As a constituent member organization of the Engineers' Council for Professional Development, the IEEE provides one or more members to ECPD accreditation teams to evaluate engineering programs at institutions throughout the US. The policies, method of evaluation, and general criteria for accreditation are described in "Objectives and Procedures for Accrediting Programs in Engineering in the United States," published in the latest Annual Report of ECPD.* The guidelines set forth below, compiled by a subcommittee of the IEEE Educational Activities Board, are intended to supplement the ECPD publication in order to assist the IEEE visitor in evaluation of computer science and engineering programs.**

General ECPD procedures should be followed in evaluation of the qualifications of the faculty and students, facilities, supporting staff, finances, and administration of the institution. Acceptable curricula in computer science and engineering should satisfy ECPD criteria. In addition, these curricula should satisfy the IEEE guidelines below. The guidelines amplify and interpret the criteria as they apply to programs in computer science and engineering.

Basic-level program

To be accredited, a basic-level program in computer science engineering must lead to a baccalaureate degree. It must include at least the equivalents of about

1) 2\(\frac{1}{2}\) years of study in the areas of mathematics, science, and engineering allocated as
   a) \(\frac{1}{2}\) year of mathematics, \(\frac{1}{2}\) year of basic science
   b) 1 year of engineering science
   c) \(\frac{1}{2}\) year of design-related engineering course work.

2) \(\frac{1}{2}\) year in the area of humanities and social sciences.

This minimum requirement leaves the student with about one year to accomplish other objectives and to satisfy institutional requirements.

Mathematics and science. A minimum sequence in mathematics is discrete structures and differential and integral calculus. It is highly desirable that the one-half year of mathematics include at least one of the following: linear algebra and matrices, numerical analysis, differential equations, and probability and statistics, and that discrete mathematics be a focus in several courses. One-half year of basic sciences typically includes physics and computer science. Chemistry, the natural sciences, and the life sciences are also valuable especially when integrated with later courses in engineering. It is important that the students' motivation be kept high even during the early part of the program when mathematics and basic science courses predominate. It is desirable that the faculty for the computer science and engineering program maintain liaison committees with faculty from computer science, mathematics, physics, and other departments where required courses exist.

Courses in programming must include at least one high-level language and one assembly language. These courses and mathematically-oriented computer science courses should be included in this portion of the curriculum.

Engineering science. One year of engineering science is required. A substantial portion of the engineering science courses must be in computer science and engineering, elec-
Electrical engineering, or electronics engineering, but some engineering science courses may be outside the major program, since computer engineers will frequently work with other engineers. Engineering science based on mathematics and basic science serves as a bridge to engineering and applications. Engineering science courses in computer science and engineering should include topics such as digital information processing, logic, digital systems, digital device technology, computer organization and architecture, microprogramming, computer languages, computer graphics, data transmission, interfacing, operating systems, and software. Other important topics are data structures, automata theory, theory of algorithms, and digital signal processing. Engineering science courses in electrical engineering and electronics engineering may include topics such as analysis of networks and electronic circuits, system science including an introduction to communication and control systems, electromagnetic fields, electromechanics, physical principles of electrical and electronic devices, and quantum electronics.

**Engineering design.** One-half year must be devoted to design-related engineering course work. In the ECPD criteria, engineering design is defined as "the process of devising a system, component, or process to meet desired needs." It is a decision-making process (often iterative) in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the perception of needs, the formation of appropriate objectives from perceived needs, development of criteria, synthesis, analysis, construction, testing, and evaluation. Central to the process are the essential and complementary roles of synthesis and analysis. This definition is intended to be interpreted in its broadest sense including both hardware and software design. In particular, the words "system, component, or process" and "convert resources optimally" operate to indicate that sociological, economic, aesthetic, legal, ethical, etc., considerations can be included.

One of the most important responsibilities of the visitor is to ascertain whether or not there is sufficient engineering design in the program, as interpreted by IEEE. An apparent consequence of rapid changes in the technology of computer science and engineering is that many of the courses appear to be engineering science courses. On closer examination, many of these courses are design-oriented and the exposition of the material contains much design philosophy. For instance, courses in logic design, digital system design, and computer organization are heavily design-oriented as are several topics in software engineering. Moreover, courses in electrical networks, electronics, digital signal processing, communications, controls, and systems typically involve a substantial amount of design. Some individual and team project courses, by their very nature, are clearly design courses. Some laboratory projects are also clearly engineering design courses. These courses tend to integrate a wide variety of previous engineering science courses, engineering design-oriented courses, and social and environmental considerations as well. However, the visitor should not overlook the design content inherent in many electrical engineering and computer science and engineering courses. When specific goals or performance criteria for the creation or operation of hardware or software components, processes, or systems are set, when several alternative solutions are possible and tradeoffs are examined, when a choice or decision has to be made, engineering design is involved.

**Laboratory.** The computer science and engineering program must involve fundamentals of digital system design as well as experience with at least some of the following: transducers, analog and digital signal processing, and interfacing processors with peripheral devices. The laboratory sequence should emphasize good experimental procedures including equipment selection and use, planning of experimental set-ups, data collection and analysis, and data processing. It should include report writing and effective documentation. The availability of resources and service staff for maintaining modern equipment in proper operating condition is vitally important to the success of a laboratory program. There should be a regular plan for acquisition of new equipment and replacement of obsolete equipment. Reliable and fast repair service together with a modest amount of equipment duplication is essential. Several frustrating experiences with unreliable equipment, questionable data, excessive computer downtime, and unfinished experiments could quickly dampen students' enthusiasm for laboratories.

**Computer facilities.** The computer engineer must have an early introduction to the general structure and organization of digital computers. In addition, the computer engineer must be competent with at least two computer programming languages, one at high level, one at assembly level. This ability must be acquired early in the program so that meaningful problem-solving with computers can be integrated throughout the curriculum. Computational facilities, including minicomputer or microcomputer systems, must be readily accessible to all students. These should be used in most computer science and engineering courses. Some "hands-on" experience with computers is necessary.
Advanced-level program

For accreditation at the advanced level, ECPD requires the equivalent of one year of study beyond that required for a basic-level program. The program must include a substantial amount of advanced material not normally associated with the basic level. This additional year should include approximately one-third year of engineering design, and one-third year of advanced mathematics, basic sciences, engineering sciences, or engineering design. The remaining one-third year is not specified. The IEEE guideline on engineering design is that it should be interpreted broadly, as in the basic-level program. Design may be incorporated in much of the computer engineering science courses, in thesis research, or special projects.

It should be noted that advanced level accreditation in computer science and engineering can be given by ECPD only if all students in the program have the full equivalent of an accredited basic-level program in computer, electrical, or electronics engineering in addition to the year of advanced study. According to present ECPD criteria, "a student admitted to an accredited advanced level program, and who has pursued studies in a different field, may have certain deficiencies to remedy. In addition to an accredited advanced level program, an institution may offer one for which it may not seek accreditation and which would allow the admission of non-engineering students and/or baccalaureate engineering-degree holders from other curricula who may not wish to remedy all deficiencies in their basic-level preparation. There are many advanced level programs of high quality which admit such students but which do not meet the objectives of the current criteria." The above guidelines are not intended to restrict experimentation. Innovative and forward-looking programs that show substance are to be encouraged. Likewise, programs must be flexible in meeting changing situations, as well as the needs of a variety of students and the local environment.

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