This is the ABET self-study document for the **Computer Science & Engineering Program** *in the* **Computer and Information Science Department** *at the* **Ohio State University**. *It is in the format specified by ABET.*

A couple of important points:

- *Not all the information required by ABET has been included. For instance, information about faculty workloads etc. have been omitted.*
- *There are some differences between the program as it is today and the information provided in this self-study. The main differences are with respect to the assessment procedures. The set of assessment procedures described here is more than we have in place today, but is what we plan to implement later this year and early next year.*

Program Self-Study Report for Computer Science and Engineering

I. Background Information

A. Degree Titles

The Ohio State University awards[1] the
Bachelor of Science in Computer Science & Engineering

B. Program Modes

The *Bachelor of Science in Computer Science & Engineering program* is offered in a single mode: conventional day classes.

C. Actions to Correct Previous Deficiencies

The *BS in CS&E* program has not been previously evaluated by the *EAC*.

D. Major Developments During the Last Few Years

This section is not required by the ABET guidelines but has been included in order to briefly summarize some recent major changes in the Department.

- The Department moved into a brand new building about four years ago. The building has been designed to provide a good working environment for faculty and staff, provide some classrooms wired to support workstations for each student, provide a comfortable environment for students to interact with faculty and teaching assistants, and provide room for the growing research needs of the Department.
- About three years ago the computing equipment in the various student computing labs as well as in faculty offices was replaced by a new generation of equipment. Plans are currently under way to go through yet another round of upgrading of the computing equipment.
- The first three courses in the program, *CIS 221, 222,* and *321* have been revised substantially to stress *software engineering* principles. While the previous version of these courses did pay considerable attention to software engineering issues, they were not fully integrated

[1]The *BS in CS&E* program is in the *Computer and Information Science Department* of the *Ohio State University*; the Department also offers several other programs, for example, a *Bachelor of Science in Computer and Information Science* degree in the College of Arts and Sciences. Only the *BS in CS&E* program is being evaluated.

with each other. The new version of these courses is tightly integrated and enables the student to develop the ability to design robust software systems. We have also taken this opportunity to move these courses from *Modula-2* to a disciplined version of *C++*, a version that encourages students to pay attention to designing reliable systems rather than just hacking together something that 'works'.

- Several new capstone design courses have been introduced to allow students to engage in a quarter-long design exercise in a field that they find most interesting.
- Our hiring of senior and junior faculty in computer networking has enabled us to introduce several new (elective) courses in this important area.
- We have hired new faculty both junior and senior not just in networking but in several important areas. This will enable us to offer the best possible and most up-to-date courses and research opportunities to our students.

II. Accreditation Summary

A. Students

ABET Criterion 1: *The quality and performance of the students and graduates is an important consideration in the evaluation of an engineering program. The institution must evaluate, advise, and monitor students to determine its success in meeting program objectives.*

Our students are of high quality and perform well in a demanding curriculum. The average ACT scores for students admitted into our program last year was 25. The average gpa of our students is 2.77. The student population is also fairly diverse, with about 13% percentage being women and about 30% minorities[2]. We have a designated faculty advisor, currently Professor Renee Miller, who is available to advise women and minority students. Prof. Miller has been extremely active in acquiring industrial support to enhance the diversity of the student population. A recent industrial grant obtained as a result of this activity provides for support for minority undergraduate students interested in participating in research projects in the Department (there is also a matching amount to support the concerned faculty member's research program).

Average time to complete the degree is 5.3 years. A large percentage of our students gain work experience and support their education through participation in co-op programs and summer internships. Our graduates are highly sought after by major companies. The companies that have recently recruited our graduates include *Adobe Systems, Boing, CompuServe, FedEx, IBM, Lucent, MicrSoft, Motorola, Proctor & Gamble*, etc. Starting salaries for our graduates are close to $40,000 per year. About 6.5% of our graduates enter graduate school immediately after completion of the program; we should note that an important reason why relatively few of our graduates go on to graduate school is the very strong demand for them from industry.

[2]The 30% figure includes students of Asian origin; if we exclude those, the figure is 9%.

Evaluation of student performance is directly linked to our Program Educational Objectives and Program Outcomes through the course syllabi (*Appendix 2*: this contains the course descriptions for our required courses). Students are advised and their progress monitored by a professional Advising office staffed by a full-time Academic Advisor (Ms. Peg Steele) who is assisted by two Graduate Administrative Associates, and by the faculty as described below:

- Information about the program is available to the students in hardcopy from the advising office, and also on the Department's web page (http://www.cis.ohio-state.edu).
- Students are admitted to the pre-CSE major upon their acceptance to the University. Once they have completed a series of seven prerequisite courses, and have attained the minimum cumulative point hour requirement, they are eligible to make application to the major. Assuming they have met the requirements, they will be formally admitted to the major and assigned a faculty advisor. The faculty advisor has an area of expertise that the student expects to specialize in. The faculty-student relationship is expected to be an on-going interaction until the student has graduated from the program. The professional full time advisor is available for program concerns as needed.
- The *Degree Audit Registration System* (DARS) is a program that enables the students to verify, on-line, what requirements they still need to meet in order to complete the program.
- Advising reports recording the progress of their advisees are available to faculty advisors.
- Students are evaluated on a quarterly basis, and those who are not making satisfactory progress are put on probation and advised of what they need to do to get back in good standing; failure to overcome the deficiencies (typically low overall *gpa* or low *gpa* in computing courses) results in dismissal from the program. Probation and dismissal decisions are made by a standing committee of the College of Engineering consisting of faculty and advising representatives from the various programs, after consultation with the faculty advisors of the concerned students.

B. Program Educational Objectives

ABET Criterion 2: *Each engineering program must have in place:*

- *detailed published educational objectives that are consistent with the mission of the institution and these criteria*
- *a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated*
- *a curriculum and process that ensures the achievement of these objectives*
- *a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.*

Program Educational Objectives, which were derived in part from the Computer & Information Science Department's Vision and Mission statements (included in *Appendix 3*), have been established and published in both hard copy and electronically. The process used for establishing these Objectives involved all of our constituencies, including faculty, students, staff, and professionals from industry.

The Educational Objectives of the Computer Science & Engineering program are:

1. To provide graduates with a thorough grounding in the key principles and practices of computing, and in the basic engineering, mathematical, and scientific principles that underpin them.

2. To provide graduates with an understanding of additional engineering principles, and the mathematical and scientific principles that underpin them.

3. To provide graduates with an understanding of the overall human context in which engineering and computing activities take place.

4. To prepare graduates for both immediate employment in the CSE profession and for admission to graduate programs in computing.

Our educational objectives are published in the College of Engineering bulletin. It is also available on the Department's web page.

The process used to formulate and refine the objectives and develop strategies to meet these objectives is indicated in Figure 1.

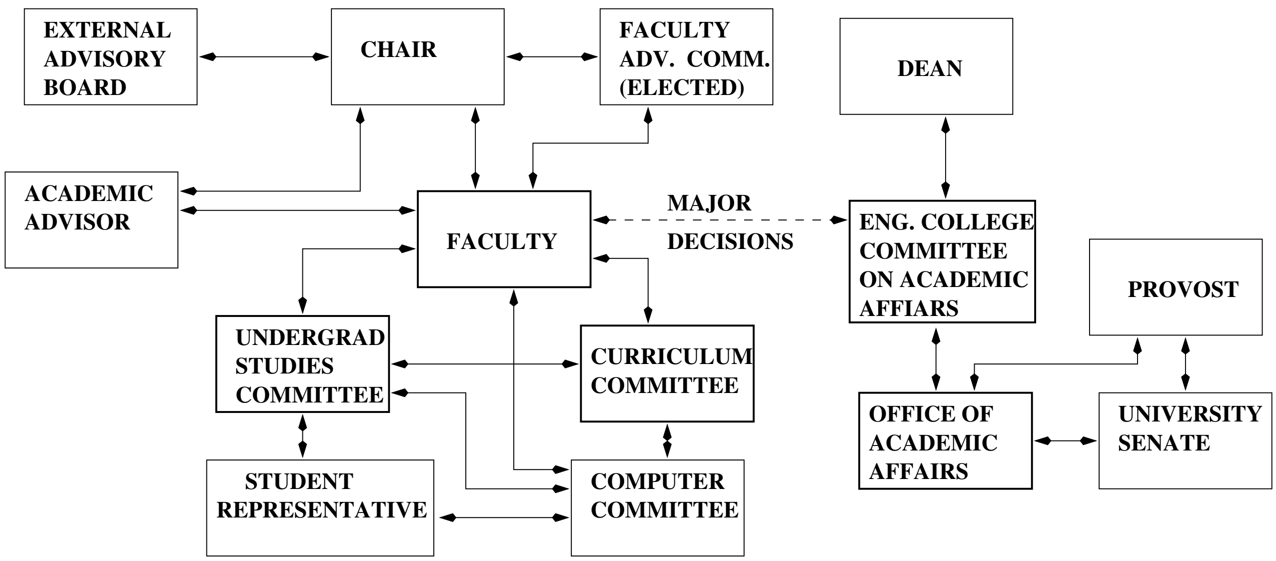

Figure 1. Constituent Interactions and Academic Decision Making in the Department of Computer & Information Science (Boxes in bold indicate major decision makers)

The Undergraduate Studies Committee and the Curriculum Committees are standing committees of the faculty. Together they are responsible for considering and making recommendations to the faculty on all aspects of the undergraduate program. The meetings of these committees are open to all students and faculty. The agendas as well as minutes of the meetings are posted on student as well as faculty electronic newsgroups.

The curriculum has been designed to ensure that each of the program educational objectives is fully met. For instance, many of our courses, starting from the beginning CIS221, and CIS222, all the way to the senior level capstone design course contribute towards meeting objective 1 by providing graduates with a thorough grounding in the key principles and practices of computing. Objective 2, that of providing graduates with an understanding of additional engineering principles outside the computing domain, is mainly met by courses offered in other departments; these courses include *Electrical Eng 300, 309, 320; Engineering Mechanics 220; Ind. & Sys. Eng. 504; Eng. Graphics 166; Mat. Sc. and Eng. 500.* Objective 3, to provide graduates with an understanding of the overall human context, is met by *CIS 601*, the required course on *Social and Ethical Issues in Computing*, as well as by a number of General Education Courses. Objective 4, to prepare graduates for immediate employment and for admission to graduate programs, is met by most of the CIS courses in the curriculum, including especially the 600 level courses, the capstone design courses, and the many elective courses on such current topics as networking and computer graphics that students choose from. *Appendix 1* summarizes, in a tabular form, how various courses contribute to meeting the individual educational objectives. More details appear in *Appendix 2* in the descriptions of individual courses.

The system of evaluation used to demonstrate the achievement of these objectives and identifying needed changes to improve the effectiveness of the program has a number of components: The first component is the on-line student surveys used in each course that require students to evaluate to what degree (on a scale of 1 through 6) the objectives of the particular course was met; the survey the students complete in the capstone design course also has similar evaluation of the degree to which overall program objectives were met. A second component are on-line surveys that instructors in each section of each course completes to record the degree to which, in their opinion, the objectives of the course were met, and to record suggestions for possible changes in the course. The data obtained from these surveys is analyzed by the respective course coordinators who report, on an annual basis, to the Undergraduate and Curriculum Committees on the effectiveness of the various parts of the curriculum to meet the educational objectives, and make recommendations for changes. These discussions are open and initially often carried out electronically (on newsgroups accessible to faculty and students) so a variety of views may be heard. A recent example of such a discussion was the possibility of making changes to the way that we present the material on discrete mathematics. On the basis of these discussions, a pilot section of the discrete mathematics course was taught using a new approach pioneered by *Gries and Schneider*. Another example is the proposal to pilot a version of the 600-level Data Structures course to focus more on algorithm analysis issues, since some of the software engineering issues that have been included in this course are now being discussed in *CIS 221, 222,* and *CIS 321*. Yet another example, this one at the College level, was a day-long retreat that nearly a hundred faculty and several advisors and students attended, to discuuss ways of revising the introductory engineering courses to include a strong design component. The retreat was also attended by industry representatives. The ideas suggested at the retreat are now being examined by an ad-hoc subcommittee appointed by the Dean of the College; this sub-committee is expected to report to the *College Committee on Academic Affairs* (see figure 1) on possible revisions to the introductory courses.

C. Program Outcomes and Assessment

ABET Criterion 3: *Engineering programs must demonstrate that their graduates have:*

- *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*
- *d. an ability to function on multi-disciplinary 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 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.*

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the outcomes of the program, including those listed above, are being measured. Evidence may include: student portfolios including design projects; nationally-normed subject content examinations; alumini surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

The institution must have and enforce policies for the acceptance of transfer students and for the validation of credit courses taken elsewhere. The institution must also have and enforce procedures to ensure that all students meet all program requirements.

The Department treats the question of *transfer credits* seriously both in order to ensure that students get credit for coursework they have performed elsewhere, and to ensure that transfer students are indeed well prepared to continue with the rest of the *CS&E* program. With this in mind, transfer credits are handled by a two-tier system. The Department supplies the University Admissions Office with a *transfer-credit-course* list identifying specific courses from specific universities and the equivalent courses in our program. The correctness and currency of this list is evaluated annually. Any student who has taken course X in university Y, upon filing the requisite application with the Admissions Office, gets transfer credit for the equivalent course Z of the *CS&E* program as per this list.

Since there are frequent instances where students believe they ought to receive transfer credit for a specific course although the corresponding entry does not appear on the transfer-credit-course list, the Department also has a designated faculty member who acts as a *transfer-credit-coordinator*. This coordinator is appointed by the Chair of the Department on an annual basis and receives a reduction of one-half course in his teaching responsibilities. The University Admissions Office refers to this coordinator all cases that cannot be resolved on the basis of the list supplied to them. Prof. Bill Ogden is the current (1996-97) transfer credit coordinator.

Ensuring that all students meet all program requirements is checked both in the Department as well as in the College of Engineering. Certifying students for graduation begins three quarters prior to their intended quarter for graduation. Students are required to apply for the degree so that the proper audit is made on their academic records. The Department reviews the coursework, and it is then forwarded to the Degree Certification office in the College. It is then reviewed a total of two times and one final time the week before graduation to ensure that students are meeting the requirements for degree. The automated degree audits (DARS) are used for this purpose. If there is any problem along the way, students are notified in sufficient time in order to make adjustments. This process involves at least three staff personnel, and ensures students have met curricular requirements prior to commencement.

Turning next to the *outcomes*, for each of the *Program Educational Objectives* described in the previous section, specific expected *program outcomes* have been identified. These outcomes are listed below, *1a, 1b, 1c* being the outcomes corresponding to objective 1, and similarly for each of the other objectives:

1a. Students will demonstrate proficiency in the areas of software design and development, algorithms, operating systems, programming languages, and architecture.

1b. Students will demonstrate proficiency in relevant aspects of mathematics, including discrete mathematics, as well as the appropriate concepts from physics and electrical circuits and devices.

2a. Students will demonstrate an understanding of differential and integral calculus, differential equations, physics and several areas of basic engineering sciences.

2b. Students will have the ability to work with others and on multi-disciplinary teams in both classroom and laboratory environments.

3a. Students will demonstrate an ability to communicate effectively.

3b. Students will obtain familiarity with basic ideas and contemporary issues in the social sciences and humanities.

3c. Students will obtain an understanding of social, professional and ethical issues related to computing.

4a. A large fraction of graduates will be immediately employed in high-technology companies that utilize their computing education.

4b. Strong graduates from the program will be prepared to enter good graduate programs in *CS&E*.

These program outcomes are in addition to the outcomes listed under *ABET Criterion 3*.

Our curriculum is designed to ensure that these outcomes are achieved. For each of the required courses in the curriculum *Appendix 2* lists not only the various objectives of the course, but also, for each objective the specific *ABET Criterion 3* outcome(s) and the specific *CS&E program* outcome(s) that correspond to that course objective. It also lists the specific strategies used in the particular course to achieve those specific outcomes. *Appendix 1* summarizes this information in a tabular form. As *Appendix 1* makes clear, most of the outcomes are achieved in more than one course. The terminology used in this table deserves a brief explanation here: If a particular outcome is a *primary theme* in a particular course, that is indicated by *XXX* in the appropriate place in the table; similarly *XX* indicates that the outcome in question is a *secondary* theme of the course; and an *X* means that the outcome in question is not a theme of the course, but it is still treated in the course in a non-trivial way.

Here we briefly consider a few of the *ABET Criterion 3* outcomes, a few of the *CS&E program* outcomes, and some of the specific courses in the curriculum in which these outcomes are achieved. *ABET Criterion 3.c*, the ability to design a system, component, or process to meet desired needs, is a running theme not just in one course but through the entire curriculum. Starting from *CIS 221* and *CIS 222* where students learn the importance of designing small programs that meet stated requirements, all the way to the capstone design courses where they design a system to meet requirements that may sometimes conflict with each other, this theme appears again and again. The related *ABET Criterion 3.e*, the ability to identify, formulate, and solve engineering problems, also appears repeatedly, especially in junior and senior level courses such as *CIS 560, 655*, where students are required to arrive at solutions for problems whose requirements may be stated at a relatively high level and in a relatively imprecise manner.

ABET Criterion 3.b, the ability to design and conduct experiments, as well as to analyze and interpret data, is particularly important for *CS&E* professionals, since the nature of the systems they design often requires considerable experimentation to test their correct functioning, and to eliminate any ‘software bugs’. By requiring the design and debugging of a range of systems large and small, our program ensures that students become adept at choosing appropriate input data for testing their systems, and at analyzing the resulting behavior of the systems. They also develop the ability to use appropriate software tools effectively for debugging systems.

The constant pace of change in computing makes *ABET Criterion 3.i*, the recognition of the need for and the ability to engage in lifelong learning, another very important one for *CS&E* professionals. Courses such as *CIS 655*, *CIS 660*, and *CIS 675*, by presenting the changes that have taken place in programming languages, operating systems, and computer architecture over the last three decades, and by discussing the reasons behind the changes, ensure that students appreciate the need not only for keeping up with new languages, and systems, but also for understanding the conceptual advances behind the changes.

Turning now to the *CS&E* program outcomes, outcome *1a* reiterates the importance of students' abilities in the area of software design and development and in related areas. Nearly every one of the courses in our curriculum has one or more of these issues as a primary theme, as reflected in the table in *Appendix 1*. Meeting this outcome almost directly guarantees that we meet program outcome *4a*, that a large fraction of our graduates will immediately be employed by high-tech companies that utilize their computing education.

Discussions with our industrial partners have highlighted the importance of program outcome *3a*, the ability to communicate effectively; this is likely to become even more critical as software systems become more and more widely employed. Our students develop the ability to document the systems they design through practice, starting in *CIS 221*, through *CIS 560* which places a heavy emphasis on appropriate documentation, to the capstone design courses where again students are required to suitably document their designs. In addition, by requiring students to engage in team discussions in *CIS 221, CIS 222*, and *CIS 321*, as well as requiring them to make presentations to small groups in *CIS 560*, and finally by having them particpate in formal debates in *CIS 601*, we ensure that their oral communication skills are also well developed.

The assessment process we use has a number of components. Chief among them are the assignments and exams used in the individual courses to measure the degree to which the *ABET* and *CS&E* program outcomes related to that course are achieved. Examples of completed student assignments and exam for each of the required courses, and for a variety of students (classified as 'average', 'above average' and 'below average' on the basis of performance in the specific course) will be available for inspection.

A second component of the assessment process involves completion, by the students, at the end of each course, of an electronic form that asks them to evaluate, on a scale of 1 through 6, the degree to which they felt that each of the outcomes of that course –stated in the official syllabus of the course– were indeed achieved. The form also provides students an opportunity to provide comments on changes they would like to see in the objectives of the particular course. Similarly, each instructor of each of the required courses completes an electronic form at the end of each course in which he or she records, on a scale of 1 to 6, the degree to which he or she felt each of the stated outcomes of the course was met, and comments on possible changes, if any, in the course objectives. All of this information is collected and discussed by the course coordinator and key instructors once a year, usually in the Fall or Winter quarter. The results of this discussion are summarized and presented to two faculty committees, the Curriculum Committee and the Undergraduate Studies Committee, that have primary responsibility for the program. Any possible changes, based on the observations and conclusions of the course coordinators and instructors, are discussed in either or both of these committees before being recommended to the full faculty for a vote. Students and faculty have full opportunity to participate in the discussions of both the Curriculum and Undergraduate Studies Committees.

A third component of the assessment process involves requiring the students to complete an electronic form at the end of their capstone design course. This form allows the students to provide feedback on the entire program. It asks them to evaluate, on a scale of 1 to 6, to what degree each of the *ABET Criterion 3* outcomes, as well as the *CS&E* program outcomes were achieved; and comment on changes they would like to see made in the program. This form also asks the students to provide information on their future plans, with respect to employment or graduate studies as may be appropriate. The results of this survey are discussed by the Undergraduate Studies Committee during the Winter and Spring quarters. Again, interested faculty and students have an opportunity to fully participate in these discussions. Proposals for changes are then presented to the full faculty for possible adoption.

The final component of the assessment process consists of collecting information about our graduates and their future career development. We rely on the College of Engineering for obtaining much of this information. Any unusual trends observed in the information so collected is brought to the attention of the Undergraduate Studies Committee (usually by the professional Academic Advisor) for discussion and possible action.

D. Professional Component

The Professional Component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The engineering faculty must assure that the program curriculum devotes adequate attention and time to each component, consistent with the objectives of the program and institution. Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political. The professional component must include

(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline

(b) one and one-half years of engineering topics, to include engineering sciences and engineering design appropriate to the student's field of study

(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

The *CS&E* curriculum meets *ABET* and *CS&E* Program Objectives. The program culminates in a major design experience which builds on previous courses.

Curriculum Course Content

The curriculum for the *Bachelor of Science in Computer Science & Engineering* is given in Table 1, *Basic Level Curriculum for Computer Science and Engineering*. A total of 200 quarter hours is required for the degree, including 60 quarter hours (40 semester hours) of mathematics and basic sciences, 95 quarter hours (63.7 semester hours) of engineering topics, and 45 quarter hours (30 semester hours) of general education curriculum. (To convert to semester hours, quarter hours were multiplied by 2/3.)

The curriculum has been tailored to meet each of the *CS&E* program objectives. As noted earlier, *Appendix 1* summarizes the contribution each course makes towards meeting the outcomes appropriate to the various objectives.

Engineering Design Experience

Design is an integral part of the *CS&E* curriculum. Several of the required courses, including *CIS 221, 222, 321, 360, 560, 570, 655, 680*, have a strong design component as indicated by the table in *Appendix 1*, and in more detail in the descriptions of these courses. The first four of these courses require the students to design a number of relatively small software systems. For each design, the student goes through stages of understanding the requirements, developing an initial design, debugging the design to arrive at a final system, and documenting the system, often working in small teams for parts of the design exercise. *CIS 560* is a more extensive design task, with students working in formal teams, meeting at regular times, and providing complete documentation of the final design. The last three courses require students to again design several small systems focussing on the specific conceptual topics of the individual courses.

The capstone design experience is a quarter-long course. Based on their technical interests, students choose one of the following courses: *CIS 731, CIS 758, CIS 762, CIS 772, CIS 778, EE 769*. In each of these courses the intent is to provide a realistic design experience albeit in an academic environment. The experience relies on technical knowledge gained in earlier courses, and builds on design skills acquired in the courses mentioned in the last paragraph. Students address a significant design problem, and are expected to proceed through the entire design process from problem formulation to implementation, and documenting the final system.

E. Faculty

To be completed.

F. Facilities

To be completed.

G. Institutional Support and Financial Resources

To be completed.

H. Program Criteria

The applicable Program Criteria are as follows:

Curriculum

The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.

Graduates must have demonstrated

- *knowledge of probability and statistics, including applications appropriate to the program name and objectives;*
- *knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software components, as appropriate to program objectives.*

Graduates of programs containing the modifier "computer" in the title must have demonstrated a knowledge of discrete mathematics.

The *CS&E* curriculum covers a wide range of topics from software design and development using modern Software Engineering principles, to computing at the machine level and principles of computer architecture, to operating systems that make it easier to use the power of the machines, to a variety of high level languages and programming paradigms to solve a range of problems using the machines, as well as the fundamental theories underlying the discipline as a whole. Each of these topics is dealt with at considerable depth and students are required to apply the ideas they learn to solve non-trivial problems in each area. Specifically, the courses *CIS 221, 222, 321, 560, 570, 680* have to do with software design and development, courses *CIS 360, 560, 675* have to do with computer architecture, *CIS 560, 660* have to do with operating systems, *CIS 221, 222, 321, 655* have to do with high-level programming languages and paradigms, and *CIS 625, 680* discuss fundamental theories underlying computing. In addition, a range of related engineering topics is covered in *EE 261, 206, 300, 309, 320, 567*, and *ISE 504*.

Probability and Statistics are covered in *Stat 427, 428*, and used in computing applications in *CIS 660* and *CIS 680*. Mathematics through differential and integral calculus and ordinary and partial differential equations is covered by a sequence of five courses, *Math 151, 152, 153, 254, 415*. Basic sciences and engineering sciences are covered in *Physics 131, 132, 133, Chem 121, 125, Eng Mech 220, Ind Sys & Eng 504, Mat Sc& Eng 405, Mech Eng 500*.

Discrete mathematics is covered in *Math 366* and used in *CIS 570, 625, 655, 675*.