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METHODS OF SOLVING LINEAR COMPARISONS

N. Mirzakarimova
teacher of Ferghana State University
A.Kholmatov
teacher of Tashkent University of information technologies
Ferghana branch academic lyseum

It turns out that the theory of residual division is based on any two

$a, t >$ **0** will find such single q_1 and r numbers for the whole number,

$$a=mq_1+r \qquad (1)$$

the equation is performed, where $\mathbf{0}\leq r<m$.

For an entire number

$$b = mq_2 + r. \qquad (2)$$

let's take a b number that is equal. (1) and (2) the same residue remains when the equations divide the numbers a and b into t.

Description. If the remains produced when the number a and b are divided into t natural numbers, then numbers a and b are called equal residual numbers by t module or comparable numbers by t module.

If numbers a and b are compared by t module, then the following are determined:

$$a\ {}^{o}b\ (mod\ m) \qquad (3)$$

(3) The numbers a and b are read as being comparable by t module.

Description. This

$$ax^{o}\ b\ (\text{mod m}) \qquad (4)$$

The comparison in the view is called an unknown, first-class comparison (where a and b are whole numbers, m is a natural number).

Description. If the $ax_1{}^{o}b$(mod$m$) comparison is correct when (4) is $x=x_1$ in the comparison, then the x_1 number (4) is called satisfied with the comparison.

1. Testing method. The essence of this method is that $ax^{o}b$ (modm) (5) will be replaced by x in the comparison, and all discounts in the full system of discounts will be inserted sequentially according to the m module. Whichever of them makes (5) the correct comparison, the class that participates in that discount is the solution. But this method is not so convenient when the coefficients are on the floor enough.

2. Method of changing coefficients: Using the properties of comparisons in practical exercises, (5) you need to change the coefficient in front of the unknown and b in such a way that the

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number generated on the right side of the comparison should be divided into the coefficient of the excess.

Example 1. Solve the $7x^{o}$ 5 (mod9) comparison.

$$7x\ ^{o}5+9\ (\text{mod}9),\ 7x^{o}\ 14\ (\text{mod}9).$$

$(7;\ 14) = 7$ and $(7;\ 9) = 1$ result in an $x\ ^{o}\ 2$ (mod9) solution.

Example 2. Solve the $17x\ ^{o}$ 25(mod28) comparison.

$$17x+28x^{o}\ 25(\text{mod}28),\ \ 45x^{o}25\ (\text{mod}28).$$

From $9x^{o}$ 5 (mod28),

$$9x^{o}\ 5-140\ (\text{mod}28)\ ^{o}{-135}\ (\text{mod}28),\ 9x^{o}-135\ (\text{mod}\ 28),\ x^{o}{-15}\ (\text{mod}\ 28),.$$

an x^{o} 13(mod 28) solution is formed.

3. How to use Eyler theory. As you know $(a;m) = 1$, then the $a^{\varphi(m)o}1$ (mod$m$) comparison was appropriate. You can also write $x^{o}a^{\varphi(m)}\cdot b$(mod$m$) comparison. By comparing the last comparison with the $ax^{o}b$(modm) comparison, we make sure it is $x^{o}a^{\varphi(m)}\cdot b$(mod$m$). When solving examples, you should bring the expression $a^{\varphi(m)}\cdot b-$ to the smallest positive discount by module m .

Example 3. Solve the $3x^{o}7$ (mod11) comparison.

$x^{o}3^{\varphi(11)-1}\cdot 7$ (mod11), $\varphi(11)=10$, $3^{2o}\ 9^{o}{-2}$ (mod11), $3^{4o}4$ (mod11),

Since $3^3= 12^{o}1$(mod11), $x= 3^9\cdot 7= 28^{o}6$(mod11), $x^{o}6$(mod11) is produced. If the module of the comparison is large enough, the following method is much more useful.

4. Method of using continued fractions .

This

$$ax^{o}b(\text{mod}\ m) \qquad (6)$$

is given a comparison (a; m) = 1 and $a>0$.

$\frac{m}{a}$ spreading the tower into a continuous fortress, $\frac{P_k}{Q_k}(k=\overline{1,n})$ and we're going to mark it like this. $\frac{P_k}{Q_k}$ because it's an unbeniable fraction $P_n = m,\ Q_n=a$ it happens, then $P_n\ Q_{n-1}-P_{n-1}Q_n=(-1)^n$ parity $mQ_{n-1}-a\ P_{n-1}=(-1)^n$ takes the form. From last equation $a\ P_{n-1}=-(-1)^n+mQ_{n-1}$ or $a\ P_{n-1}{}^{o}-(-1)^{n-1}$ (mod m) is formed. Both parts of the last comparison $(-1)^{n-1}\times b$ and multiply,

$$a(-1)^{n-1}\times bP_{n-1}{}^{o}\ b\ (\text{mod}m) \qquad (7)$$

we're going to have a comparison. (16) and (17) compared,

$$x^{o}\ (-1)^{n-1}\times bP_{n-1}\ (\text{mod}m) \qquad (8)$$

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we're going to make a comparison. Here P_{n-1} consists $\frac{m}{a}$ of a picture of the last tower $(n–1)$ – of a worthy tower. (6) Since the comparison has a single solution (8) there will be a solution to the solution (6).

Example 4.Solve comparison $285x$ º 117(mod 924).

(285;924) = 3, 177/3

because the module and both parts of the comparison are divided into 3,

$95x$ º 59 (mod 308)

we're going to make a comparison. Now $\frac{308}{95}$ we spread the tower into worthy towers. To do this, we do the following to have a series of residues:

$308 = 95 \times 3 + 23,$

$95 = 23 \times 4 + 3,$

$23 = 3 \times 7 + 2,$

$3 = 2 \times 1 + 1,$

$2=1\times2$

$q_1 = 3, q_2 = 4, q_3=7, q_4 = 1, q_5 = 2,$

We make the following table:

q_k		3	4	7	1	2
P_k	1	3	13	94	107	308

So $P_{n-1}=P_4= 107$ From this

x º $(–1)^4 \times 107 \times 59$ (mod 308)

or

x º 153 (mod308).

Otherwise, the given comparison solutions will be:

x º 153, 461, 769 (mod 924).

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