THE EVOLUTION OF AN ELECTRICAL ENGINEERING ORIENTATION COURSE

William A. Bares and David A. Rogers
Department of Electrical and Electronics Engineering
North Dakota State University, Fargo, ND 58105

ABSTRACT

During the last three quarters faculty members in Electrical Engineering at North Dakota State University have been experimenting with possible new directions for a traditional orientation course for freshman electrical engineers. These new directions are an effort to meet the challenges of: (1) the increasing enrollments, (2) the continual pressures on the curriculum caused by new technologies, and (3) the realization that our students need a more formal education in engineering professionalism. Topics presented on an experimental basis this past year are analyzed and suggestions for future course development are presented in this paper.

Introduction

Large numbers of students are attracted to electrical engineering due to such causes as the rapid growth of computer technology and the attractive salaries offered recently graduated engineers. Most new students in engineering have no idea of what a profession is, nor of the responsibilities and obligations attendant to it. The state of disarray of both the professional and perhaps the technical side of our profession lends credibility to these deficiencies in the practice of engineering. Many of these students probably could benefit from more information about the life and work of the professional engineer in order to obtain more from their studies, to make adequate career planning, and to carry these benefits into their professional practice. One way to affect this is through an orientation to electrical engineering course.

Erlandsen [1] reviewed dozens of university catalogs and found that only about 50% of the engineering programs offered something like an engineering orientation course. Further, study of the last several years of the IEEE Transactions on Education will reveal very few articles on such a course. It seems as though very few people are motivated to contribute in this area perhaps due to the lack of professional compensation for such efforts.

History

Probably many schools have offered such a course and subsequently dropped it due to the necessity of devoting more student credit hours to

"hard" technical courses. In the past this type of course has been used to help students decide which branch of engineering was best for them. Presently at North Dakota State University (NDSU), the College of Engineering and Architecture offers several courses of this type devoted to the specific engineering branch. In the Department of Electrical and Electronics Engineering (EEE), this course is called Fundamentals of Electrical and Electronics Engineering II (EEE 102). It is one of two EEE courses offered especially for freshmen, the other being EEE 101, a course mainly in BASIC/FORTRAN programming and problem solving.

EEE 102 is a 3-credit-hour course (quarter system) in which a letter grade is assigned. It has been offered for several years on a three-times-a-week basis. Originally it was offered in the years of low enrollments as a means of encouraging students to stay in electrical engineering since they would not see core EEE courses until late in the sophomore year. It also served as a course the non-EEE could take to see if he had an aptitude for electrical engineering. In Fall Quarter of 1978, this course was being offered using the schedule shown in Fig. 1. Aside from the survey of electrical engineering topics apparent from the outline, the course required that the student perform some mini-experiments or design projects involving printed-circuit boards, Ohm's law, frequency response, logic circuits, etc.

By Fall Quarter of 1980 the student population had increased so dramatically that the mini-experiments or projects had to be dropped due to a shortage of faculty and facilities. The modified course outline is shown in Fig. 2. The authors have had many good reports of the value of EEE 102 to the students, especially the "hands on" experimental aspect. Also the aspect of "getting" to the good technical topics is appealing to new students. However, the large student population mitigates against such an approach at the present time.

Philosophy

Since the EEE 102 instructor serves at a critical point in the educational career of a student, it is important that this person be aware of the needs of young students. It is important too, that the institution recognize the uniqueness of this professor's contribution through adequate support of the course and by appropriate recognition of the faculty involved. This course is no place for the inexperienced instructor, nor should it be the home of the institution's most incompetent faculty. Such conceptions can only contribute to the demise of the course.

The student should be presented with helpful, necessary professional engineering material in order to guarantee the course's viability.

Period

1. Introduction to course requirements and instructor expectations.
2. Representation and interpretation of time functions.
3. Logarithmic relationships.
4. Plots for Characterization of physical phenomena.
5. Resistance: Static and Dynamic.
6. Kirchoff's voltage law, Kirchoff's current law, Ohm's law.
7. Elementary resistive network analysis.
8. Power and energy.
9. Review.
10. Hour Examination.
11. The binary number system. Conversion between bases, 2's complements.
12. Logic networks with gates. Logical functions.
13. Analysis of combinational logic networks via truth tables.
14. From logic diagrams to printed circuit layout.
15. Flip-flops as memory modules.
16. Timing waveforms for sequential networks.
17. Review.
18. Hour Examination.
19. Rate of change relationships.
20. Sinusoidal waveforms and functions.
21. Harmonic analysis and modulation.
22. Operational amplifiers.
23. Use of operational amplifiers.
24. Resistive-diode operational amplifier networks.
25. Use of feedback in providing effective control.
26. Review.
27. Hour Examination.
28. Electromagnetic Principles.
29. Rotating motors.
30. Review.
31. Final Examination.

Fig. 1. EEE 102 Course Outline for Fall Quarter 1978 as Developed by Professor Floyd M. Patterson

Period	Topic
1.	Introduction to course requirements and instructor expectations.
2.	Representation of time functions.
3.	Interpretation of time functions.
4.	Sinusoidal waveforms and functions.
5.	Periodic functions.
6.	Sums and products of functions.
7.	Harmonic analysis and modulation.
8.	Hour Exam #1.
9.	Logarithmic relationships.
10.	Logarithmic plots.
11.	Frequency response.
12.	Rate of change relationships.
13.	Acceleration-velocity-position.
14.	More on rates-of-change.
15.	Hour Exam #2.
16.	Introduction to electrical properties and units.
17.	Resistance-Static and Dynamic, Ohm's Law.
18.	Kirchoff's Laws.
19.	Elementary Network Analysis.
20.	More analysis.
21.	Electrical power and energy.
22.	Hour Exam #3.
23.	The Binary number system.
24.	2's Complement numbers.
25.	Logic gates and logic functions.
26.	Truth Tables.
27.	Flip-flops.
28.	Flip-flops networks.
29.	Hour Exam #4.
30.	Review.
31.	Final Exam.

Fig. 2. EEE 102 Course Outline in Fall 1980.

Experimentation

An orientation course must always be relevant to command student interest. For the past three quarters, several instructors (W. A. Bares, F. M. Patterson, and D. A. Rogers) have been experimenting with new approaches to 102 teaching. We have been coupling into 102 some broader aspects of the engineer's life and work which we call engineering professionalism. While teaching 102 we have emphasized the importance of a solid mathematical background [2] and a grounding in the fundamental concepts of electrical engineering. However, we have also plunged into such topics as the societal impact of many ethical decisions, the importance of developing communications skills, the effects of technological absolescence, the impact of inflation on engineering salaries, and unemployment [1], [3].

In Spring Quarter 1981, the different sections of 102 were taught with the instructors presenting a course based on the dual outline shown below.

Introduction to EEE and the Profession of Engineering

Topics

Engineering Professionalism

1. History of Engineering
2. Engineering Reports
3. Engineering Profession and Ethics
4. Engineering Work:Society and Government
5. Professional Societies
6. Engineering Standards
7. Engineering Successes and Failures
8. Setting Careers and Goals
9. Educational Accreditation and Curriculums

Engineering Tools

1. Calculations and Measurements
2. Data and Errors
3. Units and Conversions
4. Functions, Variables and Graphs
5. Problem Formulations-Words to Equations
6. Analog vs Digital Problems
7. Basic Electrical Circuits

TEXT: "The Engineer and His Profession" by Kemper

Several senior EEE students were registered concurrently in a special projects course in which they studied engineering professionalism and acted as team leaders for two to four 102 students. They studied both professional and technical topics together under the guidance of the section instructor. They were involved in case studies of engineering ethics problems, technical problems, circuit construction, etc., through individual team meetings and class meetings.

The outcomes were both positive and negative. On the positive side side we saw:

1. General student acceptance of the course.
2. Most student groups mixing well and group interaction benefitting all involved.
3. Student interest maintained by a good variety and integration of topics.

On the negative side, we observed:

1. Excessive loads on some student leaders (from lack of uniform assignments).
2. Some student "freeloading".
3. Some teams not performing to capacity.
4. A wide variety of different emphases within the teams.

One quarter of the small-section, senior team-leader approach to 102 was enough to convince us that this method is useful when faculty and senior student resources are available to do it, i.e., in an occasional spring quarter. With some modifications this method may be reasonable with one faculty leader meeting one large lecture with senior team leaders having separate team meetings to cover the technical problems. A mini-project might be possible with this mode. This quarter there are about 100 students in one large section of 102 so a more traditional large-lecture approach has been used. A similar approach was used this past summer with a very small 102 class, but the mini-project of the past was revived. The Fall 1981 outline is shown in Fig. 3.

Conclusion

Presently we feel that 102 should be retained in the curriculum and that the teaching method that best matches resources available should be selected, keeping in mind the benefits of smaller sections and senior-student involvement.

References

1. Erlandsen, R. F., "Rethinking the Introduction to an Engineering Course," IEEE Transactions on Education, Vol. E-22, No. 4, Nov. 1979, pp. 161-165.

2. Gottfried, B.S., Introduction to Engineering Calculations. New York: McGraw-Hill, 1979.

3. Kemper, J. D., The Engineer and His Profession. New York: Holt, Rinehart and Winston, 1975.

Session Number	Topic	Reading (Gottfried)	Reading (Kemper)
1.	Introduction	Preface	iii-xiv
2.	Engineering Calculations	1-6, 20	1-37
3.	Circuit Construction	6-13, 21-22	38-47
4.	Discussion - Kemper - Ethics	13-19	47-58
5.	Kirchoff's Laws	--	59-73
6.	Unit Systems	25-33, 36	73-83
7.	Dimensional Analysis	33-35, 37-39	84-95
8.	Discussion - Kemper - Salaries	--	95-119
9.	Exam I	--	
10.	Graphs	44-47, 70-71	120-128
11.	Logic Gates	48-58, 71-72	129-139
12.	Discussion - Kemper - Manufacturing	--	139-153
13.	Graphs (Continued)	58-65, 74-75	153-164
14.	Antenna Patterns	65-70, 76-79	165-191
15.	Graphs (Continued)		
16.	Discussion - Kemper - Consulting		192-205
17.	Elementary Statistics	87-91, 105-6	206-218
18.	Elementary Statistics	92-98, 107-8	219-231
19.	Exam II		
20.	Network Equations	98-101, 109-12	
21.	Diode Logic Gates	102-105, 113-15	232-242
22.	Discussion - Kemper - Design		243-248
23.	Nonlinear Equations	122-130	
24.	Inductance	131-140	249-257
25.	Gain and dB	141-148	258-270
26.	Wire Resistance		
27.	Economics in Engineering	157-170	
28.	Computer-Aided Circuit Analysis	176-195	271-288
29.	Review		
30.	Final Exam		

TEXT: "Introduction to Engineering Calculations" by Gottfried.
"The Engineer and His Profession" by Kemper

Fig. 3. EEE 102 Course Outline, Fall 1981

Biographical Note

Dr. William A. Bares is Professor and Chairman of the Department of Electrical and Electronics Engineering, North Dakota State University. His graduate degrees are from the University of North Dakota, Stanford, and the University of Wyoming. Previously he was Department Head and Professor at the University of North Dakota from 1968 until 1978.

Dr. David A. Rogers is Associate Professor of Electrical Engineering at North Dakota State University. His engineering graduate degrees were earned at Illinois Institute of Technology and the University of Washington. He also holds a graduate degree in Theology from Trinity Evangelical Divinity School. Prior to coming to NDSU in the Fall of 1980, he taught at the State University of Campinas (Brazil).