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## **PECULIARITIES OF THE DISTANCE LEARNING OF GRAPHIC DISCIPLINES**

*The article covers the peculiarities of the creation and application of distance learning courses in Engineering and Computer Graphics (ECG) using the up-to-date software environment of Collaborator platform. It also specifies the structure for the creation of teaching aids in the subject and gives a thorough analysis of the methodological peculiarities of the educational process control while studying ECG. The authors outline the advantages of the application of ECG distant courses for the training support of the students of different forms of study on the bases of the research held at the Vinnytsia National Technical University.*

**Key words:** *distance learning; engineering and computer graphics; technical drawings, informational module; distance course; knowledge control.*

**Formulation of the problem.** Distance education is one of the ways of information society development and education modernization, which presupposes the usage of up-to-date instructional information technologies when giving students an essential part of educational material. It also implies the interaction between teachers and students with the help of modern information teaching aids. The organization of such work demands thorough and detailed methodological projecting of the educational process, it needs the development of appropriate teaching aids as well as the modelling of flexible and mobile pedagogical technologies. Remote teaching, along with any other method of teaching, requires certain organizational and educational support. As has been stated [1-3], distance course should have the following structural elements:

- the maintenance of instructive materials (courses) projecting;
- the delivery of instructive materials to the recipients;
- the maintenance of additional materials (library);
- consultations;
- knowledge control;
- the organization of communication (group teaching methods).

Recently, for arranging and holding distance courses, it has become popular to use specialized web services for joint development of projects. The most popular of them is GitHub. A tutor puts all his/her materials, including templates or tests, on this web service. Students log in and branch off the tutor's materials. That is, a copy of the tutor's materials is made for them which they can further change by themselves. At the same time, the tutor can "watch" them and provide appropriate consultations, check of materials, etc. This significantly simplifies the interaction between the tutor and the students. Over 2 years of existence, individual distance courses in the field of information technology in the United States have more than 200 thousand of such branches, i.e. students - a very powerful and convenient tool for mass application.

For the organization of mass open online courses, specialized web platforms are used. The most famous are:

- Coursera – opened in 2012 by professors of Stanford University, USA;
- edX – opened in 2012 by the Massachusetts Institute of Technology and Harvard University, USA.

A number of courses within these systems have courses with subtitles in Ukrainian. For example, in the "Coursera" system, there are 2 courses in Ukrainian and other 19 courses have Ukrainian subtitles. These systems have distance courses on the subject of descriptive geometry, technical drawing, engineering and computer graphics:

- «Interactive Computer Graphics» (The University of Tokyo) (Coursera, <https://www.coursera.org/learn/interactive-computer-graphics>);
- «Engineering 3D Graphics» (National Taiwan University) (Coursera, <https://www.coursera.org/learn/cad3d>);
- «Computer Graphics» (The University of California, San Diego, USA) (edX, <https://www.mooc-list.com/course/cs1841x-foundations-computer-graphics-edx?static=true>).

In Ukraine, there is only one platform known, "Prometeus", but unfortunately, it does not include any remote courses of descriptive geometry, technical drawing, engineering and computer graphics.

Despite the large number of, and thus, some kind of competition, available foreign remote courses and developed means of their arrangement and conduct, the statistics shows that on an average only 10% of students complete these courses successfully. Therefore, the theoretical concepts of arrangement of these courses still need to be revised.

**Article's aim.** The aim of the work is theoretical justification and development of engineering and computer graphics distance teaching methods with the creation of adaptable training material; materials for remote practical classes; system of tests for self-checking and checking the levels of knowledge and skills of the students.

**Results and discussion.** In Ukraine, over the last 5-10 years, remote courses of ECG were presented in the following educational environments: Moodle, Collaborator, Web-class KPI", etc.

On the basis of comparative analysis and expert judgment method (the experts from the Vinnytsia National Technical University, Distance Education Centre) Collaborator has been used as the basis for the distance learning courses development and organisation. This modern platform allows creating distance-learning Internet centres based on the software from Davintoo Company (Ukraine) [4]. The system implies the usage of the Internet for teaching. The subsystem user interface looks like a web-page which is being created dynamically. To organize an educational process, Collaborator provides the following possibilities:

- the system gives the possibility of being extended and it adapts itself due to a user's needs in accordance with its modular structure, ways of setting and integration;
- the system gives the possibility of being extended and it adapts itself due to a user's needs in accordance with its modular structure, ways of setting and integration;
- enables roles formation, thus allowing to provide flexible re-distribution of the functions of every user;
- has embedded methods for adaptive teaching and testing;
- is capable of processing and controlling the level of knowledge and skills;
- provides both on-line and off-line studies (case-study);
- allows the registration both of educational courses and students, manages their personal profiles;
- publishes instruction and training materials, exercises;
- gives statistics information both of the teachers and students using electronic registers;
- forms and maintains schedules which synchronize concurrently between all the participants of the learning process;
- gives the possibility to use educational resources;
- uses adaptive learning techniques (the educational content is defined on the basis of statistical results of the educational process and its objectives);
- enables automatic assessment;
- ensures various forms of educational processes both on the level of traditional ones (day-time, correspondence), and distance forms of studies;
- presupposes different communication means: forums, chats, virtual classes, training courses, video-conferences, etc.

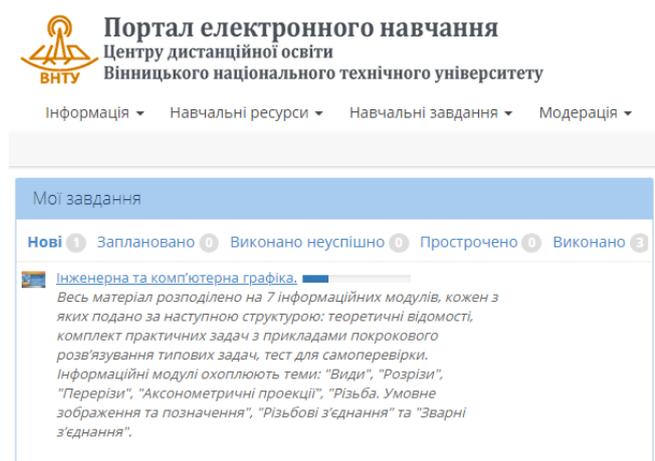


Fig.1. Virtual learning environment Collaborator

– analyses the results of the educational activities, prepares various forms of accountability [4; 5].

Engineering and Computer Graphics is the discipline containing elements of descriptive geometry (theoretical basis of the creation of the three-dimensional drawings of the objects), technical drawings and computer techniques. Being based on mathematics, the discipline provides the further study of all specialized subjects connected with the creation of mathematical and graphical models of engineering elements as well as the development of different kinds of graphical engineering documents.

Engineering and Computer Graphics is one of the general engineering subjects. Its remote teaching is accomplished under the guidance and the supervision of the tutor; it is an organized pedagogical process the aim of which is to provide students with the knowledge and skills, which are absolutely necessary for any engineer for expressing technical ideas and notions with the help of the drawings. This course aims to combine theoretical approaches with modern computer graphics techniques. On completion, students are able to create 3-D models on planes and to produce engineering drawings (the documents); they are familiar with the requirements concerning the

drawings creation and their specifications; they can solve the tasks connected with synthesis, analysis and planar images processing; they can develop and manage designer documentation using modern graphical systems. The course will involve students in mastering computer graphics techniques and applying advanced modelling tools on which their future specialty is based (Fig.2).

While developing the methodological background for the discipline, the emphasis was given to the creation of such teaching aids the structure of which would conform with the peculiarities and the key notions of distance learning courses in the sphere of Engineering and Computer Graphics, namely:

- the presentation of the teaching material in the form of the informational, control and final assessment blocks;
- the structurization of the theoretical material of the informational block for the students of different forms of studies; the presenting of information according to the principles of distance lectures creation (the design and structure of the instructing text, the use of visual-aids and supplementary materials, the series of examples and the selection of the questions for the control and self-control);
- the organization of the control is accomplished with the help of the control block that allows day-time students to estimate their level of mastering this or that part of the material; it also gives the opportunity for the teachers to check the level of proficiency of the students;
- the use of the developed structure for the creation of the distance learning courses for the technical disciplines.

Distance learning courses in Engineering and Computer Graphics consist of the informational block, the control block and the final assessment block. Theoretical material covers main

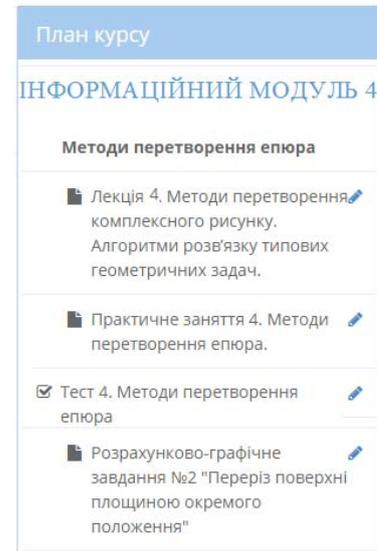


Fig.2. The structure of the informational module creation

Інженерна графіка  
Розв'язання  
В заданій задачі пряма загального положення  $l$  перетинається з поверхнею призми (рис.6.2).

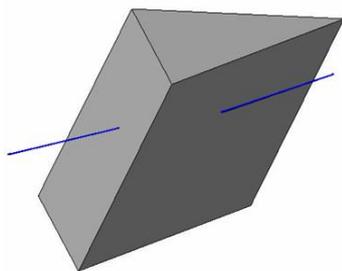


Рисунок 2  
1. Через пряму  $l$  проводимо допоміжну фронтально-проекційвальну площину  $\delta$  (рис. 6.3).

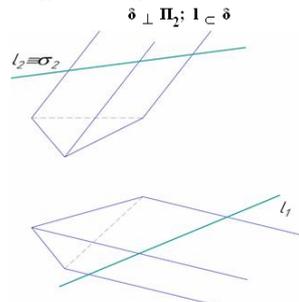


Fig.3. Example of a step-by-step solution of graphic problems

option on each page.

notions and principles of Engineering Graphics. This part of the lecture should be created using the styles of the text document, it is supposed to look like a lecture summery. As for the graphical material, the introduction of the drawings should be divided into stages. Each stage is followed with the theoretical explanation of the performed actions (Fig.3).

Lectures should employ three-dimensional images of the graphical material. The entire material is subdivided into 7 informational modules (IM), each of which is given according to the following structure: the theoretical part, a set of practical tasks with the stepped examples of the typical tasks solving, a test for self-checking. Instructional materials contain the navigational elements on every page; there is also a multi-stage menu structure and help

The control block includes the checking of the level of the students' activity. It organises the process of testing, the discussion of the problems in Forum; the participation in chats and practical tasks fulfilment. The system Collaborator presupposes the creation of the tests directly on the server, using either the means of its interface or special software for tests creation. Besides, a student himself has an opportunity to choose proper means of studies, to employ self-control and self-estimation, to play the role of a tutor by teaching himself and by forming and developing skills and abilities from the given subject. The virtual learning environment Collaborator allows the application of the methods of adaptive testing:

- adaptive stress-testing. This regime implies the automatic selection of the questions from the chapters to which a student has paid the least attention;
- adaptive dynamic testing. The tasks of different levels of difficulties are chosen. They are stipulated by the necessity to increase the credibility of the knowledge estimation while minimizing the number of questions being asked;
- adaptive statistic testing. The results of the previous tests are taken into consideration. The tasks covering the students' "lack of knowledge" areas are selected.

The task or the question formation consists of several steps. The text with the formulation is given on the first stage and the way of answering is chosen. The system Collaborator gives the possibility to use the next question types:

- a) one true variant – it is necessary to choose the correct answer from the suggested ones;
- b) several true answers – one or more true answers from the suggested ones should be given;
- c) matching – you should match two groups with one another;
- d) with the attached file – a student should download a certain file to his computer;
- e) to fill in a form – it is necessary to fill the gaps with the correct value;
- f) free answer – free answer is given;
- g) to choose a picture – you should indicate one correct answer from those given in picture (drawing);
- h) to choose from a set of pictures (drawings).

The peculiarity of descriptive geometry is that all the tasks are solved with the help of graphical constructions.

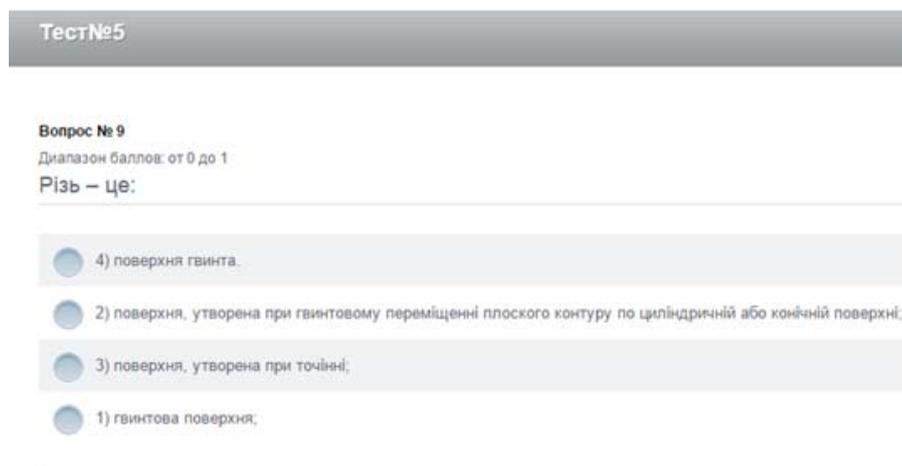


Fig. 4. The example of the textual question test from the Informational module 5

That is why textual tasks (Fig. 4) can be used mainly for the students' self-control after the theoretical material has been studied [6–9]. To create tasks containing graphics or implying drawing or its editing, it is recommended to use such types of tasks as d), f), j), h) (Fig.5). The system Collaborator has got the developed subsystem of testing which allows creating and performing the test of any level of difficulty. Each test (or test task) contains questions of different types. The amount of questions that can be used in a test is not limited. The testing subsystem stores all the questions of test tasks in its database. Each question can belong both to one test task and to several of them. We should point out that the testing subsystem Collaborator is meant not only for testing process organization, that is why such notions as 'training course' or 'file downloading' are used there as well. These tools make possible the formation of practical and control tasks. It explains why the term 'Task' is used in the cases when an ordinary test is meant.

The estimation of the acquired skills and abilities is performed due to the possibility to create training programs and apply them in testing blocks.

The counting generator enables formation not only of the typical accounting documents but also timetables or statistical educational reports in accordance with the following criteria: the time period, an academic group, other characteristics of the educational process. Apart from the above mentioned constituent parts, the program underlines clearly defined functions both of the teacher, the student and the administrator (thanks to the functions of the system administrator or the organizational manager, virtual university with its structural subdivision can be created).

Thus, the integration of distance learning courses into the process of Engineering Computer Graphics studying allows:

– to combine day-time and correspondence forms of studying in order to organize the efficient process of students' self-education;

– to increase the number of consultations and to create educational medium aimed at extending the opportunities for the students to perform calculating and graphical tasks relying on the information provided by the distance learning course of studies;

– to create favourable conditions for communication between teachers and students; to organize democratic relationships and interaction during all the period of studying with the help of lectures, consultations and computer technologies;

– to make contribution into the formation of certain professional qualities of the students which

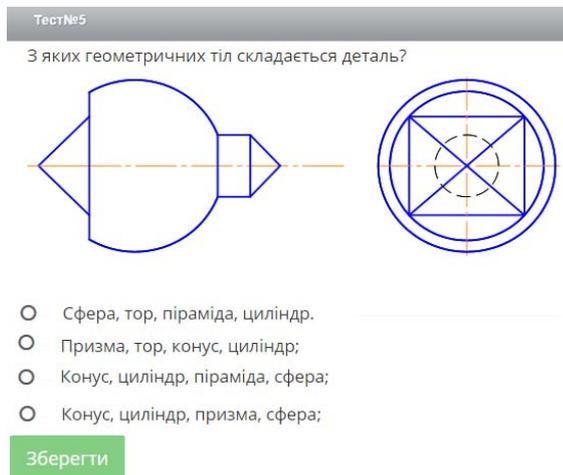


Fig. 5. The example of the test task containing a drawing

will lead to the upbringing of future highly-qualified specialists.

**Conclusions.** In the paper, the method of formation of engineering and computer graphics skills under the conditions of distance teaching adapted to various forms of organization of educational process at a technical university has been theoretically substantiated. The authors generalized theoretical and methodological basis for the development of training materials for the remote course of engineering and computer graphics, as well as methodological requirements to the design of remote courses of graphic disciplines. Formation of ECG skills in students is a necessary part of their professional training in the conditions of the information society. A successful arrangement of distance teaching of ECG is possible under the use of an educational virtual environment. Integration of traditional and distance educational technologies ensures the creation of forms and means of training of ECG course which enable to effectively organize the process of formation in students of appropriate knowledge and skills.

Methodological requirements to the arrangement of the process of formation of graphic skills (preparatory stage of a remote course, learning process; assessment of training) are of practical nature and can be used by teachers in the development of information and methodological materials for teaching ECG. The application of distance learning leads to the enlarging of the level of students' competence in technical subjects; it promotes the development of graphical thinking, enables the realization of the students' potential and ensures professional training. That is why it is necessary to continue research in the sphere of the educational methodological background of distance courses development in Engineering and Computer Graphics as it can extend the capabilities for the effective perception of the instructive materials and create the conditions for the favourable work and professional development of the students.

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#### **ОСОБЛИВОСТІ ДИСТАНЦІЙНОГО НАВЧАННЯ ГРАФІЧНИХ ДИСЦИПЛІН**

*Розглянуто особливості створення та використання дистанційного курсу з інженерної та комп’ютерної графіки (ІКГ) у середовищі сучасної платформи Collaborator. Окрім того, визначено структуру для створення навчальних посібників із предмету та наведено докладний аналіз*

методологічних особливостей контролю навчального процесу при вивченні ІКТ. Авторами, базуючись на дослідженні, проведеному у Вінницькому національному технічному університеті, окреслено переваги застосування дистанційних курсів з ІКТ для підготовки студентів різних форм навчання.

**Ключові слова:** дистанційне навчання; інженерна та комп'ютерна графіка; технічні креслення, інформаційний модуль; дистанційний курс; контроль знань.

### PECULIARITIES OF THE DISTANCE LEARNING OF GRAPHIC DISCIPLINES

**Abstract.** *Introduction.* Distance education is one of the ways of information society development and education modernization, which presupposes the usage of up-to-date instructional information technologies when giving students an essential part of educational material. It also implies the interaction between teachers and students with the help of modern information teaching aids.

*Purpose.* The aim of the work is theoretical justification and development of engineering and computer graphics distance teaching methods with the creation of adaptable training material; materials for remote practical classes; system of tests for self-checking and checking the levels of knowledge and skills of the students.

*Methods.* Theoretical methods: studying and analysis of psycho-pedagogical literature and courseware, analysis of existing software platforms for distance education, studying the structure and content of the existing distance courses in engineering and computer graphics; systematization of data, comparative analysis, generalization of the obtained information. Empirical methods: observation and generalizing of the higher-school staff's experience; own pedagogical observation on the educational process and analysis of the 1st and 2nd-year students' study results.

*Results.* The advantages of the use of virtual learning environments for creating and conducting distance learning courses were analyzed in the work. The factors which have an influence on the distance learning effectiveness, particularly level of motivation, activity and self-discipline of students, computer skills, students' psychological readiness for the distance learning were determined. Distance learning courses in Engineering and Computer Graphics consist of the informational block, the control block and the final assessment block. Integration of traditional and distance educational technologies ensures the creation of forms and means of training of ECG course which enable to effectively organize the process of formation in students of appropriate knowledge and skills.

*Originality.* Methodical requirements for the distance courses on engineering graphics, theoretic and practice basement of formatting students' graphics skills using Collaborator system have had further development.

*Conclusion.* In the paper, the method of formation of engineering and computer graphics skills under the conditions of distance teaching adapted to various forms of organization of educational process at a technical university has been theoretically substantiated. The authors generalized theoretical and methodological basis for the development of training materials for the remote course of engineering and computer graphics, as well as methodological requirements for the design of distance courses on the graphic disciplines. Methodological requirements to the arrangement of the process of formation of graphic skills (preparatory stage of a remote course, learning process; assessment of training) are of practical nature and can be used by teachers in the development of information and methodological materials for teaching engineering graphic.

**Key words:** distance learning; engineering and computer graphics; technical drawings, informational module; distance course; knowledge control.

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