

## Elaborating Electrical Engineering Curricula in Developing Countries

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### Abstract

One of the aims of education in developing countries is that it should be comparable and compatible with that offered in industrialized societies, so that graduates produced in these countries may be as competent and as productive as their counterparts elsewhere. In Engineering Education, students from developing countries are disadvantaged, in that the facilities available are often poor and costly to improve. Furthermore, students, although highly motivated, do not receive the sort of technological exposure that is constantly available in industrialized countries.

High drop-out rates in the first year of engineering study, due to the sudden relaxation of the rigid rules of behavior that had prevailed during the pre-university schooling days, and the lack of understanding of many abstract engineering concepts, make it necessary for lecturers to provide the engineering freshman with a picture of engineering which is both interesting and fruitful.

In this paper, the design of Electrical Engineering curricula is examined and means of making Electrical Engineering interesting to engineering freshmen are discussed. A simulation exercise centering on a visit to a large industrial concern and “non-traditional” laboratory experiments are described.

### 1. Introduction

The development of any curriculum involves addressing such fundamental issues as what should the students be helped to learn, the learning experiences that should be provided for them to learn and how these learning experiences can be organized to maximize their cumulative effects [1]. In Engineering Education, the end product sought is a student who has the ability to inquire independently and to be critical.

The concept of engineering rests on the basic premise that many problems associated with the well-being of the community must first be resolved through analytical means before the ensuing practical solutions can be



implemented [2]. The education and training of engineering students generally pose less difficulty in the industrialized countries than in the developing ones. In the former countries, adequate facilities are provided for the learning process to take place. In addition, students are constantly exposed to technological developments, thus providing them with a broad, yet solid information base.

The situation is often different in developing countries, where access to new technological developments is limited. Furthermore, facilities such as laboratories, libraries etc. at tertiary engineering institutions are often indigent. The engineering student therefore receives an education which relies heavily on theoretical principles with little exposure to the practical aspects of engineering. An abstract picture of engineering, particularly for electrical engineering freshmen, slowly develops.

## 2. **Elaborating Electrical Engineering Curricula**

In most Bachelor's engineering programs, the first year of study consists mostly of basic science subjects. That year of study is meant to bridge the gap between the basic sciences and engineering. It is the most vulnerable time for the engineering student. He/She is not sure what engineering is about, being exposed during that time to further study in the basic sciences. There is no clear understanding of the close linkage between basic science and engineering. Some students feel that they do not really belong to the engineering community. This sometimes leads to loss of confidence, and motivation for further study wanes.

At this early stage, the study of electrical engineering imposes more burden on the student by virtue of its abstract nature. How does one relate to the magnetic effects in the process of energy conversion, for instance? What can, therefore, be done to make electrical engineering interesting and yet maintain the rigors of a solid engineering education. Since this is to be achieved in a developing country, flexibility in the curriculum plan would be desirable [3]. This flexibility could be built in the final year of study when students would specialize in one of two main areas, e.g. Power Engineering or Electronics/Communications. Depending on staff availability, a range of subjects in each area could be offered as electives during that final year of study. The intervening years between the first and last years would consist of study of subjects that first extend some of the basic electrical engineering principles that students would have been introduced to in the first year of study, and then reinforce these principles. Such subjects as Circuit Theory, Energy Conversion, Electronics, Communications and Computers would form the backbone of the study. The idea is to provide the student with enough knowledge so that he/she would not be unduly disadvantaged when confronted, later, with problems in the area of specialization which he/she opted out of. A price to pay for this polyvalent education is a slight increase in the number of contact hours.

## 3. **Introduction to Electrical Systems**



To prepare the student, especially the marginally committed ones, for the latter years of study, Electrical Engineering must be made attractive and interesting. One subject which is suited for this purpose is "Introduction to Electrical Systems". The aim is to expose the student to real-life engineering installations in a way that he/she is able to appreciate that, when searching for solutions to engineering problems, socio-economic, environmental and other issues should also be considered [4]. At the end of the course, the student is expected to have developed the following:

- (a) an understanding of the operation, from a technical point of view, of a major electrical engineering concern,
- (b) an appreciation of the complexities involved in the search for solutions to engineering problems,
- (c) an awareness of socio-economic, environmental and other issues associated with engineering projects, and
- (d) an ability to work in a team.

The subject consists of the following components:

- a lecture series
- a site visit
- a debriefing session
- writing and submission of a report, and
- a simulation exercise

The subject centers on a visit to a major engineering installation which, initially, could be a hydro-electric power station. This would provide the students with an insight into the complexities of not only electrical engineering but also of such major disciplines as civil and mechanical engineering. Later, depending on the orientation of the departmental staff, and the availability of suitable sites, other installations could be chosen.

In this exercise, it is hypothetically stated that the authorities have proposed to increase the capacity of the reservoir, where the hydro-electric plant is situated. This would involve flooding land owned and settled by hundreds of villagers. The task of the students, who working in small groups, would be to engage in a critical analysis of the arguments for and against the proposed extension.

The first stage of preparation of the students consists of a series of lectures. These would be based, initially, on the generation, transmission and distribution of electrical energy and would be followed by specific ones on the plant and its associated environment. Lectures on the construction of dams and on water turbines would also be given.



A site visit would then be organized, so that students could find out, from first hand, the operation of the hydro-electric facility and the location of the proposed flooding. For the visit to be more effective, students would be briefed, prior to the visit, about the items at the site which were most relevant.

After the site visit, a debriefing session would be organized at which students would be able to put questions to the lecturing staff, so as to complement the information gained during the visit. Each group of students would then write a report on their findings about the power station and the proposed extension of the reservoir.

The final component of the subject relates to the simulation of a public inquiry into the extension of the reservoir. Representing various factions, students put forward and defend their views on technical, socio-economical and environmental issues relating to the extension.

This type of exercise has been shown to be useful in the students' learning process [4]. In addition to developing their skills in report writing and learning the rudiments of the utilization of electrical energy, students are able to appreciate the direct impact of engineering on the community. The many unanswered technical/scientific questions that would have emerged at the end of this exercise would sustain the students' attention in Electrical Engineering during the remaining years of study.

#### **4. Laboratory Work**

In addition to this insight into real-world engineering issues, practical work based on the more tangible forms of engineering would stimulate students' curiosity further. For example, rather than conduct classical experiments such as to verify Ohm's Law, (of course this can follow later) practical work which produce readily graspable results could be undertaken. Below are a few examples [5]:

##### **Electrical distribution in domestic premises**

A laboratory model of the plan view of a house is used to demonstrate some basic principles of electrical power distribution in a house. Students wire up the electrical points specified and make measurements of voltage, current and power at various points in the installation. These are followed by calculations. At the end of the exercise, students are able to understand some aspects of electrical distribution in a domestic setting and can relate these to some laws of electricity.

##### **Efficiency of energy conversion**

A stationary modified bicycle is mounted by a student who pedals a wheel that drives a DC generator. The latter provides power to a pump which is used to transfer water from a container on the ground to another one on the



bench. Parameters such as volume of water raised, height to which the water is raised and others are measured. These allow the students to calculate input and output powers and thereby determine the efficiency of the energy conversion process.

### **Photo electric conversion-the Solar Cell and the Electric Lamp**

A photo-voltaic panel is used to power a fluorescent lamp via an electronic circuit. Students study the characteristics of the Solar Cell and estimate the efficiency of the conversion process. They also compare the light output of 2 different types of lamp, e.g., the filament lamp and the fluorescent tube and estimate the efficiencies.

### **Conversion of sound into electric signals**

Using a microphone, amplifier, loudspeaker and oscilloscope, students are introduced to the basic principles of Communication Engineering. They are able to appreciate the concepts of the conversion of sound into electric signals and vice-versa. They are also handed walkie-talkies, which they take outside the laboratory to demonstrate the transmission and reception of information.

## **5. Conclusions**

Some of the issues associated with the elaboration of Electrical Engineering curricula in developing countries have been discussed and ways of making Electrical Engineering interesting to the freshmen have been described.

## **6. References**

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