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# METHODOLOGICAL ASPECTS OF FUNDAMENTALIZATION OF MATHEMATICAL KNOWLEDGE OF FUTURE SPECIALISTS IN THE FIELD OF ELECTRONICS AND TELECOMMUNICATIONS

**A. A. Kolomiiets***

*The methodology of the educational process and mathematical training of future bachelors in the field of electronics and telecommunications, in particular, is due to a large number of approaches and methods. Traditional approaches include: knowledge-centric, systemic, activity, complex, personality-oriented, personality-activity; the new approaches include situational, contextual, informational, ergonomic, competence and others. The paper analyzes the educational and professional programs of specialties in the field of 17 Electronics and Telecommunications 15 technical HEIs to determine the number of hours allocated for the study of higher mathematics. The analysis allowed us to conclude that an average of 16.5 credits were allocated for the study of higher mathematics, which is about 7 % of the total number of credits (240 credits) allocated for general training of future technicians in electronics and telecommunications. Such a narrow time frame for the study of a fundamentally radically important discipline – Higher Mathematics, encourages the search for methodologically new approaches in the educational process. The article analyzes and reveals the essence of the main approaches that help increase the level of mathematical training of future technicians, and can also be introduced into the process of general professional training of future technicians.*

*Particular attention is paid to the disclosure of systemic, personal, activity, reflexive, competence, synergetic approaches.*

*The modern education system provides for the introduction of information and communication technologies (ICT) in the learning process, including the study of higher mathematics. Such implementation is most effective when ICT is included in the educational and methodological complexes, i.e. the combination of software and accompanying printed materials is optimal. The use of modern ICT tools in the educational process, as well as any traditional means and systems of education, should be based on the general principles of learning; principles of scientificity and systematicity; consciousness of creative activity of students in education; the principle of clarity, the principle of strength of knowledge acquisition, formation of skills and abilities; the principle of a differentiated approach to the teaching of each student under the conditions of collective work of the group; the principle of developmental learning.*

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***Key words:*** *fundamental mathematical training, electronics and telecommunications, pedagogical approaches, competence approach, activity approach, synergetic approach.*

# МЕТОДОЛОГІЧНІ АСПЕКТИ ФУНДАМЕНТАЛІЗАЦІЇ МАТЕМАТИЧНИХ ЗНАНЬ МАЙБУТНІХ СПЕЦІАЛІСТІВ ГАЛУЗІ ЕЛЕКТРОНІКИ ТА ТЕЛЕКОМУНІКАЦІЙ

**А. А. Коломієць**

*Методологія освітнього процесу і методологія математичної підготовки майбутніх бакалаврів галузі електроніки та телекомунікацій, зокрема, обумовлена досить великою кількістю підходів та методів. До традиційних підходів належать: знанієво-центристський, системний, діяльнісний, комплексний, особистісно зорієнтований, особистісно-діяльнісний; до нових – ситуаційний, контекстний, інформаційний, ергономічний, компетентнісний та інші. У роботі проведено аналіз освітньо-професійних програм спеціальностей галузі 17 Електроніки та телекомунікацій 15 технічних ВЗО на визначення кількості годин, що відведені для вивчення вищої математики. Проведений аналіз дозволив зробити висновки, що в середньому на вивчення вищої математики відведено 16,5 кредитів, що становить близько 7 % від загальної кількості кредитів (240 кредитів), які відведені для загально професійної підготовки майбутнього технічного фахівця галузі електроніки та телекомунікацій. Такі вузькі часові рамки для вивчення фундаментальної радикально важливої дисципліни – Вища математика, спонукають до пошуку методологічно нових підходів у освітньому процесі. У роботі проведено аналіз та розкрито суть основних підходів, що сприяють підвищенню рівня математичної підготовки майбутніх технічних фахівців, а також можуть бути впроваджені у процес загально професійної підготовки майбутніх технічних фахівців. Особливу увагу у роботі приділено розкриттю системного, особистісного, діяльнісного, рефлексивного, компетентнісного, синергетичного підходів.*

*Сучасна система освіти передбачає впровадження інформаційно-комунікаційних технології (ІКТ) у процес навчання, зокрема і вивчення вищої математики. Таке впровадження найефективніше за умови, коли ІКТ включені до складу навчально-методичних комплексів, тобто оптимальним є поєднання програмних засобів та супроводжуючих друкованих матеріалів. В основу використання засобів сучасних ІКТ у навчальному процесі, як і будь-яких традиційних засобів і систем навчання, повинні бути покладені загальновизнані дидактичні принципи навчання, такі як єдності навчання, виховання і розвитку; принципи науковості і систематичності; свідомостії творчої активності студентів у навчанні; принцип наочності, принцип міцності засвоєння знань, формування умінь і навичок; принцип диференційованого підходу до навчання кожного студента за умов колективної роботи групи; принцип розвиваючого навчання.*

***Ключові слова:*** *фундаментальна математична підготовка, електроніка та телекомунікації, педагогічні підходи, компетентнісний підхід, діяльнісний підхід, синергетичний підхід.*

**Introduction of the issue.** In modern domestic pedagogy, the basis of training is based on a large number of different approaches. Traditional approaches include: knowledge-centric, systemic, activity, complex, personality-oriented, personality-activity; among new approaches are the following: situational, contextual, informational, ergonomic, competence and others.

**Current state of the issue.** Note that almost all types of approaches are methodologically well developed. Thus, systemic, activity and complex approaches have a convincing justification. Their essence is revealed from the standpoint of philosophy, psychology, pedagogy. They are widely represented in the scientific and pedagogical literature [1].

**Outline of unresolved issues brought up in the article.** To a lesser extent, personality-oriented and individual-activity approaches have been developed. Despite the fact that they have become widespread in recent years among theorists and practitioners of education, but there is no clarity in their content [4]. One of the reasons is the lack of fundamental knowledge about the individual in modern conditions.

**Aim of the research.** The *purpose* of the article is to substantiate the methodological basis for the application of some approaches to the fundamental mathematical education of future bachelors in electronics and telecommunications. The *task of the article* is to analyze the features of approaches and principles, to determine the features of the teacher and students in the study of higher mathematics. In this regard, the analysis of philosophical, psychological and pedagogical, special scientific literature and systematization, generalization and synthesis of analysis results.

**Results and discussion.** In order to implement the tasks set in the work, we analyzed the number of credits allocated for the study of Higher Mathematics by future bachelors in the field of 17 Electronics and Telecommunications (hereinafter – FBFETK). For arbitrarily selected technical HEIs, the amount of hours varies from 8 to 22 ECTS credits (table 1); hours, which is about 7% of the total number of academic hours (240 h., which are set aside for general training of future technicians); higher education institution (HEI).

*Table 1*

**List of higher education institution, on the basis of which the training of specialists in the field 17 - Electronics and telecommunications and the value of the number of credits allocated for the study of higher mathematics**

| | ***Name of higher education institution*** | ***The name of the educational and professional program EPP and specialties of the industry 17*** | ***Discipline and the number of credits allocated for its study*** |
|---|---|---|---|
| 1 | Vinnytsia National Technical University (VNTU) | EPP- Radio engineering Telecommunications and radio engineering | Higher mathematics 18 |
| 2 | State higher educational institution «Uzhhorod National University» | EPP – Electronic systems<br><br>Electronics | Higher mathematics 19 |
| 3 | Oles Honchar Dnipro National University | EPP – Infocommunications and communication systems Telecommunications and radio engineering | Higher mathematics 15 |
| 4 | Zaporizhzhya National University. Engineering Institute | EPP Electronics | Higher mathematics 8 |
| 5 | Lutsk National Technical University | EPP – Electronics Electronics | Higher mathematics 19 |
| 6 | National Aviation University | EPP – Telecommunication systems and networks Telecommunications and radio engineering | Higher mathematics 16,5 |

| | | | |
|---|---|---|---|
| 7 | National University «Poltava Polytechnic named after Yuri Kondratyuk» | Telecommunications and radio engineering | Higher mathematics 14 |
| 8 | National Technical University of Ukraine «Kyiv Polytechnic Institute named after Igor Sikorsky» | EPP – Intelligent technologies of microsystem electronic equipment Electronics and telecommunications | Higher mathematics 20 |
| 9 | National Technical University of Ukraine «Kyiv Polytechnic Institute named after Igor Sikorsky» | EPP – Electronic components and systems Electronics | Mathematical analysis 17,5 |
| | | | Analytical geometry 4,5 |
| 10 | National Technical University « Dnieper Polytechnic » | EPP – Telecommunications and radio engineering Telecommunications and radio engineering | Higher mathematics 16 |
| 11 | Odessa National Polytechnic University | EPP – Electronic and computer technology Electronics and telecommunications | Higher mathematics - 21 |
| 12 | Ivan Pulyuy Ternopil National Technical University | EPP – Telecommunications and radio engineering | Higher mathematics (ч.1-ч.3) - 13,5 |
| 13 | Kharkiv National University of Radio Electronics | EPP Radio engineering Telecommunications and radio engineering | Higher mathematics -12 |
| | | | Higher mathematics (special sections) - 4 |
| 14 | Central Ukrainian National Technical University | EPP – Telecommunications and radio engineering Telecommunications and radio engineering | Higher mathematics 15 |
| 15 | Yuriy Fedkovych Chernivtsi National University | EPP – Radio-electronic computerized means Telecommunications and radio engineering | Higher mathematics 15 |

*(formed by the author on the basis of educational and professional programs)*

Given that the course of higher mathematics is the basis for the study of many special disciplines, it contains fundamental concepts and logical constructions that are key tools in mastering special disciplines, mathematical training of future technicians requires such transformational changes, due to which framework (7% of the total number of ah) could address the problems of fundamental training.

Modern methodological approaches in teaching higher mathematics at the

Technical University involve the establishment of general pedagogical laws as a basis for scientific research, the establishment of worldviews (philosophical, scientific, biological, psychological ideas of pedagogical research and their impact on the results and conclusions). The normative side of the methodology is related to the study of the general principles of the approach to the study of pedagogical objects, to the study of the system of general and particular methods and techniques.

The methodological level of pedagogical research is based on the leading principle that on the basis of empirical and theoretical research the general principles and methods of research of the pedagogical phenomena are formulated, the theory is constructed. Studies of this level are called fundamental [6].

In the context of the organization of education, we can identify the following methodological approaches that are often used in practice in the process of fundamental mathematical training FBFETK:

- *systemic* – modern general scientific methodology is represented by a system approach, the essence of which is that relatively independent components are considered not in isolation, but in relationships, in the system with others; system approach allows to identify integrative system properties and qualitative characteristics that are absent in the individual elements that make up the system, taking into account the close relationship with the concept of integrity, structure, connection, element, relationship, subsystem; a systematic approach becomes important in the process of acquiring fundamental knowledge and, thus, knowledge, skills and abilities reach integrity;

- *personal* – is that in the design and implementation of the pedagogical process focus on the individual as a goal, subject, result and the main criterion of its effectiveness. According to the content of the approach, the uniqueness of the student's personality, his intellectual and moral freedom, the right to respect is recognized; it is envisaged to create in teaching and education appropriate conditions for the natural process of self-development of talents and creative potential;

- *activity* – is based on the recognition of activity as the basis, means and decisive condition for the development of personality. This necessitates its implementation in pedagogical research and practice in conjunction with a personal approach. The activity approach requires special efforts aimed at selecting and organizing student activities, activating and creating conditions for a special position of the student in terms of knowledge, work and communication, which, in turn, involves developing skills to choose a goal, plan activities, organize, perform , regulate, control it, analyze and evaluate its results;

- *reflexive* – rethinking and restructuring by the subject of the content of the experience of comprehending the acquired knowledge, their deep and conscious assimilation, awareness and practical use as methods of further self-development of the creative personality. The student can develop reflective skills only in the process of active activity in a particular situation with awareness of the results of their own activities (why learned, what is missing, what still needs to be learned). The development of reflexive qualities in the student age allows an individual to feel and regulate the level of their professional skills, not only to analyze personal achievements or troubles, but also to model further activities based on their own achievements and mistakes. Based on the analysis of the scientific literature, the following areas of training students in higher technical education to identify their professional reflective position can be identified: the disclosure of the main ways of acquiring professionalism in professional training; formation of readiness of a young specialist for self-improvement in the

process of professional activity; formation of a focus on permanent self-education. Thus, the issues of reflection were covered by scientists in various fields, but no study touched on the problem of purposeful formation of professional-reflective life position of the future specialist [3];

- *competence* – aimed at the comprehensive acquisition of knowledge and methods of practical activities that ensure the successful functioning of the teacher (manager) in key areas of life in the interests of himself and society, the state and others. Competence approach in the process of fundamental mathematical training FBFETK allows to design and implement such learning technologies that will create situations of inclusion of students in various activities (communication, problem solving, discussion, practical work and projects); researchers proposed to modernize education on the basis of a competency-based approach. This approach reflects the content of education, which is not reduced to a knowledge and oriented component, but provides a holistic experience of solving life problems, performing key (ie belong to many special areas) functions, social roles, competencies [4];

- *synergetic* – an approach to the formation of fundamental mathematical knowledge in the context of professional training FBFETK reveals the special role of the individual, which is realized in more complex systems and becomes able to directly influence the evolution of phenomena, bring them to the predicted future state. Synergetics is a qualitatively new approach that is used today in the pedagogical sciences in order to model the features of pedagogical systems and processes and their further improvement.

In this regard, one of the main goals of modern education is the formation of a culture of self-organization in parallel with the intellectual, informational, research (learn to learn). The idea of self-organization is a key point of the synergetic approach to the methodology of science in general, the methodology of education in particular. The traditional approach involves the study of the world, the emphasis is on closed systems, with a special focus on stability and homogeneity. These principles characterize the paradigmatic basis and the way of approach to the study of natural processes of traditional science The synergetic approach focuses the attention of scientists on open systems, disorder, instability, the existence and functioning of nonlinear relations. It is quite natural for scientists, teachers and lecturers to concentrate on a synergetic worldview, on the desire to transfer its concepts and provisions directly into pedagogical activities. The potential of synergetics can be revealed at different levels, because each structural element of the pedagogical system (student, teacher, student group) is an open information system. Therefore, modern pedagogy is based on scientific methods of cognition and management of a complex object. The synergetic approach is the development of system-functional methods used in pedagogy. The results of synergetic analysis of some issues of pedagogy include: goals and structures of education; a new paradigm for choosing the content of education; new learning technologies as intensification of information exchange; synergetic essence of pedagogical management of independent work of students. Now in the theory of pedagogy there are many works in which the methods of *synergetics* are applicable. One of the main methodological approaches in education is synergetic, based on the theory of complex nonlinear dynamic natural systems that are self-regulating. On its basis, methodological by nature, fundamental knowledge of the future engineer is formed.

Substantiation of methodological bases of professional training of future engineers requires identification of its main components. The reference to the dictionary [4] methodology is: 1) a set of

research techniques used in a science; 2) the doctrine of methods of cognition and transformation of reality. Note that "methodology in pedagogy is not only a means of theoretical knowledge, but also is a tool for the practical transformation of pedagogical reality on a scientific basis" [2] this allows to include methodological approaches and principles in the main components of the methodology of professional training of engineers.

Obviously, when organizing student education, it should be not only about the tasks that will arise in the future as a result of professional activities, but also about those that are valued at the moment. The fundamental nature of education determines its advanced property in relation to the applied tasks of the practical activity of the future specialist. The connection between applied and fundamental components should be carried out through classical examples of the application of higher mathematics [5]. One of the important areas for improving the level of perception of students of technical universities of mathematics and other fundamental disciplines of the formation of their competencies related to future professional activities are topics with an applied focus.

Information and communication technologies (ICT) learning can only be effective if they fit organically into a traditional learning system. Dosvid vykladachiv, which zastosovuyut komp'yuterno-oriyentovani zasoby navchannya testifies chto nayefektyvnishoyu formoyu vykorystannya informatsiynyh tehnolohiy in navchalnomu protsesi is their vklyuchennya till the skladu navchalno-metodychnyh kompleksiv, tobto vykorystannya prohramnyh zasobiv razom with suprovodzhuyuchymy drukovanymy materialamy. The use of modern ICT tools in the educational process, as well as any traditional teaching aids and systems, should be based on general principles. These include: the principle of unity of education, upbringing and development; principles of scientific systematicity; consciousness of creative activity of students in education; the principle of clarity, the principle of strength of knowledge acquisition, formation of skills and abilities; the principle of a differentiated approach to the teaching of each student under the conditions of collective work of the group; the principle of developmental learning. Specifying the requirements for the educational process organized with the use of ICT, the following principles can be distinguished as the main ones: The principle of science. The reproduction of educational material, in particular with the use of ICT tools, must be adequate to scientific knowledge and at the same time accessible to students. Methods of presenting educational material must correspond to modern scientific methods of cognition. These are the methods of modeling (physical, natural, mathematical, informational), the methods of system analysis, which contribute to the deepest knowledge of knowledge. In the conditions of informatization of pedagogical education any pedagogical technologies are inconceivable without wide application of ICT that allow to reveal fully pedagogical, didactic functions of these methods, to realize the potential opportunities put in them.

ICT is an easy way to solve problems of storing, finding and delivering information to students. Currently, the university has accumulated significant information resources in electronic form, but the available examples of the use of ICT in universities are presented in fragments. This is primarily due to the lack of scientific and methodological framework, a clear idea of technical and methodological problems, the use of ICT in the educational process. Despite some successes in the use of ICT, the results obtained are fragmented, have private solutions, are not replicable and implemented in different educational

institutions. Therefore, the tasks come to the fore: the creation on the basis of generalizations and development of the achieved results of the use of ICT in the educational process of a single concept of building an information educational environment; development of methods for designing and implementing an information educational environment in the educational process in order to further improve the efficiency of education, expand the export of educational services and adequate response to the growing dynamics of knowledge change, especially in the field of pedagogical sciences. The main principles of using modern ICT in engineering education are: clear definition of purpose, purpose; scientificity; increase motivation; purposefulness; openness; systematicity; use in technology only those components that guarantee the quality of education; efficiency; ensuring a high level of individualization of education; providing stable feedback; monitoring the development process; logical completeness; practicality; professionalism; leading role of the teacher.

Thus, in the context of the organization of education we can identify the following methodological approaches, which are often used in practice: - systemic – taking into account the close relationship with the concept of integrity, structure, connection, element, relationship, subsystem; - personality-oriented – taking into account the characteristics of each individual in the process of its free development; - personal-activity – creation of conditions for emergence of a special position at the student concerning knowledge;- reflexive – rethinking and restructuring by the subject of the content of his experience; - dialogical – stimulating the disclosure of creative potential and ensuring the formation of personal independence, responsibility; - creative – development of abilities, is necessary for successful progress towards the goal set by the person; - competence – aimed at the comprehensive acquisition of knowledge and methods of practical activities that ensure the successful functioning of the teacher (manager) in key areas of life in the interests of both himself and society, the state; - axiological, which considers the subject of the development of the culture of personal relations; - acmeological – the holistic development of man, ie movement to his "acme" (top), the manifestation of the phenomenon of professional maturity, which is based on professional competence, pedagogical skills and humanistic orientation of the individual, a strong motivation for self-improvement; - andragogic – involves the establishment of a special climate conducive to adult learning; determining the direction of learning; development of plans (projects) of educational activity – and all this is obligatory with participation of the student; implementation of educational activities, assessment.

**Conclusions and research perspectives.** The current situation in education, in particular the reduction of hours devoted to the study of fundamental disciplines, encourages the search for ways that would compensate for the compaction of time for the acquisition of fundamental knowledge. Methodologically important approaches that will contribute to the improvement of fundamental mathematical training include systematic, personal, activity, reflexive, competence, and synergetic approaches.

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