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SOME THE EQUATIONS WITH RESPECT TO THE NEW VARIABLES SYSTEM OF EQUATIONS TO SOLVE

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ANNOTATION

This in the article some equations new equations with respect to variables system to solve to bring In some cases, the solution of complex algebraic equations is reduced to the solution of simple equations as a result of changing variables. Only students when solving an equation, they do not immediately notice how the given equation can become simpler when replacing the unknowns. In some cases, the equations are reduced to solving a system of equations with respect to the newly introduced variables . We give examples of solving such equations.

Key words : Equation , equations system , variable , solution , root .

INTRODUCTION

In some cases, the solution of complex algebraic equations is reduced to the solution of simple equations as a result of changing variables. Only students who solve an equation do not immediately notice how replacing the unknowns can make the given equation look simpler. In some cases, the equations are reduced to solving a system of equations with respect to the newly introduced variables . We give examples of solving such equations.

Example 1. This

$$(2-x)^5+(x-3)^5+1=0 \qquad (1)$$

solve the equation.

Solving. x_0 Let (1) be the solution of Eq. $u=2-x_0$ and $\upsilon=x_0-3$ by introducing a new variable we create the following system.

$$\begin{cases} u+\upsilon=-1 \\ u^5+\upsilon^5=-1 \end{cases} \qquad (2)$$

$$u^5+\upsilon^5=(u+\upsilon)(((u+\upsilon)^2-2u\upsilon)^2-u\upsilon(u+\upsilon)^2+u^2\upsilon^2)$$

(2) we write the system in the following form.

$$\begin{cases} u+\upsilon=-1 \\ (u+\upsilon)(((u+\upsilon)^2-2u\upsilon)^2-u\upsilon(u+\upsilon)^2+u^2\upsilon^2)=-1 \end{cases} \qquad (3)$$

by substituting in -1equation 2 of the system$u+\upsilon$

$$(1-2u\upsilon)^2-u\upsilon+u^2\upsilon^2=1,$$

$$5(u\upsilon)^2-5(u\upsilon)=0$$

we form the equation From this $u\upsilon=0$or $u\upsilon=1$. Thus , u the following to find s and υ We create 2 systems.

$$\begin{cases} u+\upsilon=-1 \\ u\upsilon=0 \end{cases} \qquad \begin{cases} u+\upsilon=-1 \\ u\upsilon=1 \end{cases}$$

Solution of the first system

$$u_1=0, \quad \upsilon_1=-1 \text{ and } \qquad u_1=-1, \quad \upsilon_1=0.$$

From this, equation (1) $x_0^{`}=2$ can be a solution and numbers. $x_0^{``}=3$

Second system to the solution have not _ Inspection shows that both of these numbers are solutions to the equation.

Answer : $x_1=2, \quad x_2=3$.

Example 2. This

$$x^2+\frac{9x^2}{(3+x)^2}=40 \qquad (4)$$

solve the equation.

Solving. x_0 Let be the solution of equation (4). We introduce a new $y_0=\frac{3x_0}{3+x_0}$ variable. Then x_0 we create a new system to find and . y_0

$$\begin{cases} 3(x_0-y_0)-x_0y_0=0 \\ x_0^2+y_0^2=40 \end{cases} \qquad (5)$$

$x_0^2+y_0^2=(x_0-y_0)^2+2x_0y_0$ as is, $u_0=x_0-y_0$ we write the system (5) in the following form by introducing new and variable. $\upsilon_0=x_0y_0$

$$\begin{cases} 3u_0-\upsilon_0=0 \\ u_0^2+2\upsilon_0=40 \end{cases}$$

The solution of this system $u_0=4, \quad \upsilon_0=12$ is and $u_0=-10, \quad \upsilon_0=-30$.

x_0 and y_0 to find , we create the following system of equations.

$$\begin{cases} x_0-y_0=4 \\ x_0y_0=12 \end{cases} \qquad \begin{cases} x_0-y_0=-10 \\ x_0y_0=-30 \end{cases}$$

The solution of the first system is $x_0=-2$, $y_0=-6$ and $x_0=6, \quad y_0=2$. Second the system has no solution. $x_0=-2$ and , $x_0=-6$ as a result of checking, equation (4) will be the solution.

Answer : $x_0=-2$, $x_0=-6$.

Example 3. This

$$\frac{30}{x\sqrt[3]{35-x^3}}=x+\sqrt[3]{35-x^3} \qquad (6)$$

solve the equation.

Solving. x_0 (6) be the solution of Eq. We introduce a new $\sqrt[3]{35-x^3}=y_0$ variable. Then x_0 and y_0 will be the solution of the following system.

$$\begin{cases} \frac{30}{x_0y_0}=x_0+y_0 \\ x_0^3+y_0^3=35 \end{cases} \qquad (7)$$

Introducing new $u = x_0 + y_0$ and variable (7) system $\upsilon = x_0 y_0$

$$\begin{cases} u\upsilon = 30 \\ u^3 - 3u\upsilon = 35 \end{cases} \qquad (8)$$

we write in the form. (8) solution of the system $u = 5, \quad \upsilon = 6$.

As a result, x_0 we create the following system to find and . y_0

$$\begin{cases} x_0 + y_0 = 5 \\ x_0 y_0 = 6 \end{cases}$$

This system has 2 pairs of solutions $x_0^{`} = 2, \quad y_0^{`} = 3$ and $x_0^{``} = 3, \quad y_0^{``} = 2$ as a result of checking $x = 2$ and $x = 3$ is the root of the equation.

Answer： $x_1 = 2, \quad x_2 = 3$.

Example 4. This

$$\sqrt[3]{x+45} - \sqrt[3]{x+16} = 1 \qquad (9)$$

solve the equation.

Solving. x_0 (9) be the solution of the equation. $\sqrt[3]{x_0 + 45} = u$, $\sqrt[3]{x_0 - 16} = \upsilon$ we introduce a new variable. Then u and υ will be the solution of the following system.

$$\begin{cases} u - \upsilon = 1 \\ (u - \upsilon)(u^2 + u\upsilon + \upsilon^2) = 61 \end{cases}$$

y ok

$$\begin{cases} u = \upsilon + 1 \\ (\upsilon+1)^2 + \upsilon(\upsilon+1) + \upsilon^2 = 61 \end{cases} \qquad (10)$$

(10) is the solution of the system $\upsilon_1 = 4, \quad u_1 = 5, \quad \upsilon_2 = -5, \quad u_2 = -4$.

From this, the roots of equation (9) $x_0^{`} = 80$ can be only and . $x_0^{``} = -109$ Check these numbers show that (9) is a solution to Eq.

Answer J： $x_1 = 80, \quad x_2 = -109$.

Example 5. This

$$\sqrt{x} + \sqrt[3]{x+4} = 4 \qquad (11)$$

solve the equation.

Solving. x_0 (11) be the solution of the equation. We do new $x_0 = u^2$ and $x_0 + 4 = \upsilon^3$ exchange. Then u and υ satisfy the following system.

$$\begin{cases} |u| + \upsilon = 4 \\ \upsilon^3 - u^2 = 4 \end{cases} \qquad (12)$$

In the first equation , $|u| = 4 - \upsilon$ we create the equation by substituting $\upsilon^3 - (4-\upsilon)^2 - 4 = 0$ in $4 - \upsilon$ the 2nd equation . $|u|$

This equation $\upsilon = 2$ has only one root. In that case $x_0 = 4$. We check that it is a solution by putting it into equation (11).

Answer： $x = 4$.

Example 6. This

$$\sqrt[4]{10+x^2+x}+\sqrt[4]{7-x^2-x}=3 \qquad (13)$$

solve the equation.

Solving. x_0 be the solution of the equation. $\sqrt[4]{10+x_0^2+x_0}=u$ and $\sqrt[4]{7+x^2-x}=\upsilon$ we introduce new variables. Then u and υ will be the solution of the following system of equations.

$$\begin{cases} u+\upsilon=3 \\ u^4+\upsilon^4=17 \end{cases}$$

The solution of this system $u_1=1,\ \upsilon_1=2$ is and $u_2=2,\ \upsilon_2=1$.

From this x_0 $\sqrt[4]{10+x_0^2+x_0}=1$ or $\sqrt[4]{7+x^2-x}=2$ satisfies Eq.

The first equation has no solution. The solution of the second equation $x_0^{`}=2$ and $x_0^{``}=3$. Substituting this into the given equation, we see that they are solutions.

Answer : $x_1=2,\ x_2=-3$.

Example 7. This

$$\sqrt[4]{87+[\log_2(4^{2x}-3\cdot4^x+6)]^2-5\log_2(4^{2x}-3\cdot4^x+6)}+$$
$$+\sqrt[4]{7+[\log_2(4^{2x}-3\cdot4^x+6)]^2-5\log_2(4^{2x}-3\cdot4^x+6)}=4 \qquad (14)$$

solve the equation.

Solving. $f(x)=[\log_2(4^{2x}-3\cdot4^x+6)]^2-5\log_2(4^{2x}-3\cdot4^x+6)$

by performing substitution, we write equation (14) in the following form.

$$\sqrt[4]{87+f(x)}+\sqrt[4]{7+f(x)}=4 \qquad (15)$$

x_0 (15) be the solution of the equation.

We create the following system by performing new $\sqrt[4]{87+f(x_0)}=u$ and replacement. $\sqrt[4]{7+f(x_0)}=\upsilon$

$$\begin{cases} u+\upsilon=4 \\ u^4-\upsilon^4=80 \end{cases} \qquad (16)$$

From the first equation $u=4-\upsilon$. Substituting this into Eq.$2u$

$$\upsilon^3-6\upsilon^2+16\upsilon-11=0$$

we form the equation This equation $\upsilon=1$ has only one root. From this x_0

$$[\log_2(4^{2x}-3\cdot4^x+6)]^2-5\log_2(4^{2x}-3\cdot4^x+6)+6=0 \qquad (17)$$

satisfies Eq.

$y^2-5y+6=0$ Since the equation has 2 $y_1=2$ and roots, equation (17) is as strong as the following set of equations. $y_2=3$

$$\log_2(4^{2x}-3\cdot4^x+6)=2 \text{ and } \log_2(4^{2x}-3\cdot4^x+6)=3$$

These in turn are as strong as the following set of equations.

$$4^{2x}-3\cdot4^x+6=4 \text{ and } 4^{2x}-3\cdot4^x+6=8$$

We write the last complex in the following form.

$$4^{2x}-3\cdot4^x+2=0 \text{ and } 4^{2x}-3\cdot4^x-2=0 \qquad (18)$$

$z^2-3z+2=0$ the equation has 2 roots $z_1=1$ and $z_2=2$. In that case, the first equation of (18) is as strong as the following 2 sets of equations. $4^x=1$ and $4^x=2$ .Of these $x_1=0$ and $x_2=\frac{1}{2}$.

$z^2-3z-2=0$ the equation also has 2 roots $z_1=\frac{3+\sqrt{17}}{2}$ and $z_2=\frac{3-\sqrt{17}}{2}$.

This is the second equation of (18).

$$4^x=\frac{3+\sqrt{17}}{2} \qquad \text{and} \qquad 4^x=\frac{3-\sqrt{17}}{2}$$

t adjectives as strong as the complex. These $x_3=\log_4\frac{3+\sqrt{17}}{2}$ have a unique solution. Putting the found x_1, x_2 and x_3 into the given equation (14), we make sure that they are the roots of the equation.

Answer： $x_1=0$, $x_2=\frac{1}{2}$, $x_3=\log_4\frac{3+\sqrt{17}}{2}$

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