Middle-East Journal of Scientific Research 17 (1): 121-126, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.17.01.12164

Research on Damped Oscillations in Oscillatory Circuit by Means of it-Technologies of Co-Operating with Students

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Abstract: The computer is a universal tutorial, its use allows to form students not only knowledge, skills and practice but also develop the personality of students, to meet its educational interests. By means of IT the level of knowledge achieves high results. In the process of teaching the subject visualization is provided with multimedia presentation in addition to the graphic, volumetric means of visual aids, manuals and educational films. The article considers the modeling technology in the educational process for students of senior courses of the higher educational institutions.

Key words: Modeling technologies in the educational process · Methods of working out subjects of studies · Techniques of solving tasks · Development of thinking skills of students

INTRODUCTION

Application of information technologies for the preparation of the electronic abstract of the lesson requires new approaches and to the aesthetics of the class process. Design of the lesson-presentation with demonstration of video and computer virtual reality should not significantly lag behind the level of the design of the web pages of the Internet and TV channels. In such conditions they increase professional requirements for teachers of physics, chemistry, mathematics and other disciplines in terms of mastery of modern software means and (or) organization of joint work in the course of the lesson of teachers of the subject and computer designers [1].

IT- disciplines are a wide class of subjects and fields related to technologies of management and processing of data and also making data, including the use of computer technology.

Traditionally preparation of students of technical University as future professionals begins at the senior courses but according to the results of the questionnaire they can judge that the interest in physics as one of the main disciplines in engineering education is considerably reduced [2]. Besides, the special disciplines form largely narrow professional skills and a modern graduate must have a good fundamental base to mastery the ability to learn and quickly retrain. In connection with that there is a goal to prepare students in Junior courses of higher technical educational institutions in the main subject

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physics so as to retain the interest in the subject and promote rising new formations in the form of popular currently competences.

For solving the task learning physics is carried out on practical training, implemented according to IT-technologies on the basis of experimental specialized audience with feedback [3].

Methodology: Interaction of a teacher and a student is provided in the following way: at the introductory lesson for receiving complete information and creation a model of a student they conduct the testing of students. At the same time they carry out work training of students in the automated system of management of cognitive activity of the student.

In the organizational and technological environment on the basis of IT-technologies the key functional element is an autonomous unit intended for the formation of specific student ability to solve tasks of a certain class which form his special competence.

An autonomic unit consists of practical and theoretical parts. The practical part which forms the skills, consists of tasks on physics in accordance with the work program and topics of the projects, includes a standard algorithm for solving these tasks, reference material on different subjects, texts-prompts as assistance in the selection of a problem situation and the subsequent decision of the task. The theoretical part consists of a combination of theoretical modules which are necessary and sufficient for formation of conscious understanding of each step of the algorithm of the decision of tasks, as well as the vision of a problem in a whole context. Algorithmic method generates the student's ability to highlight errors at every step of the solution from the problem to the problem situation and the problem task.

Modern IT is the practical part of the scientific field of physics, which is a set of means, ways, methods through automated collection, processing, storage, transmission, use, production information for receipt certain, obviously expected results.

Informatizations of education systems, which use different classifications of IT application in education, are chosen as the basis for the classification the type of the input and output information received on the practice, defined functions for transformation of input information carried out in the system IT technologize educational process according to the following criteria:

- substantive content of the programs (physics, mathematics and Informatics, etc.; thematic principle);
- Function: diagnostic, monitoring, training;
- The degrees of activity of students, defined by the structure and type of the activity: the demonstration, constructing programs;
- The target group of users: instrumental pedagogical means: databases, editors, computer magazines and abstracts;
- The level of communicativeness: subject-oriented, communicative oriented, network communication.

Informatization issues in physics are solved in educational institutions belonging to various specified levels. Teacher of physics should know that the specificity of the use of information technologies depends on the subject, as well as on the provision educational institutions with other visual aids, instruments, demonstration and laboratory equipment.

They notice the change of the purposes and content of education related to the following conditions:

- With expansion of areas of use of IT disciplines, the application of which is becoming the norm in all types of a human labor activity and in the process of education in many other areas of professional specialties;
- With a rethinking of the role of the IT disciplines in the development of nature and society. Informatics becomes fundamental science about information and informational processes not only in technical systems, but in the nature and in the society, that implies defining it as a place of the subject in the content of education;
- With the integration of IT in the system of education in Kazakhstan as new means that extends the sphere of educational activity;
- With the influence on the aims and content of education of informatization processes of the society, leading to greater change of a human lifestyle, it is necessary to develop a qualitatively new model of preparation of members of the information society.

We dwell on specific principles inherent in IT for their implementation in the education system:

- The Principle of humanistic learning process - orientation learning on the basis of IT to a human, creation the maximal favorable conditions for mastering social experience concluded in the content of education by the trainees, mastering the chosen profession, for the development and manifestation of creative individuality etc.

- Principle of pedagogical reasonability which requires the pedagogical estimate of efficiency of using IT in conjunction with educational technologies.
- Principle of selection of content of education, which determines the compliance of the content, presented IT to the regulatory requirements of the Republic of Kazakhstan.
- Principle of security of information circulating in the system of education based on IT - disciplines of education, the need for organizational and technical ways of its safe and confidential storage, transfer and use, guaranteeing its security.
- Principle of priority of the pedagogical approach to the design of electronic educational products of digital educational resources.
- Principle of the starting level of education - effective training on the basis of IT education demands certain initial set of knowledge, skills, practice (for productive training, the student should be familiar with the scientific foundations of an independent academic labor, have certain skills to use the computer etc.).
- Principle of mobility, variability of training - use for training information networks, databases and knowledge and data of remote education.
- Principle of non-antagonism of education on the basis of the identity of IT - disciplines of education with existing forms of education, they will not be a foreign element in the traditional educational system and naturally integrated into it.

The Main Body: The method of modeling is widely used in the practice of teaching physics in the higher institution. We can demonstrate very clearly to students all stages of the modeling method on the example of the "Movement of a charged particle in a magnetic field" in the environment of programming C++ Builder. The process of modeling is described below.

Task: with the help of IT technologies is to explore the damped oscillations in the oscillatory circuit [4].

Periodically repeating changes of the strength of the current in the coil and tension between the plates of a capacitor without consumption of energy from external sources are called free electromagnetic oscillations.

Electric oscillating circuit is called a system consisting of inductance coil *L*, inductance capacitor *C* and having a full active resistance *R*.

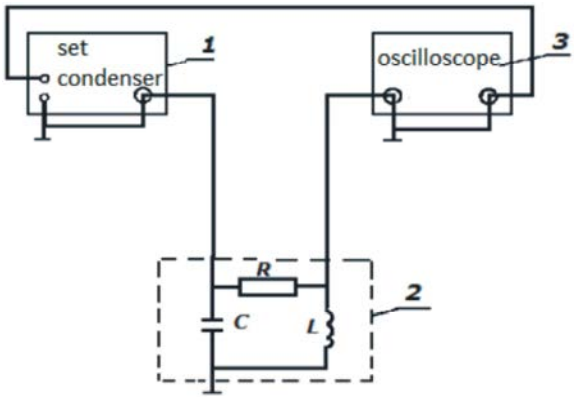

Fig. 1: Scheme of the experimental setup

Purpose of Study:

- To learn to measure the main characteristics of damped oscillations and oscillatory circuit in the period of oscillation, relaxation time, damping factor and logarithmic decrement of damping, good quality with the help of IT;
- To explore some regularities of measurement mentioned characteristics, depending on the quantity R (L or C).

Installation consists of the nominal capacitor MHI 1, electronic oscillograph S1 - 72, Figure - 1 [5].

Parameters of R, L and C - circuit can be changed with the help of switches. The resistance R circuit consists of its own resistance of circuit R0 (unknown) and additional resistance Radd, which can have values:

$Radd_1 = 0$
$Radd_2 = 50$ ohm
$Radd_3 = 150$ ohm

We set how the charge changes at the time (potential difference) on capacity C. For that we will proceed from Ohm's laws for the circuit:

$$IR = \varphi_1 - \varphi_2 + \varepsilon_c \quad (1)$$

The potential difference across the capacitor is equal to:

$$\varphi_1 - \varphi_2 = \frac{q}{C} \quad (2)$$

Where q - capacitor charge

E.m.f. (electromotive force) of self-induction in the coil is:

$$\varepsilon_c = -L\frac{dI}{dt} \tag{3}$$

Putting (2) and (3) in (1) and taking into account that discharge current of condenser:

$$I = -\frac{dq}{dt} \tag{4}$$

We have the differential equation:

$$\frac{d^2q}{dt^2} + \frac{R}{L}\frac{dq}{dt} + \frac{1}{LC}q = 0 \tag{5}$$

We will bring in notation:

$$\beta = \frac{R}{2L} \tag{6}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \tag{7}$$

Now the equalization (5) will be of the form like this:

$$\frac{d^2q}{dt^2} + 2\beta\frac{dq}{dt} + \omega_0^2 q = 0 \tag{8}$$

The equalization (8) is known as a differential equation of free damped oscillations of linear system. Solutions of this equalization are known as well [6]. They have different form in the different correlations between ω_0 and β. In $\beta = \omega_0$ the solution of the equalization (8) is of the form like this:

$$q = q_0 e^{-\beta t}\sin\varphi_0 \tag{9}$$

It means that the capacitor discharge should descend from the experiment.

If $\beta > \omega_0$ то $\left(\frac{R}{2L} > \frac{1}{\sqrt{LC}}\right)$, the solution of the equalization (8) is of the form:

$$q = C_1 e^{-\alpha_1 t} + C_2 e^{-\alpha_2 t} \tag{10}$$

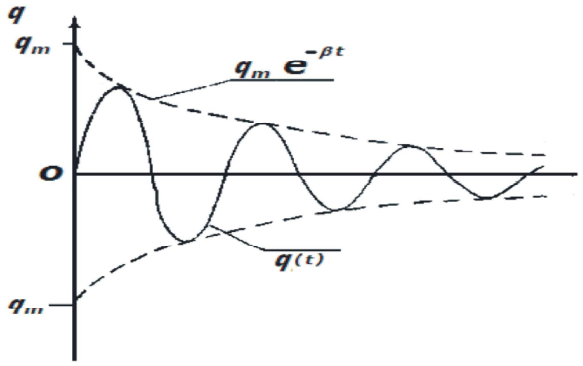

Fig. 2: The graph of the function (11) for the special case of φ0 = 0

where

$$\alpha_1 = \beta + \sqrt{\beta^2 + \omega_0^2}$$

$$\alpha_2 = \beta - \sqrt{\beta^2 + \omega_0^2}$$

And C1 and C2 - constant coefficients depending on the starting conditions.

In carrying out the condition $\beta > \omega_0$, oscillations in the circuit can not appear either [7].

If $\beta < \omega_0$, the solution of the equalization (8) is of the form of oscillating function:

$$q = q_0 e^{-\beta t}\sin(\omega t + \varphi_0) \tag{11}$$

Where φ_0 - initial phase, ω - oscillation frequency, it is:

$$\omega = \sqrt{\omega_0^2 - \beta^2} \tag{12}$$

Graph of function (11) for particular case $\varphi_0 = 0$ is of the form which is shown in Figure 2

It is clear that the graph of dependence passes through the time axis in the direction of increasing (decreasing) at regular intervals, called conditional period T, which equals:

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\omega_0^2 - \beta^2}} \tag{13}$$

Value:

$$q = q_0 e^{-\beta t} \tag{14}$$

Is called damped oscillations amplitude. The higher coefficient β is, the faster the amplitude decreases. That is why coefficient β is called the coefficient of damping.

Period of time $\tau = \frac{1}{\beta}$, during which the amplitude decreases for e = 2,71 times, is called the relaxation time [8].

Logarithmic decrement is called a dimensionless value δ, which is equal to the natural log of the ratio between the amplitudes of oscillations at the moment t to the amplitude of the moment ($t + T$):

$$\delta = \ln \frac{A(t)}{A(t+T)} \quad (15) [9]$$

From (15) and (14) implies that:

$$\delta = \beta T = \frac{T}{\tau} = \frac{1}{N} \quad (15\ a)$$

where $N = \frac{\delta}{T}$ is the number of oscillations, during which the amplitude decreases for e = 2,71 …. times.

Good quality factor of oscillatory system is called a dimensionless quantity Q which is equal to:

$$Q = 2\pi \frac{W(t)}{W(t) - W(t-T)} \quad (16) [10]$$

where $W(t)$- is the energy of oscillations at the moment l, $W(t)$–$W(t - T)$- loss of energy fluctuations during the period. It can be shown that the quality factor Q and the logarithmic damping rate δ are related by the equation:

$$Q = \frac{2\pi}{1 - e^{-2\delta}} \quad (17)$$

If δ>>1, then

$$Q \approx \frac{\pi}{\delta} \quad (17\ a)$$

If the resistance in the circuit $R \to 0$, then

$\omega \to \omega_0$

$\beta \to 0 (\beta << \omega_0)$

$\delta \to 0$, $Q \to \infty$

In this case the oscillations become undamped. Their frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ is determined only by the parameters L and C of the path. So ω_0 is called natural frequency. Period of undamped oscillations is given by Thomson formula [11]:

$$T = \frac{2\pi}{\omega_0} = 2\pi\sqrt{LC} \quad (18)$$

CONCLUSIONS

As a result theoretical information, pre-experiment, allows the student to solve concrete tasks on the topic. In the experiment the student learns to apply IT and the methods of processing of measurement results and acquires skills for compiling reports on. Thus, the simultaneous combination of information technology and the theory of the subject can significantly improve the level of understanding of the subject and, consequently, the quality of education.

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