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Some Methods for Solving Fourth-Order Equations

Kodirov Komiljon Raximovich
Ferghana State University Candidate of physical and mathematical Sciences

Kodirova Mukhlisa Zokirjon kizi
Teacher of secondary school No. 5

Yunusalieva Mohinur Tulkinjon kizi
Ferghana State University, student

Abstract: This article discusses some methods for solving fourth-order equations and in examples.

Keywords: equation, linear, bilinear, coefficient, cubic, algebra, imaginary, roots.

In the school mathematics course, the solution of third and higher level whole coefficient equations is solved by performing some algebraic transformations, dividing them into multipliers and decreasing their order. Readers are interested in the question of whether there is a formula for solving higher-order equations, such as a formula for solving quadratic equations. Also, a deeper study of mathematics by students often encounters third- and fourth-level equations in the process of solving Olympic problems. In addition, solving different practical problems also leads to solving similar equations. The curriculum of general secondary schools does not include topics related to the solution of tertiary and higher level equations [1].

There are known methods, algorithms for solving some types of equations, for example, for first-order linear equations, quadratic and quadratic equations. The rules for solving first- and second-order algebraic equations have long been known. There are methods for solving higher-level equations only for certain types [2].

This article discusses some ways to solve high-level equations. We illustrate this method with some examples.

Example 1. $x^4+8x-7=0$ **Solve the equation.**

Solution: To solve a given equation, we make its left side into a square difference, i.e. $x^4+2x^2+1-2x^2-1+8x-7=0$ or $x^4+2x^2+1-2(x^2-4x+4)=0$

From this,

$$(x^2+1)^2-2(x-2)^2=0 \text{ or } (x^2+1)^2-(\sqrt{2}(x-2))^2=0$$

we have the equation in the form. By applying the short multiplication formulas to the last equation, we obtain the following equation:

$$(x^2-\sqrt{2}x+1+2\sqrt{2})(x^2+\sqrt{2}x+1-2\sqrt{2})=0$$

From this,

$$x^2-\sqrt{2}x+1+2\sqrt{2}=0 \text{ or } x^2+\sqrt{2}x+1-2\sqrt{2}=0$$

we have equations. The discriminant of the first quadratic equation is negative, which means it has no real solution. By solving the second quadratic equation, we obtain the following solutions:

$$x_1 = \frac{-\sqrt{2}+\sqrt{8\sqrt{2}-2}}{2} \text{ or } x_1 = \frac{-\sqrt{2}-\sqrt{8\sqrt{2}-2}}{2}$$

Example 2. $(x-1)(x-2)(x-4)(x-8)=10x^2$ **solve the equation.**

Solution: To solve this equation, by multiplying the first and fourth multipliers on the left, as well as the second and third multipliers, the above equation can be written as follows:

$$(x^2-9x+8)(x^2-6x+8)=10x^2$$

The resulting equation is not a solution $x=0$, so we divide both sides x^2 of the equation and

$$\frac{x^2-9x+8}{x}\frac{x^2-6x+8}{x}=10 \text{ or } (x+\frac{8}{x}-6)(x+\frac{8}{x}-9)=10$$

we have the equation. In the last equation $x+\frac{8}{x}-6=t$ enter the designation, t relative to $t(t-3)=10$ or $t^2-3t-10=0$ we have a quadratic equation and solve it:

$$t_1=\frac{3+\sqrt{49}}{2}=\frac{3+7}{2}=5 \text{ or } t_2=\frac{3-\sqrt{49}}{2}=\frac{3-7}{2}=-2$$

Substituting the found values of t into the above notation, we obtain the following equations:

$$x+\frac{8}{x}-6=5 \text{ and } x+\frac{8}{x}-6=-2 \text{ or}$$

$$x+\frac{8}{x}-4=0 \text{ and } x+\frac{8}{x}-11=0$$

That's it, $x^2-4x+8=0$ and $x^2-11x+8=0$

we have equations and solve them. Since the discriminant of the first equation is negative, it follows that it has no real solution [3]. Solve the second equation:

$$x_1=\frac{11+\sqrt{89}}{2},\ x_2=\frac{11-\sqrt{89}}{2} \text{ we have roots.}$$

Example 3. $\frac{1}{x}+\frac{1}{x+1}+\frac{1}{x+2}+\frac{1}{x+3}+\frac{1}{x+4}=0$ **solve the equation.**

Solution: To solve a given equation, we enter the notation twice in a row. To enter the initial notation, we find the arithmetic mean of the numbers added to x in its denominator: $\frac{0+1+2+3+4}{5}=2$.

Now we enter the notation in the equation in the form $t=x+2$. In this case, $x=t-2$ it happens. Then we make the above notation in the equation and we have the following equation:

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$$\frac{1}{t-2}+\frac{1}{t+2}+\frac{1}{t-1}+\frac{1}{t+1}+\frac{1}{t}=0.$$

We add the first and second fractions of the resulting equation, as well as the third and fourth fractions by giving the common denominator and

$$\frac{t+2+t-2}{t^2-4}+\frac{t+1+t-1}{t^2-1}+\frac{1}{t}=0 \text{ or } \frac{2t}{t^2-4}+\frac{2t}{t^2-1}+\frac{1}{t}=0$$

we form the equation. Then we add the three fractions by giving the common denominator, and the result is the following equation:

$$\frac{2t^2(t^2-1)+2t^2(t^2-4)+(t^2-4)(t^2-1)}{t(t^2-4)(t^2-1)}=0.$$

Given that the fraction is equal to zero, its image is zero, and its denominator is different from zero,

$$2t^2(t^2-1)+2t^2(t^2-4)+(t^2-4)(t^2-1)=0$$

and enter the designation in it $z=t^2$, by entering the designation

$$2z(z-1)+2z(z-4)+(z-4)(z-1)=0$$

we obtain the equation in the form.

$$2z^2-2z+2z^2-8z+z^2-5z+4=0$$

$$5z^2-15z+4=0$$

From this equation $z_1=\frac{15+\sqrt{145}}{2}$, $z_2=\frac{15-\sqrt{145}}{2}$ find the roots.

Let us denote $z=t^2$ the found values of z and in turn:

$$x_1=\sqrt{\frac{15+\sqrt{145}}{2}}-2,\ x_2=-2-\sqrt{\frac{15+\sqrt{145}}{2}};\quad x_3=\sqrt{\frac{15-\sqrt{145}}{2}}-2,\ x_4=-2-\sqrt{\frac{15-\sqrt{145}}{2}}$$

find the roots.

So the equation has four real solutions.

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