USING COMPUTER MATHEMATICS SYSTEMS IN THE LEARNING PROCESS OF COMPUTER MATHEMATICS AT PEDAGOGICAL UNIVERSITY VIA DISTANCE LEARNING

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***Abstract**: According to the person-centred trends in the modern society development, learner-centered technologies are implemented. Professional training of future informatics teachers is focused on the high level of information culture and future teacher readiness to use ICT in professional activities. Computer mathematics systems (CMS) are effectively used in application tasks modeling, because the computer becomes a power tool for universalization and integration of research scientific work. Special attention will be paid to the process of informatics teachers training, shaping of their knowledge, skills and competence in CMS work, and pedagogically considered usage of this in the learning course "Computer Mathematics". Hence, the distance educational course "Computer Mathematics" with using modern CMS is proposed.*

Keywords: Computer Mathematics Systems, distance learning, e-learning, informatics science, computer science

INTRODUCTION

Under conditions of the aggravation of the social and economic, scientific-technical and cultural relationship, the society needs specialists with fundamental knowledge in the field of modern information technologies and able to use them in practical activities. PC software rapidly changes; so that skills acquired by means of regular repetition of certain actions (without fundamental principle) quickly go out of date. As a consequence, students need fundamental knowledge characterized by the maximum level of generalization and structuring (Ramsky 2003).

The relevance and feasibility of implementation and studying of Computer Mathematics at pedagogical university for the students of the specialty "Computer science" (regardless of their future professional activities such as pedagogical, scientific or practical work) are conditioned upon (Djakons 2001):

- continuing fundamental education of the students of the specialty "Computer science" at the pedagogical university;
- implementation and usage of computer equipment (with appropriate software) practically in all the fields of human activity (in the process of secondary and high education; scientific, technical, economic and health care affairs);
- the fact that Computer Mathematics is one of the priorities area of research scientific work in informatics sphere as well as in physical-mathematical sciences.

One of the current high education problems is development of effective teaching system, its adaptation to Bologna process and implementation of Information and Communication Technologies (ICT), especially it concerns application of computer mathematics system (CMS) in the learning process. CMS application in the education system deprives students of making routine calculations and releases time for solution algorithms analyzing, problem statements, mathematical models constructing, and presenting results in the most convenient manner. The released time can be used for further learning of mathematical sense of problems and methods to solve them. This opens new opportunities for humanization of the learning process, humanization of education, and differentiation of studies according to the needs, attitudes and abilities of students. Using CSM can also improve students' skills in solving of mathematical problems. Despite their focus on strong mathematical calculations, CMS may be useful for lots of users such as students, teachers, engineers, PhD students, scientists, and even for pupils from mathematical classes of comprehensive and specialized school. CMS are widely applied in education system of advanced western countries. CMS using in domestic educational institutions demonstrates integration of our education system to the world system and points to the fact of increasing of fundamental informatics (informatics science, computer science) and mathematics education role (Kobylnyk (2008)).

The study of the course of "Computer Mathematics" shall show a place and importance of computer equipment not only for the educational process, but also for human professional development. This also should supply students with knowledge and skills in usage of computer equipment in the learning process, develop knowledge of purpose and classification of application software, functions and didactic opportunities for the distance learning systems in the learning process (Zhaldak 1997, Chechkin 1991).

Educational subject of course unit is consistent of components of Computer Mathematics methodological system at the pedagogical universities.

Interdisciplinary coordination is one of the important components of the training course. To comply with accessibility, consistency and science requirements, the study of "Computer Mathematics" is based on knowledge and skills got during

studying of "Mathematical Analysis", "Algebra and Numbers Theory", "Informatics", and "Mathematical logic and Algorithms Theory". "Computer Mathematics" studying provides with the necessary knowledge to master "Methods of Informatics Learning", "Information systems and technologies in Economics".

Program of study for the variable-based course "Computer Mathematics" is prepared in accordance with educational and professional bachelor-level program of 0403 "System sciences and Cybernetics", specialty 6.040302 "Computer Science*", and serves as basic document to define scope and orientated schedule of study of content packages according to high education industry standard.

Program of the course "Computer Mathematics" includes the following components (packages):

1. CMS and their usage in the learning process.
2. General informatics theory. Mathematical framework of computational geometry.
3. Fundamentals of coding theory and cryptology.

1. PURPOSE AND OBJECTIVES OF COURSE UNIT

Purpose of "Computer Mathematics" is to develop students' knowledge and skills related to the theoretical basis of informatics which are needed for their further professional activities, generation of information, mathematics and general culture elements of pupils, intensification of cognitive activity, and providing training with research and creative characteristics.

There are the following **objectives** for achievement of the purpose:

- to define a place and importance of theoretical informatics basis for general and professional education; to explore psychological and pedagogical aspects of the course mastering, the relationship between the course "Computer Mathematics" and other courses (e.g. algebra, mathematical logic and algorithms theory, and school courses of informatics and mathematics); to show practical importance of knowledge of computer mathematics, applicability of the knowledge to solving a variety of humanitarian and technical problems of society.
- to assure fundamental learning of computer mathematics terms and methods which can be used in the learning process of certain parts of informatics, mathematics and elective courses in schools.
- to develop students' knowledge and skills needed for conducting of educational work in the process related to learning of different parts of school courses of informatics, mathematics, elective courses, and other forms of extracurricular school work with ICT using;

- to instill in future teachers a creative approach to solving problems related to informatics and mathematics learning process (especially with ICT using); to give knowledge and skills needed for self dependent analysis of learning process; to develop ability and feeling of the need in continuous self-education and self-improvement, forming of informatics, mathematics and general pupils' culture, enhancing their individual cognitive and creative activity, providing training with research and creative characteristics.

The course is methodical and practical basis for all the skills and knowledge needed by the future specialist for performing of tasks related to the computer equipment usage (Graham et al. 1998).

Students' knowledge. The course "Computer Mathematics" is designed for the students, who have studied basic mathematics and informatics courses, got fundamental knowledge of PC work, Windows work and CMS usage.

As a result of the course studying, students shall get theoretical fundamentals of informatics needed for their professional improvement, consideration of computer mathematics in the mathematics and informatics education system, learning of computer mathematics elements within informatics and mathematics school courses.

Students' skills. As a result of the course studying students get and generalize necessary skills in solving of programming problems with using CMS that can assure forming of the following competences:

- social and individual;
- general scientific;
- instrumental;
- professional.

The course "Computer Mathematics" (according to the study plan of bachelors or masters) belongs to the variable-based part of scientific, professional and practical studying. 3.5 credits or 126 teaching periods are necessary for the course in general; 46 teaching periods are for individual (self-dependent) scientific and educational student work, and 80 teaching periods are for class hours (36 teaching periods for lectures and 36 for laboratory works). Individual work consists of preparing for the class hours, performance of tasks proposed within laboratory works, and preparing for module (package) control etc.

Teaching of the training course is provided by usage of scientific and technical literary sources (list of the sources is supplemented to the laboratory works instructions), technical equipment, and necessary software.

The lecture course determines the purpose and objectives of "Computer mathematics", its main terms and methods, theoretical and practical importance of the course. Besides that, lectures content shall be in consistency with previously learned data on informatics, algebra, elementary mathematics, and show relations

with materials of informatics and mathematics school courses. Performing and submitting of laboratory works shall be within laboratory classes.

Problem issues (theoretical and practical) arisen within the course shall be discussed during student consultations.

Self-dependent (individual) and distance consists of preparing to class hours, performing of tasks proposed within lectures and laboratory works, analyzing specialized literature for considering individual homework issues. This is possible due to the developed distance course "Computer Mathematics" on the basis of Moodle (module dynamic object-oriented environment for the learning process). Distance learning system Moodle is available free system of training sources management; the system is focused on the organization of student-teacher cooperation. Moodle environment is developed by using PHP programming language with the usage of SQL-base; the environment is of module architecture that allows functions branching. Also Moodle has considered safety system; administrator functions allow adjusting appearance and functionality of the system (i.e. switch on and switch off embedded modules). This makes possible for the teacher to control access to the course, use time limits, create own knowledge evaluation system, control students' delay in tasks performing, and arrive a decision concerning repeating of a test etc. Any electronic document (useful in the course development with using e-learning) can be shown via the distance learning system Moodle. Chats and forums shall be conducted for organization of cooperation between the learning process participants. Performance test is realized in the system due to the separate module which consists of different types of tests. Possibility of repeating of tests depends on the teacher permit. Plagiarize ban is possible with the help of issue randomization (Smyrnova-Trybulska 2007).

Students get their points (grades) due to the performing of laboratory works, additional individual tasks, solving of strong problems, preparing of scientific reports, and presenting of new software programs.

The important objective of the course "Computer Mathematics" is to instill in future teachers a creative approach to solving op problems related to informatics and mathematics learning process. ICT using allows to intense educational activity, add more issues for learning.

2. INFORMATION SCOPE OF THE COURSE

The content of the course "Computer Mathematics" consists of three modules (packages). The list of the main terms (for each module) that students should ***know*** and the main ***skills*** that they should get, and subjects (topics) for learning are provided below.

Module I. **Mathematical foundations of computer science**

Main terms. Mathematical model, CMS, Maple system command, Maple system package, CMS Mathematica, Derive, Maxima, Matlab, Mathcad.

Main skills. To solve problems related to the informatics and mathematics with using Maple, Mathematica, Derive, Maxima, Matlab, Mathcad.

Subject 1. Mathematical modelling.

Concept of mathematical model. Mathematical modeling method for solving application issues of mathematics, physics, biology and other sciences.

Subject 2. CMS and their using in the learning process.

Problem solving stages by the way of PC. Review of the main CMS. Syntax and the principal commands of Maple system. Analysis of the main packages of Maple system. Significant opportunities for using Mathematica system in comparison with Maple system. General characteristics of other CMS: Derive, Maxima, Matlab, Mathcad.

Module II. **Foundations of the information theory. Mathematical foundations of computational geometry**

Main terms. Amount of information, information additivity, coding of information. Computational geometry, point, intercept, vector, line, subspace, point location, polygon, convex polygon,

Main skills. To determine amount of information, to sole problems related to fundamentals of coding of information. To define distance between points, to form equation of line, to solve problems on computer graphics (related to the relative position of points and figures), to check polygon convexity, to define belonging of the point to internal part of the polygon, to calculate the polygon area.

Subject 1. Foundations of the information theory. Hartley formula and Shannon's equation for determination of amount of information.

Introduction to the information theory. Main tasks of the information theory. Hartley formula (and its application) to determine amount of information. Information additivity law. Alphabetic approach to determine amount of information. Information and probability. Shannon's equation. Optimum coding of information. Hoffman’s prefix code.

Subject 2. Mathematical foundations of computational geometry and computer graphics. Task of computer graphics concerning relative position of points and figures.

Coordinates and vectors in the subspace. Different methods to make equation of line. Computer graphics tasks concerning relative position of points and figures. Polygons. Convex polygons.

Module III. **Fundamentals of coding theory and cryptology**

Main terms. Prime number, Euclid's algorithm, Euler function, congruence, RSA.

Main skills. To put a number in the canonical form, to determine the greatest common divisor (GCD) for two whole numbers, to calculate Euler function, to solve congruence, to code and decode information according to RSA system.

Subject 1. Divisibility of numbers. Foundations of the congruence theory.

Euclid's algorithm for determination of GCD for two whole numbers. Euler function. Congruence and its properties.

Subject 2. Fundamentals of coding theory and cryptology. Pattern discernment.

Introduction to the coding theory. Elementary cryptography (mathematical approach). Public-key cryptosystem. RSA system. Digital signature. Pattern discernment.

CONCLUSION

Examination is a type of final control of students' achievements after the course studying. Students can accumulate certain amount of points due to the work within laboratory classes, performance of individual homework tasks, preparation of scientific reports, and module tests. According to this, evaluation of students' achievements is performed.

Program structure (according to the block-modular scheme) is targeted to the maximum level of the learning process individualization. Program structure is made in the way to provide students with opportunities for studying in individual pace and focusing on certain requirements concerning learning of training materials.

Monitoring of students' learning (performance rating) is performed due to the module-rating system. Educational activity of students is evaluated in accordance with 100-point system.

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