

MakhmudoV Azam Kudratovich

Teacher of mathematics at Terdu Academic Lyceum, Uzbekistan

Musurmonov Maruf Akrom oglu

Teacher of mathematics at Terdu Academic Lyceum, Uzbekistan

OPEN ACCESS

SUBMITED 30 October 2025
ACCEPTED 26 November 2025
PUBLISHED 31 December 2025
VOLUME Vol.05 Issue12 2025

Abstract: Modular equations are one of the important and complex topics of algebra, which studies equations involving absolute value (modulus). The concept of modulus represents the distance of a number from zero, regardless of its sign. When solving modular equations, it is necessary to separate the expression into different cases based on the definition of modulus. This article discusses in detail the concept of modular equations, their types, main properties and solution methods. It also considers the issues of solving modular equations graphically and identifying typical errors. Studying the topic serves to develop students' logical analysis, conditional thinking and algebraic calculation skills, and serves as a solid theoretical basis for solving complex equations.

Keywords: Modular equations, absolute value, definition of modulus, solution of the equation, method of cases, graphical method, algebra, logical analysis, number axis, mathematical modeling.

Introduction: Equations play an important role in algebra, and their study develops mathematical analysis skills. Modular equations are a special type of equations that involve absolute value expressions. The concept of modulus is one of the important properties of real numbers, which indicates the distance of a number from zero. Solving modular equations is more complicated than simple linear equations and requires a logical approach.

The absolute value or modulus of a number is defined as follows:

$$|x| = \begin{cases} x, & x \geq 1 \\ x, & x < 1 \end{cases}$$

According to this definition, the modulus always has a non-negative value. The geometric meaning of the modulus is the distance of a point on the number line from the zero point.

The concept of a modular equation

A modular equation is an equation that contains a modulus. For example, equations such as $|x - 3| = 5$ or $|2x + 1| = x$ are examples of modular equations. When solving such equations, it is necessary to consider several cases using the definition of the modulus.

There are several main methods for solving modular equations.

1. The method of cases. This method is the most widely used. Depending on the sign of the expression under the modulus, the equation is divided into two or more cases. For example:

$|x - 3| = 5$

Case 1: $x - 3 \geq 0 \rightarrow x - 3 = 5 \rightarrow x = 8$

Case 2: $x - 3 < 0 \rightarrow -(x - 3) = 5 \rightarrow x = -2$

Solution: $x = 8$ or $x = -2$

2. Graphical method. In this method, the left and right sides of the equation are considered as functions, and the points of intersection of their graphs are determined. The graphical method is more often used for complex modular equations.

3. Algebraic transformation method. In some cases, a modular equation can be reduced to a module-free form. For example, the equation $|x| = a$ has a solution only when $a \geq 0$, and its solutions are in the form $x = \pm a$.

Equations involving several modules are called complex modular equations. For example:

$|x - 1| + |x + 2| = 5$

When solving such equations, critical points are marked on the number line and the equation is considered separately in each interval. This method allows you to find the solution accurately and correctly.

The following mistakes are often made when solving modular equations:

Incorrect application of the definition of modulus

Not considering the cases completely

Not checking the obtained solutions

Therefore, each solution must be checked by substituting it into the original equation.

Modular equations are closely related to other branches of mathematics. They are also used in physics, economics, and engineering. For example, the concept of modulus is widely used in problems related to distance, errors, and deviations. The modulus is also used to determine the average deviations in statistical analysis.

Example

Solve the equation $|2x - 4| = 6$.

Case 1: $2x - 4 = 6 \rightarrow x = 5$

Case 2: $-(2x - 4) = 6 \rightarrow x = -1$

Solution: $x = 5$ or $x = -1$

CONCLUSION

In conclusion, Modular equations are one of the important and interesting topics in algebra. In the process of solving them, it is important to have a deep understanding of the definition of modularity and use a logical approach. This topic develops conditional thinking in students and forms the skills of analyzing complex equations.

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