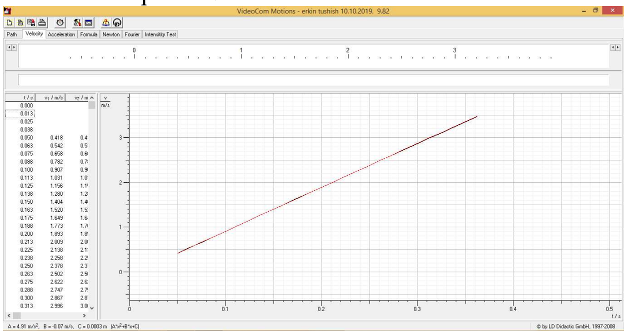
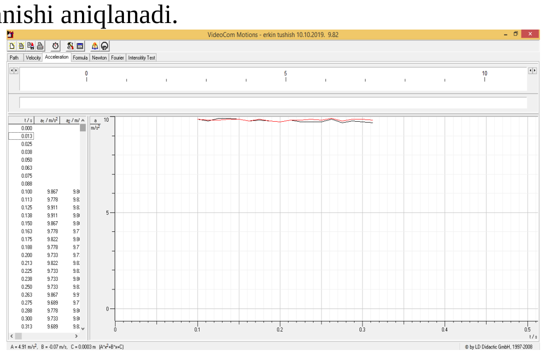
yatga ega. Parabola $Ax^2 + Bx + C$ asosida erkin tushish tezlanishi aniqlanadi.



4-rasm. Tezlik-vaqt diagrammasi.

Oniy V tezlikning "Velocity" registratorini bosib hisoblangan qiymati vaqtga chiziqli bog‘liqdir. 2Ax+B formulasi orqali to‘g‘ri chiziq qiyaligidan erkin tushish tezlanishi aniqlanadi.



5-rasm. Tezlanish-vaqt diagrammasi.

F6 tugmasini bosgan vaqtimizda esa bizga kerakli bo’lgan hisoblashlarning son qiymatlarini ko’rsatadi. Bu joyda ko’rsatilgan A ning qiymatini ikkiga ko’paytirish orqali erkin tushish tezlanishini hisoblashimiz mumkin. Bizning tajribamizda A ning qiymati 4,91 ga teng chiqdi. Bundan foydalanib g-erkin tushish tezlanishini hisoblasak quyidagicha bo’ladi:

g=2A=9,82 m/s^2

VideoCom qurilmasi aniqlangan erkin tushish tezlanishi 9,82 m/s^2 ga teng bo‘ladi. Biz g-erkin tushish tezlanish qiymatini diagrammalar orqali topdik. Bu kabi tajribalar talabalarda amaliy ko‘nikma hosil qilishga yordam beradi. Talabalarning o‘zlari ham bu tajribani mustaqil bajarib ko‘rish imkoniga ega bo‘ladi [4].

Laboratoriya ishini bajarishda har bir talaba faol ishlaydi, chunki u ongli ravishda, ma’lum maqsad bilan tajribaning qurilmasini yig‘adi, uni qiziqtirayotgan jarayonlarni ko‘radi, o‘lchashlar o‘tkazadi va ularni qaytadan ishlab chiqish fizik hodisa hamda qonuniyatlarning to‘g‘riliğa va obektivligiga ishonch hosil qiladi. Bu esa o‘z navbatida bo‘lajak fizika mutaxassisining ilmiy va amaliy bilimini rivojlanishiga imkon beradi [2].

Nazariy jihatdan erkin tushish tezlanishni $g = 978{,}049\cdot(1+0{,}005288\sin^2\varphi - 0{,}000006\sin^2\varphi)$ formulasi [3,5] orqali hisoblanadi. Bu ifoda bilan biz hoxlagan geografik kenglikta erkin tushish tezlanishning qiymatini hisoblash mumkin. Masalan: Nukus shahri uchun erkin tushish tezlanishning qiymatini hisoblasak bo‘ladi. Nukus shahrining geografik kengligi $\varphi = 42^0 28$ teng ekanligini hisobga olsak, Nukus shahri uchun erkin tushish tezlanishning qiymati g = 978,049 · (1+0,005288 · $\sin^2$42,28 - 0,000006·$\sin^2$42,28) = = 980,3 sm/s^2 = 9,803m/s^2 ekanligi kelib chiqadi.

Adabiyotlar

1. Djorayev M., Sattarova B. Fizika va astronomiya o‘qitish nazariyasi va metodikasi. -T.: “Fan va texnologiya” , 2015.
2. Razumovskiy V.G., Bugaev A.I. O‘rta maktabda fizika o‘qitish metodikasi asoslari. –T.: “O‘qituvchi” ,1990.
3. Fizikadan ma‘lumotnomalar. “Orbita.Uz kutubxonasi” -Marg’ilon – Farg’ona: 2013.
4. www.ld-didactic.de
5. www.Orbita.Uz

REZYUME

Maqolada oliy talim muassasalarida o‘qitiladigan fizika fanining “Mexanika” darsida laboratoriya mashg‘ulotlarning samaradorligini oshirishning yo‘llaridan biri haqida so‘z yuritiladi. Fizika fani laboratoriya mashg‘ulotlarida VideoCom dasturiy tizimidan foydalanish tavsiya etiladi. VideoCom dasturiy tizimi laboratoriya ishini bajarishda AKT bilan birga ishlashning fizikaviy jarayonlardagi ahamiyati haqida qisqacha ko‘rsatib o‘tishdan iborat.

РЕЗЮМЕ

В статье рассматривается один из способов повышения эффективности лабораторных занятий на уроках физики по “Механике”, преподаваемых в высших учебных заведениях. Рекомендуется использовать программное обеспечение VideoCom в лабораторных занятиях по физике. Программное обеспечение VideoCom дает краткий обзор важности работы с ИКТ в физических процессах при выполнении лабораторных работ.

SUMMARY

The article discusses one of the ways of improving the effectiveness of laboratory works at “Mechanics” lessons taught in higher educational institutions. It is recommended to use the VideoCom software system at the laboratory works. It gives a brief overview of the importance of working VideoCom software system with ICT while practice works.

ANALYTICAL TRANSFORMATIONS IN MINIMIZING LOGICAL FUNCTIONS

A.V.Kabulov - *Doctor of technical sciences, professor*
National University of Uzbekistan named after Mirzo Ulugbek
I.Kh.Normatov - *Ph.D. of Physical and Mathematical Sciences*
Scientific and innovation center of information and communication technologies
E.Urunbaev - *Ph.D., associate professor*
Samarkand state university
A.O.Ashurov - *assistant teacher*
Tashkent University of Information Technologies named after Muhammad al-Khorazmiy

Таянч сўзлар: алгоритм, доимий, мантиқий алгебра, бирлашма, дизъюнкция, Шеффер функцияси, Буль функцияси, математик мантиқ, импликация.

Ключевые слова: алгоритм, константа, логическая алгебра, конъюнкция, дизъюнкция, функция Шеффера, булевая функция, математическая логика, импликация.

Key words: algorithm, constant, logic algebra, conjunction, disjunction, Schaeffer function, Boolean function, mathematical logic, implication.

Statement of the problem

Currently, in algorithmic cybernetics, a relevant issue is to solve the problem of formation and transformation of various analytical expressions [1,2]. This paper gives some analytical formulas for transforming logical expressions in a general form.

The problems of formation and transformation of various analytical expressions are solved in the paper and the theorems of representation and transformation of formulas in various bases of functions of logic algebra are proved.

Representations of formulas in various bases of functions of logic algebra

In [3], it was proved that any function of the algebra of logic can be represented in the form of d.n.f. or the Zhegalkin polynomial. It is known that systems of Boolean functions

$$H_1 = \{x_1 \wedge x_2, x_1 \vee x_2, \neg x\} \text{ and } H_2 = \{0, 1, x_1 \wedge x_2, x_1 \vee x_2, +x\}$$

are complete in the set of all functions of the algebra of logic P_2. Transition to a system H_1 or H_2, built from a system function

$$m = \{x_1 \to x_2, x_1 \sim x_2, x_1 + x_2, x_1 / x_2, x_1 \vee x_2, x_1 \wedge x_2, \neg x\},$$

is done using the following transformations:

$$A_1 \sim A_2 = A_1 \wedge A_2 \vee \overline{A}_1 \wedge \overline{A}_2; A_1 \to A_2 = \overline{A}_1 \vee \overline{A}_2; A_1 + A_2 = \overline{A}_1 \wedge A_2 \vee A_1 \wedge \overline{A}_2;$$

$$A_1 \sim A_2 = A_1 + A_2 + 1; A_1 \vee A_2 = A_1 A_2 + A_1 + A_2; A_1 \to A_2 = A_1 A_2 + A_1 + 1;$$

$$A_1 / A_2 = \overline{A}_1 \vee \overline{A}_2; A_1 / A_2 = A_1 A_2 + 1; \neg A = \overline{A} = A + 1,$$

where A_1 and A_2 are the formulas in system P_2.

Obviously, in the sequential execution of these transformations, the numbers of various logical operations increase significantly. Introduce the following notation:

$$\xrightarrow[i=1]{n}, \ \underset{i=1}{\overset{n}{\sim}}, \ \bigvee_{i=1}^{n}, \ \bigwedge_{i=1}^{n}, \ \sum_{i=1}^{n}, \ \underset{i=1}{\overset{n}{/}},$$

which corresponds to $n-$fold implication, equivalence, disjunction, conjunction, addition by $\mathrm{mod}\, 2$ and Schaeffer operation; and i takes, in turn, the values from 1 to n.

Theorem 1. Any Boolean function consisting of a sequence of an implication operation $\xrightarrow[i=1]{n} A_i$, can be written as d.n.f.:

$$\xrightarrow[i=1]{n} A_i = \begin{cases} \bigwedge_{i=1}^{n/2} \overline{A}_{2i-1} \vee \bigvee_{j=1}^{(n/2)-1} \left(A_{2j} \bigwedge_{i=j}^{(n/2)-1} \overline{A}_{2i+1} \right) \vee A_n, & \text{if} \quad n = 2k; \\ \bigvee_{j=1}^{(n/2)-1} \left(A_{2i-1} \bigwedge_{i=j}^{(n/2)-1} \overline{A}_{2i} \right) \vee A_n, & \text{if} \quad n = 2k+1, \end{cases} \tag{1}$$

or

$$\xrightarrow[i=1]{n} A_i = A_n \vee \overline{A}_{n-1} \left(A_{n-2} \vee \ldots \vee \overline{A}_3 \left(A_2 \vee \overline{A}_1 \right) \ldots \right), \text{ if } \quad n = 2k; \tag{2}$$

and

$$\xrightarrow[i=1]{n} A_i = A_n \vee \overline{A}_{n-1} \left(A_{n-2} \vee \ldots \vee \overline{A}_4 \left(A_3 \vee \overline{A}_2 \vee A_1 \right) \ldots \right), \text{ if } \quad n = 2k+1, \tag{3}$$

where (2) and (3) are obtained from formula (1) by taking identical arguments out of brackets.

Proof. Apply the induction method:

- for $n = 2$ there is a relation $A_1 \to A_2 = \overline{A}_1 \vee A_2;$
- suppose that relation (2) holds for $n = m$.

Let us prove the truth of (3) for $n = m + 1$. Let $m = 2n$, that is, the number of elements involved, be even. Then relation (2) is written as follows:

$$\xrightarrow[i=1]{m} A_i = A_m \vee \bar{A}_{m-1}\left(A_{m-2} \vee \bar{A}_{m-3}\left(A_{m-n} \vee \dots \vee \bar{A}_3\left(A_2 \vee \bar{A}_1\right)\dots\right)\right) \quad \text{for} \quad n = m+1;$$

$$\xrightarrow[i=1]{m+1} A_i = \xrightarrow[i=1]{m} A_i \to A_{m+1} = \overline{\left(\xrightarrow[i=1]{m} A_i\right)} \vee A_{m+1} =$$

$$= A_{m+1} \vee \overline{\left(A_m \vee \bar{A}_{m-1}\left(A_{m-2} \vee \bar{A}_{m-3}\left(A_{m-4} \vee \dots \vee \bar{A}_3\left(A_2 \vee \bar{A}_1\right)\dots\right)\right)\right)} =$$

$$= A_{m+1} \vee \left(\bar{A}_m\left(\bar{A}_{m-1}\overline{\left(A_{m-2} \vee \bar{A}_{m-3}\left(A_{m-4} \vee \dots \vee \bar{A}_3\left(A_2 \vee \bar{A}_1\right)\dots\right)\right)}\right)\right) =$$

$$= A_{m+1} \vee \bar{A}_m\left(\bar{A}_{m-1}\overline{\left(A_{m-2} \vee \bar{A}_{m-3}\left(A_{m-n} \vee \dots \vee \bar{A}_3\left(A_2 \vee \bar{A}_1\right)\dots\right)\right)}\right) =$$

$$= \dots = A_{m+1} \vee \bar{A}_m\left(A_{m-1} \vee \bar{A}_{m-2}\left(A_{m-3} \vee \dots \vee \bar{A}_4\overline{\left(\bar{A}_3\left(A_2 \vee A_1\right)\right)}\dots\right)\right) =$$

$$= A_{m+1} \vee \bar{A}_m\left(A_{m-1} \vee \bar{A}_{m-2}\left(A_{m-3} \vee \dots \vee \bar{A}_4\left(A_3 \vee \bar{A}_2 A_1\right)\dots\right)\right).$$

Hence, we get

$$\xrightarrow[i=1]{m} A_i = A_{m+1} \vee \bar{A}_m\left(A_{m-1} \vee \bar{A}_{m-2}\left(A_{m-3} \vee \dots \vee \bar{A}_4\left(A_3 \vee \bar{A}_2 A_1\right)\dots\right)\right).$$

Thus, relation (3) is proved. Similarly, from (3) we can obtain the formula for odd $(n = 2k+1)$ arguments, that is, relation (2).

The theorem is proved.

It is easy to see that the expansion of any Boolean function consisting of a sequence of equivalence operations $\underset{i=1}{\overset{n}{\sim}} A_i$ in the form of d.n.f. has the following properties:

- in each elementary conjunction an even number of variables with a negation is involved;
- the rank of each elementary conjunction is equal to n;
- the number of such elementary conjunctions is $C_n^k = \dfrac{n!}{k!(n-k)!}, \ (n \geq k);$
- in $n-$dimensional cube, all expansion terms correspond to the odd cube levels; *i-th* cube level is a multitude of sets in E_n^2, the number of unit coordinates of which is i $\left(i = \overline{1,n}\right)$.

The expansion has the form:

$$\underset{i=1}{\overset{n}{\sim}} A_i = \bigwedge_{i=1}^{n} A_i \vee \bigvee_{j=1}^{n-1}\bigvee_{i=j+1}^{n}\left(B_{ji}\bar{A}_j\bar{A}_i\right) \vee$$

$$\vee \bigvee_{j=1}^{n-3}\bigvee_{t=j+1}^{n-2}\bigvee_{l=t+1}^{n-1}\bigvee_{i=l+1}^{n}\left(B_{jtli}\bar{A}_j\bar{A}_t\bar{A}_l\bar{A}_i\right) \vee \dots \vee \bigvee_{j=1}^{n-k_1+1}\bigvee_{t=j+1}^{n-k_1+2}\dots\bigvee_{i=l+1}^{n}\left(B_{jt\dots i}\bar{A}_j\bar{A}_t\dots\bar{A}_i\right),$$

where $k_1 -$ is the number of variables with negation in an elementary conjunction;

$B_{ij\dots e} -$ is the product of expressions A_k, $k = \overline{1,n}$ без $A_i, A_j, \dots, A_e$.

It is easy to see that all identical expansion terms correspond to a 5-dimensional cube of odd equations. The figure shows the vertices of the cube - not the sets, but the natural numbers corresponding to them.

A sequence of logical expressions consisting of addition operations by $\mathrm{mod}\,2$

$\sum_{i=1}^{n} A_i$, in system H_1 has the following properties:

- the rank of each elementary conjunction is equal to n;
- in each elementary conjunction, the number of variables with negation is even, if $n-$ is odd, otherwise – it is odd;
- the number of identical elementary conjunctions is $C_n^k = \dfrac{n!}{k!(n-k)!}$, $(k \le n)$;
- in n - dimensional cube, all identical terms correspond to odd levels of the cube, if $n-$ is odd, otherwise - it is even.

So, the general formula of expansion has the form

$$\sum_{i=1}^{n} A_i = \begin{cases} \bigwedge\limits_{i=1}^{n} A_i \vee \bigvee\limits_{j=1}^{n-1} \bigvee\limits_{i=j+1}^{n} \left(B_{ji}\overline{A}_j\overline{A}_i\right) \vee \bigvee\limits_{j=1}^{n-3} \bigvee\limits_{t=j+1}^{n-2} \bigvee\limits_{l=t+1}^{n-1} \bigvee\limits_{i=l+1}^{n} \left(B_{jtli}\overline{A}_j\overline{A}_t\overline{A}_l\overline{A}_i\right) \vee; \\ \vee \ldots \vee \bigvee\limits_{j=1}^{n-k_1+1} \bigvee\limits_{t=j+1}^{n-k_1+2} \ldots \bigvee\limits_{i=l+1}^{n} \left(B_{jt\ldots i}\overline{A}_j\overline{A}_t\ldots\overline{A}_i\right), \text{ if } \quad n=2k+1; \\ \bigvee\limits_{i=1}^{n} \left(B_i\overline{A}_i\right) \vee \bigvee\limits_{i=1}^{n-2} \bigvee\limits_{j=i+1}^{n-1} \bigvee\limits_{t=j+1}^{n} \left(B_{ijt}\overline{A}_i\overline{A}_j\overline{A}_t\right) \vee; \\ \vee \ldots \vee \bigvee\limits_{i=1}^{n-k_1+1} \bigvee\limits_{j=i+1}^{n-k_1+2} \ldots \bigvee\limits_{t=l+1}^{n} \left(B_{jt\ldots t}\overline{A}_i\overline{A}_j\ldots\overline{A}_t\right), \text{ if } \quad n=2k. \end{cases}$$

Here k_1- are the variables with negation;

$B_{ji\ldots l}-$ is the product of expressions A_k, $k-\overline{1,n}$ without $A_j, A_t, \ldots, A_l$.

Theorem 3. If in the expression of equivalence operation " $\sim$ " occurs sequentially and in even numbers, then it can be replaced by the addition operation by $\bmod 2(+)$, and if in odd numbers, it can be retained.

Before the general formula it is necessary to insert the negation operation and vice versa

$$\underset{i=1}{\overset{n}{\sim}} A_i = \begin{cases} \sum\limits_{i=1}^{n} A_i, \text{ if } \quad n=2k+1; \\ \neg\left(\sum\limits_{i=1}^{n} A_i\right), \text{ if } \quad n=2k. \end{cases} \qquad (4)$$

Proof. Apply the induction method. Let $m-$ be the number of equivalence operations. It is easy to see that the relation of the number of operations and arguments is $m=n-1$;

- for $n=2,\ m=1$ relation (7) is true: $A_1 \sim A_2 = A_1 + A_2 + 1 = \neg\left(A_1 + A_2\right)$;

- implying the validity of relation (4) for $m=2k+1,\ n=2k$, i.e. $\underset{i=1}{\overset{2k+1}{\sim}} A_i = \neg\left(\sum\limits_{i=1}^{2k} A_i\right)$,

We prove the same for: $m=2k,\ n=2k+1$:

$\underset{i+1}{\overset{2k+1}{\sim}} A_i = \underset{i=1}{\overset{2k}{\sim}} A_i + A_{2k+1} + 1 = \neg\left(\sum\limits_{i=1}^{2k} A_i\right) + A_{2k+1} + 1 = \sum\limits_{i=1}^{2k+1} A_i + 1 + A_{2k+1} + 1 = \sum\limits_{i=1}^{2k+1} A_i.$ Hence $\underset{i=1}{\overset{2k+1}{\sim}} A_i = \sum\limits_{i=1}^{2k+1} A_i$. Now we prove that the relation is true for $m=2k+1,\ n=2k+2$. It is easy to see that $\underset{i=1}{\overset{2k+2}{\sim}} A_i = \underset{i=1}{\overset{2k+1}{\sim}} A_i + A_{2k+2} + 1 = \sum\limits_{i=1}^{2k+1} A_i + A_{2k+1} + 1 = \sum\limits_{i=1}^{2k+2} A_i + 1 = \neg\left(\sum\limits_{i=1}^{2k+2} A_i\right)$. The theorem is proved.

It follows that the general algorithm for the transition from the Zhegalkin polynomial to the equivalence expression is determined by the following relations:

$$\sum_{i=1}^{n} A_i = \begin{cases} \overset{n}{\underset{i=1}{\sim}} A_i, \ \text{if} \quad n = 2k+1; \\ \neg\left(\overset{n}{\underset{i=1}{\sim}} A_i\right), \ \text{if} \quad n = 2k. \end{cases} \tag{5}$$

Theorem 4. A sequence of logical expressions consisting of operation of the Schaeffer stroke $\overset{n}{\underset{i=1}{/}} A_i$, in system H_2 is represented uniquely in the form of an expansion in

$$\overset{n}{\underset{i=1}{/}} A_i = \bigwedge_{i=1}^{n} A_i + \sum_{i=3}^{n}\left(\bigwedge_{j=i}^{n} A_i\right) + 1, \qquad \text{or} \tag{6}$$

$$\overset{n}{\underset{i=1}{/}} A_i = \left(1 + A_n\left(1 + A_{n-1}\left(1 + \ldots + A_3\left(1 + A_1A_2\right)\ldots\right)\right)\right), \tag{7}$$

where (7) is obtained from formula (6) by taking the identical arguments out of brackets.

Proof. Apply the induction method.

For $n = 2$ there is a relation $A_1 / A_2 = A_1A_2 + 1$, suppose that relation (7) holds for $n = m$: $\overset{n}{\underset{i=1}{/}} A_i = \left(1 + A_m\left(1 + A_{m-1}\left(1 + \ldots + A_3\left(1 + A_1A_2\right)\ldots\right)\right)\right)$.

Let us prove the validity of relation (10) for $n = m+1$:

$$\overset{m+1}{\underset{i=1}{/}} A_i = \overset{m}{\underset{i=1}{/}} A_i \Big/ A_{m+1} = \left(\overset{m}{\underset{i=1}{/}} A_i\right) A_{m+1} + 1 =$$

$$= \left(1 + A_m\left(1 + A_{m-1}\left(1 + \ldots + A_3\left(1 + A_1A_2\right)\ldots\right)\right)\right) A_{m+1} + 1 =$$

$$= \left(1 + A_{m+1}\left(1 + A_m\left(1 + A_{m-1}\left(1 + \ldots + A_3\left(1 + A_1A_2\right)\ldots\right)\right)\right)\right).$$ Hence it follows

$$\overset{m+1}{\underset{i=1}{/}} A_i = \left(1 + A_{m+1}\left(1 + A_m\left(1 + \ldots + A_3\left(1 + A_1A_2\right)\ldots\right)\right)\right).$$ The theorem is proved.

It is known that at transition to the Zhegalkin polynomial for one expression with negation, the following formula is used $\neg A = A + 1$ and for $n-$ expressions the following formulas are used

$$\bigwedge_{i=1}^{n}\left(\neg A_i\right) = \bigwedge_{i=1}^{n} A_i + \sum_{i=1}^{2}\sum_{j=i+1}^{3}\ldots\sum_{k=l+1}^{n} A_iA_j\ldots A_k + + \ldots + \sum_{i=1}^{n-1}\sum_{j=i+1}^{n} A_iA_j + \sum_{i=1}^{n} A_i + 1.$$

Conclusion. Analytical formulas for transforming logical expressions in a general form are formulated. The problems of formation and transformation of various analytical expressions are solved, and the theorems on representation and transformation of formulas in various bases of functions of the logic algebra are proved.

Reference

1. Kabulov V.K. Algorithmization in the mechanics of continuous media. –Tashkent: «Fan», Uzbek SSR, 1979.
2. Kabulov V.K. Raqamli avtomatlar algoritmlar. –Toshkent: «O'qituvchi», 1980.
3. Yablonsky S.V. Introduction to discrete mathematics. -M.: «Nauka», 1979.

РЕЗЮМЕ

Мақола дизъюнктив нормал шакллар синфидаги мантиқий функцияларни минималлаштиришнинг аналитик ўзгаришларига бағишланган. Мантиқий ифодаларни умумий шаклга айлантириш учун баъзи аналитик формулалар олинади. Турли аналитик ибораларни шакллантириш ва ўзгартириш муаммолари ҳал қилинди, мантиқий алгебра функцияларининг турли асосларида формулаларни ифодалаш ва ўзгартириш тўғрисидаги теоремалар исботланди.

РЕЗЮМЕ

Статья посвящена аналитическим преобразованиям при минимизации логических функций в классе дизъюнктивных нормальных форм. Получены некоторые аналитические формулы для преобразования логических выражений в общий вид. Автором статьи были решены проблемы формирования и преобразования различных аналитических выражений, доказаны теоремы представления и преобразования формул в различных базисах функций логической алгебры.

SUMMARY

The article is devoted to analytic transformations in minimizing logical functions in the class of disjunctive normal forms. Some analytical formulas for transforming logical expressions in a general form are derived. The problems of formation and transformation of various analytical expressions are solved, and the theorems of formulas representation and transformation in various bases of functions of logic algebra are proved.

FUNKCIYALÍQ TEŃLEMELERDI SHESHIWDIŃ GEYPARA USÍLLARÍ

Z.B.Saparov - *fizika-matematika ilimleriniń kandidatı*

S.N.Kalbaev - *magistrant*

Ajiniyaz atındagı Nókis mámleketlik pedagogikalıq institutı

Tayanch so'zlar: funktsiya, tenglama, tenglamaning yeshimi, kóphad, funktsiyalar kompozitciyasi.
Ключевые слова: функция, уравнение, решение уравнения, многочлен, композиция функций.
Key words: function, equality, equality solution, polynomial, composition of functions.

Keyingi jıllarda joqarı oqıw orınlarına matematika boyınsha test sınaqları variantlarında belgisizleri san emes, al funkciyalar bolǵan teńlemeler, teńsizlikler ushırasıp atır. Bunday teńlemeler funkciyalıq teńleme dep ataladı. Bul máseleler forması boyınsha da, sheshiw usılları boyınsha da ayrıqsha. Bunday teńlemeler menen bir qatarda funkciyalıq teńlemelerdi sheshiwdi talap etpeytuǵın ayırım máselelerge ulıwma kózqaras hám funkciyalıq teńlemeler teoriyasınıń onsha quramalı bolmaǵan tusiniklerinen usıllarınan paydalanıw judá tábiyiy bolatuǵın jaǵdaylarda sheshim alıw, usınday hár qiylı máseleler arasındaǵı baylanıslardı kórsetiw, oqıwshınıń matematikalıq mádeniyatın kóteriw mámkinshiligin beredi.

Funkciyaliq teńlemeler hám olardı sheshiw usılları, mektep matematika kursında ótilmeytugının esapqa alıp, bunday tenlemelerdi sheshiwdin geypara usillarin keltiremiz.

Parametrleniwshi teńlemeler

Belgisiz funkciya bir yaki bir neshe belgisiz parametrler menen bir mánisli táriplenetuǵın (bunday túrdegi eń ápiwayı hám eń kóp tarqalǵan funkciyalar- kóp aǵzalılar) funkciyalıq teńlemeler eń ápiwayı teńlemeler. Bul jaǵdayda belgisiz funkciyanı tabıw máselesi bul sanlı parametrlerdiń mánislerin anıqlawǵa, yaǵnıy ádettegi mektep máselesine (teńlemeler sistemasın sheshiwge) keltiriledi.

1-másele. $\forall x$ *ushın*

$$2\ f(x+1)+\ f(2-x)=2x+5 \qquad (1)$$

teńlemeni qanaatlandıratuǵın sızıqlı funkciya bar ma?

Sheshiw. Belgisiz sızıqlı funkciyanı $f(x)=kx+b$ kóriniste izleymiz. k hám b sanlı parametrler bul sızıqlı funkciyanı bir mánisli anıqlaydı. Sonlıqtan berilgen máseleni $\forall x$ *ushın*

$$2k(x+1)+2b+k(2-x)+b=2x+5 \qquad (2)$$

teńlik orınlı bolatuǵın k hám b sanlar barma?,- dep jazıw múmkin. Qawsırmalardı ashıp hám uqsas aǵzalardı jıynap, (2) teńlikti $kx+4k+3b=2x+5$ kóriniske keltiriw múmkin. Belgisizdiń birdey dárejeleri aldındaǵı koefficientlerdi teńlestirip, berilgen máseleni $\forall x$ *ushın*

$$\begin{cases} k=2 \\ 4k+3b=5 \end{cases} \qquad (3)$$

teńlemeler sistemasın qanaatldıratuǵın k hám b sanlar bar ma?,- dep jazıw múmkin. Nátiyjede, berilgen másele (3) sistemanıń birgelikliligi máselesine keltiriledi. Bul sistema jalǵız bir sheshimge iye: $k=2, b=-1.$ Solay etip, berilgen funkciyalıq tenlemeni qanaatlandırıwshı sızıqlı funkciya bar hám ol jalǵız birew: $f(x)=2x-1.$

Orınlanǵan túrlendiriwler teń kúshli hám tekseriw kerek bolmasa da, biz oqıwshıǵa tikkeley tekseriw menen tabılgan funkciya (1) teńlemeni qanaatlandıratuǵınlıǵına isenim arttırıwın másláhát beremiz.

Belgisiz shama san bolǵan ádettegi teńlemeler sıyaqlı funksiyalıq teńlemeler de sheshimge iye bolmawı, sheksiz kóp sheshimge iye bolıwı múmkin.

2- m á s e l e. $\forall x$ *ushın*

$$f(2x+1)-2f(x+1)=5x+1 \qquad (4)$$

teńlemeni qanaatlandıratuǵın sızıqlı funkciya bar ma?

Sheshiw. 1- máseledegi sıyaqlı berilgen máseleni $\forall x$ *ushın*

$$\begin{cases} 0=5 \\ -k-b=1 \end{cases}$$

teńlemeler sistemasın qanaatldıratuǵın k hám b sanlar barma?,- dep jazıw múmkin. Bul sistema birgelikli emesligi kórinip tur. Demek, berilgen funkciyalıq teńleme sızıqlı funkciyalar klasında sheshimge iye emes.

3- másele. $\forall x$ *ushın*

$$f(-1+x)-f(x-5)=-4x+6 \qquad (5)$$

teńlemeni qanaatlandıratuǵın kvadratlıq funkciyanı tabıń.

Sheshiw. Kvadratlıq funkciyanı $f(x)=ax^2+bx+c\ (a\neq 0)$ kóriniste jazamız. Sonda berilgen máseleni $\forall x$ *ushın*

$$a(x-1)^2+b(x-1)+c-(a(x-5)^2+b(x-5)+c))=-4x+6 \Leftrightarrow$$
$$\Leftrightarrow 8ax-(24a-4b)=-4x+6$$

teńlik orınlı bolatuǵın $a\neq 0, b, c$ sanlardı tabıń,- dep jazıw múmkin. Belgisizdiń birdey dárejeleri aldındaǵı koefficientlerdi teńlestirip, berilgen máseleni $\forall x$ *ushın*

$$\begin{cases} 8a=-4 \\ -24a+4b=6 \end{cases} \qquad (6)$$