

Running OER MOOC University Courses by Using Moodle Platform

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Abstract — this paper describes an i-pedagogically effective sequence of topics and methods for blended learning electric circuit analysis in a MOOC (Massive Open Online Courses) structure. We show how to teach using the web, Open Educational Resources (OER), components of a course website, and the structure of the instructional process. These Virtual Learning Environments will improve student performance in engineering courses offered at Technical University Iași, România, and Technical University of Moldova, Chișinău, Republic of Moldova. Our web-based instructional methodology focuses on teaching this systematic problem-solving skill. The development of courseware materials for student engineers in Romania and Moldova will have an increasing impact on the national scene of engineering education. The research and development of online materials devoted to the development of human resources and human potential will accelerate the process of transfer of up-to-date technology. If new information and communication technologies are introduced in order to enhance independent / autonomous learning in the context of information society development, they can be applied both to Romania and Moldova.

Key Words —MOOC, OER, electric circuits, blended learning, moodle.

I. GENERAL PRESENTATION OF OPEN EDUCATIONAL RESOURCES AND MOOCs

The Technical “Gh. Asachi” University Iași, România, (Faculty of Electrical Engineering and Department for Teacher Education —DPPD; <http://moodle.ee.tuiasi.ro/>) and Technical University of Moldova, Chișinău, Republic of Moldova (<http://elearning.utm.md/moodle/>), have initiated a multimedia research and development program to develop engineering courseware using various multimedia technologies. An important incentive was the success of the realization inter-university network during CRUNT project [26-27].

II. GENERAL PRESENTATION OF OPEN EDUCATIONAL RESOURCES AND MOOCs

Open Educational Resources (OER) have the potential to broaden access to education and to improve the quality and cost-effectiveness of teaching and learning in Europe. The best way to put OERs into practice is through Massive Open Online Courses (MOOCs). MOOCs are large-scale courses that represent one of the latest developments in open education, an initiative that is always trying to improve quality, access and equality in education and training.

MOOCs can be implemented in formal, informal and non-formal learning, and make learning ubiquitous.

Project will use leading-edge technology to create a combined Moodle MOOC platform— based on individual platforms and resources provided by project partners – making it possible to combine and transfer pilot activities in all the hubs involved.

Project will contribute to increasing awareness of the advantages of open education in Europe. The project will prove the potential of MOOCs (courses and communities) for breaking down technological barriers in learning across people with special needs or at risk of exclusion.

MOOCs adopted definition: MOOC is an online course designed for large number of participants that can be accessed by almost anyone anywhere as long as they have an internet connection, is open to everyone without entry qualifications and offers a full/complete course experience online for free.

A MOOC includes educational content, facilitation interaction among peers (including some but limited interaction with academic staff), activities/tests, including feedback, some kind of (nonformal) recognition options and a study guide / syllabus.

III. MOODLE PLATFORM USED IN DELIVERING MOOCs

MOODLE is an open-source learning management system (LMS) that allows users to build and offer online courses. It

was built for traditional online classrooms rather than MOOCs, which attract a large number of students. Moodle is suited for organizations that want a full-featured, customizable LMS. The platform offers educational tools, analytics and SCORM compliance. The trade-off is that the platform is over 10 years old. The number of configuration options can be daunting, and system performance suffers with larger numbers of students.

IV. I-PEDAGOGICAL CHARACTERISTICS OF MOOCs

1. People learn by association, building ideas or skills step-by-step. For example by mnemonics, training drills, imitation, instruction. Associative learning leads to accurate reproduction or recall. The dominant approach in Content-MOOCs is associative learning.

2. People learn by constructing ideas and skills through active discovery. For example by exploration, experimentation, guided discovery, problem-solving, reflection, etc. Constructive learning leads to integrated skills and deep understanding. The task-based MOOCs lay emphasis on active discovery by learners. Some assignments are still based on associative learning but most are based on the approach of Constructive learning. But perhaps we should not use term Task-based MOOCs because in all approaches the learners have tasks and assignments. The difference depends how open, how complex and authentic such a task is.

3. People learn by constructing ideas and skills through dialogue. For example by discussion, debate, collaboration, shared knowledge-building, etc. Social constructive learning also leads to integrated skills and deep understanding. The main approach of the original MOOCs is Social constructive learning although elements of constructive learning are also present (i.e., exploration is more important than any particular content).

4. People learn by participating in a working community. For example by apprenticeship, work-based learning, legitimate peripheral participation, learning networks, etc. Situated practice leads to the development of habits, values and identities. Hence MOOCs using the approach of situated practice are missing. MOOCs to be developed under this approach can be linked to massive simulation and/or games to networked learning i.e. learning in massive online learning networks or to concepts like Virtual Internship and Virtual Business Learning (Jansen et al., 2003)

V. LEARNING SYSTEM STRUCTURE AND WEBSITE ORGANIZATION

A modular and hierarchical structure was incorporated in designing the organization of the learning system. Five levels were maintained to hierarchically structure contents. The learning material was classified into modules at each level to ease the content and course management by providing flexibility for reuse. The structure of the learning system is shown in Figure 1. on moodle platform at <http://moodle.ee.tuiasi.ro/course/view.php?id=55>.

The structure was designed in close relationship to that of an academic curriculum. Each level can be compared relatively to a traditional education system. The top level in the system structure was broadly divided into categories called “modules”; this stage is similar to the different streams and majors in the academic curriculum that a student can take. As there may be different courses available in each stream that make them unique, the modules consists of individual “lessons” that supplement information on related topics.

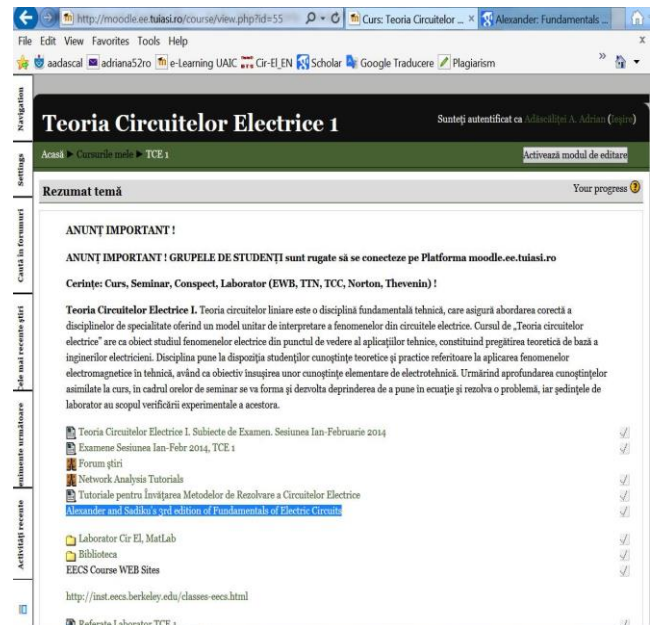


Fig. 1. Learning System Structure.

The lessons were further divided into “objectives” to provide a fundamental learning experience for the students with explicit material focusing on specific topics.

These objectives, which are the building blocks for the entire learning system, and are comparable to the different chapters in a textbook followed for a course.

The last level in the learning system was the content organization and presentation in each objective. The contents in the objective were displayed by segregating into frames. This level in the system is similar to the pages of each chapter in the textbook. As each chapter may vary in the number of pages, the objectives were also designed to vary from 1–20 frames depending on the volume of content. Though each frame displayed specific content, they were made self-contained in a single environment for an objective.

This was done to maintain continuity in learning and minimize waiting time to load each frame. This frame-based structure was designed to display small chunks of material and help the user to grasp concepts gradually before proceeding to the next one.

V. MOOCS ELECTRICAL CIRCUIT THEORY Course Organization

Course organization is based on Bloom's taxonomy of education objectives applied to e-learning of electric circuit theory, see Tables 3a and 3b.

As engineering curricula and courses continue to be restructured due to emerging technologies and ideas, it has become difficult to decide what body of knowledge to be retained and what is to be left out, given that the length of time for undergraduate education is limited to four years.

The selection of e-learning technologies should involve the assessment of course content, learning outcomes, and interaction needs. Olcott (1999) provides what he calls five “Five I’s” of effective e-learning: interaction, introspection, innovation, integration, and information.

Interaction refers not only to the communication that should occur between the student and the instructor and the student with other students but also the interaction between the students and the content of the course. Thus, asynchronous and synchronous communications as well as the presentation of print materials and links to the Internet from the technology needs of interaction. Introspection is the interpretation, revision, and demonstrated understanding of concepts. Discussion boards and graphics can be effective technologies to encourage introspection. Innovation refers to the ability of instructors to experiment with technologies to address various learning styles. Thus, combination of audio, video, and asynchronous discussion can provide various opportunities for students to learn. Integration reflects the integration of facts, concepts, theories, and practical application of knowledge. Using case studies, print exercises, and role-play can create a setting in which integration can occur. Information refers to the knowledge and understanding that is a prerequisite for students to move to the next level of learning.

The instructional objectives provide the basis for instructional activities in and outside of the classroom. For each class, the students come in with different learning styles and capabilities. Variation in learning styles of the students can be addressed through course organization. At this point, course organization is generally at the prerogative of the instructor who teaches the course. However, there is a general consensus and effort is being mounted by all faculty members to adapt instructional techniques that enhance student learning in and out of the classroom. It is therefore the instructor who is required to take into consideration the different learning styles and the teacher builds the class presentations around a hybrid of pedagogical techniques so as to accommodate all the students enrolled in the course.

Shown in Table 1 is a sample of course objective for Circuit Analysis. It is obvious from the objectives that this is not the traditional first circuit course in a typical Electrical Engineering program. Also note worthy is that only the first two sets of objectives are written out in detail. The objectives

indicate things that the student must be able to do at the end of the course.

TABLE1. SAMPLE INSTRUCTIONAL OBJECTIVE FOR CIRCUIT ANALYSIS

1.	Be able to explain basic concepts in electrical engineering: - Give a descriptive definition of an electric circuit. - List electrical and magnetic quantities, their units, and symbols. - Use scientific and metric unit notations. - Describe the relationship among the basic quantities in electric circuit theory: charge, current, potential, voltage, work (energy), and power - Distinguish between passive and active circuit elements
2.	Be able to explain experimental and basic laws: - Explain Ohm’s law - Calculate current, voltage, and resistance in a circuit; for elements in series, parallel and combinations of both. - Derive the conditions for voltage and current division. - Explain Kirchhoff’s current and voltage laws. - Apply Kirchhoff’s current law to determine an unknown branch current. - Apply Kirchhoff’s voltage law to determine an unknown voltage drop.
3.	Be able to apply methods of network (circuit) analysis
4.	Be able to apply circuit theorems to analyze circuit.
5.	Be able to use operational amplifiers as active circuit components
6.	Be able to describe the structure and characteristics of energy storage elements (capacitors and inductors)
7.	Be able to relate sinusoids, phasors, and complex numbers to circuit elements and variables.
8.	Be able to apply Ohm’s law and Kirchhoff’s laws in AC circuits
9.	Be able to determine sinusoidal and pulse response of RC circuits.
10.	Be able to determine sinusoidal and pulse response of RL circuits.
11.	Be able to analyze basic RC and RL filters.
12.	Be able to explain the concept of electromagnetism, magnetic induction, and mutual inductance.
13.	Be able to describe the construction and operation of transformers.
14.	Be able to analyze circuits with transformers.

It is pertinent to call the reader’s attention to the entries in the instructional objective Table 1. The writing of instructional objectives or course objectives is an elaborate exercise that

takes a lot of time. Generally, the instructional objectives are divided into weekly activities and entered into the course calendar.

The basic outline of the course consists of Content Building Blocks (see Table 2).

TABLE 2. COURSE CONTENT BUILDING BLOCKS

Content	Circuits Analysis
AC Fundamentals	BK/ AP
DC Fundamentals	BK/ AP
Circuit Theorems	BK/ AP
Complex Numbers	BK/ AP
Energy Storage Elements	BK/ AP
Transients	BK/ AP
AC Power Analysis	BK/ AP
Three-Phase Circuits	BK/ AP
Magnetically Coupled Circuits	BK/ AP
AC Steady-State Analysis	BK/ AP
Analog Filters	BK/ AP
Fourier Transforms	BK/ AP
Laplace Transforms	BK/ AP

BK = Basic Knowledge
AP = Application

Some helpful strategies for establishing education objectives for on line courses are:

- a) Establishing online threaded discussions that deal specifically with assignments and projects;
- b) Establishing course projects that:
 - require problem finding and problem solving, not only the rote memorization of facts and information; and
 - challenge everyday thinking to address diverse perspectives on issues;
- c) Establishing learning outcomes that translate to and have lasting benefit to real-world practice.

Create conditions for a knowledge sharing community to emerge and create as many opportunities for others to learn your infrastructure for knowledge sharing.

TABLE 3A. BLOOM'S TAXONOMY OF EDUCATION OBJECTIVES

Six categories of learning	(1) Knowledge / Remembering	(2) Comprehension / Understanding	(3) Application
<i>Student</i>	Simple Memory/General knowledge	Student knows and understands information.	Student knows, understands, and uses information.

Computer Tool:	Drill and Practice.	Visualization software, tutorials	Internet research, Databases, Spreadsheets, Simulations
Internet Task:	As students read articles and triangulate to determine the accuracy of facts, they learn the facts.	In order to avoid plagiarism, students must summarize information and relay it in their own words.	The use of an Internet based simulation / game would be useful here.

TABLE 3B. BLOOM'S TAXONOMY OF EDUCATION OBJECTIVES

Six categories of learning	(4) Analysis	(5) Synthesis / Creating	(6) Evaluation
Student	Student knows, understands, uses and critically examines information.	Student internalizes information to generalize about and beyond what is known.	Student judges known and/or hypothesized information
Computer Tool:	Presentation Software, Visualization Software, Databases, Spreadsheets, Simulations	Presentation Software, Word Processing	Presentation Software, Word Processing, Internet Research
Internet Task:	During the process of triangulation, students must examine, compare and test information and ideas for accuracy and logic	When students write their report, they create a new piece of work compiling ideas and facts as well as generating conclusions.	When students write a conclusion for their report they judge among competing ideas and draw a conclusion.

The numbers in parentheses are based on the six categories of learning from Bloom's Taxonomy of Education Objectives. Traditionally, categories (4)-(6) are considered more challenging, requiring higher level thinking skills.

As examples we considered :

- the objectives for chapter ac power analysis (1 introduction; 2 instantaneous and average power; 3 maximum average power transfer; 4 the effective value; 5 apparent power and power factor; 6 complex power; 7 conservation of ac power; 8

power factor correction; 9 applications; 9.1 power measurement; 9.2 electricity consumption cost) and

- the objectives (see Table 4) for the review of single-phase power and power factor correction, (• solve for the real,

Power Factor

- Consider A Complex Current Thru a Complex Impedance Load
- By Euler $V = ZI \Rightarrow \angle V = \angle Z + \angle I$
 $\theta_v = \theta_z + \theta_i$
or $\theta_v = \theta_v - \theta_i$
- The Current and Load-Voltage Phasors (Vectors) Can Be Plotted on the Complex Plane

Example - Complex Power

- For the Circuit At Right
- $Z_{load} = 0.0901 + j0.3\Omega$
- $P_{real} = 20 \text{ kW}$
- $V_{rms} = 220 \angle 0^\circ$
- $pf = 80\%$, lagging
- $f = 60 \text{ Hz} \Rightarrow \omega = 377 \text{ rad/s}$
- Lagging pf \Rightarrow Inductive
- From the Actual Power $P = \text{Re}\{S\} = |S| \cos(\theta_v - \theta_i) = S \times pf$
- Thus $S_L = \frac{P}{pf} = \frac{20 \text{ kW}}{0.8} = 25 \text{ kVA}$
- And Q from S Relation $Q^2 = S_L^2 - P^2 \Rightarrow Q = 15 \text{ kVAR}$

Power Factor Correction

- As Noted Earlier, Most Industrial Electrical Power Loads are Inductive
- The Inductive Component is Typically Associated with Motors
- The Motor-Related Lagging Power Factor Can Result in Large Line Losses
- The Line-Losses can Be Reduced by Power Factor Correction
- To Arrive at the Power Factor Correction Strategy Consider A Schematic of A Typical Industrial Load

Power Factor Correction cont.2

- Find θ_{new}
- Cap is a Purely REACTIVE Load
- $\tan \theta_{new} = \frac{Q_{ind} - Q_C}{P_{add}}$
- The Vector Plot Below Shows Power Factor Correction Strategy
- Use Trig ID to find Q_C to give desired θ_{new}

Fig. 2. Power Factor Correction.

reactive, apparent, and complex power of a circuit and determine the power factor (leading or lagging); • use the power triangle to relate the power components of a given circuit;

- explain the purpose of performing power factor correction;
- determine the reactive power and capacitance required to obtain a specified power factor, (see figure 2).

TABLE 4. OBJECTIVES FOR CHAPTER AC POWER ANALYSIS

(2) Comprehension	(3) Application	(4) Analysis
Describe (2) how the power triangle for a given circuit relates to the impedance components on the complex plane. Describe (2) how the power triangle for a given circuit relates to the impedance components on the complex plane. Explain (2) the purpose of doing power factor correction.	Solve (3) for the instantaneous power p(t), average (or real) power P, reactive power Q, apparent power S, complex power S, and power factor for any of the elements of an AC circuit. Use (3) the power triangle to describe the power components of a given circuit or element.	Explain (4) the physical meaning of instantaneous power, average power, reactive power, apparent power, complex power, and the power factor (leading or lagging).

CONCLUSIONS

This paper is a synthesis that presents the conception of a project devoted to use moodle Virtual Learning Environment for the development of MOOC courses which mainly contains OER materials in order to educate the Engineering Students.

We developed a framework to teach systematic problem-solving skills and allow students to complete interactive exercises at their own pace. Conventional web-based exercises tend to take two major forms: multiple-choice questions and short problems asking students to fill in numerical answers. The multiple-choice question format, even in a regular classroom, tends to encourage guessing or elimination to arrive at the correct answer.

While the ability to guess or to eliminate incorrect answers is desirable, the lower-level courses need to teach students how to use basic theory to arrive at the correct answer. The implementation of this format on the web leads to another undesirable learning characteristic: students can get to the correct answer after several wrong clicks without even guessing. There is essentially no learning involved in this fast-click exercise. The short-problem format, with filled-in boxes, avoids these drawbacks but fails to teach students how to proceed step-by-step from the problem statement to the correct solution. The systematic problem-solving skill is the major learning outcome of low-level engineering courses, and web-based instruction needs to provide methods to teach this skill. Our web-based instructional methodology focuses on teaching these systematic problem-solving skills.

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