How to design an engineering course syllabus to satisfy ABET program outcomes and course objectives faculty teach?: An assessment Instrument example

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Abstract — *Understanding the ABET engineering criteria is a complex task, however; the jargon they contain (objectives, outcomes, outcome indicators, performance metrics, etc.) is very dense and sometimes confusing to educators in preparing their syllabi and assessing their course according to ABET guidelines. Although, much has been written in the past few years about the assessment of program outcomes, relatively little attention has been paid so far to the key role of the individual faculty member on how an instructor develops or structures his or her course to achieve those outcomes. The primary purpose of this paper is to examine that role of how to design an engineering course satisfying ABET outcomes. A Case study on how to apply, align engineering course objectives and course outcomes to ABET program outcomes a through k is discussed. A detailed example of a ABET course syllabus in Electrical Engineering discipline (specifically EE 206- Circuit Analysis) satisfying ABET outcomes is presented.*

Index Terms — *ABET, outcomes.*

INTRODUCTION

The Electrical Engineering program at the University of North Dakota was started in 1902 within the College of Mechanical and Electrical Engineering. The Electrical Engineering undergraduate degree was first accredited in 1936 by the Engineer's Council for Professional Development (ECPD), and the Department of Electrical Engineering has offered an accredited Electrical Engineering undergraduate degree ever since. The mission of the UND Electrical Engineering is to provide campus and distance students with a strong foundation in the traditional and contemporary areas of electrical engineering, and to help our graduates learn the leadership, communication, multidisciplinary teamwork, and life-long learning skills necessary for success in a global marketplace. The program provides students with the knowledge and opportunities that prepare them for industry and to pursue further education at the graduate level. The program also provides distance students with the ability to advance their careers as practicing engineers or managers. It is important to note that University of North Dakota is the only institution offering ABET accredited Distance Engineering Degree program (D.E.D.P) for undergraduates majoring in Electrical (B.S.E.E), Mechanical (B.S.M.E), Civil (B.S.CIEN), Chemical Engineering (B.S.ChE) disciplines.

ABET defines the program outcomes of an engineering graduate according to Blooms Taxonomy [2] as follows:(a) an ability to apply knowledge of mathematics, science, and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; (d) an ability to function on multidisciplinary teams; (e) an ability to identify, formulate, and solve engineering problems ; (f) an understanding of professional and ethical responsibility; (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context; (i) a recognition of the need for, and an ability to engage in life-long learning; (j) a knowledge of contemporary issues; (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. The following is a example that will help instructors how to design their course to satisfy ABET outcomes [1]. To include a detail assessment of ABET and individual course outcomes, the author has also developed a Blooms Online Assessment test (B.O.A.T) to assess student learning in an distance education environment according to Blooms Taxonomy [3]. For simplicity and space constraints, it has not been included here. It could easily included in the following case study example assessing all cognitive levels of Blooms taxonomy.

CASE STUDY OF A EE 206 – CIRCUIT ANALYSIS COURSE SYLLABUS, A REQUIRED UNDERGRADUATE LECTURE COURSE

2007-2009 Academic Catalog Description: 206. Circuit Analysis. 3 credits. Prerequisite: Math 165, Calculus I. Introduces the foundations of electrical engineering, applying these concepts in developing the fundamentals of energy conversion, electronics and circuit theory. Freshmen, Sophomore

2.1. Prerequisites by topic
Math 165 Calculus I (must complete with a grade of "C" or better). Integral and differential calculus

2.2. Textbook: James W. Nilsson and Susan A. Riedel, *Electric Circuits*, Seventh Edition. Prentice-Hall, Inc., 2005. ISBN: 0-13-146592-9

2.3.Course Learning Outcomes
(1) Be able to apply Ohm's Law, Kirchhoff's Current Law, and Kirchhoff's Voltage Law, equivalent resistance (Req) calculation, voltage divider, current division in analysis of linear circuits consisting of resistors, inductors, and capacitors driven by constant and sinusoidal voltage and current sources - Program Outcomes (a), (k).

2) Be able to apply the Node Voltage and Mesh Current circuit analysis techniques. Program Outcomes (a), (e), (k)

(3) Be able to calculate voltages, currents, and gains of circuits containing operational amplifiers.
Program Outcomes (a), (k)

(4) Be able to calculate the Thevenin or Norton equivalent of a circuit. Program Outcomes (a), (k)

2.4. Class schedule
Section 1 – Call #4299 (on-campus), Monday, Wednesday, and Friday, 11:00-11:50 a.m.
Call #23416 (DEDP)
Help Session: Thursdays, 2:00-2:50 p.m.

2.5. Topics covered
Syllabus includes 42 50-minute class periods and 1 two-hour final exam period:
1. Circuit variables (voltage; current; power; and energy) (2 lectures)
2. Circuit elements (voltage and current sources; resistors; Kirchhoff's laws; and dependent sources) (3lectures)
3. Simple resistive circuits (voltage divider; current divider; delta-to-wye equivalents) (4 lectures)
4. Techniques of circuit analysis (branch current; node voltage; mesh current; source transformations; Thevenin and Norton equivalents; superposition)
(10 lectures)
5. The operational amplifier (terminal voltages and currents; inverting amplifier; summing amplifier; noninverting amplifier; and difference amplifier)
(4 lectures)
6. Inductance and capacitance (3 lectures)
7. Sinusoidal steady-state analysis (sinusoidal sources; phasors; Kirchhoff's laws in the frequency domain; techniques of circuit analysis in the frequency domain) (5 lectures)
8. Sinusoidal steady-state power calculations (average and reactive power; RMS value; maximum power transfer) (3 lectures)
9. Review and discussion sessions for the exams
(5 lectures)
10. Three one-hour exams (3 lectures)
11. Comprehensive final exam (2 hours)

2.6. Contribution of course to meeting the requirements of ABET Criterion 5

EE 206 is the first required lecture course in the B.S.E.E. basic-level curriculum within the educational thrust area of Circuits & Systems that provides the fundamental background for all future required circuits, electronics, and systems courses in the curriculum. All subsequent linear electric circuits (EE 313), signals and systems (EE 314), and electronics (EE 321, EE 421) courses utilize the techniques introduced and practiced within this introductory linear circuits course.

2.7. Computer usage

Students are required to verify a subset of their written homework solutions using the Multisim Electronics Workbench (National Instruments) circuit simulation software package. This software is provided to all students over a personal computer network administrated by the School of Engineering & Mines.

2.8. Laboratory projects

EE 306 Circuits Laboratory I is the co-requisite laboratory for electrical engineering students synchronized with theory.

2.9. Design activities

Through Homework Simulation using Multisim.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES

This course provides B.S.E.E. students with a breadth of knowledge in electrical engineering.
Program Outcome (a) – Significant – Apply knowledge of math, engineering, and science.
Program Outcome (e) – Moderate – Ability to identify, formulate, and solve engineering problems.
Program Outcome (k) – Moderate – Ability to use techniques, skills, and tools in engineering practice.

Notification: Any students with disabilities who need accommodations in this course are encouraged to speak with the instructor as soon as possible to make appropriate arrangements for these accommodations.

Note: It is not necessary that all ABET outcomes (a through k) appear or satisfy in a single course. The Instructors may need to fine tune their objectives that matches with ABET outcomes.

CONCLUSION

The author proposed an example for engineering instructors on how they can design their course objectives and relate to ABET expected outcomes in an engineering course. A case study has been presented on how to assess these outcomes through an EE 206 Circuit Analysis Course Syllabus carried out at University of North Dakota.

REFERENCES

[1] ABET (Accreditation Board for Engineering and Technology). Criteria for accrediting engineering programs: Effective for evaluations during the 2002–2003accreditationcycle.*http://www.abet.org/images/Criteria/2002-03EACCriteria.pdf*,accessed September 28, 2002.
[2] B.S. Bloom, Taxonomy of Educational Objectives. 1. Cognitive Domain. New York, Longman, 1984.
[3] Prakash Ranganathan, Kendall Nygard "A Bloom's Online Assessment Test (B.O.A.T) to assess Student learning outcome in a Distance Engineering Education course" 2nd International Conference on Computer Engineering and Technology (IEEE:ICCET 2010- to appear), 16-18 April 2010, China.

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