

# Education for Electrical Engineering

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Thirty years ago an undergraduate program in electrical engineering consisted chiefly of studying the design and operation of the electrical devices—then relatively few—that were in use at the time. The program included subjects on generators, motors, transmission systems, telephone and telegraph systems, radio, and electric batteries. An average graduate was considered to be adequately equipped to serve society in the entire electrical field. Whenever a new invention was reduced to practical use another subject was merely added to the curriculum. When the curriculum became too crowded for a student to finish it in four years, the concept of options was introduced. Under that concept the undergraduate specialized in one branch of electrical engineering. At graduation he was equipped to serve society in his own field, but was usually not well informed in other fields. He had a tendency to shy away from the other branches of electrical engineering. In more recent years there have been proposals to subdivide undergraduate options into even finer structures in an attempt to supply the needs of vastly diversified electrical industries.

Is this a wise move for the future of engineering education? The danger of the trend to further subdivision lies in the inevitable degeneration of engineering education into vocational training of highly specialized technicians. In a rapidly expanding and changing industry, the rate of obsolescence of specialization is rather high. An educational program of specialization is destined to be short-lived. The effects on both the faculty and the graduate will be undesirable, if not detrimental.

In the Department of Electrical Engineering at the Massachusetts Institute of Technology, under the leadership of Dr. Gordon S. Brown, we are experimenting with a curriculum based upon a different concept of electrical engineering for the undergraduate. In the complex electrical engineering industry we recognize that education for a qualified engineer is a continuing process that ex-

tends far beyond graduation. There are formal opportunities in the graduate schools of universities and in advanced industrial training programs. (For specialization, perhaps there is no better way than to work with the industries, where the demands and environment for such specialization exist.) The role of undergraduate electrical engineering education is, we believe, to provide the foundation and discipline necessary for advanced study and specialization in postgraduate years. It has been traditional to emphasize design and operation of devices. Principles and techniques have been introduced only to the extent that the problems required. Our new curriculum puts the primary emphasis on the principles and techniques that make the present devices possible and that will be needed in the future development of the electrical industries. Devices are treated only as illustrations of the principles and techniques.

Nowadays, there are a few terms that are important in almost every subject of electrical engineering. These are time, space, frequency, signal, energy, force, order and disorder, structure, and material. On a sound foundation of the physical sciences and the humanities, we are building a series of courses that deal with the roles and the interplay of these terms in the engineering world. If we are to learn the design and operation of existing devices, we must have a thorough understanding of these terms. Devices will become obsolete. The fundamental principles and techniques that govern them will be more enduring.

Our program has been in operation for several years. It is still too early to make a fair appraisal of the results from the students' point of view. The impact on the faculty has been astounding and gratifying. The revised program is providing us with an opportunity to re-educate ourselves in the fundamentals of electrical engineering. It is helping us to initiate new research which in the past we have left to the physicists. Perhaps it will influence our graduates in the same way. They will then be better equipped to meet the challenge of our ever-changing and expanding profession.

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