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SECTION 2. Applied mathematics. Mathematical modeling.

MATHEMATICAL MODEL OF A TECHNICAL SYSTEM

Abstract: A mathematical model of a technical system was obtained using a unified approach to building a working mathematical model. The technical system consists of a group of serially connected resistors with temperature-dependent resistance and total heat capacity. The constructed mathematical model possesses sufficient fullness, accuracy, adequacy, productivity and economy. Applying such a model reduces the costs and time spent on research and makes efficient use of the mathematical modeling capabilities.

Key words: working mathematical model, properties of mathematical models, principles of mathematical modeling.

Language: English

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1. Introduction

Articles [1; 2] describe a unified approach to building a working mathematical model that has the desired properties to a degree sufficient for a particular study. Some properties of mathematical models are described in [3; 4]. Article [5] contains an example that describes building a mathematical model that possesses the required properties to a degree sufficient for the study some results of which are presented in [6–8]. The specifics of implementing a unified approach to building mathematical models are discussed in [9; 10].

The aim of this study is to build a working mathematical model of a technical system using a unified approach. The technical system consists of a group of serially connected resistors with temperature-dependent resistance and total heat capacity.

2. Statement of the problem

Let us consider a group of n serially connected resistors shown in Fig. 1. These resistors have temperature-dependent resistance and total heat capacity.
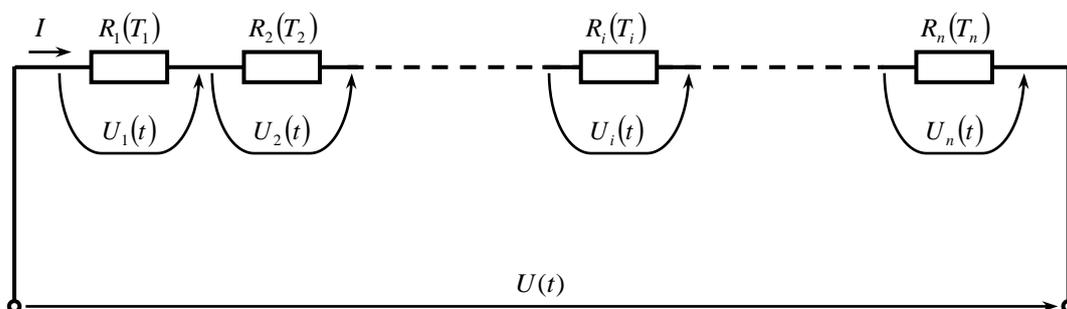

Figure 1 – The group of serially connected resistors.

The ith resistor shall be considered a body with high thermal conductivity, whose temperature T_i at the initial time point t_0 is equal to T_i^0. The resistor has the surface area S_i where convective heat exchange with the environment occurs, the ambient

temperature is equal to T_i^0; the heat transfer coefficient is known and equal to α_i. Let

$$R_i(T_i) = \frac{R_i^0}{1 + \beta_i(T_i - T_i^0)},$$

$$C_i(T_i) = C_i^0[1 + \gamma_i(T_i - T_i^0)],$$

where $R_i(T_i)$ and $C_i(T_i)$ are the resistance and total heat capacity of the ith resistor; R_i^0 and C_i^0 are the resistance and total heat capacity of the ith resistor when $T_i = T_i^0$; β and γ are the temperature coefficients, with $\beta > 0$ and $\gamma > 0$. The difference of electric potentials at the poles of the ith element is equal to

$$U_i = \frac{U_i^0}{1 + \beta_i(T_i - T_i^0)}, \qquad (1)$$

where $U_i^0 = R_i^0 I$; I is the direct current flowing through the resistors.

Let us assume that the following value is of interest in this study:

$$U = \sum_{i=1}^{n} U_i. \qquad (2)$$

Let us build a working mathematical model of the object of the study which possesses sufficient fullness, accuracy, adequacy, productivity and economy.

3. Solution

To solve this problem, we will use the results described in [11]. These results allow us to construct a hierarchy of mathematical models of the object of the study and determine the conditions under which we can calculate the sought value U with a relative error of no more than the specified value δ_0.

If the differences $T_i - T_i^0$ and $i = 1, 2, \ldots, n$ are sufficiently small, then according to (1) the sought value can be calculated using the following formula:

$$U_0 = \sum_{i=1}^{n} U_i^0 = \sum_{i=1}^{n} R_i^0 I. \qquad (3)$$

Let us define the conditions under which the resulting formula is applicable. To do this, let us consider steady-state heat transfer. In this case, according to the calculations provided in [11], we can find the steady-state value U_i using the following formula:

$$U_i^* = \frac{2U_i^0}{1 + \sqrt{1 + 4\beta_i I U_i^0 / (\alpha_i S_i)}},$$

then the steady-state value of the sought value is equal to

$$U_* = \sum_{i=1}^{n} U_i^* = \sum_{i=1}^{n} \frac{2U_i^0}{1 + \sqrt{1 + 4\beta_i I U_i^0 / (\alpha_i S_i)}}. \qquad (4)$$

The following is true for the relative error of U_0:

$$\delta(U_0) = \left| \frac{U - U_0}{U} \right| = \frac{U_0}{U} - 1 \le \frac{U_0}{U_*} - 1.$$

Therefore, if the inequality

$$\frac{U_0}{U_*} - 1 \le \delta_0 \qquad (5)$$

is satisfied, we can use formula (3) to find the sought value with a relative error of no more than δ_0.

When inequality (5) is satisfied, mathematical model (3) has sufficient fullness, accuracy, adequacy, productivity and economy.

Then let us define the conditions under which mathematical model (4) can be applied. To do this, let us consider an unsteady-state heat transfer. In this case, according to the results from [11], we obtain a Cauchy problem:

$$\frac{C_i^0 U_i^0}{\beta_i U_i^2} \frac{dU_i}{dt} = \frac{\alpha_i S_i U_i^0 - \alpha_i S_i U_i - \beta_i I U_i^2}{\gamma_i U_i^0 - \gamma_i U_i + \beta_i U_i}, \qquad (6)$$

$$U_i(t_0) = U_i^0,$$

where $i = 1, 2, \ldots, n$, and we can find the time point

$$t_i = t_0 + \frac{C_i^0}{\alpha_i S_i}\left[\frac{\gamma_i}{\beta_i}\left(\frac{U_i^*}{U_i^0} - 1 + \delta_0 \right)\frac{U_i^0}{U_i^*} + \left(\frac{U_i^0}{2U_i^0 - U_i^*} + \right.\right.$$

$$\left. + \frac{\gamma_i}{\beta_i}\frac{U_i^0 - U_i^*}{2U_i^0 - U_i^*}\frac{U_i^0}{U_i^*} - 1 \right)\ln\left(2 - \frac{U_i^*}{U_i^0} - \delta_0 \right) -$$

$$\left. - \left(\frac{U_i^0}{2U_i^0 - U_i^*} + \frac{\gamma_i}{\beta_i}\frac{U_i^0 - U_i^*}{2U_i^0 - U_i^*}\frac{U_i^0}{U_i^*} \right)\ln\left(\frac{U_i^0}{U_i^0 - U_i^*}\delta_0 \right) \right],$$

for which the following is true:

$$U_i(t_i) = U_i^*/(1 - \delta_0).$$

For $t \ge t_i$

$$\delta(U_i^*) = \left| \frac{U_i - U_i^*}{U_i} \right| = 1 - \frac{U_i^*}{U_i} \le \delta_0,$$

and U_i^* can be regarded as equal to $U_i(t)$ with a relative error of no more than δ_0. Let $t_* = \max_{1 \le i \le n} t_i$, then it is easy to demonstrate that for $t \ge t_*$

$$\delta(U_*) = \left| \frac{U - U_*}{U} \right| = \sum_{i=1}^{n}(U_i - U_i^*) \bigg/ \sum_{i=1}^{n} U_i \le \delta_0.$$

Therefore, formula (4) may be used to find the sought value with a relative error of no more than δ_0 when

$$\delta_0 < \frac{U_0}{U_*} - 1,$$

since otherwise formula (3) should be used.

If condition (5) is not met, mathematical model (4) possesses sufficient fullness, accuracy, adequacy, productivity and economy when $t \ge t_*$.

Building a new mathematical model when creating a hierarchy of mathematical models for the object of the study may lead to refining the previously determined conditions for the

applicability of the constructed mathematical models. Indeed, using mathematical model (2), (6), we can refine the applicability condition for formula (3). For this, we need to calculate the time point

$$t_i = t_0 + \frac{C_i^0}{\alpha_i S_i}\left[\left(\frac{U_i^0}{2U_i^0 - U_i^*} + \right.\right.$$

$$+ \frac{\gamma_i}{\beta_i}\frac{U_i^0 - U_i^*}{2U_i^0 - U_i^*}\frac{U_i^0}{U_i^*} - 1\right)\ln\left(1 + \frac{U_i^*}{U_i^0}\delta_0\right) - \frac{\gamma_i}{\beta_i}\delta_0 - $$

$$- \left(\frac{U_i^0}{2U_i^0 - U_i^*} + \frac{\gamma_i}{\beta_i}\frac{U_i^0 - U_i^*}{2U_i^0 - U_i^*}\frac{U_i^0}{U_i^*}\right)\ln\left(1 - \frac{U_i^*\delta_0}{U_i^0 - U_i^*}\right)\right],$$

for which the following is true:

$$U_i(t_i) = U_i^0/(1 + \delta_0).$$

For $t \le t_i$

$$\delta(U_i^0) = \left|\frac{U_i - U_i^0}{U_i}\right| = \frac{U_i^0}{U_i} - 1 \le \delta_0,$$

and U_i^0 can be regarded as equal to $U_i(t)$ with a relative error of no more than δ_0. Let $t^* = \min_{1 \le i \le n} t_i$, then it is easy to demonstrate that for $t \le t^*$

$$\delta(U_0) = \left|\frac{U - U_0}{U}\right| = \sum_{i=1}^{n}(U_i^0 - U_i)\bigg/\sum_{i=1}^{n}U_i \le \delta_0.$$

Therefore, formula (3) may be used to find the sought value with a relative error of no more than δ_0.

If condition (5) is met or $t \le t^*$, mathematical model (3) possesses sufficient fullness, accuracy, adequacy, productivity and economy.

4. Results
By constructing a hierarchy of mathematical models of the object of the study, taking into account the results described in [11], we can identify a working mathematical model that has the desired properties to a sufficient degree for a particular study. Indeed, if inequality (5) is satisfied or $t \le t^*$ in the conducted study, then (3) is considered the working mathematical model. If condition (5) is not met, and the time interval from t_0 to t_* may be disregarded in the conducted study, (4) will be chosen as the working mathematical model, otherwise (2), (6) will be the working mathematical model.

5. Conclusion
Thus, a unified approach was used to formulate the statements that allow us to define a mathematical model of a technical system. The constructed mathematical model possesses sufficient fullness, accuracy, adequacy, productivity and economy.

It is evident that using such a mathematical model not only reduces the costs and time spent on research, but also makes efficient use of the mathematical modeling capabilities.

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SECTION 30. Philosophy.

UZBEKISTAN STEPS INTO INNOVATIVE CHANGE

Abstract: *The article discusses innovations in the economic, political and social areas of the Republic of Uzbekistan in the prism of changes over the past year. The active use of innovations in the political field, and the role of reformations for the development of science in the transformation of people`s worldview as well as special peculiarities in the introduction of innovations are contemplated.*

Key words: *innovation, modernization, globalization, strategy of actions, political reformation, virtual reception, public reception, science, innovative culture.*

Language: *English*

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Introduction

Modernization processes in Uzbekistan are rapidly carried out lately. Uzbekistan, on its own way to development, along with national and historical traditions and values, is basing on the advanced experience of modernization processes, progressive and modern technologies and achievements of science in developed countries, in a word, widely-recognized economic-social and scientific-cultural values contributing to the development of our country, are increasingly being introduced into the social life. As a result of the above-mentioned processes, various innovations have been introduced into all areas of social life. The introduction of innovations in Uzbekistan leads to the creation of innovative environment , changes in traditional views among members of society, emergence of innovative thinking and the increasingly innovative nature of society .

The fact that on the initiative of the President of the Republic of Uzbekistan Shavkat Mirziyoev, innovative development has come into start in all spheres of the country confirms our view. The reformations initiated by the President are based upon the motto" The government should serve the people, rather than vice versa" The government encourages the subjects to base their activities on innovative approach, creativity, and apply innovations on a broader scale in all spheres.

Materials and Methods

Under the leadership of the first President of Uzbekistan Islam Karimov, our country gained independence and pursued its own path of political and economic development. Uzbekistan is the fourth largest gold mining country in the world, the seventh on uranium mining, the fourth largest natural gas extraction and the 11th in terms of the width of irrigated lands[1]. The wide-ranging development of market economy in the country, the attraction of foreign investments, the establishment of free economic and dozens of small industrial zones, the development of economic, political, scientific, cultural and other relations with other countries, serve as the basis of the implementation of modernization and innovation processes

Talking of the need for changes in the political life of the country, Shavkat Mirziyaev noted: "The process of further liberalization and reforming of all spheres of society are consistently continuing in our country. Actual problems, no matter what sphere or branch they concern, are openly discussed and solved with participation of the population. All decisions are made taking into account opinions, requests and appeals of our people."[2]

Uzbekistan is trying to become a country of innovations. Reforms in the political arena initiated by our President Shavkat Mirziyoev gained a new meaning. The slogan "The government should serve the people rather than vice versa," which was put forward by our President, has led to the popularity among the authorities and the people and gained the

trust in and the respect for authority. For example, in September 2017, virtual public receptions were organized. Problems that had been accumulating for many years were not solved by sending letters to traditional central organizations, and it became clear that the citizens were not content with such methods. At the same time, due to the weakness of some of the civil society institutions and the media's work failing to meet the modern requirements and the needs of the people, made it difficult for them to improve the situation.

Now it has been possible for every citizen to be directly connected to the virtual reception of the leader of the country through telephone or the Internet, inform them about their problems and get practical assistance in solving them. At such an urgent period, there was a need in an innovative approach to the problems that were to be solved in society. The problems of the population came to be solved within the framework of the existing law without introducing any changes to them. During the short period of time, the Presidential virtual reception has been so popular that on July 21, 2017, the 1 millionth caller to the Virtual Reception of the President of the Republic of Uzbekistan was registered.[3]

At present, dealing with petitions by citizens in Uzbekistan has become a priority, and there is an innovative approach to any issue about it. In particular, the introduction of the President's advisory service dealing with the problems of the population and the organization of public receptions in each region and district, as well as the newly adopted laws in this area are vivid examples for the issue.

In addition to the foregoing, innovative approaches are being implemented in such areas as human rights, freedom of speech and conscience, social rehabilitation of citizens who are exposed to religious extremist organizations.

Representatives of people who were convicted on religious extremism, but remaining outside the boundaries of social relations were putting the sustainability at risk. The work that is being carried out in this direction now also has a completely new meaning. The right path to the fight against religious extremism would be appropriate if it is implemented through absorbing true Islamic values and culture into the minds of people, and especially in the minds of young people.

The President Shavkat Mirziyoev also offered a unique approach to solving the problem stating as follows: "It is not enough to remove those who have strayed from the right path from the list. They need to be provided with practical support, decent work, cheap loans, and housing. In order to bring these people back to healthy life, this affair should be approached reasonably, with enlightenment and delicacy, and primarily serving as a role model since

they are also citizens of Uzbekistan. At same time, they should never forget that along with the same rights and freedom as the citizens of Uzbekistan, they have responsibilities and duties as well ".[4]

In tackling the problem as religious extremism, it is emphasized to focus not only on the use of force, but also on education and religious knowledge of people. For this purpose, the Islamic Cultural Center in Uzbekistan, the Samarkand International Research Center named after Imam Bukhari, and the madrasahs teaching Islamic knowledge in each region have been assigned to be established Shavkat Mirziyoev highlighted this aspect in his speech at the UN General Assembly: "Islam calls us to kindness and peace, preservation of a genuine human beginning".[5]

Modernization of the economy, further development of market relations and further introduction of innovations in these processes, regular introduction of innovative technologies and techniques into entrepreneurship are important actors determining the economic independence and development of the country. In this regard, some work is being done to meet the spirit of the current period. Particularly, the responsibility for business activities and the responsibility for illegal investigations has been intensified Vacant buildings , which were actively used in the former Soviet Union period, were provided free-of-charge(with a zero value) for enterpreneurs on condition they make an investment.

Special attention by the President is being paid to the issue of creating favorable conditions for business entities in the country for further development of entrepreneurship. These may be confirmed by the following said by Shavkat Mirziyoev: " ….an enterpreuner is a real devoted human. Personally, I am ready to praise to the skies the businessman who created just two workplaces ".[6]

The abnormal regime of currency exchange in economic life has been a major obstacle to the entrepreneurial activity. From September 2017, the head of the state has started buying foreign currency from the citizens of the largest country of Central Asia, with a population of 32.5 million. Also, the sale of foreign currency to citizens' conversion cards has begun. The foreign currency in the hands of the population was largely sent by the migrants abroad as a whole, and the entire illegal system that was formed with the exchange of it to the national currency has thus been eliminated.

It is possible to say that introduction of new methods of work in this area, new approach, organization of activities on a creative basis , in short, introduction of innovations became an important impetus for the development of entrepreneurship. As Shavkat Mirziyoev highlighted at the 72nd session of the United Nations General

Assembly, the Ombudsman for the protection of the rights of entrepreneurs was introduced in our country for the first time. Taxes on the business sector have been dramatically reduced, and credit opportunities have been expanded. The new free economic zones, where investors were given wide range of privileges, have been created,

Cooperation with international financial institutions is successfully developing, and we have re-established partnership relations with the European Bank for Reconstruction and Development.[7]

Taking into account that science is the driving force of the economy in Uzbekistan, a number of measures are being taken. The innovative approach to this is primarily the science and thus the desire for the implementation of the economy is increasing. The President's approach in this regard is also unique, and, according to him, this approach should be carried out through a new look at the heritage of the great ancestors of the Uzbek people and the pursuit of the future.[8] For example, in September 2017, a specialized school for the deepening of knowledge in the field of information and communication technologies named after Mirzo Ulugbek and the Astronomy and Aeronautics Park and the M. Al-Khorezmi International Specialized School were organized.[9]

Today in Uzbekistan there are more than 300 scientific-research institutions, scientific-production enterprises and innovation centers. Over the past year, new scientific and innovative structures - the Center for Genomics and Bioinformatics, the International Solar Energy Institute, the High-Tech Center, and the Uzbek-Japanese Youth Innovation Center have been set up. In all these centers, Uzbek youths are conducting joint research with scientists from countries such as South Korea, Japan, the United States and the United Kingdom.

Recently, the issue of educating young people on the basis of innovative development in the country, whether it is a science or entrepreneurship, and the formation of new approaches in their minds is raised. For example, in accordance with the Decree of the President of the Republic of Uzbekistan "On measures to further strengthen the infrastructure of scientific research institutions and develop innovation activities", targeted quotas for doctoral studies have been given to provide the necessary conditions for wide involvement of talented youth in scientific research and it was planned to strengthen the mechanisms for the academic mobility of academic staff and support their scientific advancement.[10]

The Mirzo Ulugbek Innovation Center was established to encourage young scientists who are able to find innovative solutions. Residences of the center have been granted extensive privileges. The Innovation Center has all IT professionals in the country, who have been provided with a decent working environment and promising jobs. In addition, the Yashnobod Innovative Technopark was built and it is planned to carry out innovative researches, implementation of foreign modern and local technologies in the Uzbek manufacturing enterprises. It is also planned to establish leading industrial and small innovative enterprises for the production of high-tech, competitive products in the domestic and foreign markets.

All such changes are carried out within the framework of the Strategy adopted by a nation-wide discussion and every year the government has been attracting citizens to develop its own action plans. In particular, at the end of 2017, citizens will be able to make suggestions on what reforms should be undertaken by public authorities next year.[11]

The innovation process has its own complexities. At any stage, there are those who resist it and who cannot change traditional views. In such a situation, free worldview, open, equitable and direct dialogue with the world community will help to change people's minds and support progressive reforms. People need to be free to understand the essence of their problems. Only then can they make an objective look at their lives. Uzbekistan has chosen the innovative way to implement reforms is a reflection of the fact that bureaucratic approach has been abandoned and it is seen in theclear , relevant activities of the population. Taking into consideration the level of living standards, knowledge and outlook of the population, the necessary conditions for the adoption of modern innovations are created.

Conclusion

In fact, the desire for change, the emergence of modern, innovative needs mean the commence of all the positive achievements and people`s motives to look for modernization and innovation. The fact that people in Uzbekistan have a new, free worldview can lead to the emergence of their intellectual potential, their abilities and talents. This process, in turn, gives a strong impetus to the success of the ongoing reforms in society. As a result, modernization and innovation processes in Uzbekistan will grow faster.

As globalization is gaining momentum in the world, Uzbekistan is becoming an active participant of these processes. Globalization requires both comprehensive modernization of the country and making decisions on the basis of innovative approaches. No other way is certain to exist . Avoiding such a path leads to the isolation of the country from the world community. It is difficult to imagine the future of the country without the advent of innovative technology. Therefore, by applying innovation in all areas of society, it is possible to

achieve the prosperity of the country and take a decent place among the developed countries.

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