Teaching Communication Circuits Online Efficiently

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Introduction:

Online courses can take advantage of mobile technology available today. Students working fulltime, unable to take classes during the day, can benefit from this format of teaching without compromising the ABET standard.

Teaching lab is the biggest predicament in teaching Electronics Engineering Technology (EET) courses online. After mastering hands on labs in lower level courses, labs in upper level courses can be taught online using mobile technology, where analysis of the circuit output is more significant for the learning outcome of the course than how the circuits are physically built. Consequently, upper level EET courses such as Communication Circuits, Control Systems Engineering, Advanced Microprocessors, etc., can be taught online using simulated labs. Along with studying the principles of communication circuits, a simulation software package like the module Multisim in Electronic Workbench is used for modeling, constructing, and testing the circuit. Electronic Workbench simulates circuits normally analyzed in a lab and the results are obtained more quickly than actual hands on experiments.

The idea of teaching Communication Circuits online also focuses on the needs of fulltime working students. Students who work full-time look for opportunities to take upper level EET courses online to earn a Bachelor of Science degree from a four year college/university. Offering courses online could provide an opportunity for working students to pursue further academic endeavors beyond an associate degree. Also, programs struggling for lab space can improve efficiency by replacing lab equipment, including bread boards, circuit elements, power supplies, digital multi meters, function generators, oscilloscopes, spectrum analyzers, etc., with only a laptop or a desktop computer.

Finally, by analyzing the simulated lab results, one of ABET's criteria, "An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes" will be met.

Background:

Online teaching is the necessary teaching practice for the future

Online instructional strategy can provide an efficient way of delivering course material and improving students learning outcomes. The online method can enhance student learning by updating additional simulated lab resources that are easily accessible through the electronic simulation software Multisim. With the infusion of Multisim, online method has enhanced higher

education in EET. The most important advantage of teaching online courses is it's accessible from anywhere using a computer with internet connection. It also provides both efficient interface for quality instruction and an affordable solution for student learning.
Students who work full time can enhance their capabilities for communication, coordination, and collaboration to catch up with school work, lectures, or assignments using mobile technology. Essentially, mobile technology facilitates alternative learning processes and instructional methods that can ensure effective learning fulfilling ABET learning outcomes.

For an engineering student, working for a cable company, mobile technology can facilitate designs for situated learning in Communication Circuits by targeting real-world experience and involving projects of relevance and interest to the learner.

Mobile technology can enable personalized learning by allowing students to learn at their own pace. Students without access to a traditional learning environment will be benefitted in several ways. Simulated communication circuit analysis can provide immediate feedback of a modulated signal thus offering continuous motivation for those who are frustrated with troubleshooting hardware problems of a hands-on lab performed in a traditional educational setting.

Teaching communication circuits online has an additional advantage for students to interact with teachers and collaborate with other students without being constrained by any fixed location or time. Students can work in groups without meeting face-to-face. It provides greater communication among them and results in fulfilling the learning outcomes as required by ABET.

Upper level EET courses can be taught online:

Benefits working and transfer students

Community college graduates, working in industries can take advantage of online upper level EET courses and earn a Bachelor of Science (BS) degree from a four year college.
Allowing additional credit transfer through an articulation agreement, and offering upper level calculus based major EET courses online, when appropriate, will benefit working and transfer students tremendously. Most importantly, those students, who have the potential for higher education but limited by the accessibility, will have a chance to pursue their academic endeavors. Students transferring from community colleges are exposed to advanced state of the art lab equipment. Those who goes to community colleges directly out of high school, earn tremendous amount of hands-on lab experience while pursuing two year associate degrees in EET. Many of them are already working in industries straight out of high school earning valuable hands-on experience(s) while at work - hands-on experience that many EET graduates from four year colleges do not have access to until they start working in an industry.

Upper level courses like Communication Circuits could be offered online to these transferring students from two-year colleges. It will allow them a smooth transition from non-calculus based Electronics Technology (ET) to a calculus based EET program, where mathematical analysis is more critical than hands-on labs. General education and junior level classes that require hands-on lab activities can be transferred through articulation agreements. It can be a win-win situation for both the community colleges as well as for the universities offering BS degree in EET.

Taking appropriate measures by facilitating community college students' transfer could also help the university program sustain and grow the existing EET program. Transferring students from community colleges can increase the graduation rates and help EET programs struggling with retention issues.

Communication Circuit is a senior course

Course Description for Communication Circuits Class: The principles of communication circuits and systems are studied, including filters, oscillations, amplifiers, modulation, antennas and transmission lines. Information theory, voice and data communications are considered also.

Course Objectives: Upon successful completion of this course the student will be able to demonstrate an understanding of:

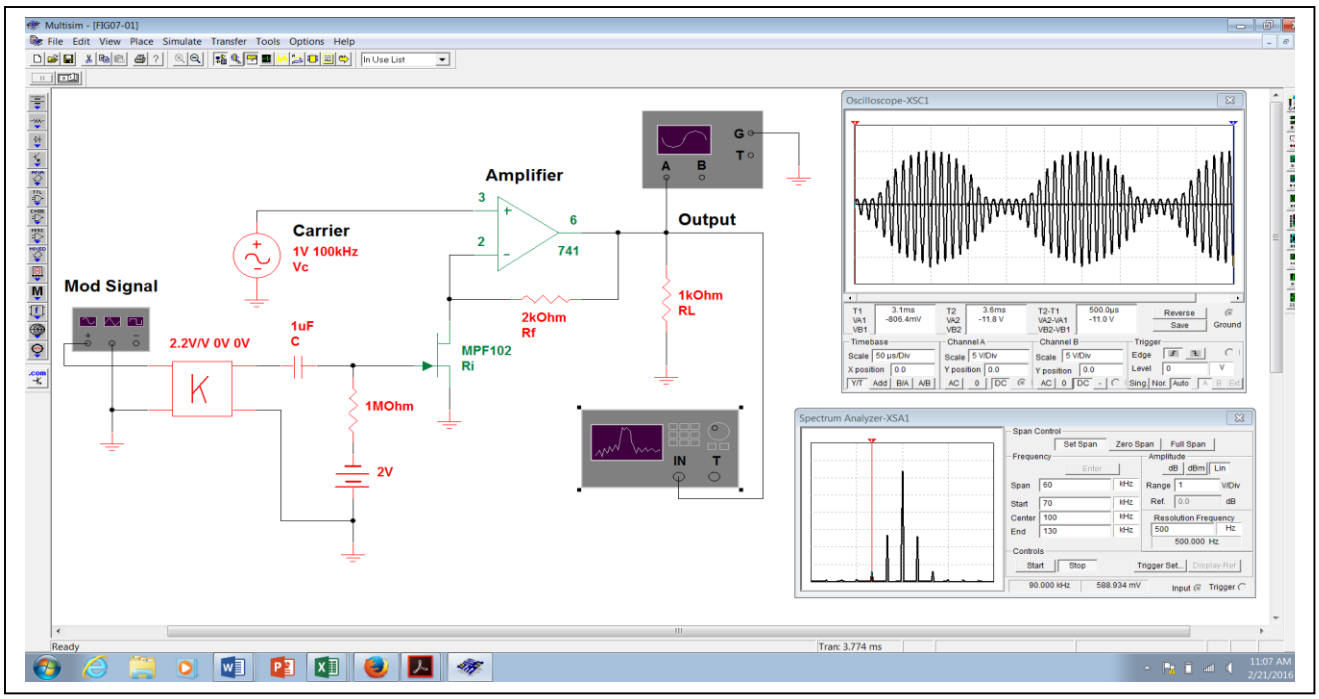
a. Filters, Oscillators, Phase-Lock loops, and Frequency Synthesizers, and their usage and applications.
b. Different types of modulation transmission and reception, and their circuits and mathematical analysis.
c. Fourier Theory in frequency and time domain for signal analysis of sinusoidal and complex waves.
d. Electronics Workbench Multisim, a workbench in a laboratory environment where circuits are simulated on a computer and results are obtained more quickly; used for modeling, constructing, and testing circuits.

Communication Circuits is a senior level class for the EET program. Like most of the EET courses, in Communication Circuits lectures are followed by the labs. Most of the labs in the EET program are hands-on. Due to the complex nature of circuits, upper level courses can be taught using simulated circuits. In lower level classes, students already learn how to build these circuits hands-on, including Low Pass Filter (LPF), High Pass Filter (HPF), Band Pass Filter (BPF) and Pass Band Filter (PBF). These filters are being built by the students in the prerequisite course for Communication Circuit, Analog Circuits, hands-on. Practicing theories learned during lecture on simulated circuits allows students more time to build a rather complex circuit instead of troubleshooting the hardware. Transmitted signals can be displayed on a Multisim oscilloscope and analyzed on its spectrum analyzer the same way as it is done in any hands-on lab without compromising the analytical value of the subject.

The Online Class Saves Space

For the Communication Circuits class, online instruction is also a more efficient way of doing EET labs where analysis of the output signal is more significant than hands-on instrumentation of the lab procedure. Programs struggling for lab space can improve efficiency by replacing lab equipment, including bread boards, circuit elements, power supply, digital multi meter, function generator, oscilloscope, spectrum analyzer, etc., with only a laptop or a computer with a monitor.

Figure1: Simulated Lab for Communication Circuits:



Learning Electronics Communications through Experimentation using Electronic Workbench Multisim, Richard H. Berube, Prentice-Hall, Inc

Multisim should be for seniors

The academic system makes it challenging and limits first year student to navigate through a complex subject like Electronic Engineering. It is crucial that the theoretical concepts in the classroom avail themselves to a hands-on, visual and practical experience in the lab. For an online lower level EET class such as Electronic circuit Analysis, performing simulated labs on computers may not be appropriate. Hands-on lab experience is essential for a freshman student to excel in an electronics engineering class before performing simulated labs on computers. For example, just as elementary school students should not be introduced to calculators before learning fundamental mathematical operations like how to add and subtract, an EET student should use Multisim after learning how to perform hands-on electronics lab procedures.

Infuse writing while submitting report benefits students' communication skills

An ET faculty from EMU wrote to 185 industries for a survey, and 100% of those who responded agreed that the communication skills of ET graduates have been very poor. Teaching Communication Circuits online will create an opportunity for improving writing skills for EET students. In online teaching, writing in undergraduate technology education has become more important than ever before. Online instruction has facilitated teaching strategies, furthermore, the introduction of computers in online teaching has also created a new domain of writing assignments that students have to contend with. For example, almost every student now must email progress reports to their teachers explaining the projects they are involved with.

Convincing the teacher of the quality of the project requires fairly good argumentative and technical writing skills. For all these reasons, it is even more important to infuse writing into the undergraduate technology curriculum today than ever before. Such infusion of writing into the EET curriculum will enhance the quality of instruction for faculty, and learning for the students.

Practicing electronics engineering technologists must be able to communicate with people who are unfamiliar with the complexities of the engineering theories. A majority of the students graduating in EET will end up working for industries. They will often have to write progress reports to a superior or a client who may or may not be a technologist. In such situations, transcribing the technical terms into normal everyday language in a coherent manner will be crucial to their success.

ABET:

Online Communication Circuits class satisfies ABET requirements

According to the ABET, "student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students attain as they progress through the program." In this paper we used a senior level EET course, Communication Circuit, offered online involving state of the art mobile technology and simulated labs. In this course the principles of communication circuits and systems are studied, and an Electronics Workbench, Multisim, is used for modeling, constructing, and testing circuits. Multisim is a workbench in a laboratory environment where circuits are simulated on a computer and results are obtained more quickly.

In an effort to meet ABET criteria academic institutions define their own student outcomes and then link them back to the ABET outcomes. Eastern Michigan University's EET program follows the guidelines for student outcomes that include the 11 general ABET student outcomes (a-k) criteria for accrediting engineering technology programs as well as the 5 additional criteria (l-p) based on the outcomes expected of our EET program (Figure 2). Our course on Communications Circuits can be linked to 5 of those 16 students outcomes including 4 (a, b, c & f) out of the 11 general outcomes as well as 2 (m, n) of the 5 additional outcomes directly related to the EET program.

Communication Circuits is a required course in our EET program. Simulation software Multi-Sim allows design and implementation of the circuit of communications systems. The output of the circuit is then analyzed on a computer, thus fulfilling the ABET criteria. In addition to fulfilling general ABET criteria (a, b, c, & f), the infusion of writing in Communication Circuits online also fulfills ABET's general criteria (g) and creates a stronger link to EET criteria (n) as well. Eventually an assessment technique is used to assess the overall student learning outcome.

Figure2: ABET Student Outcomes

ABET has 11 general student outcomes listed below:

a. an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;

b. an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

c. an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;

d. an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;

e. an ability to function effectively as a member or leader on a technical team;

f. an ability to identify, analyze, and solve broadly-defined engineering technology problems;

g. an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;

h. an understanding of the need for and an ability to engage in self-directed continuing professional development;

i. an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity;

j. a knowledge of the impact of engineering technology solutions in a societal and global context; and

k. a commitment to quality, timeliness, and continuous improvement.

Additional student outcomes based upon ABET's criteria for the EET program:

l. the application of circuit analysis and design, computer programming, associated software, analog and digital electronics, and microcomputers, and engineering standards to the building, testing, operation, and maintenance of electrical/electronic(s) systems.

m. the application of natural sciences and mathematics at or above the level of algebra and trigonometry to the building, testing, operation, and maintenance of electrical/electronic systems.

n. the ability to analyze, design, and implement one or more of the following: control systems, instrumentation systems, communications systems, computer systems, or power systems;

o. the ability to apply project management techniques to electrical/electronic(s) systems; and

p. the ability to utilize differential and integral calculus, as a minimum, to characterize the performance of electrical/electronic systems.

2016-2017 Criteria for Accrediting Engineering Technology Programs
(http://www.abet.org/wp-content/uploads/2015/10/T001-16-17-ETAC-Criteria-10-16-15.pdf)

Conclusion:

The number of courses and programs in higher education institutions that are offering online EET courses, continues to grow exponentially. Alongside the growth of online learning, educators are changing the way they think about education. Now, they are capable of adopting multiple instructional strategies in delivering course material and improving student learning outcome. Yet, accessibility to education is the most important advantage for many working and transferring students. For higher academic institutions, online teaching of upper level classes like Communication Circuits will also offer an optimum solution toward fulfilling the ABET requirements.

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