An Electronic Web-based Assessment System

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Abstract

In keeping with the outcome-based assessment outlined by ABET's Education Criteria 2000, the School of Engineering at the University of Bridgeport has defined fifteen general student outcomes. These outcomes form the basis of its instructional program and assessment activities. In assessing and monitoring the attainment of these outcomes, formal assessment tools such as test and quizzes as well as assignment and project reports prove to be major indicators. This study is an attempt to perform the assessment process using the Internet and its capabilities. Presented in the paper is a new technique for presentation of relevant materials for accreditation under ABET and CSAB Criteria for Engineering and Computer Science programs. The course materials from all courses offered in Fall 2002 and Spring 2003 is gathered and organized into separate course websites. Our electronic assessment (e-assessment) system (**http://assesseng.bridgeport.edu/**) is designed and implemented such that it allows the assessment evaluator to browse in a logical and convenient manner starting from the program objectives and outcomes to specific course materials where they are implemented. This process also includes browsing the course versus outcomes matrix and individual course grids. The feedback loop is closed with the evaluation of the course versus outcomes and outcomes versus ABET criteria matrix. Program objectives and program constituents such as the students and alumni are also involved in the process. The achievement of the program outcomes and objectives is at the heart of the assessment process. In this paper, the focus is on the program outcomes and how they are achieved at the course level.

1. Introduction

The Accreditation Board for Engineering and Technology (ABET) is a professional accrediting organization that accredits applied science, computing, engineering, and technology educational programs. ABET promotes quality and innovation in education, assures quality and stimulates innovation in applied science, computing, engineering, and technology education [1].

The awarding of accreditation signifies that the accredited program of education has met Commission standards and is willing to both maintain those standards and improve its educational program by implementing the recommendations in the accreditation report. The accreditation is valuable not only to the institution and its faculty but also to the students [1].

The value of the accreditation for faculty members is the enjoyment and professional pride of teaching courses of an accredited program. Accreditation provides both a personal and professional opportunity to work towards educational improvement. The evaluation experience affords the opportunity for the administration and faculty to conduct and to receive a rigorous analysis of present conditions so that needed changes may be carefully planned.

Students are most affected by accreditation since they are the central focus of the educational process. Accreditation assures them that their needs are being met through a quality educational program and that their preparation reaches high levels. It also assures them that prestigious institutions will more likely accept their transfer credits and their degree will be a tool for finding a good job and for personal development. The accreditation also increases their confidence in their educational program and teachers, and their attitude toward academic work. The CpE and CS Programs accreditation indicates that the program prepares students for entry into the profession. The ABET accreditation criteria [*Appendix A*] are developed by engineering professionals from both industry and education which allows the education to truly meet the demands of the engineering profession, ultimately preparing students for greater success [4].

In the United States, the Accreditation Board for Engineering and Technology (ABET) is responsible for accrediting over 2300 engineering, engineering technology and engineering-related programs at some 500 institutions[7,8]. Engineering programs accredited by ABET prepare students for a profession in which a knowledge of mathematical and natural sciences gained by study and practice is applied to the materials and forces of nature to benefit mankind. Engineering technology programs prepare students for a technologist or technician position that requires the application of scientific and engineering knowledge combined with technical skills that support engineering activities[4].

The Computer Engineering Program of School of Engineering of University of Bridgeport is one of the programs accredited by ABET since 1989. A new goal of the School of Engineering is to obtain CSAB accreditation for the first time for the Computer Science Program of the school and continue the ABET accreditation that it already has.

The School of Engineering has requested evaluation of its CPE and CS programs and has completed the internal review of each one of them, which entails examining the program's students, curriculum, faculty, administration, facilities and institutional support. To meet the requirements of the outcome-based assessment outlined by ABET's EC2000, the School of Engineering of the University of Bridgeport has defined its objectives and fifteen related general student outcomes [*Appendix B*]. Formal assessment tools such as tests and quizzes as well as assignment and project reports demonstrate the level at which the criteria and educational objectives are being met.

2. School of Engineering Goals

One of the strengths of the American educational system is the diversity of educational programs. Such a large selection of educational offerings makes quality a vital issue. Accreditation is the quality assurance that education is meeting minimum standards. In the United States, accreditation is a non-governmental, peer review process that ensures educational quality. Educational programs volunteer to periodically undergo this review to determine if minimum criteria are being met. Accreditation verifies that a program meets the criteria, ensuring a quality educational experience. In this regards, the School of Engineering of the University of Bridgeport should define its mission and objectives to meet the needs of constituencies. Below are some of the goals of the School of Engineering, which guided the preparation for the accreditation process in Fall 2003.

- The prepared educational objectives should be comprehensive, measurable and flexible, and clearly tied to the mission. The objectives have to be systematically reviewed and updated.

- Outcomes assessment requires definition of all outcomes, systematic evaluation and process improvement and involvement of all support areas. The common sources of problems should be understood and eliminated.

- Assessment constituents have to show a high degree of involvement in defining the objectives and desired outcomes. They should present sustained evidence of strategic partnerships with all key components.

- Processes should assure not only continuous quality improvement but also that minimum standards are met for all elements of the criteria. The processes have to be clearly understood and controlled. They should be tied to the mission, the program objectives, and the constituents' needs. The processes should be generally viewed as benchmarks by other institutions.

- Results of the course work should cover world-class outcomes. They should be clearly caused by a systematic approach.

- The assessment presentation system should be highly integrated and deployed throughout the program, school, and institution. It has to be driven by mission and objectives. [2]

These are the goals of School of Engineering that are to be achieved for the incoming ABET and CSAB accreditation. The School of Engineering faculty will focus on the assessment of the quality of the collected data and presentation rather than quantity to simplify and clarify the accreditation process.

3. Methodology

3.1 Components Collection

The ABET accreditation process of School of Engineering of the University of Bridgeport was started with the evaluation request of its Computer Engineering and Computer Science programs. An internal review was completed for each of the programs that examined the program's students, curriculum, faculty, administration, facilities and institutional support. Different components were collected to prove the quality of education in these programs to the evaluation team that will be sent by ABET to visit the programs on campus.

The required components (Fig.1) consist of a Mission Statement, program objectives and outcomes defined to match the ABET and CSAB criteria, courses vs. outcomes matrix that illustrates where in the curriculum the outcomes are being met and at what level, and course grids and formal assessment tools such as student work samples from assignments, projects, exams and quizzes that indicate the level at which the program outcomes are met. The outcomes versus ABET criteria grids further map the outcomes to the ABET criteria and assist in closing the assessment loop.

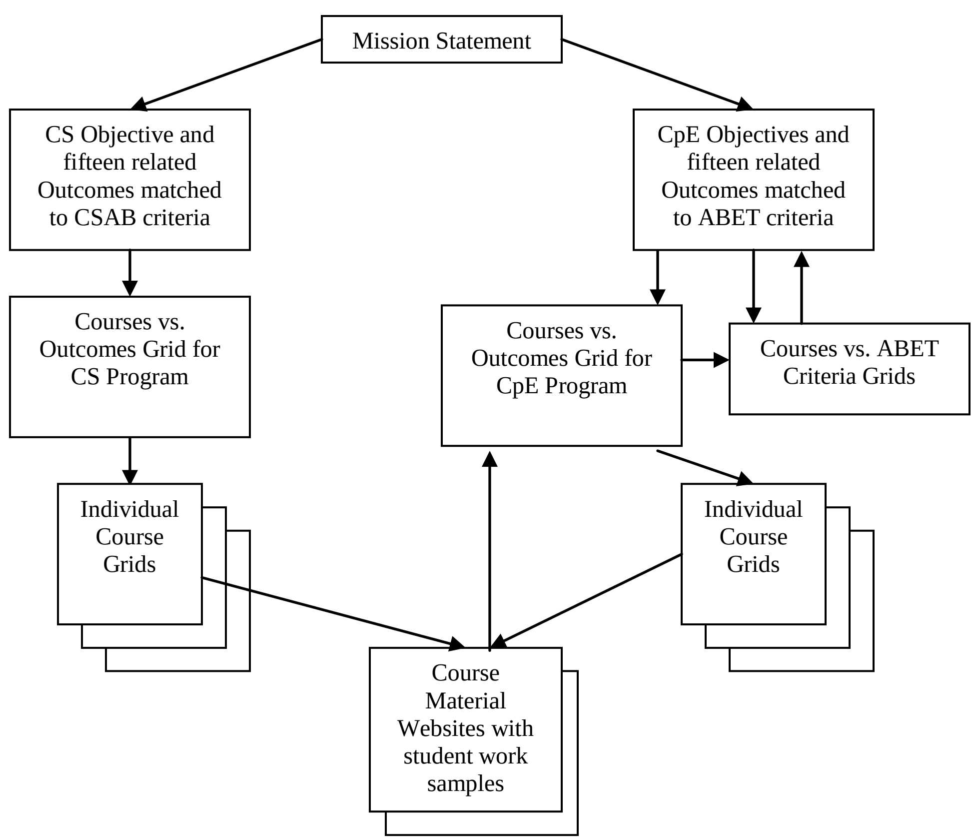


Fig. 1 - *Required components for Accreditation process*

3.1.1. Mission Statement

One of the most general but also most important components is the institution Mission Statement. In few paragraphs it generally describes the goals and mission of the institution and the value it can bring to potential students. Below is the mission statement of the School of Engineering of the University of Bridgeport:

> *"The School of Engineering of the University of Bridgeport provides educational opportunities and serves as a knowledge resource in the sciences, engineering and technology. Our clients are students, the companies that hire them, and various other institutions in Bridgeport and the surrounding region, the United States, and all parts of the world.*
>
> *Our Programs are designed with attention to the institutions we serve. The education we offer features acquisition of fundamental knowledge in a wide range of fields and an application oriented approach to issues that are progressively more interdisciplinary.*
>
> *Graduates of our program possess broad knowledge, professional training, and learning skills that enable their success in an evolving global economy and allow for the betterment of the communities in which they live."*
>
> *Dr. Tarek Sobh, Dean of the School of Engineering*

3.1.2. Student Oriented Objectives

Program objectives are a more concrete definition of the School goals and mission. While the Mission statement is valid for the institution, the Student Oriented Objectives are defined for each of the programs within this institution. Below you can see the Student Oriented Objectives of the Computer Science and Computer Engineering Programs of the School of Engineering:

CpE Program

1. *Students will be proficient in designing hardware, software and a variety of computer-controlled engineering systems. (Program Outcomes 1,2,3,4,5)*
2. *Students will develop an understanding of contemporary global and societal issues, ethical considerations and communication skills, both oral and written. (Program Outcomes 8,11,12)*
3. *Student will develop abilities in applying mathematical and scientific tools to solve engineering problems. (Program Outcomes 6,7,9,10)*
4. *Students will develop skills that will prepare them for employment upon graduation and the ability to undertake life-long learning. (Program Outcomes 13,14,15)*

CS Program

A graduate of the computer science program will be proficient in designing and implementing software systems using a variety of programming languages, algorithms, tools and techniques.

3.1.3. Student Oriented Outcomes

The School of Engineering has defined fifteen student outcomes for each of the Computer Science and Computer Engineering programs which cover all ABET and CSAB criteria [*Appendix A*]. The listing of these outcomes can be found in *Appendix B.*

3.1.4. Courses vs. Outcomes Grids

The Courses versus Outcomes Grids [*Appendix C*] were developed for both programs with material gathered from the faculty members teaching each of the courses. The grids list the program course requirements and describe at what level each of the fifteen student outcomes is met in each course. Depending on the level a particular outcome is achieved in a given course, the level is indicated by **B** (for Beginner), **D** (for Developing) and **P** (for Proficient).

3.1.5. Outcomes vs. ABET Criteria Grids

Two versions of the said grid have been prepared. The first one [*Appendix D*] was developed as a mapping between the program outcomes and the ABET criteria. The second is a more detailed version where the individual course which form the intersection of the two axes are listed (http://assesseng.bridgeport.edu/grids.htm). At present, these grids have been prepared for the CpE program only but the same will be put together for the CS program in the near future.

3.1.6. Course Grids

The contents of an individual course grid match each outcome applicable for the course with the class activities that satisfy it and the ABET/CSAB criteria that this particular outcome covers. The course grids describe course Outcomes, Performance Indicators, Strategies and Actions, Assessment Methods and Metrics, Evaluation and Feedback. Few sample course grids are listed in *Appendix E*.

3.1.7. Course Material Websites

All applicable course material was gathered for each course in the Computer Engineering and Computer Science programs including courses from other Schools of the University of Bridgeport, for example, the School of Arts and Sciences. The gathered material is from courses taught in the Fall 2002 and Spring 2003 semesters.

A detailed example showing how each of the individual components is connected to the other components follows in the next section of this paper.

The authors of the paper had the full cooperation of the faculty members and received all the materials requested.

3.2 Technical Implementation

3.2.1. Architecture of the E-Assessment System

The School of Engineering Assessment website (http://assesseng.bridgeport.edu/) is an interface for the ABET accreditation visit in Fall 2003. The website consists of an Assessment Presentation Website and Courses Material Websites for each of the School of Engineering courses as well as courses from other schools that are included in the Computer Science and Computer Engineering programs.

The function of the Assessment System is to present to the accreditation evaluator a grid of the School of Engineering assessment outcomes and objectives and student work samples, which are indicators of assessing and monitoring the level of achievement of the instructional program. The gathered student samples include but are not limited to: exams and quizzes as well as assignments and project reports. Additionally, course lectures and presentation material is gathered from the courses' instructors.

The system implementation allows the assessment evaluator to browse in a logical and convenient manner, starting from the objectives and outcomes to specific course materials where they are being met. The process also includes browsing the course versus outcomes matrix and individual course grids.

3.2.2. Assessment Website (Interface to the System)

Figure 2 shows the outlook of the assessment website interface.

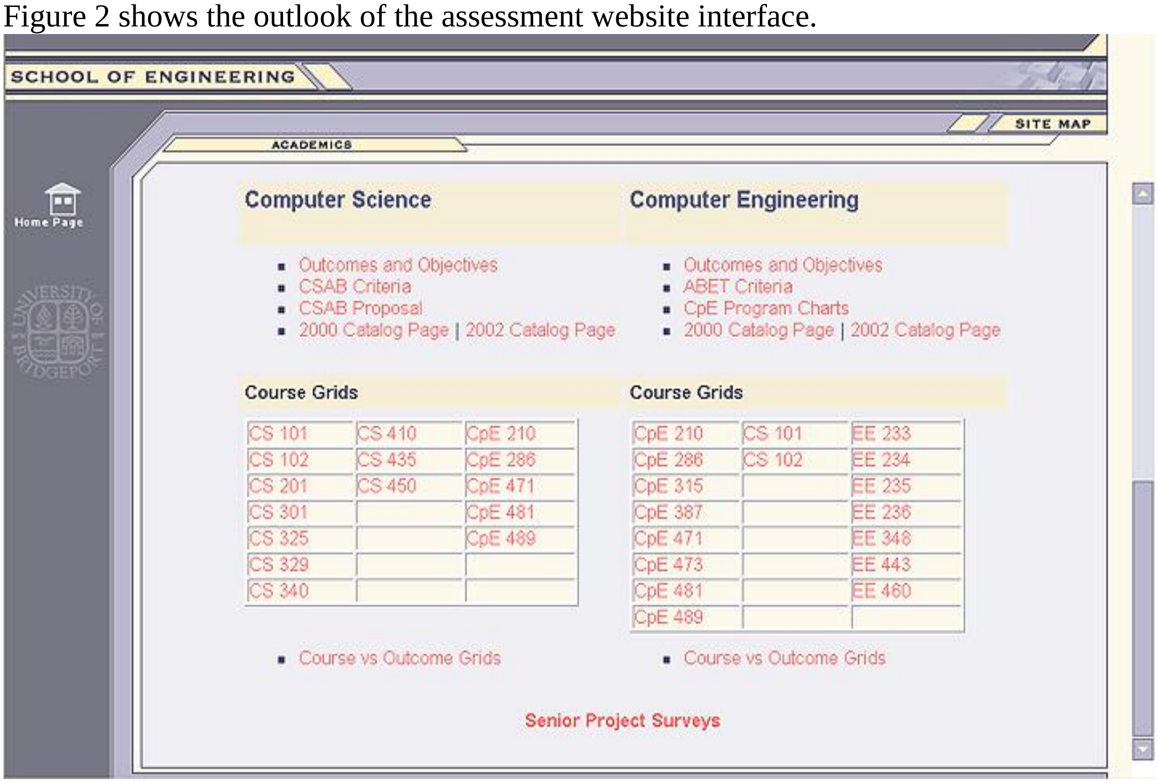


Fig. 2 – *The general outlook of the Assessment Website of School of Engineering*

3.2.2.1. Website Content

Figure 3 shows the structure of the assessment website.

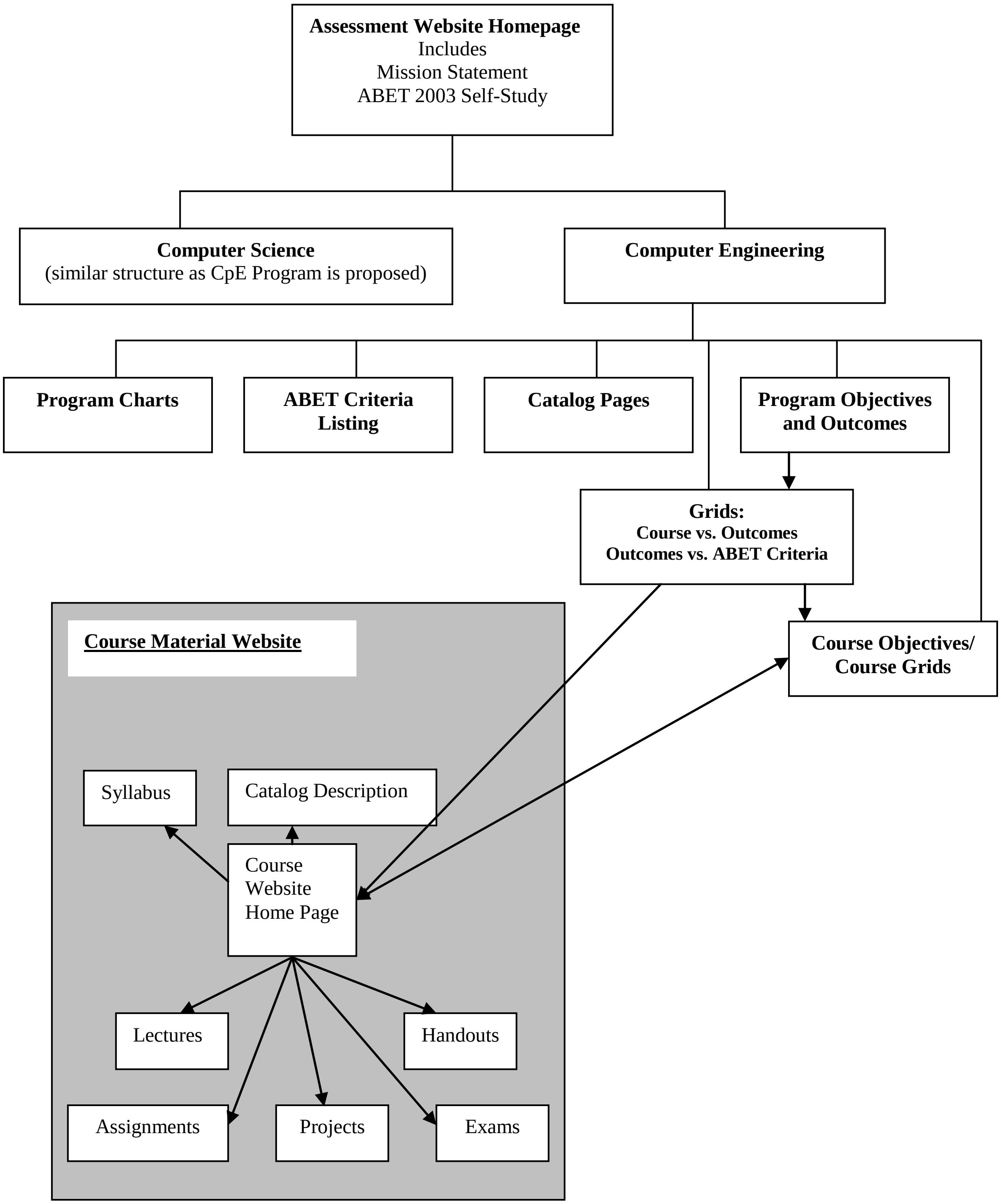


Fig. 3 – *Structure of the Assessment Website*

Figure 4 shows the Outcomes and Objectives page that displays the list of the fifteen outcomes defined by the School of Engineering of the University of Bridgeport.

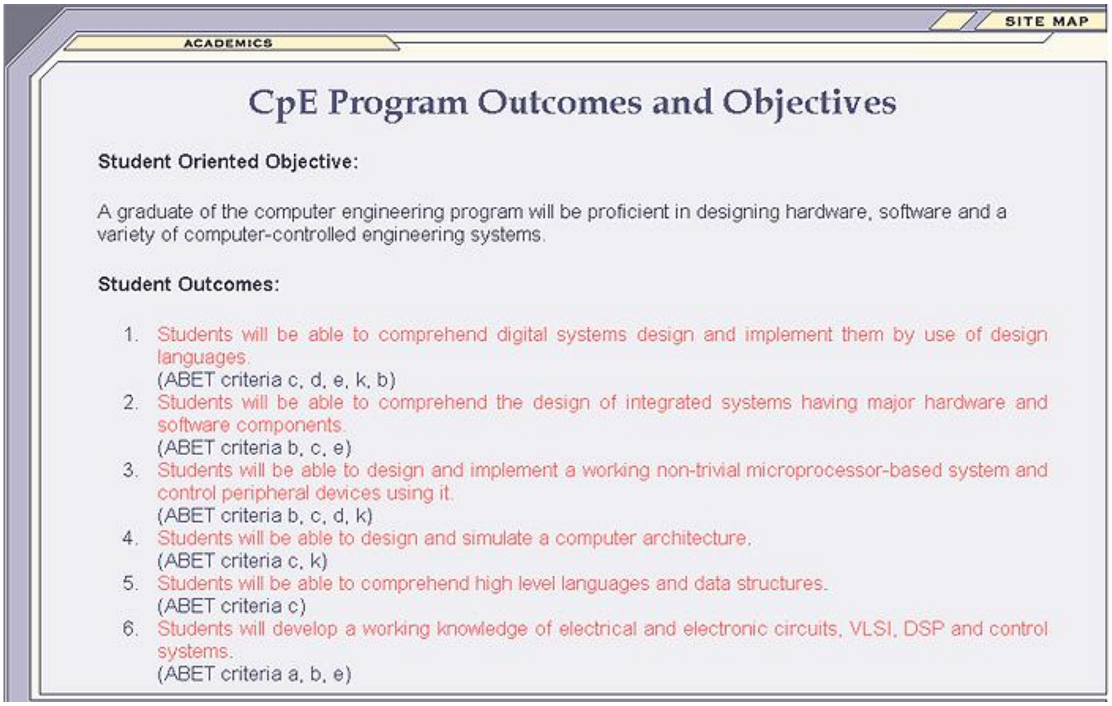


Fig. 4 – *Screenshot of the CpE Outcomes and Objectives Page*

The user can select any outcome from the Outcomes and Objective page. If the user selects Outcome 7, then the Course vs. Outcomes grid is displayed with the Outcome 7 highlighted as shown in Figure 5. Thus, the user can see which course leads to the achievement of the particular outcome and at what level. In Figure 5, for example, one can observe that Engr 111 achieves the outcome at a Beginners level while Engr 300 meets it at a proficient level. Likewise, each of the outcomes is dynamically linked to courses vs. outcomes grid.

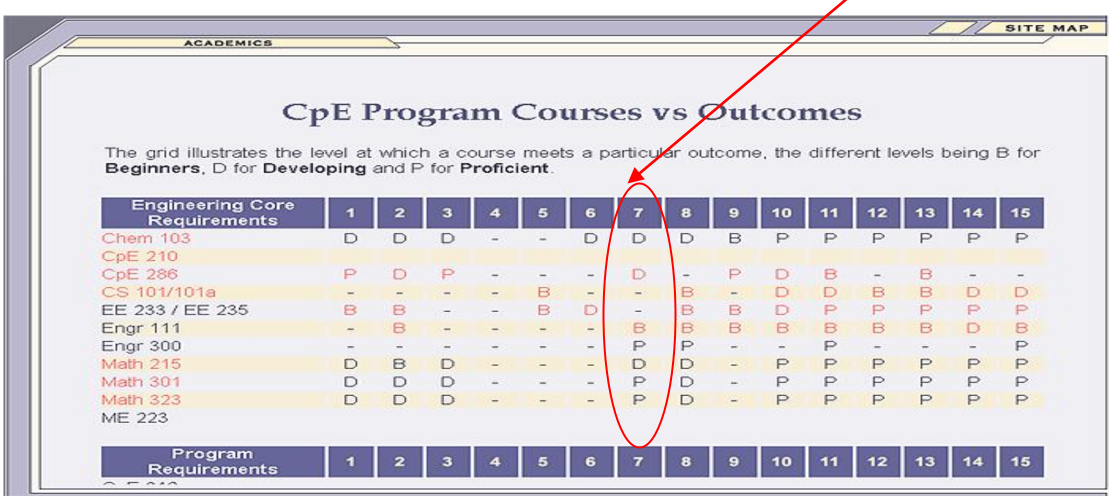


Fig. 5 – *Screenshot of the CpE Courses vs. Outcomes Grid Page*

The Courses vs. Outcomes grid displays a matrix of all the courses from the Computer Engineering (Computer Science) program versus the fifteen outcomes for this program as defined by School of Engineering. In each cell is placed the level with which the outcome is covered in the class:

- “B” – Beginner Level
- “D” – Developer Level
- “P” – Professional Level
- “-” – Non Applicable for the course

The letters are linked to the Course Grid for the course they describe. In the current example, the letter “B” from Outcome 11 for the course CS101/101a will link to two pages as shown in Figures 6 and 7.

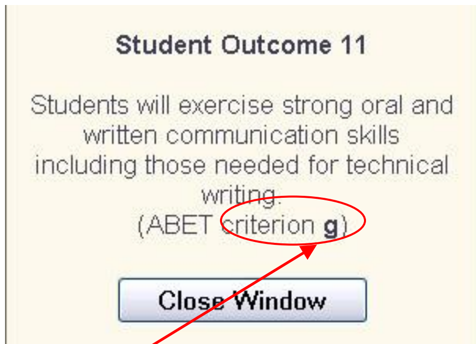
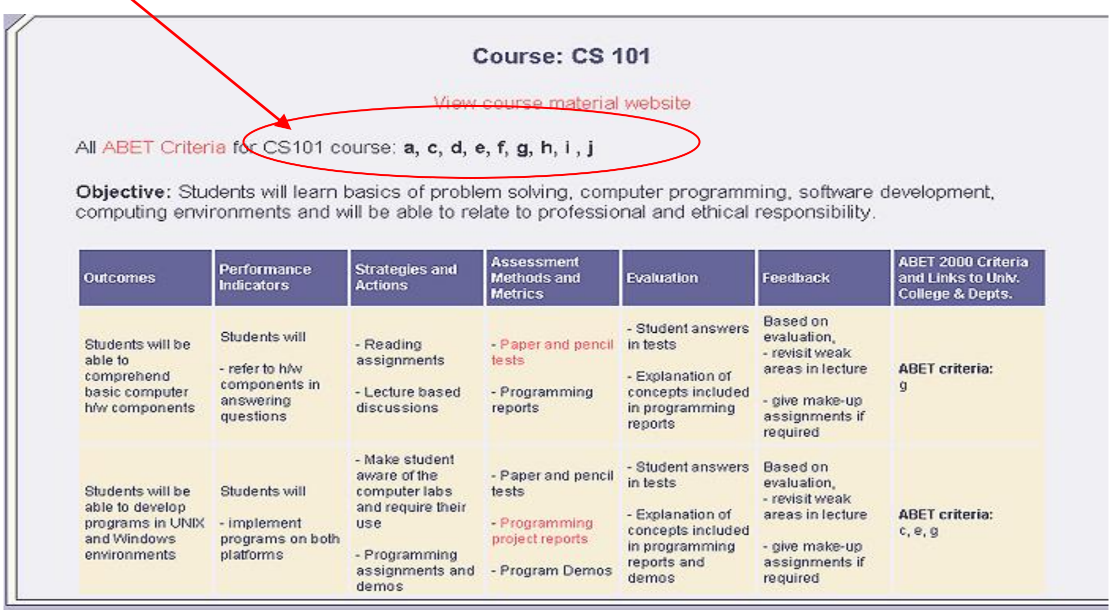


Fig. 6 – *Screenshot of an Outcome description*

The chosen Outcome description is displayed in a pop-up page as a reminder for the accreditation evaluator. The ABET (CSAB) criteria connected to the outcome (in this case “g”) should appear in the list of all ABET (CSAB) criteria applicable for the course. They are listed on the top of the second page that opens - the course grid page as shown in Figure 7.



Course: CS 101

View course material website

All ABET Criteria for CS101 course: **a, c, d, e, f, g, h, i , j**

Objective: Students will learn basics of problem solving, computer programming, software development, computing environments and will be able to relate to professional and ethical responsibility.

Outcomes	Performance Indicators	Strategies and Actions	Assessment Methods and Metrics	Evaluation	Feedback	ABET 2000 Criteria and Links to Univ. College & Depts.
Students will be able to comprehend basic computer h/w components	Students will - refer to h/w components in answering questions	- Reading assignments - Lecture based discussions	- Paper and pencil tests - Programming reports	- Student answers in tests - Explanation of concepts included in programming reports	Based on evaluation, - revisit weak areas in lecture - give make-up assignments if required	**ABET criteria:** g
Students will be able to develop programs in UNIX and Windows environments	Students will - implement programs on both platforms	- Make student aware of the computer labs and require their use - Programming assignments and demos	- Paper and pencil tests - Programming project reports - Program Demos	- Student answers in tests - Explanation of concepts included in programming reports and demos	Based on evaluation, - revisit weak areas in lecture - give make-up assignments if required	**ABET criteria:** c, e, g

Fig. 7 – *Screenshot of a Course Grid Page*

Some of the indicators that students achieve each of the course outcomes are not assessable (for example answering questions in class, reading assignments, etc.) but the collectable materials (quizzes, tests, exams, assignments, projects, etc.) are organized and listed as proof that each outcome is met.

In the current example, the link "Paper and Pencil Tests" will lead the inspector to the following page with certain written tests or quizzes which include questions and tasks evaluating the first outcome as shown in Figure 8.

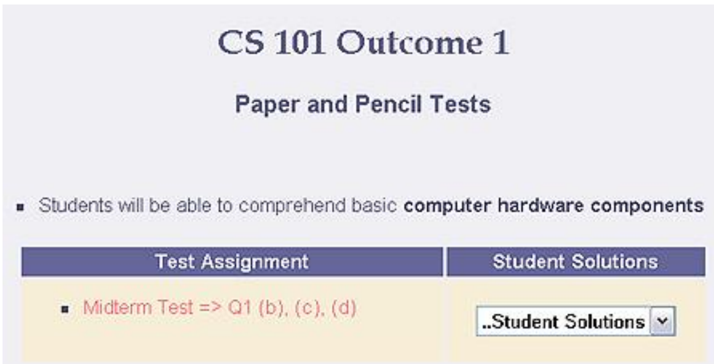


Fig. 8 – *Screenshot of a Course Test Work Page that proves that a certain outcome is covered*

The accreditation evaluator can further check the test assignment, listed questions, as well as the student work samples for this test. Similarly the link "Programming Project Reports" for Outcome 2 will open a page listing all programming assignments that validate this outcome as shown in Figure 9.

Fig. 9 – *Screenshot of a Course Assignment Work Page*

The above example demonstrates the logical path from what is stated to where it is achieved in the program. This can be utilized both by the department as well as the accreditors to assess the program by monitoring if the said outcomes have been met in a satisfactory manner. Another point of interest is to ascertain if the ABET criteria has been met in the curriculum. The aforesaid data can be used to that purpose by using the Outcomes versus ABET criteria grids. Figure 10 shows the compact version of the two grids. Here, for example, if outcomes 6, 7 and 10 have been successfully achieved, ABET criteria 'a' can be claimed to have been attained.

ABET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a						√	√			√					
b		√	√			√			√						
c	√	√	√	√	√										
d	√		√												
e	√	√				√	√								√
f								√					√		
g											√				
h								√				√			
i													√	√	√
j								√				√			
k	√		√	√					√						

Fig. 10 – *Screenshot of Outcomes versus ABET Criteria Grid*

Other than being part of the outcomes based assessment, the evaluator can browse the complete course contents (accessible via the "View course material Website" link) that are organized into separate websites.

3.2.3. Course Material Websites

Figure 11 shows a sample view from the main page of one of the course material websites (CS 102, in this case):

Fig. 11 – *Screenshot with the general outlook of a Course Material Website*

The particular course material is decided in advance by the course instructor and each website is built accordingly. The full set of pages would include Projects, Assignments, Exams, Quizzes, Lectures and Handouts pages. The course Syllabus and Objective are also part of the content. Student sample material can be found in all applicable pages (assignments, projects, exams, quizzes). Figure 12 shows a screen shot of the assignments page.

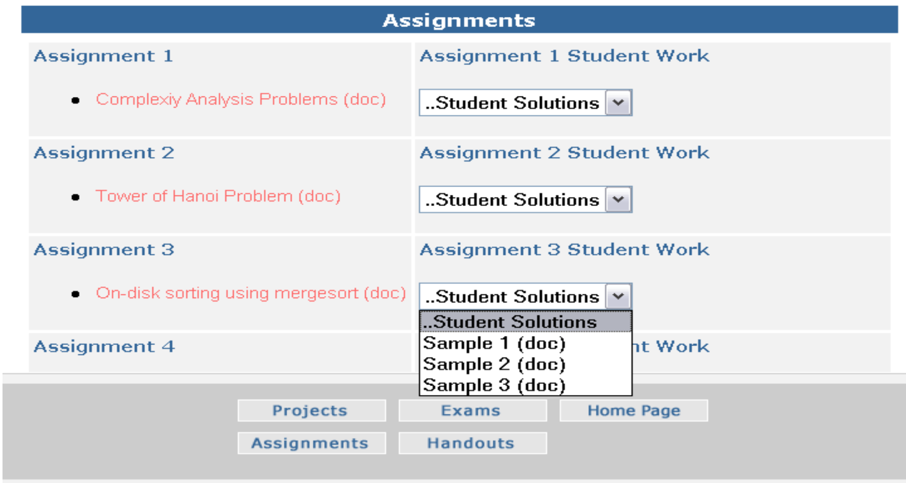


Fig. 12 – *Screenshot of the Assignments Page*

3.2.4. <u>Hardware and Software Used</u>

The system was implemented using the following software:

- Macromedia Dreamweaver MX
- Adobe Photoshop 7.0
- Microsoft Office XP (MS Word, MS PowerPoint, MS Excel)
- Adobe Acrobat 5.0

The Assessment website is best viewed with Internet Explorer 5+. The course content websites require an installed Acrobat Reader 5.0, MS Word and MS PowerPoint for the student work samples preview.

The system was developed and tested on Windows 2000/NT/XP platforms. It is hosted on an Apache Web server.

3.2.5. <u>Privacy and Security</u>

The folder with student sample materials and courses websites on the server is protected by password and only faculty members are able to access it for review purposes. Unauthorized individuals could not access any file in this folder. The files were stored on the University of Bridgeport Apache web server machine that also has very limited access (only the System Administrator and the Webmaster).

The primary author of the paper was the only individual to add and edit in the Course Material Websites as well as the Assessment Website. All course materials are posted as received from the courses' instructors. No student work was exposed in any way to external individuals or used for other purposes but to build the online e-assessment system.

4. Conclusion

This paper presents the School of Engineering of University of Bridgeport's work towards the accreditation visit in the fall of 2003. One goal of the paper is to present the comprehensive, measurable and flexible educational objectives and outcomes as well as their systematic evaluation process.

Another goal of the paper is to describe a new technique for presentation of assessment material for accreditation by ABET and CSAB Criteria for Engineering and Computer Science programs. The e-assessment presentation system is highly integrated and deployed throughout the CS and CpE programs and clearly driven by the School of Engineering outcomes and objectives.

The developed system is to be systematically reviewed and updated to ensure a complete and realistic reflection of the quality of education in the CS and CpE programs of the School of Engineering. It will allow the faculty and instructors to control and evaluate their own teaching techniques and improve the system of education.

The mission of the complete e-assessment system is not only to serve as a presentation tool of the CS and CpE educational programs, but also to be generally viewed as a benchmark by other institutions and programs.

5. References

1. Official ABET Website: http://www.abet.org
2. **Criteria 2000** Evaluator Training: http://www.abet.org/AnnualMeeting/Laptop%20Presentations/Session%207/Jacobson-Town%20Meeting.pdf
3. List with ABET Criteria: http://www.abet.org/criteria.html
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5. Computing Sciences Accreditation Board (CSAB) home page: http://www.csab.org/
6. Council on Higher Education Accreditation: http://www.chea.org/
7. List of CSAB accredited programs: http://www.csab.org/acrsch_jnt.html
8. List of ABET accredited programs: http://www.abet.org/accredited_programs/EACWebsite.html

6. Biographies

RAINA PETROVA received her B.S. and M.S. in Information and Communication Technologies from University of Sofia, Sofia, Bulgaria in 2000 and 2001 and her M.S. in Computer Science from University of Bridgeport, CT, USA in 2003. She is currently employee of Selective Insurance, Glastonbury, CT as a Web Developer.

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TAREK M. SOBH received the B.Sc. in Engineering degree with honors in Computer Science and Automatic Control from the Faculty of Engineering, Alexandria University, Egypt in 1988, and M.S. and Ph.D. degrees in Computer and Information Science from the School of Engineering, University of Pennsylvania in 1989 and 1991, respectively. He is currently the Dean of the School of Engineering at the University of Bridgeport, Connecticut; the Founding Director of the Interdisciplinary Robotics, Intelligent Sensing, and Control (RISC) laboratory; and a Professor of Computer Science and Computer Engineering.

7. Appendices

<u>Appendix A – ABET and CSAB Criteria</u>

ABET Criteria

- a - apply math, science and engineering principles
- b - design and conduct experiments
- c - design a system, comp. or process
- d - function in teams
- e - solve engineering problems
- f - be professional and ethical
- g - communicate effectively
- h - understand global and societal impact
- i - learn life-long
- j - understand contemporary issues
- k - use modern engineering tools

CSAB Criteria

General

- IV-1
  The curriculum must include at least 40 semester hours of up-to-date study in computer science topics.
- IV-2
  The curriculum must contain at least 30 semester hours of study in mathematics and science as specified below under Mathematics and Science.
- IV-3
  The curriculum must include at least 30 semester hours of study in humanities, social sciences, arts and other disciplines that serve to broaden the background of the student.

- IV-4
  The curriculum must be consistent with the documented objectives of the program.

Computer Science

- IV-5
  All students must take a broad-based core of fundamental computer science material consisting of at least 16 semester hours.
- IV-6
  The core materials must provide basic coverage of algorithms, data structures, software design, concepts of programming languages, and computer organization and architecture.
- IV-7
  Theoretical foundations, problem analysis, and solution design must be stressed within the program's core materials.
- IV-8
  Students must be exposed to a variety of programming languages and systems and must become proficient in at least one higher-level language.
- IV-9
  All students must take at least 16 semester hours of advanced course work in computer science that provides breadth and builds on the core to provide depth.

Mathematics and Science

- IV-10
  The curriculum must include at least 15 semester hours of mathematics.
- IV-11
  Course work in mathematics must include discrete mathematics, differential and integral calculus, and probability and statistics.
- IV-12
  The curriculum must include at least 12 semester hours of science.
- IV-13
  Course work in science must include the equivalent of a two-semester sequence in a laboratory science for science or engineering majors.
- IV-14
  Science course work additional to that specified in Standard IV-13 must be in science courses or courses that enhance the student's ability to apply the scientific method.

Additional Areas of Study

- IV-15
  The oral communications skills of the student must be developed and applied in the program.
- IV-16
  The written communications skills of the student must be developed and applied in the program.
- IV-17
  There must be sufficient coverage of social and ethical implications of computing to give students an understanding of a broad range of issues in this area.

Appendix B – School of Engineering Objectives and Outcomes

Computer Engineering Program

Student Oriented Objectives:

1. Students will be proficient in designing hardware, software and a variety of computer-controlled engineering systems. (Program Outcomes 1,2,3,4,5)
2. Students will develop an understanding of contemporary global and societal issues, ethical considerations and communication skills, both oral and written. (Program Outcomes 8,11,12)
3. Student will develop abilities in applying mathematical and scientific tools to solve engineering problems. (Program Outcomes 6,7,9,10)
4. Students will develop skills that will prepare them for employment upon graduation and the ability to undertake life-long learning. (Program Outcomes 13,14,15)

Student Outcomes:

1. Students will be able to comprehend digital systems design and implement them by use of design languages. [ABET criteria c, d, e, k, b]

2. Students will be able to comprehend the design of integrated systems having major hardware and software components. [ABET criteria b, c, e]

3. Students will be able to design and implement a working non-trivial microprocessor-based system and control peripheral devices using it. [ABET criteria b, c, d, k]

4. Students will be able to design and simulate computer architecture. [ABET criteria c, k]

5. Students will be able to comprehend high level languages and data structures. [ABET criteria c]

6. Students will develop a working knowledge of electrical and electronic circuits, VLSI, DSP and control systems. [ABET criteria a, b, e]

7. Students will be able to identify and apply concepts of engineering economics and project planning. [ABET criteria a, e]

8. Students will demonstrate knowledge of contemporary global and societal issues and their relationship to professional ethics and engineering solutions. [ABET criteria f, h, j]

9. Students will be able to plan and conduct laboratory experiments and interpret and report the results. [ABET criteria b, k]

10. Students will demonstrate basic math and science skills. [ABET criterion a]

11. Students will exercise strong oral and written communication skills including those needed for technical writing. [ABET criterion g]

12. Students will develop appreciation of diversity in the world and in intellectual areas such as but no limited to humanities and social sciences. [ABET criteria h, j]

13. Students will be able to function competently in a related entry-level career. [ABET criteria i, f]

14. Students will show the desire and ability to keep learning throughout life. [ABET criterion i]

15. Students will develop the cognitive and analytical skills needed to succeed in graduate programs. [ABET criteria i, e]

Computer Science Program

Student Oriented Objective:

1. A graduate of the computer science program will be proficient in designing and implementing software systems using a variety of programming languages, algorithms, tools and techniques.

Student Outcomes:

1. Students will be able to exercise strong problem solving, analytical and software design skills. [Criteria IV-6, IV-7]

2. Students will be able to comprehend a variety of programming languages and will be proficient in at least two high-level languages. [Criterion IV-8]

3. Students will be able to comprehend and analyze algorithms and data structures. [Criterion IV-6]

4. Students will demonstrate a strong theoretical foundation of computing concepts. [Criterion IV-7]

5. Students will develop a working knowledge of computer organization and architecture. [Criterion IV-6]

6. Students will be able to design and implement industry-like web-enabled applications integrating database and networking skills. [Criteria IV-5, IV-9]

7. Students will be able to identify and apply concepts of computing economics and project planning. [Criterion IV-14 and/or IV-17]

8. Students will demonstrate knowledge of contemporary global and societal issues and their relationship to professional ethics and computing solutions. [Criterion IV-17]

9. Students will be able to plan and conduct laboratory experiments and interpret and report the results. [Criterion IV-13]

10. Students will demonstrate basic math and science skills. [Criteria IV-10, IV-11, IV-12, IV-14]

11. Students will exercise strong oral and written communication skills including those needed for technical writing. [Criteria IV-15, IV-16]

12. Students will develop appreciation of diversity in the world and in intellectual areas such as but not limited to humanities and social sciences.

13. Students will be able to function competently in a related entry-level career.

14. Students will show the desire and ability to keep learning throughout life.

15. Students will develop the cognitive and analytical skills needed to succeed in graduate school programs.

Appendix C – Courses vs. Outcomes Grids

Computer Engineering Program Courses vs. Outcomes grid:

Courses	**Outcome**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Engineering Core Requirements															
Chem 103	D	D	D	-	-	D	D	D	B	P	P	P	P	P	P
CpE 210															
CpE 286	P	D	P	-	-	-	D	-	P	D	B	-	B	-	-
CS 101/101a	-	-	-	-	B	-	-	B	-	D	D	B	B	D	D
EE 233/235	B	B	-	-	B	D	-	B	B	D	P	P	P	P	P
Engr 111	-	B	-	-	-	-	B	B	B	B	B	B	B	D	B
Engr 300	-	-	-	-	-	-	P	P	-	-	P	-	-	-	P
Math 215	D	B	D	-	-	-	D	D	-	P	P	P	P	P	P
Math 301	D	D	D	-	-	-	P	D	-	P	P	P	P	P	P
Math 323	D	D	D	-	-	-	P	D	-	P	P	P	P	P	P
ME 223															
Program Requirements															
CpE 312															
CpE 315															
CpE 387															
CpE 408	-	P	-	-	D	-	-	-	D	-	D	-	-	-	P
CpE 447															
CpE 448															
CpE 449A,B															
CpE 489	-	B	-	-	P	-	P	D	P	P	P	D	P	P	P
CS 102/102a	-	-	-	-	D	-	-	-	B	D	D	B	B	D	D
CS 227	D	D	D	B	D	-	D	D	-	P	P	P	P	P	P
EE 234/236	B	B	B	B	D	P	B	D	D	P	P	P	P	P	P
EE 348	D	D	D	D	P	P	D	P	P	P	P	P	P	P	P
EE 460	P	P	D	P	P	P	P	P	P	P	P	P	P	P	P
EE 443	P	P	D	P	P	P	P	P	P	P	P	P	P	P	P
Engl 204															
Math 214/314	D	D	D	B	-	-	P	D	-	P	P	P	P	P	P
2 Technical Electives															
1 Free Elective															
General Education Requirements															
Engl C101	-	-	-	-	-	-	-	B	B	-	B	B	B	B	B
Math 110	D	B	D	-	-	-	D	D	-	B	D	D	D	P	D
Math 112	D	B	D	-	-	-	D	D	-	D	P	D	P	P	P
Phys 111	D	D	D	-	-	D	D	D	B	D	P	P	P	P	P
Phys 112	D	D	D	-	-	D	D	D	D	D	P	P	P	P	P
Hum C201	-	-	-	-	-	-	-	D	-	-	D	P	B	B	D
Hum C202	-	-	-	-	-	-	-	D	-	-	D	P	B	B	D
SoSc C201	-	-	-	-	-	-	-	D	D	-	D	P	B	B	D
SoSc C202	-	-	-	-	-	-	-	D	D	-	D	P	B	B	D
IntSt C101															
A&D C101	-	-	-	-	-	-	-	D	-	-	B	B	B	B	B
Caps C390	-	-	-	-	-	-	-	D	-	-	P	P	D	B	D
Choice of Technical Electives															
CpE 410															
CpE 460	-	P	D	-	-	P	-	-	P	-	D	-	-	-	P
CpE 471															
CpE 473	-	-	-	-	-	-	D	-	-	B	B	-	D	-	-

Computer Science Program Courses vs. Outcomes grid:

Courses	Outcome														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Math and Science Requirements															
Math 110	B	-	-	D	-	-	D	D	-	B	D	D	D	P	D
Math 112	B	-	-	P	-	-	D	D	-	D	P	D	P	P	P
Math 215	P	-	-	P	-	-	D	D	-	P	P	P	P	P	P
Math 323	P	D	-	P	-	-	P	D	-	P	P	P	P	P	P
Math Elective (one out of three)															
Math 214 (elective)	P	D	-	P	-	-	P	D	-	P	P	P	P	P	P
Math 314 (elective)	P	D	-	P	-	-	P	D	-	P	P	P	P	P	P
CS 340 (elective)	P	-	D	-	-	-	-	-	-	P	-	-	P	D	P
Phys 111	P	-	-	-	-	-	D	D	B	D	P	P	P	P	P
Phys 112	P	-	-	-	-	-	D	D	D	D	P	P	P	P	P
Science Elective															
Humanities Requirements															
Engl C101	-	-	-	-	-	-	-	B	B	-	B	B	B	B	B
FA C101	-	-	-	-	-	-	-	B	-	-	B	B	B	B	B
IntSt C101															
Engl 204															
Hum C201	-	-	-	-	-	-	-	D	-	-	D	P	B	B	D
Hum C202	-	-	-	-	-	-	-	D	-	-	D	P	B	B	D
SoSc C201	-	-	-	-	-	-	-	D	D	-	D	P	B	B	D
SoSc C202	-	-	-	-	-	-	-	D	D	-	D	P	B	B	D
Caps C390	-	-	-	-	-	-	-	D	-	-	P	P	D	B	D
2 Humanities Electives															
Core Requirements															
CS 101/101a	B	B	B	B	-	-	-	B	-	D	D	B	B	D	D
CS 102/102a	D	D	D	D	-	-	-	-	B	D	D	B	B	D	D
CS 201	D	D	D	D	B	B	B	B	D	D	B	B	D	D	D
CS 203	P	D	D	D	D	-	-	-	-	D	D	-	P	D	P
CS 227	P	D	P	P	-	-	D	D	-	P	P	P	P	P	P
CpE 210															
CpE 286	D	-	-	D	D	-	D	-	P	D	B	-	B	-	-
CS 300	P	-	-	-	-	B	P	P	-	-	P	-	-	-	P
CS 301	P	P	D	P	D	-	D	B	D	D	D	D	-	P	P
CS 329	P	-	P	-	-	-	-	-	-	P	D	-	P	D	P
CS 311															
CpE 408	P	D	D	D	D	-	-	-	D	-	D	-	-	-	P
CS 449															
CS 450	D	D	D	D	D	P	D	D	P	D	D	D	D	P	D
CpE 471															
CS 489	P	P	P	P	P	P	P	D	P	P	P	D	P	P	P
3 CS Electives															
Free Elective															
2 Technical Electives															
CpE 481															
CS 435	D	-	-	D	-	-	B	-	-	D	B	-	P	-	-
CS 410	D	P	D	D	B	P	B	B	D	-	D	D	D	P	D
CS 460	P	-	-	-	-	-	-	-	P	-	D	-	-	-	P

Appendix D – Outcomes vs. ABET Criteria Grid

ABET Criteria	Program Outcomes														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
A						√	√			√					
B		√	√			√			√						
C	√	√	√	√	√										
D	√		√												
E	√	√				√	√								√
F								√					√		
G											√				
H								√				√			
I													√	√	√
J								√				√			
K	√		√	√					√						

Outcomes vs. ABET criteria (Detailed)
Here, the expanded view of the second row is depicted. For the complete grid please refer to http://assesseng.bridgeport.edu/grids.htm.

ABET Criteria	Program Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
b		CPE 286 (D) ENGR 111 (B) CPE 315 (D) CPE 387 (P) CPE 408 (P) CPE 447 (D) CPE 449 (P) CPE 489 (B) CPE 460 (P)	CPE 286 (P) CPE 387 (P) CPE 447 (D) CPE 449 (P) CPE 460 (B)			CPE 448 (P) EE 348 (B) EE 360 (B) EE 443 (B) CPE 460 (P)			CPE 210 (D) CPE 286 (P) ENGR 111 (B) CPE 315 (D) CPE 387 (P) CPE 408 (D) CPE 447 (P) CPE 448 (D) CPE 449 (P) CPE 489 (P) CS102 (B) EE 360 (P) EE 443 (P) CPE 481 (P) CPE 460 (P)						

Appendix E – Sample Course Grid

CS 101 Course grid with ABET and CSAB Criteria:

Outcomes	**Performance Indicators**	**Strategies and Actions**	**Assessment Methods and Metrics**	**Evaluation**	**Feedback**	**ABET 2000 Criteria and Links to Univ., College & Depts.**
Students will be able to comprehend basic computer h/w components	Students will refer to h/w components in answering questions	Reading assignments Lecture based discussions	Paper and pencil tests Programming reports	Student answers in tests Explanation of concepts included in programming reports	Based on evaluation, revisit weak areas in lecture give make-up assignments if required	ABET criteria: g CSAB criteria: IV-6, IV-7, IV-8, IV-16
Students will be able to develop programs in UNIX and Windows environments	Students will implement programs on both platforms	Make student aware of the computer labs and require their use Programming assignments and demos	Paper and pencil tests Programming project reports Program Demos	Student answers in tests Explanation of concepts included in programming reports and demos	Based on evaluation, revisit weak areas in lecture give make-up assignments if required	ABET criteria: e, g CSAB criteria: IV-6, IV-7, IV-8, IV-16
Students will be able to solve problems through programming	Students will participate in class discussions implement programs to solve problems	Lecture based discussions Programming assignments	Paper and pencil tests Programming project reports	Student answers in tests Explanation of concepts included in programming reports	Based on evaluation, revisit weak areas in lecture give make-up assignments if required	ABET criteria: e, g CSAB criteria: IV-6, IV-7, IV-8, IV-16
Students will be able to exercise the basics of object-oriented design and programming	Students will participate in class discussion implement programs using object-oriented approach	Lecture based discussions Programming assignments and demos	Paper and pencil tests Programming project reports Program demos	Student answers in tests Explanation of concepts included in programming reports and demos	Based on evaluation, revisit weak areas in lecture give make-up assignments if required	ABET criteria: e, g CSAB criteria: IV-6, IV-7, IV-8, IV-16
Students will be able to exercise the basics of object-oriented design and programming	Students will participate in class discussion implement programs using object-oriented approach	Lecture based discussions Programming assignments and demos	Paper and pencil tests Programming project reports Program demos	Student answers in tests Explanation of concepts included in programming reports and demos	Based on evaluation, revisit weak areas in lecture give make-up assignments if required	ABET criteria: e, g
Students will be able to cite and relate to the code of ethics outlined by the ACM	Students will participate in class discussion prepare and present a project based on the ACM code of ethics	Project presentation and written report based on ACM code of ethics	Paper and pencil tests Project presentation Project report	Student answers in tests Presentation of material in the ethics assignment report	Based on evaluation, revisit relevant topics in lecture	ABET criteria: d, f, g, h CSAB criteria: IV-15, IV-16, IV-17

NOTE: *For all the stated assessment methods, student progress is systematically documented based on established rubrics.*