Modern trends of student training on vacuum technique and technology

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Abstract. Creation and location of education content at a size of electronic education resource – online courses trends are analysed. Vacuum technique and technology online course structure, which consists of vacuum technique history and application fields from electronics and machinery and space technique to medicine and biology and food industry is represented. Theoretical and practice parts of the online course are described. Remote access to laboratory vacuum equipment system example of using is represented.

Vacuum technique and a wide range of vacuum technologies implemented on its basis are the most important components of modern high, critical technologies. Such technologies are usually based on a symbiosis of natural and technical sciences, in which deep fundamental research becomes more and more practice-oriented, aimed at solving specific scientific and technical problems. The rapid development and complication of these technologies, their continuous saturation with new information requires the continuous improvement of the quality of training specialists for these areas.

Modern trends in higher education, including engineering education, represent a wide range of new educational technologies. A special place in this spectrum is occupied by e-learning based on online courses. Creation and placement of educational content in the format of online courses on the federal information resource of “one window” essentially becomes the prescriptively prescribed type of work of leading universities [1]. At the same time, the experience of applying such courses in the educational process is very small, and in engineering education is practically absent. Analysis of the introduction of so-called mass open online courses (MOOC) shows the similarity of this process with the process of damped oscillations. The optimistic statements of the MOOC adherents that “Online education will change the world” were based on the registration of over 180,000 participants for the popular introductory computer science course at Harvard in October 2012. The following month, the New York Times declared “2012 the Year of the MOOC” [2].

However, it soon became clear that less than 1 percent of the initial membership had completed the full course required for obtaining a certificate. There were reasonable questions about whether such a large-scale system is able to be effective for training masses of students with different levels of training, can it form those complex skills that were previously formed in university classrooms? The reaction to this result was very sharp. So, Stanford President John Hennessy said in an interview with the Financial Times: "Two words are wrong in MOOC: massive and open." By the end of 2013, the headline in The Washington Post simply asked: “Are MOOCs already over?” [2].
Fluctuations in opinions about online courses have not been completed to this day, however, they seem more and more close to a state of stable equilibrium. Experience with electronic educational resources, including online courses, showed a number of their significant advantages compared with traditional educational materials.

First of all, there is an opportunity to independently choose the time of study and the intensity of learning, minimizing students time and resources. In addition, the availability of educational resources at the very beginning of the semester allows to start the learning process from the first week of the semester, without waiting educational information to be considered in lectures.

The importance of this circumstance increases in view of the research results, which unequivocally qualified lectures to large flows of students as the least effective type of educational process [3]. An alternative way is the organization of active work with students in groups, which is most effective when there are electronic educational resources for students for home learning of the course.

This approach underlies the so-called blended learning, which in recent years has been increasingly used both in leading Western universities (Harvard, Massachusetts Institute of Technology, Stanford), and in domestic ones (St. Petersburg Polytechnic University of Peter the Great, Bauman University).

An important feature of engineering education in the study of both natural science and special disciplines is a mandatory workshop and the acquisition of skills in working with laboratory equipment (technological, research, measuring).

Modern electronic educational resources include in their arsenal a different type of simulators, which provide a preliminary acquaintance of the student with complex techniques and facilitate mastering it in real conditions. Remote access systems allow to conduct full-fledged experiments on unique, expensive equipment, also located in an inaccessible place, such as a clean room.

The purpose of the article is to consider the features of structure and content of an electronic educational resource, such as the course on vacuum technique and technology, which can be used as an online course for everyone, as well as to provide blended learning in full-time education.

Online course in the vacuum technique and technology consists of three sections (figure 1), and gives opportunity to students to study the fundamental basics of vacuum technique and typical processes of thin film deposition, vacuum-plasma etching, ion implantation and so on. They will can to know about some methods of measurement and control into vacuum. To capture all students of “vacuum” a history of vacuum technique evolution from ancient times to nowaday is shown. Vacuum technique and technology basic conceptions and phenomenon and characteristics are presented with animation fragments for visibility. The online course is finished by remote access to laboratory practicum: by means of trainer-simulator at the beginning and with using of real vacuum equipment after that.

Section 1 includes a stages in vacuum technique evolution and a modern trends of vacuum technique and technology. Vacuum technique history is very eventful – a lot of monuments around a world is dedicated to significant events or progress of vacuum science. Among them the monument with some horses and two semi-spheres with pumped air in Magdeburg which symbolizes Otto von Guericke experiment of atmospheric pressure force, for example. An electro-vacuum devises of famous physicist Enrico Fermi are stored in La Sapienza University in Rome and unique museum of vacuum technique is in R&D institute named after Vekshinsky in Moscow.

Knowledge of vacuum technique and technology application fields (figure 2) will help students to choose a placement in the future because this fields include electro-vacuum and semiconductor devices manufacturing, and space research, and space technique creation, etc. Modern mechanical engineering, metallurgy, energetics, constructing, chemistry and petro-chemistry, biology, medicine, nanotechnology and so on do not dispense with vacuum technological environment.

Section 2 is intended for receive a basic knowledges on physic of vacuum and vacuum technology as well. Tenuous gas pressure and molecule thermal velocity and molecules stream to surface unit in time unit and so on conceptions are given at section 2. Pumping method and vacuum ranges and basic parameters of vacuum pumps and vacuum measurement devices are described at section 2 as well. Such conceptions as gas diffusion and solubility in solid state, gas thermal conductivity and environment for electron technology and nanotechnology are given at this section as well.
Electron, ion and plasma processes use vacuum as technological environment for electron and ion and molecule streams and gas discharge plasma as well forming. The aggregate state of materials and geometrical dimensions of device elements and surface characteristics of patterns variation take place by means of electron or ion stream impact to work up material. Particularity of electron technology is an opportunity of geometrical dimensions and surface characteristics measurement by means of the same electron or ion stream.

Remote access to laboratory practicum on vacuum technique and technology methodic is studied at Section 3. This methodic consists of a theoretical part of laboratory practicum on vacuum technique and thin film deposition learning and of a practice part executing of vacuum chamber pumping and thin film deposition by means of trainer-simulator. After testing and getting of permission on laboratory practicum, our students begin the real laboratory practicum by means of control program on PC in computer class (figure 3).
Figure 3. Introduction with vacuum equipment in laboratory (a), learning of vacuum equipment scheme (b) and laboratory practicum executing methodic (c), person executing of real laboratory practicum in computer class (d).

For remote access to laboratory equipment, a special program – remote access server – was elaborated. Automatic control system of vacuum laboratory coater is jointed with remote access server by means of pairing driver. The pairing driver is intermediate link between coater and remote access server. Common scheme of remote access to equipment organization is described in [5].

In spite of conservative nature of education system, she must has reaction to modern education trends such as online education, for example. So online education and online courses are a modern trend and need form of education technology at higher education.

References

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