

Open online training courses for engineering purpose

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Abstract. The application of tools for development of the open online courses and promising ways of use of free access resources to improve the technologies and electronic means of online training in national universities are analyzed.

Key words: online courses, information technology, learning and teaching support materials of higher education in engineering fields.

1 Introduction

Information technologies are deeply integrated into all spheres of economy and public life. Modern youth, brought up under conditions of domination of electronic communication means, gives preference to the virtual space not only for communication, but for information retrieval and education as well. Spatial and economic barriers disappear due to the emergence of free educational resources such as Open CourseWare [1] deposited in the public domain. Educational space of the information society is increasingly globalizing [2] and generating the need for the information technology use, including online learning. In 2008, the term “Massive Online Open Courses” (MOOC) was coined for the first time for the course “Connectivism and Connective Knowledge”, which has been attended simultaneously by several thousands of online listeners. The current state of online learning is characterized by the presence of multi-million audience of participants in extensive open online courses [3], as the result of the wide adoption of revolutionary web technologies. Those who are eager to acquire knowledge can virtually attend lectures delivered by leading professors from the world’s best universities, Harvard, MIT or Stanford [4], with no need for visa or tuition fee, travel and accommodation expences. Certainly, education has become a global phenomenon due to the open educational resources offered by the best universities in the world for free. For Ukrainian higher technical education institutions, this not only sets a competitive environment, but first and foremost creates extremely rich opportunities to improve their own teaching materials and techniques as well as stimulate student’s independent learning.

Quality assurance in education is one of the fundamental principles of the European Higher Education Area (EHEA), creation of which is commonly referred to as the Bologna Process [5]. Setting aside numerous misconceptions about the principles of activity and reforms of the European educational systems, which unfortunately accompany the educational reform in Ukraine, we would like to focus our attention on the principles and practical aspects of massive online open courses that can fundamentally change the educational services market [2, 3] and become significant factors in improving the national system of higher education. For practical needs of the Ukrainian academic community, the unique opportunity to upgrade the knowledge base, compare our training courses with the world standards and improve teaching methods is the most important. In the academic environment, the idea that open courses threaten the existence of traditional universities and traditional educational programs is popular. We consider that openness the vital necessity for both science and education. Taking into account the requirements of international legislation concerning copyright, the teachers of national educational institutions can sufficiently enrich the training courses and improve their competitiveness by using plethora of the freely available educational materials. Encouraging the students to acquire knowledge by means of open courses in their specialty, a new type of motivation and the barrier between the post-Soviet countries and European Union can be eliminated.

2 Analysis of the online training platforms

Learning materials, the overwhelming majority of which are open, and the accumulated statistics (the number of participants of a typical massive online open course is 10 thousand to 100 thousand people) are resources, the importance of which can not be overestimated as far as improvement of the education quality by means of the introduction of new teaching technologies is concerned. Due to the possibility of attracting significant material and human resources, use of the leading world universities' achievements, unprecedented opportunities to collect statistical data for educational content improvement, correction of educational methods and policies, the operating platforms were developed and open access to extremely valuable training resources was provided. These tools, including lecture demonstrations, visualization and simulation tools, technologies for communication with students, teaching methods, can be successfully integrated [6] into e-learning courses, provided by Ukrainian universities on the basis of ATutor and Moodle online platforms.

Mastering the online course by a student is assured by a complex of educational means, ranging from watching the video-tutorials and reading additional learning material to the formative assessment in the form of tests or essays and participation in forums, where the important issues are discussed. Some courses provide a rigid schedule for watching videos and taking tests (these, particularly, includes courses on edx.org, coursera.org, iversity.org platforms) the deviation from which does not contribute to the successful course mastering, others (like p2pu.org, udacity.com, openuped.eu) provide the opportunity to arrange the learning schedule individually

(learning at own pace). Clear determination of training goals, list of competences acquired by the learner after successful course completion, requirements for its initial training and estimate of the time needed for completion of tasks are now compulsory for online courses. As a rule, the registration for the course involves the obligation not to break certain ethics principles (honor code), not to cheat on or share solutions.

The use of video clips and video workshops (Figure 1) posted on the open access servers (e.g., youtube.com or vimeo.com) becomes more and more extensive. This allows the students to revise the instructor's explanation several times whenever convenient to them or if needed at the following teaching stages.

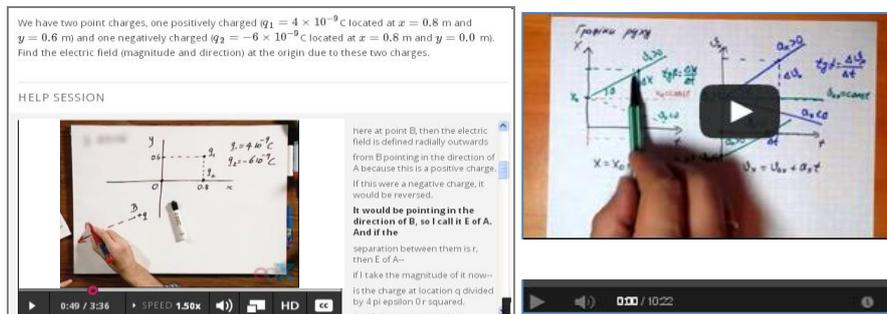


Fig.1. Use of videoconference on edx.org platform in the course of Massachusetts Institute of Technology "8.01x Classical Mechanics" (on the left) and on ATutor platform in the course of TNTU "Physics: online preparatory course" (on the right)

A significant number of educational platforms provide free access to educational courses and educational content (textbooks, virtual simulators, and educational versions of computer programs), but access to them on general grounds is limited. This allows the students of national universities to join the lecturers from the leading universities as well as the lecturers to improve their qualifications by incorporation of new scientific and methodological achievements of foreign educational institutions.

In the context of reduction in the number of credits allocated for fundamental courses the use of massive open online courses resources can become an effective element of information support for courses taught at the university. At the same time, the problem of implementation of the academic achievements assessment tools which should be adequately informative, authentic and provide correcting function, is one of the most important [2].

3 Online courses in TNTU

Testing systems (TS) of e-learning courses being an important component of teaching and methodological support have been already used at Ternopil Ivan Puluj National Technical University for several years [6]. The optimal use of TS is their combination with traditional, well-developed and approved control methods. Fast processing of results and possibility of simultaneous knowledge testing of a large number of students, release of the teacher from the monotonous work of checking examination and

test papers are considered to be electronic TS advantages. It should be noted that TS of massive online courses in the field of natural sciences and mathematics necessarily include a set of various complexity tasks with componentwise solutions checks in the form of tests with open response automatically checked even in analytical form (see Fig. 2 and Fig. 3).

COAXIAL CABLE WITH DIELECTRIC : 14.0 POINTS

A certain coaxial cable consists of a copper wire, radius a , surrounded by a concentric copper tube of inner radius c . The space between is partially filled (from b out to c) with material of dielectric constant K . The goal of this problem is to find the capacitance per unit length of this cable. You may neglect edge effects.

Note that for technical reasons, we use the symbol λ for charge per unit length, rather than the more typical Λ . Do not get confused, λ is not a length!

(a) Assume that the copper wire has uniform positive charge per unit length λ and the copper tube has uniform negative charge per unit length on its inner surface $-\lambda$. Calculate the radial component of the electric field in the region $0 < r < a$. Express your answer in terms of a, b, c, K, λ, r , and ϵ_0 (enter $\epsilon_{0,0}$ for ϵ_0 , π for π and $\ln(x)$ for natural logarithm of x).

✓

Calculate the radial component of the electric field in the region $a < r < b$. Express your answer in terms of a, b, c, K, λ, r , and ϵ_0 (enter $\epsilon_{0,0}$ for ϵ_0 , π for π and $\ln(x)$ for natural logarithm of x).

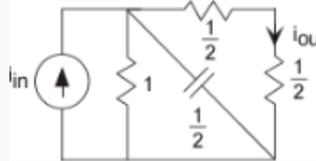
✓

Fig.2. Problem with automated solution check in analytical form on the platform of Rice University “Fundamentals of Electrical Engineering” course

It is impossible to overestimate the importance of introduction the visualization tools into online course (Figure 4), which allow the student while experimenting individually with phenomenon or device to “feel” it on their own, and to develop scientific intuition, as well as simulators of technical installations and electrical circuits (Fig. 5). These tools considerably increase the motivation for independent work and the profundity of the material learnt.

Question 5

In the following circuit, the output current $i_{out}(t)$ equals $\cos(2t)$.



Find the source, expressed as a real-valued signal.

You entered:

$\text{sqrt}(5) \cdot \cos(2 \cdot t + \text{atan}(0.5))$

Preview

Help

Your Answer

Score

$\text{sqrt}(5) \cdot \cos(2 \cdot t + \text{atan}(0.5))$



1.00

Total

1.00 / 1.00

Question Explanation

Since $\frac{I_{out}}{I_{in}} = \frac{2}{s+4}$, when the input is $I_{in}e^{j2\pi ft}$, the output is $\frac{2I_{in}}{j2\pi f+4} e^{j2\pi ft}$.

Fig.3. Problem with automated stagewise solution check in Massachusetts Institute of Technology „8.02x Electricity and Magnetism” на edx.org course

The use of social networks ("social networking") for educational purposes has both positive and negative consequences. Negative ones include the danger of scattering the student's attention to irrelevant things, impossibility of complete control of the learning environment and avoiding the penetration of advertising, intolerant and provocative materials. Positive ones are the development of skills for professional cooperation, professional discussion, even the creation of professional network (see Figure 6). The greatest benefit from forums in open online courses is that the student can find support and advice or gain additional motivation by providing such support to others at any time. The latter encourages the students to study the course material even deeper than it is stated in the curriculum. The experience of using TS shows that knowledge acquiring due to online learning provides an opportunity to enjoy learning, which is a powerful motivation for self-education over a lifetime.

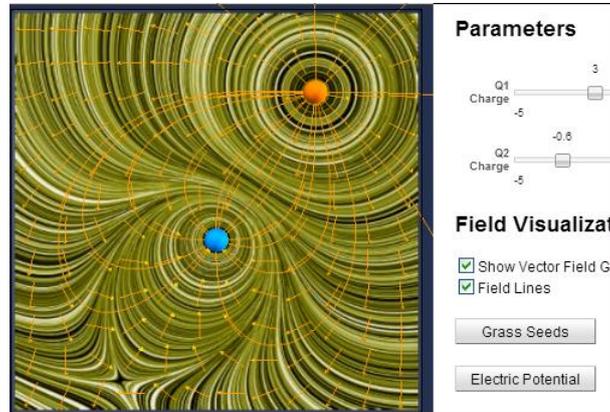


Fig.4. Visualization of the dipole electric field in Massachusetts Institute of Technology „8.02x Electricity and Magnetism” на edx.org course

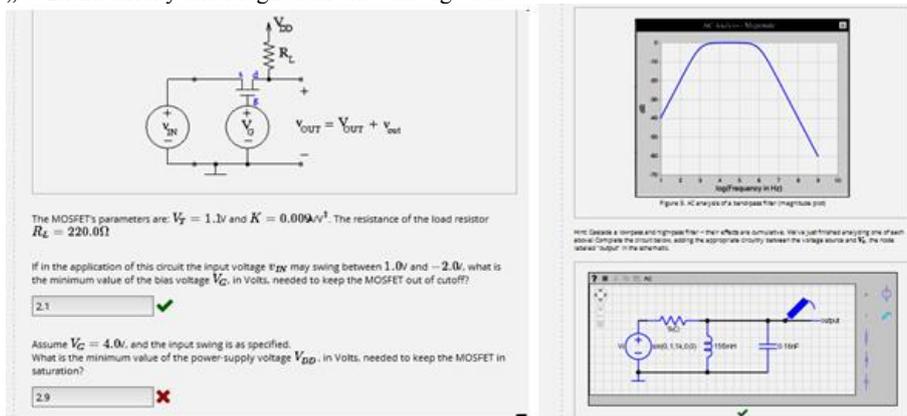


Fig.5. Tools for construction and analysis of electrical circuits in Massachusetts Institute of Technology „6.002x Circuits and Electronics” на edx.org course

Forums / General Discussion

Help

3D MOS Transistors?

Matthew Hartensveld · 2 years ago

Anyone have an idea how a 3D MOS transistor varies from a traditional MOS transistor we are studying and what advantages the 3D transistors have?

↑ 0 ↓ · flag

Oriol Sanchez Garcia · 2 years ago

If you are referring to FinFet, I believe that the trick is that they actually envelope the silicon were the channel will form between Source and Drain with the Gate, making the effective surface of the Gate bigger than what you should expect at that scale with 2D transistors.

Fig.6. Example of topic discussion beyond the curriculum frame at Columbia University „MOS Transistors” forum course on coursera.org platform.

An interesting methodological approach used while organizing the training process on the coursera.org platform is the peer grading of the students works according to the criteria specified by the instructor. Such practical aspect makes it possible to increase the level of student responsibility and gives them additional opportunity to learn from their colleagues (Figure 7).

Peer Assessments / Série 12 Help

Submission Phase	Evaluation Phase	Results Phase
1. Do assignment <input checked="" type="checkbox"/>	2. Evaluate peers <input checked="" type="checkbox"/>	3. Self-evaluate <input checked="" type="checkbox"/>
		4. See results <input checked="" type="checkbox"/>

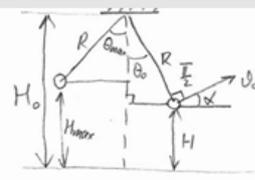
Veuillez répondre sur une ou plusieurs pages A4 (manuscrites ou pas), scanner (ou photographier avec votre smartphone) et "uploader".

serie12

Exercice 1

a) L'énergie potentielle maximale
 $mgH_{max} = mg(H_0 - R \cos \theta_{max})$

L'énergie totale
 Au point $\theta_0 < \theta_{max}$:
 $\frac{mv_0^2}{2} + mgH = \frac{mv_0^2}{2} + mg(H_0 - R \cos \theta)$



Evaluation/feedback on the above work

Note: this section can only be filled out during the evaluation phase.

Voici le corrigé de la série 12. Utilisez-le pour juger du travail de vos collègues, ainsi que du vôtre.
 Insuffisant (0 pt) correspond à un travail bâclé et/ou incomplet. Suffisant (1 pt) correspond à une copie dont la qualité est juste satisfaisante. Bien (ou très bien, 1 pt) récompense un rendu soigné et complet.

En quelques mots, quelle(s) remarque(s) constructive(s) pouvez-vous faire sur le travail que vous venez de corriger?
 Vous pouvez nuancer et justifier votre note brièvement ci-dessous.

peer 1 → [This area was left blank by the evaluator.]

peer 2 → Exercice 1, revoir le calcul des amplitudes qui sont erronées Exercice 2, la dernière étape dans le calcul de Ec est fausse, il manque donc un facteur dans l'expression finale, meme si le résultat est bon pour alpha.

Fig.7. Students peer grading of École Polytechnique Fédérale de Lausanne „Mécanique I” course on coursera.org platform
 Taking into account the need for constant development of training methods and means over a year the Department of Physics in TNTU is carrying out the experiment

focused on the use of elements of massive open online courses "Nanotechnology: the basics", "Fundamentals of Electrical Engineering" on Coursera platform and "Circuits and Electronics" on the edX platform as additional training resources for courses in physics and electronics. Since the effectiveness of introducing innovations in education is to be estimated only on the basis of analysis of a sufficient amount of objective data, such as learning outcomes (for example, statistics on the academic achievements monitoring), the experiment carried out in TNTU can not be considered as the basis for detailed conclusions or recommendations, in contrast to the results of mass open online courses use, where statistical data are beneficial for thorough analysis [3, 7].

However, based on the results of the first observations, it can be stated that the introduction of external online courses elements increases motivation and makes discussion in the classroom more lively and qualified, although it creates certain polarization within the student group, dividing them into active and passive participants in educational activities. For both the lecturer and the student, a wide range of open online courses extends the possibility horizons. Particular, the students who have successfully completed several online courses on computer networks are much better trained for the programs offered by the CISCO Networking Academy functioning at TNTU or other similar training programs.

4 Conclusions and prospects for further investigations

In order to meet the requirements of the European Higher Education Area, curricula for specialists training in engineering specialties should be constantly updated and improved, taking into account the requirements of modern labor market. One of the most advanced elements of online courses is listeners' knowledge assessment system [7]. It is generally acknowledged that, despite certain disadvantages, means of automated knowledge assessment have the advantages of fast and unbiased assessment of a large number of students. Multi-level tests based on practical tasks are used to assess the acquired knowledge after mastering certain courses in physics, mathematics and engineering subjects. Testing tools of ATutor management system used by our universities are not so flexible as coursera.org and edX.org platforms. However, the platform created at the university has a number of advantages, since, with the support of the staff of Online Learning Institute, it is appropriately modified at the university level. The flexibility of the academic achievements test system has been improved [6] by combining three components: external propaedeutic tests from specially selected open online course, ATutor local testing platform, and traditional written tests (the only ones that involves personal communication between the student and the lecturer). In such a way, benefits of different approaches are strengthening mutually. Coordinated use of internal and external educational tools can be considered the certain stage of integration [8] of the national educational system and global educational area.

It should be also noticed that massive open online courses offered by universities in the United States and Europe are able to accelerate the cultural adaptation process for dual diploma students, developing their ability to adapt to new conditions and requirements, involving them into intensive intercultural communication.

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