

B.4 CRITERION 4 - CONTINUOUS IMPROVEMENT

B.4.1 Information Used for Program Improvement

B4.1.1 Fundamentals of Engineering Exam Results

CEE FE Exam results for the period of October 2002 through October 2007 are shown below in Table 4-1.

Table 4-1. Results of the Fundamentals of Engineering Exam, Number Taking Exam and Pass Rate (percent)

| Academic Semester | TTU Civil Engineering | | | National | | |
|---------------------|-----------------------|----|-------------------------|----------|----|-------------------------|
| | Number | % | Four Semester Average % | Number | % | Four Semester Average % |
| April 2003 | 39 | 87 | 88 | 4009 | 79 | 78 |
| October 2003 | 20 | 90 | 87 | 1697 | 81 | 80 |
| April 2004 | 30 | 83 | 88 | 4379 | 74 | 78 |
| October 2004 | 21 | 90 | 88 | 1809 | 75 | 77 |
| April 2005 | 32 | 75 | 85 | 4753 | 79 | 77 |
| October 2005 | 16 | 75 | 81 | 3147 | 64 | 73 |
| April 2006 | 24 | 63 | 76 | 4945 | 71 | 72 |
| October 2006 | 18 | 78 | 73 | 2702 | 71 | 71 |
| April 2007 | 17 | 76 | 73 | 4045 | 76 | 71 |
| October 2007 | 26 | 88 | 76 | 2893 | 72 | 73 |

As described in Section B.3, the performance success criterion for FE Exam is that the average pass rate for CEE students taking the exam for the first time should meet or exceed the national average. A four-semester running average is used for the comparison. The data in Table 4-1 shows that the average four-semester pass rate for graduating seniors in Civil Engineering is above the national average consistently. This comparison indicates that the required percent passing rate has been met for the past six years. The results also appear to be consistent with the responses to the question on the 2000 - 2005 alumni survey regarding quality of courses in preparation for employment.

The FE Exam subject average scores of TTU Civil Engineering students are also compared with the national average scores, as recommended in the last ABET Review Report. Before October 2005, the 12 subjects in the FE morning session included Chemistry, Computers, Dynamics, Electrical Circuits, Engineering Economics, Ethics, Fluid Mechanics, Mater Science, Math, Mechanics of Material, Statics, and Thermodynamics. The 11 subjects in afternoon session were Construction Management, Computer & Numerical Methods, Environmental Engineering, Hydraulic/Hydrology Systems, Legal & Professional Aspects, Structural Analysis,

Structural Design, Soil Mechanics & Foundation, Surveying, Transportation Facilities, and Water Purification & Treatment. Since October 2005, the subjects in the FE morning session have been changed to Mathematics, Engineering Probability & Statistics, Chemistry, Computers, Ethics/Business Practices, -Engineering Economics, Engineering Mechanics (Statics/Dynamics), Strength of Materials, Material Properties, Fluid Mechanics, Electricity & Magnetism, and Thermodynamics. The number of subjects in the FE afternoon session has been reduced to nine, which include Surveying, Hydraulics/Hydrologic Systems, Soil Mechanics & Foundations, Environmental Engineering, Transportation, Structural Analysis, Structural Design, Construction Management, and Materials.

Figure 4.1 shows the TTU success rates and the national averages rates under all exam subjects in April and October 2003 (old format) and April and October 2007 (new format). The comparisons give an insight on how well the TTU students have learned through their education at Tennessee Technological University and how much they have mastered on various subjects. For majority of the subjects, the TTU scores are higher than the national average scores. Noticeably, TTU subject ratings in the afternoon sessions are consistently higher than the national ratings except for a few outliers. The strength of TTU students are clearly on the CEE major technical subjects.

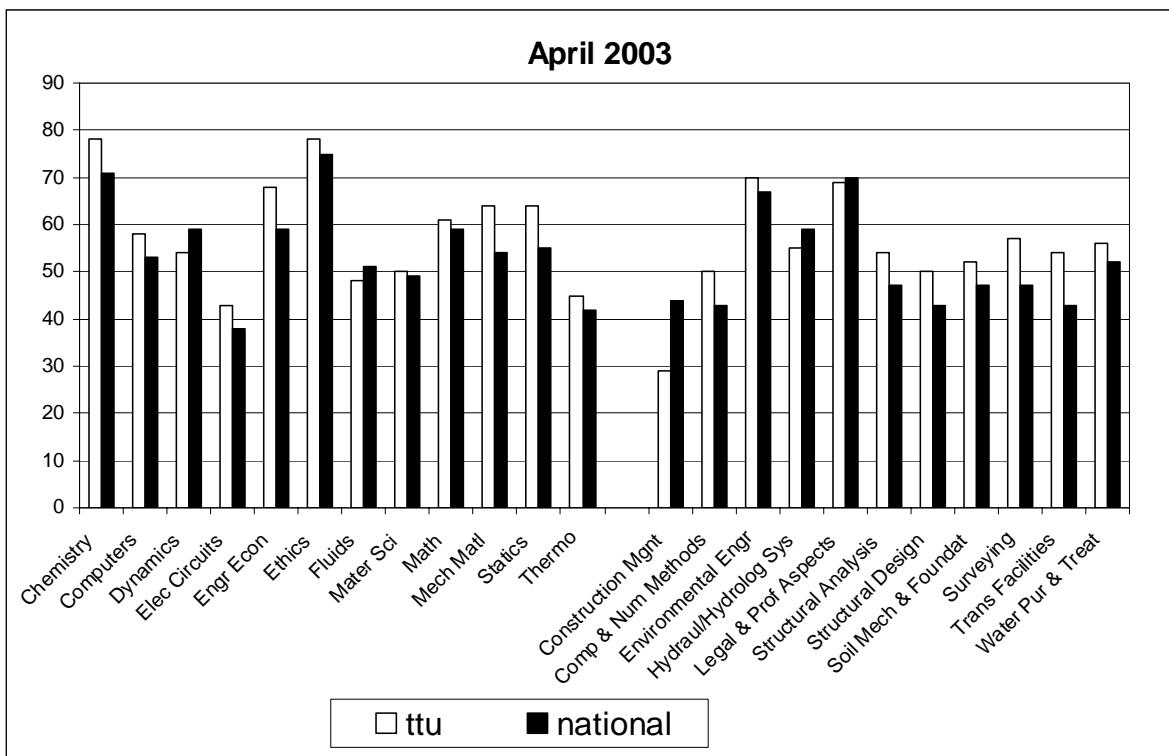


Figure 4.1(a) Subject Results of the Fundamentals of Engineering Exam (April 2003)

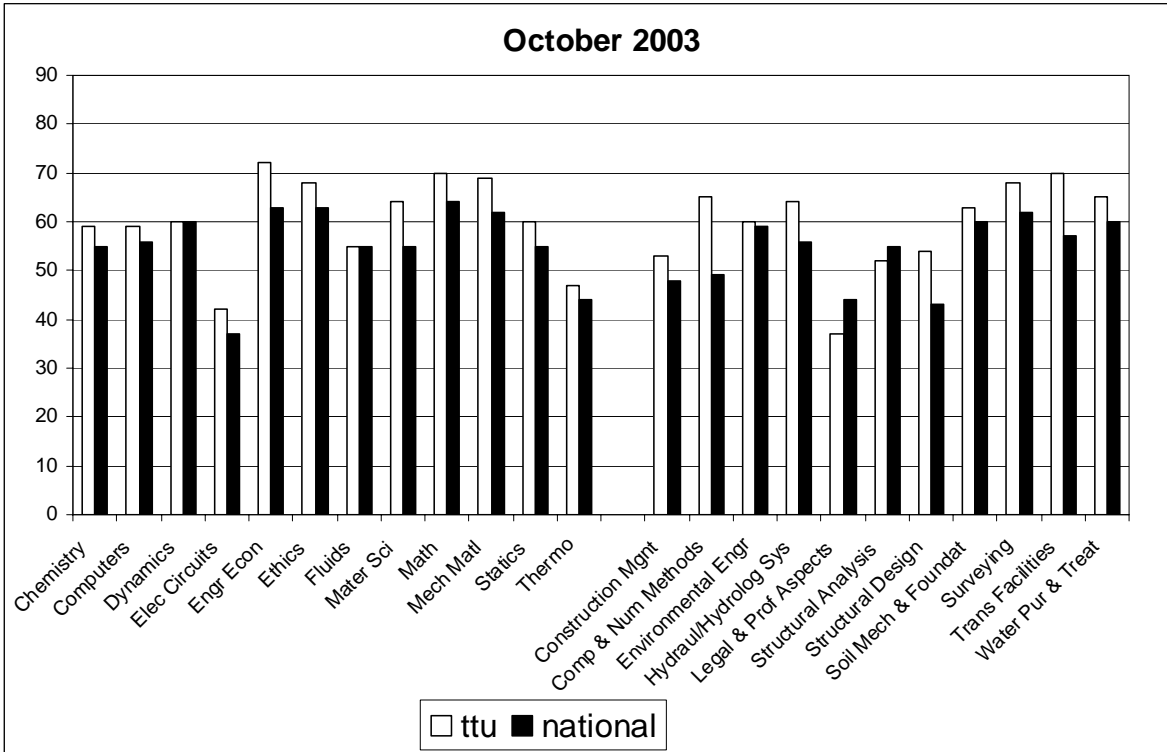


Figure 4.1(b) Subject Results of the Fundamentals of Engineering Exam (October 2003)

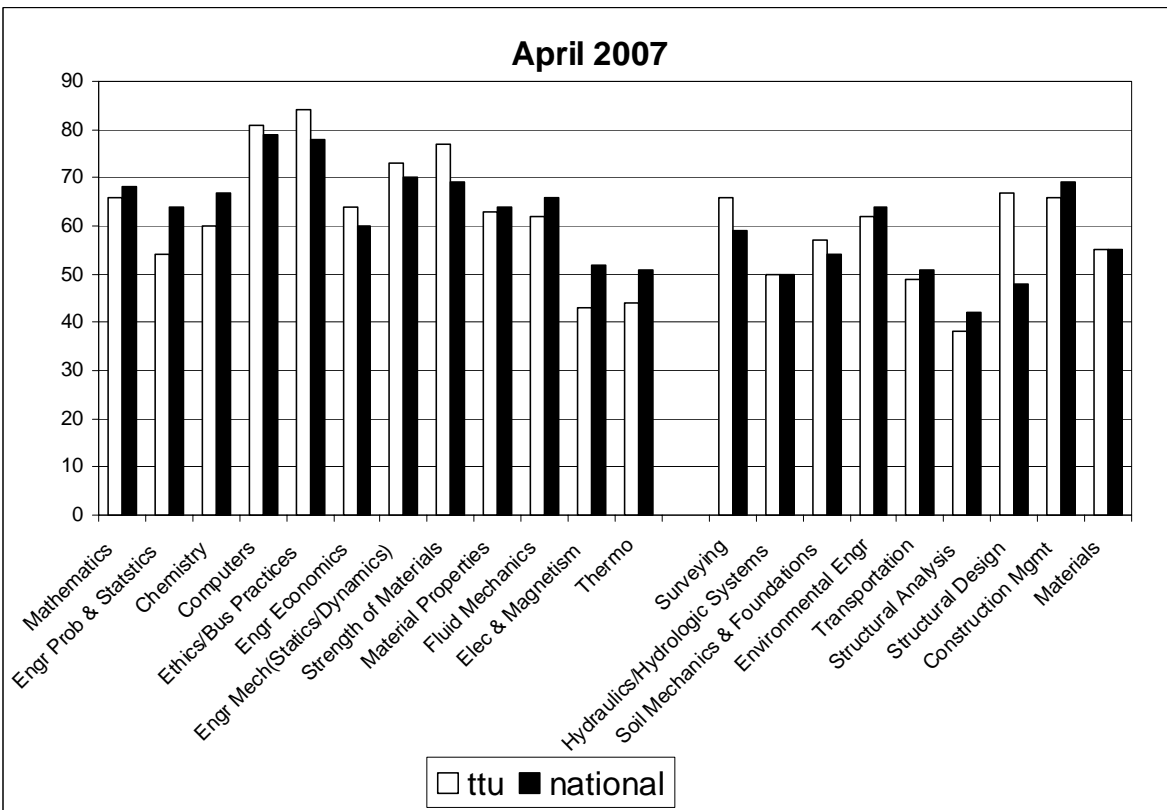


Figure 4.1(c) Subject Results of the Fundamentals of Engineering Exam (April 2007)

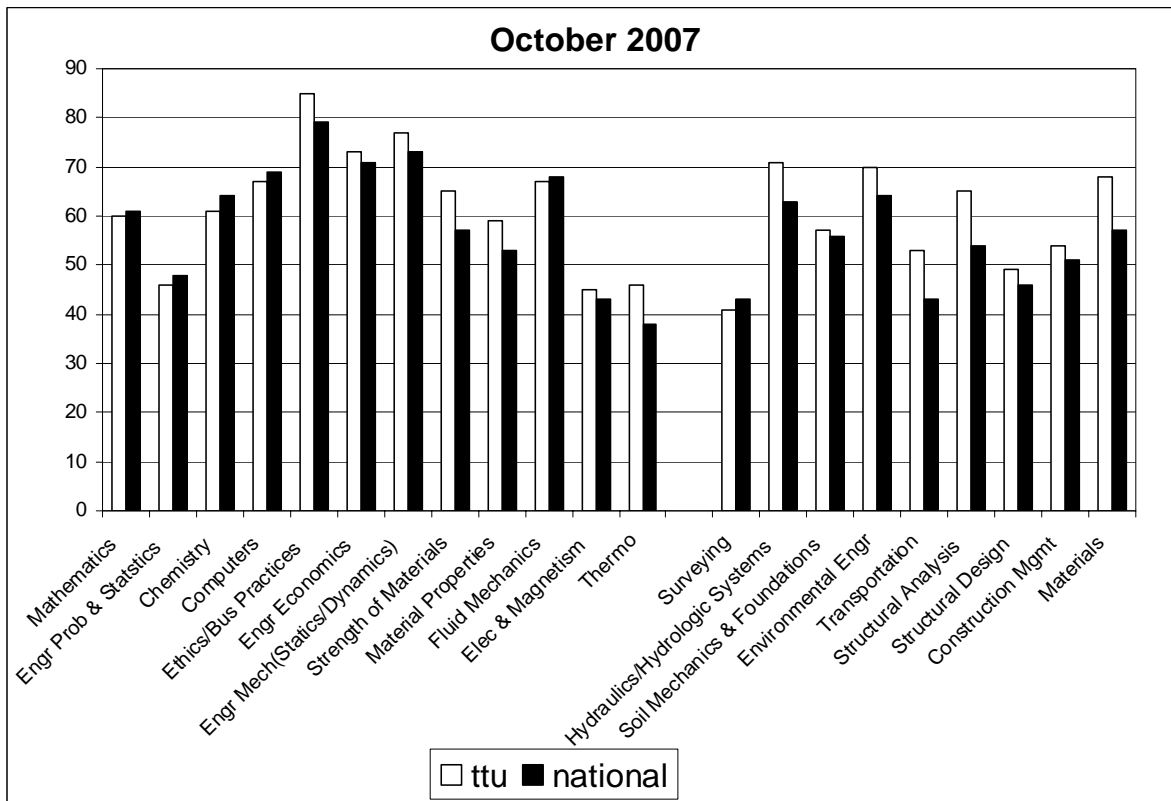


Figure 4.1(d) Subject Results of the Fundamentals of Engineering Exam (October 2007)

B.4.1.2 College Based Exam Results

Based on the available data at the university, the graduating CEE students' composite scores were 355 and 349 for academic years 2004-2005 and 2003-2004, respectively. These results are consistent with the historical data and exceed the university composite scores of 304 and 312 for the same periods. This superior performance of CEE students in comparison to the performance benchmark established meant that no deficiencies were identified and therefore no actions were required. Beginning in 2005, the university adopted the California Critical Thinking Skills Test (CCTST) as the format for College Base Exam. The graduating CEE students' CCTST scores were 23.4 and 21.2 for academic years 2005-2006 and 2006-2007, respectively. These average scores are higher than the university average scores of 18.6 and 18.9 for the same periods.

B.4.1.3 Graduating Senior Survey Results

The CEE Department has been continuously conducting outcome assessment surveys with the graduating seniors for the past five years. A summary of the results for each year is presented in Appendix E.6. In reviewing the survey results presented in this section, it should be noted that there are currently no annual survey results for Outcome 12 since it was recently added in fall semester 2007.

The results to date have shown that the CEE students are very satisfied with the depth of knowledge in fundamentals of engineering, the knowledge gained in the major area of interest, and the overall Civil Engineering program. It was also observed that the percentage of favorable responses (percent agree and strongly agree) was overwhelmingly higher than the negative responses (percent disagree or strongly disagree).

The first 17 questions in the Exit Interview Questionnaire are directly related to the CEE Program Outcomes and curriculum. Table 4-2 lists a summary of Graduating Senior Surveys in fall 2007 as well as the correlations between CEE Program Outcomes and the questions in the surveys. Of the 11 Outcomes, 10 Outcomes were rated over 80% as 'strongly agree' and 'agree'. One outcome (#11) on the awareness of the significance of applied research received a rate of 70% of favorable responses. This favorable rating value caught the attention of the CEE Chairperson and members of the ABET committee. To determine whether or not prompt remedial action was required, a summary of five years of Graduating Senior survey data shown below in Figures 4.2 (a) to 4.2 (d) were examined. These indicated that the lower rate obtained for fall 2007 could not be affirmatively described as part of a consistent downward trend on the attainment of this Outcome since in each of the six semesters preceding spring 2007, the favorable rating had been about 90%. Thus no immediate action beyond continued monitoring was required.

Again, observing Figures 4.2 (a) – (d), which shows the summary of five years of Graduating Senior Surveys versus the program Outcomes, it is observed that for Outcomes 1, 2, 3, 4, 6, 7, 8, and 10, the satisfactory rates are consistently in the range of 80% to 90%. In one semester, the favorable rate for Outcome #6 'Multidisciplinary Teams' dropped to 55%. However, the single-data could be anomalous as the rate of satisfactory rose to the 90% range afterwards. Outcome #5 is another outcome that displays the variation of satisfactory rates. Outcome 5.1-5.3 cover written communication skills and Outcome 5.4-5.5 deal with oral communication skills. Lower satisfactory rates of Outcome 5.1-5.3 (63, 74) and Outcome 5.4-5.5 (68, 69) are observed in fall 2005 and spring 2006 semesters. Although the results are clearly higher than 50%, the variation could suggest a possible concern. Several actions at university level and departmental level have been taken to address the issue. It can be observed that the satisfactory rates in the later semesters are clearly improved. Outcome #9 was rated, in general, with a high percentage of satisfactory responses. However, one question under Outcome #9, knowledge of contemporary issues, consistently received lower satisfactory rates with an average of 59% for past five years. The lower rating of this question could highlight another possible concern. For Outcome #11, except for a few outliers, the satisfactory rates in the majority of semesters for the last five years demonstrate the achievement of this Outcome.

Questions 18 through 23 are used for the assessment of CEE faculty and facilities. Of the six questions, only one question on lab facilities received a consistently lower satisfactory rate, ranging from 50% to 80%. The other survey-statements had 75 to 100% of the respondents indicating either "Agree" or "Strongly Agree" with the survey statement.

Although none of responses on individual Program Outcome constituted less than 50% of combined "agree or strongly agree," the Department ABET advisory committee did review and discuss the results. The reviews of the results by the ABET committee and by the CEE faculty resulted in actions in response to Outcomes #5 and #9 dealing with communication skills and knowledge of contemporary issues, respectively. Actions were also taken to resolve the concern on laboratory facilities. These are documented in B.4.2 - Actions to Improve the Program.

Table 4-2. Summary of Graduating Senior Surveys from Fall Semester 2007 Senior

| Program Outcome # | Program Outcome Description | Question # on Senior Survey | % Agree or Strongly Agree from Graduating Seniors |
|--------------------------|---|------------------------------------|--|
| 1 | Knowledge of math, science, engineering | 1 | 100 |
| 2 | Comprehension of Civil Engineering areas | 14 | 100 |
| 3 | Explaining professional registration process | 15 | 85 |
| 4 | Identifying, formulating, and solving engineering problems | 3 and 4 | 95 and 100 |
| 5 | Effective communication skills | 7 and 8 | 85 and 90 |
| 6 | Multidisciplinary teams | 6 | 89 |
| 7 | Conducting experiments and analyzing data | 2 and 5 | 100 and 90 |
| 8 | Techniques, skills, modern tools for engineering practice | 9 | 89 |
| 9 | Understanding professional and ethical responsibility and contemporary issues | 10, 11 and 13 | 100, 100, and 68 |
| 10 | Need for life-long learning | 12 | 89 |
| 11 | Awareness of the significance of applied research | 16 | 70 |
| 12 | Engineering management, business, public policy, and leadership | Not available | |

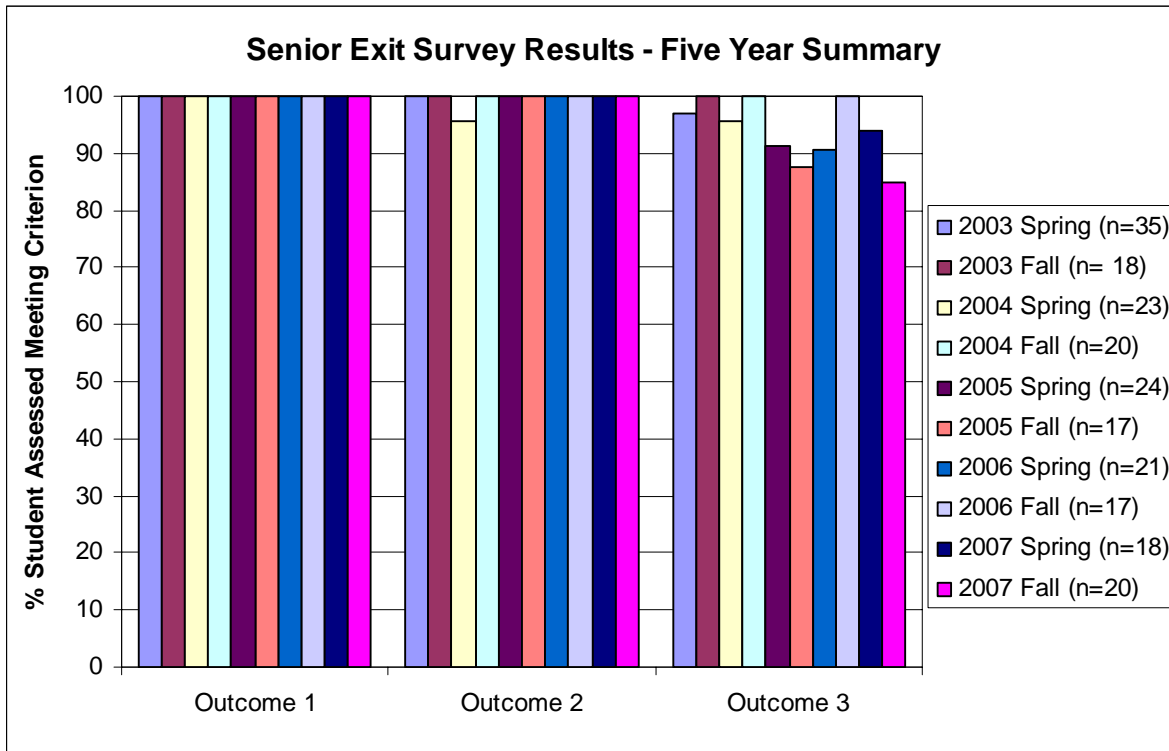


Figure 4.2 (a) Five-year Summary of Graduating Senior Surveys (Outcomes 1-3)

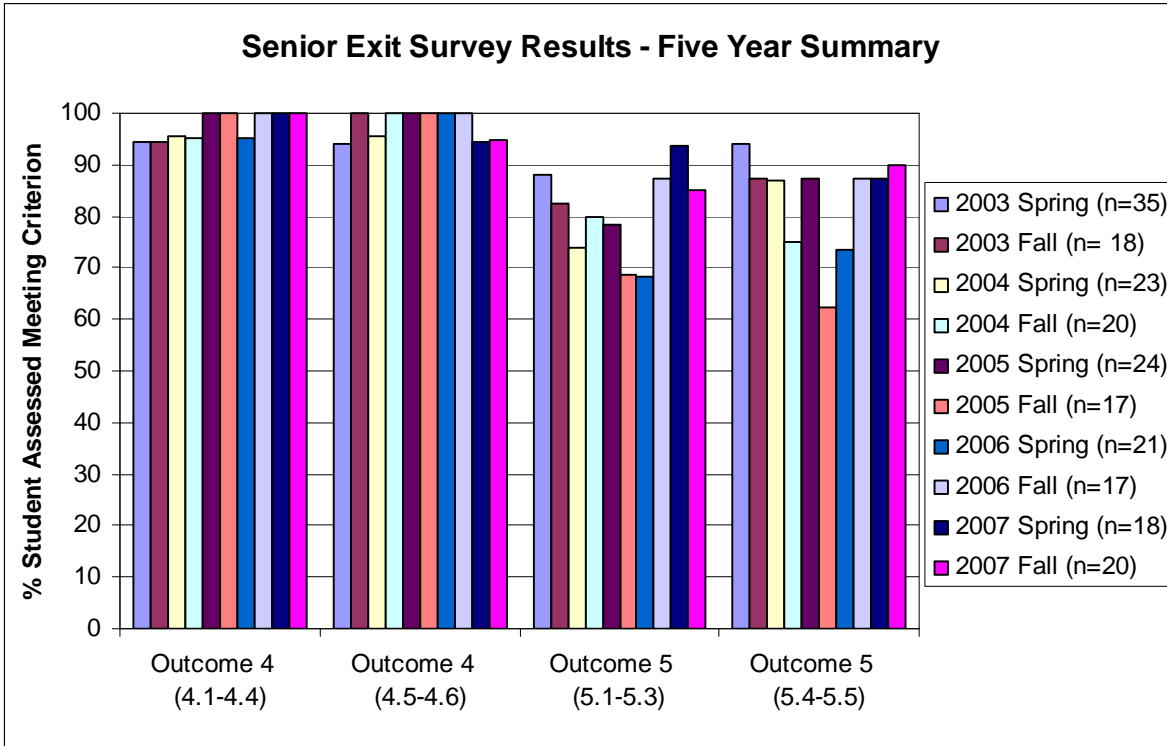


Figure 4.2 (b) Five-year Summary of Graduating Senior Surveys (Outcomes 4-5)

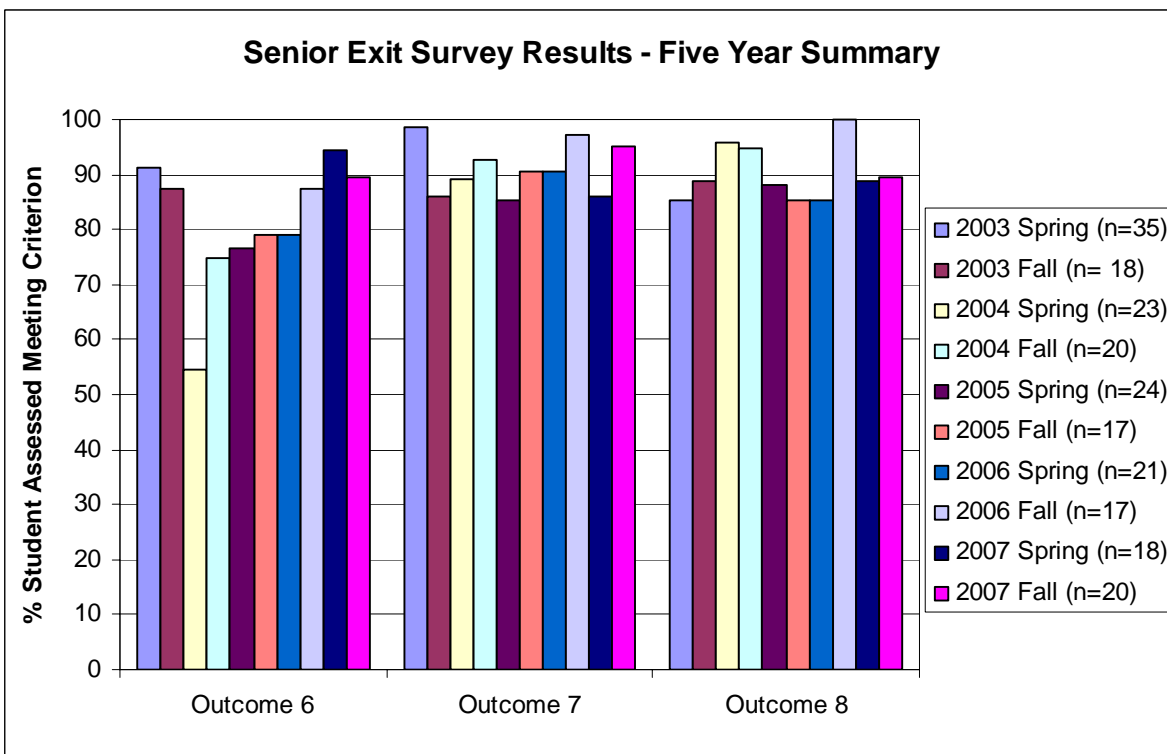


Figure 4.2 (c) Five-year Summary of Graduating Senior Surveys (Outcomes 6-8)

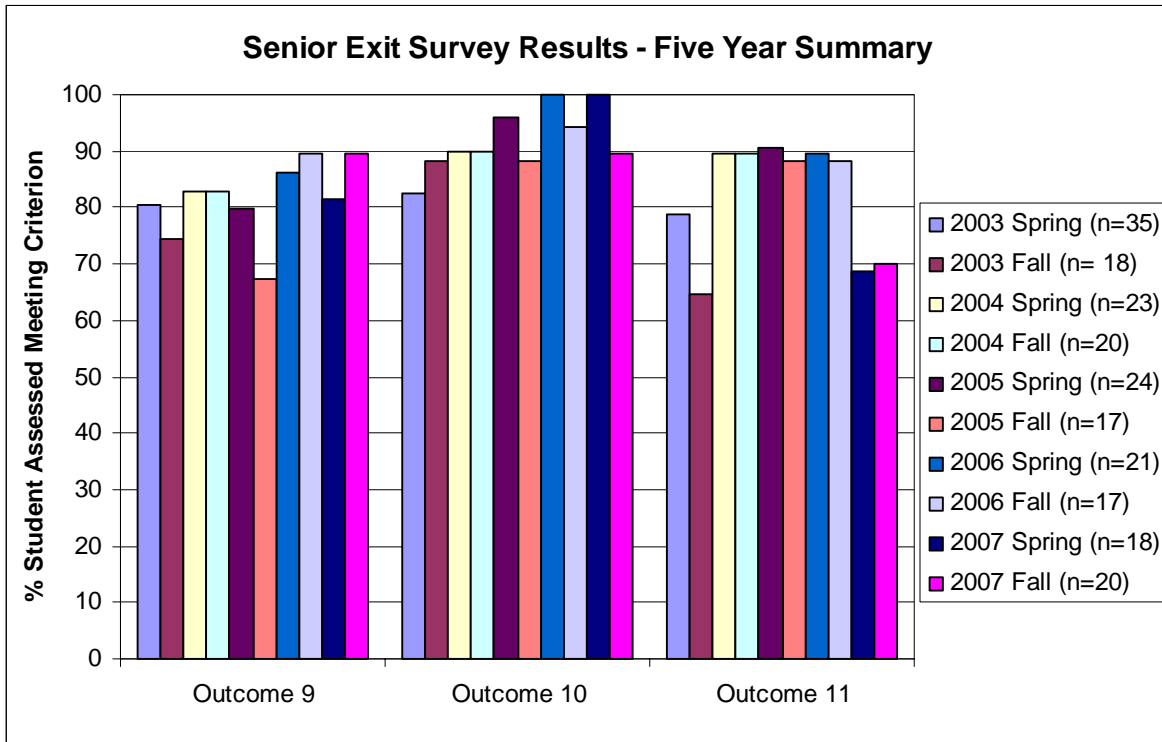


Figure 4.2 (d) Five-year Summary of Graduating Senior Surveys (Outcomes 9-11)

B.4.1.4 One-Year Alumni Survey Results

The CEE Department has been continuously conducting one-year surveys of Civil Engineering graduates. The results from the one-year alumni survey are used primarily for the assessment of Program Outcomes. The summary of the one-year alumni survey results is presented in Appendix E.8. There are 41 statements on the one-year survey. The first 17 statements directly relate to the CEE Program Outcomes and CEE curriculum. Statements 18 to 23 relate to CEE faculty and facilities. Finally, the last 18 statements relate to the quality of course work taken at Tennessee Technological University.

Table 4-3 shows the summary of the one-year alumni surveys for students who graduated in 2005 and 2006. From the results for the 2005 graduates, all of the eleven Outcomes had more than 80% of the respondents strongly agreeing or agreeing with the survey statements. From the results for 2006 graduates, ten Outcomes had more than 80% of the respondents strongly agreeing or agreeing with the survey statements, while the Outcome on communication skills received a favorable rating that is less than 80% but still higher than the 50% benchmark below which action is required. It is also noted that the question on knowledge of contemporary issues (under Outcome #9) received relatively lower favorable rate of around 70%.

Table 4-3. Summary of One-Year Alumni Survey from 2005 and 2006 graduates

| Outcome # | Program Outcome Description | Question # on Alumni Survey | % Agree or Strongly Agree | |
|-----------|---|-----------------------------|---------------------------|-----------------|
| | | | 2005 graduates | 2006 graduates |
| 1 | Knowledge of math, science, engineering | 1 | 100 | 100 |
| 2 | Comprehension of Civil Engineering areas | 14 | 100 | 100 |
| 3 | Explaining professional registration process | 15 | 100 | 100 |
| 4 | Identifying, formulating, and solving engineering problems | 3 and 4 | 100 and 100 | 100 and 78 |
| 5 | Effective communication skills | 7 and 8 | 92 and 100 | 50 and 63 |
| 6 | Multidisciplinary teams | 6 | 92 | 100 |
| 7 | Conducting experiments and analyzing data | 2 and 5 | 100 and 92 | 100 and 75 |
| 8 | Techniques, skills, modern tools for engineering practice | 9 | 100 | 100 |
| 9 | Understanding professional and ethical responsibility and contemporary issues | 10, 11 and 13 | 92, 100 and 73 | 100, 100 and 71 |
| 10 | Need for life-long learning | 12 | 100 | 100 |
| 11 | Awareness of the significance of applied research | 16 | 90 | 86 |
| 12 | Engineering management, business, public policy, and leadership | Not available | | |

Figures 4.3 (a) – (d) shows the five-year summary of One-year Alumni Surveys versus the Program Outcomes. Compared to the number of respondents for the other years, only eight 2006 graduates responded to the one-year survey, a small number of respondents. Thus the results cannot be deemed as reliable, and there is the potential for bias in the computed statistics. In general, except for Outcome #5, the rates of satisfactory responses for the other Outcomes clearly improved over the five-year period. Relatively low favorable rates for Outcome #5 – Communication Skills and a statement under Outcome #9 on knowledge of contemporary issues suggest possible concerns.

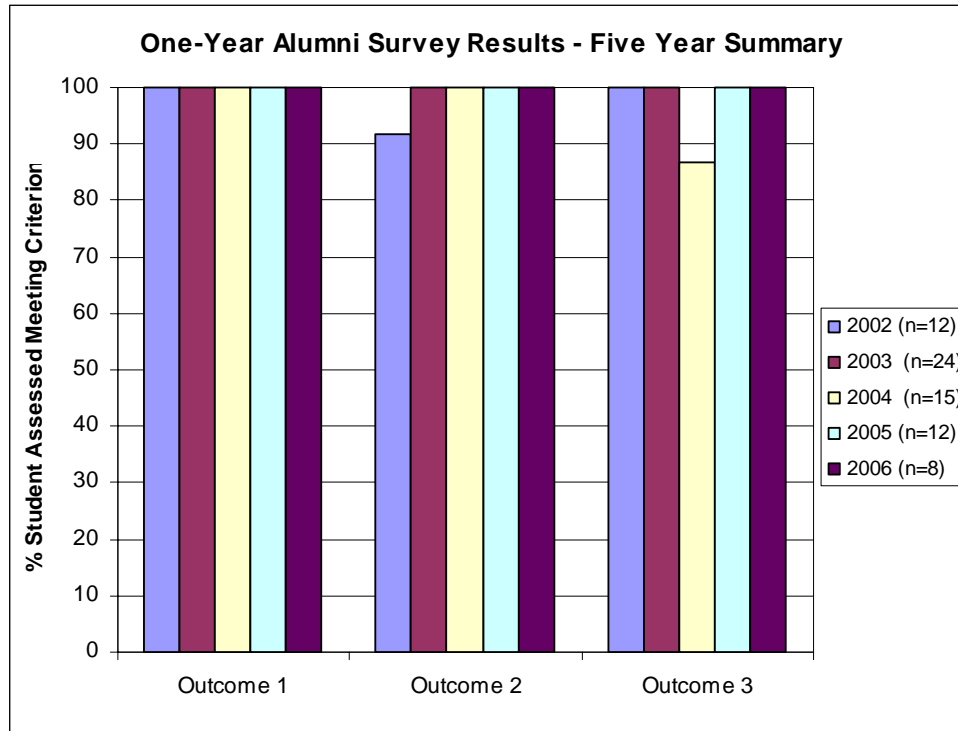


Figure 4.3 (a) Summary of One-Year Alumni Surveys (Outcomes 1-3)

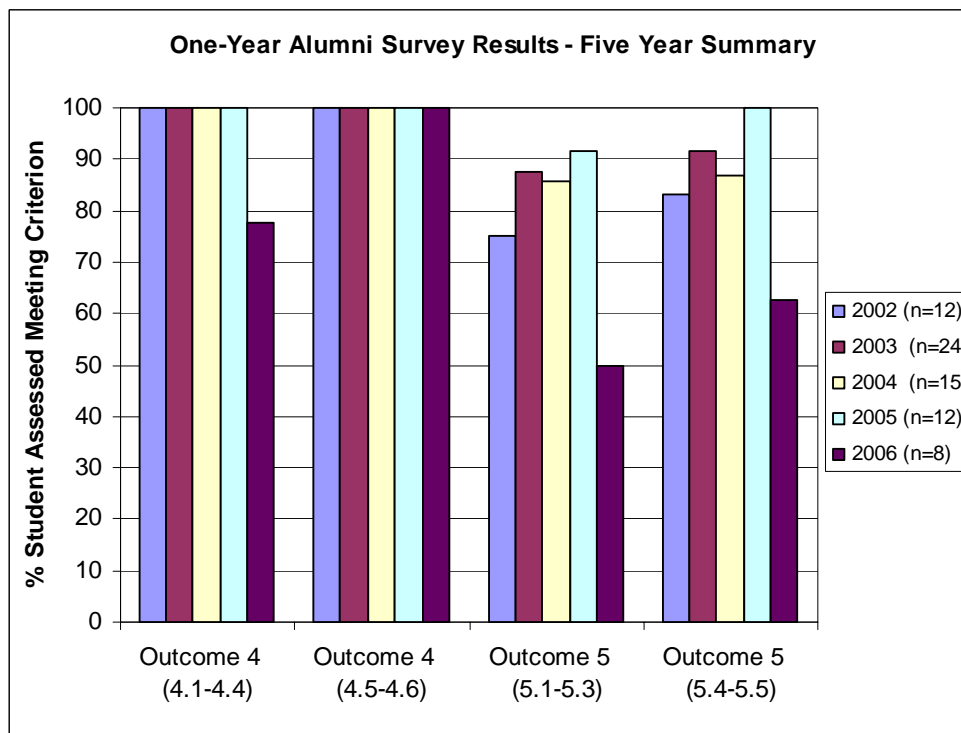


Figure 4.3 (b) Summary of One-Year Alumni Surveys (Outcomes 4-5)

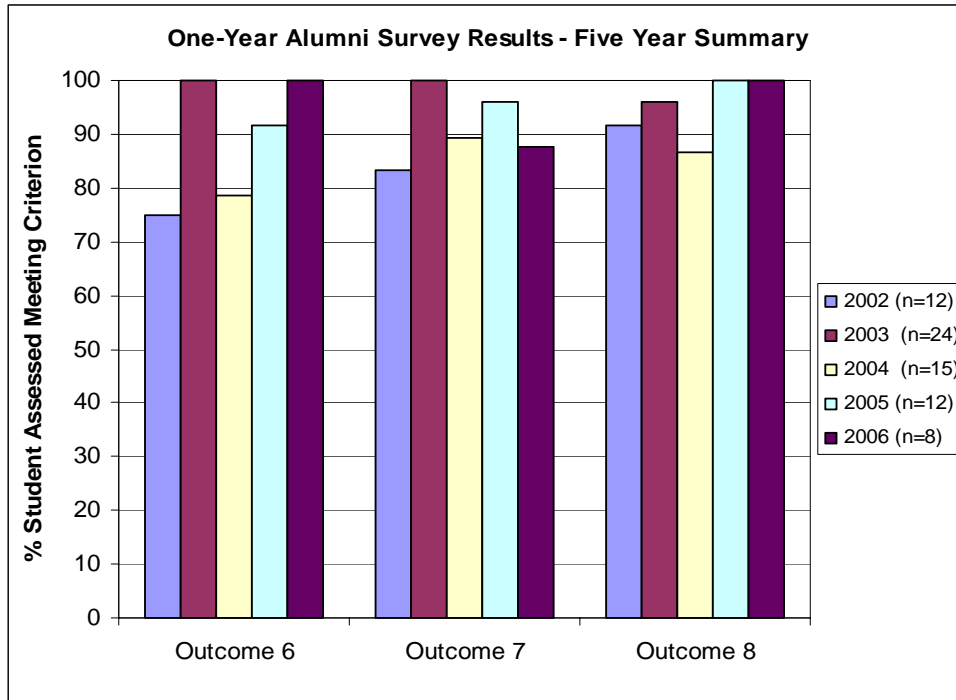


Figure 4.3 (c) Summary of One-Year Alumni Surveys (Outcomes 6-8)

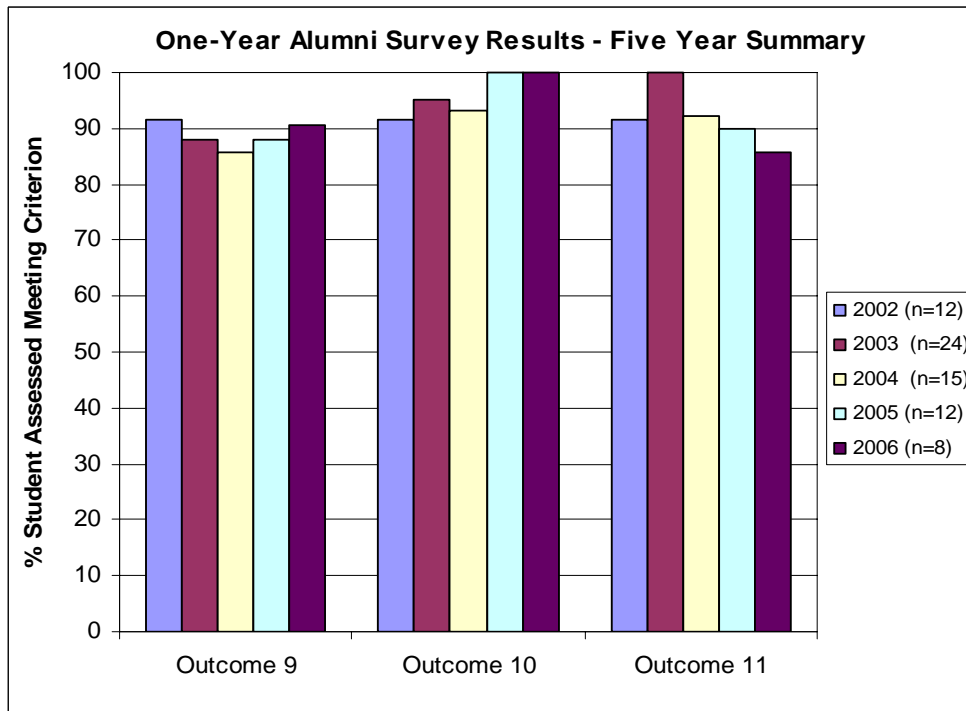


Figure 4.3 (d) Summary of One-Year Alumni Surveys (Outcomes 9-11)

In assessing the Civil Engineering undergraduate curriculum, survey results have revealed that 83% to 100% of the respondents agree or strongly agree that they were satisfied with the quality of courses in the curriculum and level of competence of CEE faculty. In

response to the question dealing with their level of preparation for the Civil Engineering profession, they indicated satisfaction with an overwhelmingly favorable response (100% agree or strongly agree), well above the established benchmark.

From the review of the assessment results for faculty, facilities, and course work quality, it is observed that all of the statements related to faculty are overwhelmingly positive. Students indicated that CEE faculty are competent, knowledgeable, and dedicated to the program. However, the statement on departmental laboratory facilities (Statement # 21) received a lower satisfactory rating, averaging 68% of agree and strongly agree responses. Additionally, the questions on the use of AutoCAD (Statement #37) and the use of engineering software (Statement #38) received lower ratings.

The review of these results by the ABET committee and CEE faculty led to several actions directed at improving achievement of Outcomes #5 and #9, which deal with communication skills and gaining an appreciation for humanities and social sciences respectively. Actions were also taken to resolve the concerns with laboratory facilities, use of AutoCAD, and use of engineering software. These are documented in Section B.4.2 - Actions to Improve the Program.

B.4.1.5 Course Surveys/Evaluations

At the end of each semester, a survey is conducted of all CEE courses taught. CEE faculty develop the statements on the survey based on the course-topics and measurable Outcomes. The surveys are used as an effective tool to evaluate the level of achievement of the course learning objectives. Table 4-4 shows the summary of CEE course evaluations based on surveys over the last five years. The threshold rating is 3.0 out of 4.0. As seen from the table, all courses except one freshman course, CEE 1020 – Connections to CEE, have satisfactory ratings in excess of 3.0. CEE 1020 is a recently initiated non-technical class. It is expected that the course rating will improve with appropriate actions being taken by the instruction faculty. Even though all of the courses received very good ratings, faculty still regularly examine the results of individual statements and plan actions to improve the achievement of course outcomes. Appendix E.11 presents samples of ABET course evaluations. The following is an example of evaluations and planned actions based on the course survey:

CEE 3030 - Civil Engineering Materials

Statement 7. I can design basic Portland Cement Concrete (PCC) mixtures via the ACI method.

Program Outcomes it Meets: 1, 2, 4, 7, and 11

Evaluation (Ratings): Fa11 2007 - 3.26; Fa11 2006 - 3.21; Spring 2006 - 3.08

Action: A full lecture will be devoted to this practical concept including in-class work.

Compared to previous semesters, this information will be presented at a slower pace and more basic examples will be given. In addition, a "laboratory" will be devoted to the ACI mix design procedure instead of class time, thus allowing more time for explanation and in class work.

Statement 8. *I have a basic understanding of hot mixed asphalt (HMA) materials and tests.*

Program Outcomes it Meets: 1 and 2

Evaluation (Ratings): Fa11 2007 - 3.33; Fa11 2006 - 3.13; Spring 2006 - 2.87

Action: This concept will be presented in several lectures and homework. Previously, the students often confused terminology; thus, more introductory material will be given regarding definitions, leading to the observation of improved student attitudes and learning.

Table 4-4. Summary of CEE Course Evaluation

| Class | Year of Evaluation | | | | | | | | | | Threshold |
|--------------|--------------------|------|--------|------|--------|------|--------|------|--------|------|------------|
| | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | |
| | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | |
| CEE 1020-201 | -- | -- | -- | -- | -- | -- | -- | 3.04 | -- | 3.00 | 3.0 |
| CEE 1020-202 | -- | -- | -- | -- | -- | -- | -- | 2.58 | -- | 2.96 | 3.0 |
| CEE 1020-203 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.91 | 3.0 |
| CEE 2110-001 | 3.39 | 3.51 | 3.62 | 3.38 | 3.40 | 3.53 | 3.39 | 3.51 | 3.59 | -- | 3.0 |
| CEE 2110-002 | 3.67 | 3.45 | 3.35 | 3.49 | 3.56 | 3.48 | 3.40 | 3.45 | 3.72 | 3.16 | 3.0 |
| CEE 2110-003 | 3.53 | 3.44 | -- | 3.33 | -- | 3.67 | -- | 3.43 | 3.43 | 3.65 | 3.0 |
| CEE 2110-004 | -- | -- | -- | -- | -- | -- | -- | 3.51 | 3.48 | -- | 3.0 |
| CEE 2110-500 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.65 | 3.0 |
| CEE 3020 | -- | 3.56 | -- | 3.44 | 3.58 | 3.56 | 3.62 | 3.56 | 3.72 | 3.52 | 3.0 |
| CEE 3030 | 3.39 | 3.36 | 3.26 | 3.36 | 3.23 | 3.09 | 3.05 | 3.26 | 3.59 | 3.23 | 3.0 |
| CEE 3040 | 3.30 | 3.57 | 3.59 | 3.50 | 3.71 | 3.60 | 3.61 | -- | 3.70 | -- | 3.0 |
| CEE 3100 | 3.52 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 |
| CEE 3110-001 | 3.27 | 3.41 | 3.70 | 3.35 | 3.45 | -- | 3.48 | 3.54 | 3.41 | 3.31 | 3.0 |
| CEE 3110-002 | 3.75 | 3.12 | 3.09 | 3.07 | 3.49 | 3.52 | 3.20 | 3.10 | 3.40 | 3.44 | 3.0 |
| CEE 3110-003 | 2.92 | -- | -- | -- | 3.13 | 3.23 | -- | -- | 3.39 | 3.05 | 3.0 |
| CEE 3120-001 | 3.67 | 3.27 | 3.44 | 3.42 | 3.29 | 3.39 | 3.58 | 3.38 | 3.65 | 3.47 | 3.0 |
| CEE 3120-002 | 3.08 | 3.67 | -- | 3.84 | -- | 3.35 | -- | 3.49 | 3.52 | 3.52 | 3.0 |
| CEE 3320 | 3.26 | 3.52 | 3.68 | 3.52 | 3.52 | 3.60 | 3.50 | 3.51 | 3.54 | 3.64 | 3.0 |
| CEE 3410 | 3.16 | 3.11 | 3.03 | 3.22 | 3.33 | 3.02 | 3.23 | 3.34 | 3.26 | 3.38 | 3.0 |
| CEE 3420 | 3.12 | 3.19 | 3.09 | 3.34 | 2.65 | 2.76 | 3.30 | 3.23 | 3.27 | 3.34 | 3.0 |
| CEE 3610 | 3.42 | 3.54 | 3.59 | 3.12 | 3.33 | 3.41 | 3.19 | 3.72 | 3.53 | 3.36 | 3.0 |
| CEE 4130 | -- | 3.46 | -- | 3.45 | -- | 3.20 | -- | 3.36 | -- | 3.75 | 3.0 |
| CEE 4160 | 3.71 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 |
| CEE 4190 | -- | 3.40 | -- | 3.48 | -- | 3.43 | -- | 3.28 | -- | 3.49 | 3.0 |
| CEE 4310 | 3.80 | 3.61 | 3.69 | 3.72 | 3.62 | 3.67 | 3.58 | 3.80 | 3.52 | 3.64 | 3.0 |
| CEE 4320 | 2.89 | 3.65 | 3.47 | 3.52 | 3.62 | 3.71 | 3.07 | 3.44 | 3.09 | 3.67 | 3.0 |
| CEE 4350 | -- | 3.44 | -- | 3.62 | -- | 3.69 | -- | 3.49 | -- | 3.60 | 3.0 |
| CEE 4360 | 3.22 | -- | 3.42 | -- | 3.34 | 3.18 | 3.30 | 3.42 | 3.33 | 3.27 | 3.0 |
| CEE 4380 | 3.58 | -- | 3.64 | -- | 3.81 | -- | 3.73 | -- | 3.90 | -- | 3.0 |
| CEE 4410 | 3.14 | -- | 3.44 | -- | -- | 3.02 | -- | -- | -- | -- | 3.0 |
| CEE 4420 | -- | 3.61 | -- | 3.38 | -- | 3.51 | -- | 3.52 | -- | 3.60 | 3.0 |
| CEE 4430 | 3.53 | -- | 3.43 | -- | 3.30 | -- | 3.22 | -- | 3.72 | -- | 3.0 |
| CEE 4440 | 3.24 | -- | 3.13 | -- | 3.30 | -- | 3.55 | -- | 3.57 | -- | 3.0 |
| CEE 4500 | -- | 3.11 | -- | 3.45 | -- | -- | 3.56 | -- | -- | -- | 3.0 |
| CEE 4600 | -- | -- | -- | -- | 3.58 | -- | 3.45 | -- | -- | -- | 3.0 |
| CEE 4610 | -- | 3.42 | -- | 3.49 | -- | 3.26 | -- | 3.32 | -- | 3.26 | 3.0 |
| CEE 4630 | 3.68 | -- | 2.91 | -- | -- | 3.83 | -- | 3.69 | -- | 3.53 | 3.0 |
| CEE 4640 | -- | 3.33 | -- | -- | 3.35 | -- | 3.78 | -- | 3.19 | -- | 3.0 |
| CEE 4660 | 3.22 | -- | 3.74 | 3.56 | -- | 3.64 | -- | 3.71 | -- | 3.59 | 3.0 |
| CEE 4700 | 3.17 | -- | 3.11 | -- | 3.17 | -- | 3.70 | -- | 3.77 | -- | 3.0 |
| CEE 4800 | 3.27 | 3.50 | 3.31 | 3.54 | 3.37 | 3.51 | 3.30 | 2.93 | 2.69 | 3.50 | 3.0 |
| CEE 4920 | 3.37 | 3.68 | 3.74 | 3.70 | 3.66 | 3.05 | 3.31 | 3.44 | 3.72 | 3.48 | 3.0 |
| CEE 4930 | -- | -- | -- | 3.55 | -- | -- | -- | 3.04 | -- | -- | 3.0 |
| CEE 4940 | 3.12 | 2.96 | 3.24 | 3.24 | 3.32 | 3.43 | 3.22 | 3.46 | 3.58 | 3.27 | 3.0 |
| CEE 4950 | 3.30 | 3.73 | 3.10 | 3.26 | 3.26 | 3.39 | 3.19 | 3.59 | 3.42 | 3.43 | 3.0 |
| CEE 4990 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 |