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USING THE VARIABLE SUBSTITUTION METHOD WHEN SOLVING SOME FOURTH-ORDER EQUATIONS

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ABSTRACT

This article provides theoretical information about the use of the method of substitution of variables in solving some fourth-order equations. Examples of these substitutions are shown below.

If $F(f(x))=0$ (1)

if the equation is given, $y=f(x)$ using substitution

$$F(y)=0 \quad (2)$$

is displayed. After that, all of equation (2) $y_1, y_2, ..., y_n, ...$ find the solutions and solve the following set of equations.

$f(x)=y_1, \quad f(x)=y_2, \quad ..., \quad f(x)=y_n, ...$ (3)

We consider methods of changing variables for various special cases of fourth-order equations of the form (1).

1. $(x-\alpha)(x-\beta)(x-\gamma)(x-\delta)=A$ solving equations of the form

$(x-\alpha)(x-\beta)(x-\gamma)(x-\delta)=A$ (4)

in this $\alpha, \beta, \gamma, \delta$ vaand A in this n $\alpha<\beta<\gamma<\delta$ va $\beta-\alpha=\delta-\gamma$ if the conditions are appropriate

$$y=\frac{x-\alpha+x-\beta+x-\gamma+x-\delta}{4}$$

by performing the substitution, the biquadratic equation is solved.
by performing the substitution, the biquadratic equation is solved.

$(x+1)(x+2)(x+4)(x+5)=0$ solve the equation.

Solving. $y=\dfrac{x+1+x+2+x+4+x+5}{4}$ $y=x+3$ or $x=y-3$ Substitution completes the equation

$(y-2)(y-1)(y+1)(y+2)=10$

can be written as

$$(y^2-4)(y^2-1)=10$$

This biquadratic equation has 2 roots. $y_1=\sqrt{6}$ va $y_2=-\sqrt{6}$.

The resulting equation has 2 roots. $x_1=-\sqrt{6}-3$; $x_2=\sqrt{6}-3$

Answer: $x_1=-\sqrt{6}-3$; $x_2=\sqrt{6}-3$

2. $(ax^2+b_1x+c)(ax^2+b_2x+c)=Ax^2$ solving equations of the form

$(ax^2+b_1x+c)(ax^2+b_2x+c)=Ax^2$ (5)

in this $c \neq 0$ va $A \neq 0$, $x = 0$ does not have a root, therefore dividing both sides of equation (x) by is equal to it

$$\left(ax + \frac{c}{x} + b_1\right)\left(ax + \frac{c}{x} + b_2\right) - A = 0$$

we form the equation $y = ax + \frac{c}{x}$ solving the quadratic equation by performing the substitution.

Example 2. This $(x^2 + x + 2)(x^2 + 2x + 2) = 2x^2$ solve the equation.

Solving. $x = 0$ the given equation will not have a root, so it x^2 is as strong as him

$$\left(x + 1 + \frac{2}{x}\right)\left(x + 2 + \frac{2}{x}\right) = 2$$

we form the equation $y = x + \frac{2}{x}$ performing a replacement $(y+1)(y+2) = 2$ we form the equation

From this $y_1 = 0$ va $y_2 = -3$. The resulting equation is as follows

$$x + \frac{2}{x} = 0 \text{ va } x + \frac{2}{x} = -3$$

is as strong as the set of equations. This union is 2 $x_1 = -1$ and $x_2 = -2$ has a root.

Answer: $x_1 = -1$, $x_2 = -2$.

3. $(x-\alpha)(x-\beta)(x-\gamma)(x-\delta) = Ax^2$ solving visual equations.

$$(x-\alpha)(x-\beta)(x-\gamma)(x-\delta) = Ax^2 \qquad (6)$$

in this $\alpha, \beta, \gamma, \delta$ and A lar such that, $\alpha\beta = \gamma\delta \neq 0$. Multiplying the first bracket by the second, the third bracket by the fourth $(x^2 - x(\alpha+\beta) + \alpha\beta)(x^2 - x(\gamma+\delta) + \gamma\delta) = Ax^2$ Multiplying the first bracket by the second and the third bracket by the fourth

Example 3. This $(x-2)(x-1)(x-8)(x-4) = 7x^2$ solve the equation.

Undo. $[(x-2)(x-4)][(x-1)(x-8)] = 7x^2$

$$(x^2 - 6x + 8)(x^2 - 9x + 8) = 7x^2$$

$x = 0$ since the equation does not have a root, it must be x^2 we divide by and form a strong equation equal to.

$$\left(x - 6 + \frac{8}{x}\right)\left(x - 9 + \frac{8}{x}\right) = 7$$

$x + \frac{8}{x} = y$ performing that replacement $(y-6)(y-9) = 7$ we obtain the quadratic equation.

$$y_1 = \frac{15+\sqrt{37}}{2} \text{ va } y_2 = \frac{15-\sqrt{37}}{2}$$

The resulting equation is as strong as the following set of equations.

$$x + \frac{8}{x} = \frac{15+\sqrt{37}}{2}; \quad x + \frac{8}{x} = \frac{15-\sqrt{37}}{2}$$

This is the solution of the first equation of the Union

$$x_1=\frac{\frac{15+\sqrt{37}}{2}+\sqrt{\left(\frac{15+\sqrt{37}}{2}\right)^2-32}}{2},\quad x_2=\frac{\frac{15+\sqrt{37}}{2}-\sqrt{\left(\frac{15+\sqrt{37}}{2}\right)^2-32}}{2},$$

Equation 2 of the union has no solution. Hence, the given equation has 2 roots

Answer: $x_1=\frac{15+\sqrt{37}+\sqrt{30\sqrt{37}+134}}{4}$, $x_2=\frac{15+\sqrt{37}-\sqrt{30\sqrt{37}+134}}{4}$.

4. $a(cx^2+p_1x+q)^2+b(cx^2+p_2x+q)^2=Ax^2$ solving visual equations.

$$a(cx^2+p_1x+q)^2+b(cx^2+p_2x+q)^2=Ax^2 \qquad (7)$$

in this a,b,c,q,A numbers, $q\neq 0,\ A\neq 0,\ c\neq 0,\ b\neq 0$.

$x=0$ does not have a root. Hence the equation (7) is x^2 GA is equal to strong

$$a\left(cx+\frac{q}{x}+p_1\right)^2+b\left(cx+\frac{q}{x}+p_2\right)^2=A$$

we obtain the equation. $y=cx+\frac{q}{x}$ the substitution is brought to solve the quadratic equation by performing.

Example 4. This $3(x^2+2x-1)^2-2(x^2+3x-1)^2+5x^2=0$ solve the equation.

Undo. $x=0$ since there is no root of a given equation, one has both sides x^2 Ga Divisi,

$$3\left(x+2-\frac{1}{x}\right)^2-2\left(x+3-\frac{1}{x}\right)^2+5=0$$

we obtain a strong equation equal to the given equation. $x-\frac{1}{x}=y$ replacing the last equation by performing

$$3(y+2)^2-2(y+3)^2+5=0$$

let's write in the look. This quadratic equation is 2 $y_1=1,\ y_2=-1$ has a root. Therefore, the equation is as strong as the following set of equations.

$x-\frac{1}{x}=1$ va $x-\frac{1}{x}=-1$

This set of equations has four roots.

$$x_1=\frac{-1-\sqrt{5}}{2},\quad x_2=\frac{-1+\sqrt{5}}{2},\quad x_3=\frac{1-\sqrt{5}}{2},\quad x_4=\frac{1+\sqrt{5}}{2}.$$

These will be the roots of the given equation.

Answer: $x_1=\frac{-1-\sqrt{5}}{2},\quad x_2=\frac{-1+\sqrt{5}}{2},\quad x_3=\frac{1-\sqrt{5}}{2},\quad x_4=\frac{1+\sqrt{5}}{2}$.

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