Chapter 21
The Use of Active Learning in Biotechnical Engineering Education

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ABSTRACT

This chapter presents information-computing complex of modular type to perform interdisciplinary laboratory work. The object of the study is a complex biosystem – the human body. Feature of information-computing complex is the developed hardware and software for identification and study of systems and processes. Unique biosignal sensors allow to record electrocardiograms and sphygmograms in the process of laboratory work, to realize various algorithms of digital processing of signals and to use them in the process of structural and parametrical identification of cardiovascular system. Other sensors estimate an individual's psychophysiological state in different conditions. Thus, the student becomes the object of the research. This, undoubtedly, increases their motivation to assimilate new knowledge.

INTRODUCTION

Creating and delivering meaningful learning opportunities require a thoughtful and deliberate approach. Often, learning opportunities use innovative technology in course design to motivate and entertain students (Moats, 2015).

In this case, it is necessary to consider the characteristics and content of innovative education. Innovative education involves the purposeful formation of certain knowledge, skills, and methodological culture. This imposes special demands on the educational program content and teaching methodology. The following principles of an organization's educational process in innovative education system contains the following:

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- Problem-oriented interdisciplinary approaches to the study of natural and technical disciplines
- Active methods of contextual learning, learning from experience, and learning through research
- Case studies of methods (based on practice)

This chapter represents a conceptual model for implementing the noted principles of an innovative education system. Their implementation is illustrated through an example of a methodology for studying a complex biological system (Anishchenko et al., 2009). This chapter presents information-computing complex for the study of methods and algorithms to assess the functional state of human health based on the registration and processing of biosignals (Buldakova & Suyatinov, 2002).

Problem Orientation and the Research Object

The problem orientation of innovative education is determined by the dominant strategy of scientific and technological development. A new technological paradigm based on the synthesis of nano-, bio-, information, and cognitive technologies (NBIC) is dominant (Roco & Bainbridge, 2003). This primarily applies to studies of natural processes for technologization of knowledge and the creation of new anthropomorphic systems. By their efficiency and profitability, these would be like living systems. Successful implementation of this strategy will provide essential competitive advantages and create conditions for economic and social domination (Kamensky, 2015).

NBIC-systems are complex and poorly formalized. Therefore, the key moments in the development of NBIC-technologies are the application of interdisciplinary approaches and convergence of sciences and technologies in the study of complex systems characterized by synergistic behavior (Fedorov, Norenkov, & Korshunov, 2006). Poorly formalized complex systems represent real objects in the fields of industry, medicine, economics, and ecology. They are the object of close theoretical study because the successful solution of the problems of diagnostics and forecasting depends on the formal description of the complex system and the construction of its model.

The main difficulties in studying complex systems are their abstract representation and complexity of their experimental study. There is a limited choice of complex systems convenient for experimental research under laboratory conditions.

The human body is a complex system of natural origin. In modern technical, physical, economic, and other sciences, such complex systems are considered to behave like biological systems. Therefore, using the example of identification and research of the human body, it is possible to study fundamental principles of the functioning of complex systems of various nature.

From the standpoint of synergetics, a complex system of natural origin has many degrees of freedom. However, in the process of natural evolution, several degrees are distinguished as order parameters (the others are adjusted accordingly). The dynamics of a limited number of these parameters reflect basic properties of the entire complex system. This chapter will use this to base the principle of the model representation of complex systems of different physical nature.

The essence is that it is a priori assumed that, firstly, there are characteristic types of motion inherent in systems of different physical nature. Secondly, the entire physical variety can be presented in the form of enough simple model equations.