2006-459: SO YOU SURVIVED THE ABET VISIT… HOW TO CONTINUE A SUSTAINABLE ASSESSMENT EFFORT

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How to Continue a Sustainable Assessment Effort

Abstract

This paper focuses on the development of a sustainable assessment plan for the Electrical Engineering program at the University of Detroit Mercy. Other programs at the university have adopted variations of this plan, which requires coordination among departments. The paper will discuss the merits and shortcomings of this approach to the continuous assessment problem and explain why the adopted process was chosen.

Background and Preparation for First EC2000 Visit

In the late 1990's, the Accreditation Board for Engineering and Technology's (ABET) Engineering Accreditation Commission published new criteria for the accreditation of engineering programs, Engineering Criteria 2000.[1] Criterion 3 calls for programs to define program outcomes and to measure student achievement of those outcomes.

The faculty of the Electrical and Computer Engineering department at the University of Detroit Mercy began a very modest initial preparation for evaluation under the EC2000 criteria before the 1998 accreditation visit by ABET by requiring instructors to define course outcomes and include these on all course syllabi. The college elected to be visited under the previous criteria in 1998. After the successful visit, the departments began to discuss plans for implementing outcomes based assessment on the program level.

The effort to formulate Program Educational Objectives (Criterion 2) and Program Outcomes (Criterion 3) intensified about three years prior to the 2004 accreditation visit. It was also during this year that the Electrical Engineering program faculty began to experiment with course and program assessment activities. While these ad hoc experiments did not provide the department with much useful assessment data, this period of experimentation was vitally important in getting faculty members to begin thinking about how they might assess student achievement of program outcomes. As many in the engineering and technology education community maintain, faculty buy-in is essential to the success of any ongoing assessment process that tracks continuous improvement.[2-5] The time of experimenting with different processes allowed faculty to take ownership of processes they designed themselves rather than to resist compliance with processes foisted on them from above.

In the 2002-2003 academic year, Program Assessment activities began a transition from ad hoc to more formal. Once the Program Educational Objectives and Program Outcomes were created and validated by various constituencies, it was possible to begin to formulate and implement an assessment plan in preparation for the 2004 accreditation visit.

Assessment Process for 2004 Accreditation Visit

Figure 1 depicts the overall evaluation and assessment process. Note that Outcomes Assessment takes place on an annual cycle.

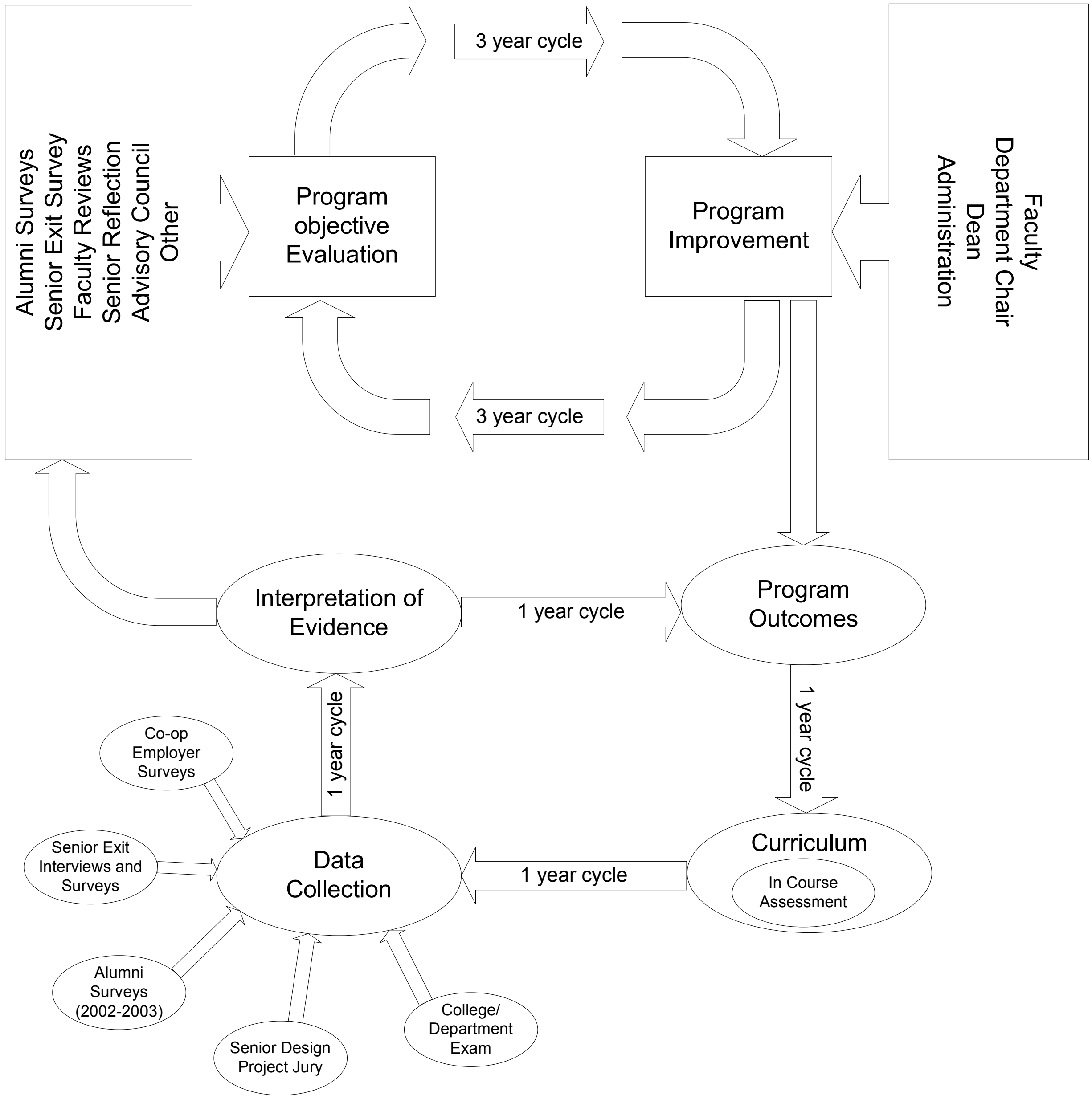

Figure 1: Electrical Engineering Program Educational Objectives Evaluation and Outcome Assessment Process

The Electrical Engineering Program Outcomes (provided in Appendix A) are assessed using a number of assessment strategies: College/Department Exam, Senior Exit Survey/Interview, Coop Employer Survey, Alumni Survey, Senior Design Project Jury, and a number of In-Course Assessment Instruments implemented in the curriculum. In this paper, we forgo a detailed discussion of each of the strategies with the exception of In-Course Assessment. Of all of the assessment processes, this is the one that demands the most faculty time and effort, and so the paper focuses on this strategy and explains how we have been able to streamline the process.

In-Course Assessment.
For each of the Electrical Engineering Program Outcomes, courses in the curriculum that address that outcome have been identified. This is standard practice for many programs. For each Program Outcome addressed by a course, the department faculty have determined target metrics that should be achieved by the students taking the course. The simple rubric is as follows:

1	=	competency increased somewhat
2	=	competency increased significantly
3	=	complete Outcome statement is fulfilled

For example, consider the Program Outcome related to the ability to communicate effectively. Because the capstone design experience in the final year requires formal oral presentations and an extensive written report, the design course sequence is assigned a target of “3”. A laboratory course that has a focus on written reports might be assigned a target of “2” or “3”, depending on the emphasis placed on writing or presentations. A theory course with perhaps one project report or an otherwise reduced emphasis on communication competency might be assigned a target of “1”. Courses that require little or no writing beyond mathematical problem solving are not assigned a target at all.

Each time an Electrical Engineering or support course (e.g., Mathematics, Physics, Chemistry) is offered, the instructor completes a Course Worksheet which must discuss evidence that indicates the extent to which the course outcomes are being achieved. A sample worksheet is provided in Appendix B. The worksheet must also document how the course has been changed to address action items that were identified in the previous offering of the course. This worksheet, along with the syllabus, samples of student work, and other evidence that support the conclusions, are placed in a Course Notebook. The worksheet also links the course outcomes to the Program Outcomes. The evidence that is presented may include indirect, as well as direct measures of the degree of student achievement of course outcomes. Some instructors conduct an end-of-course self-assessment, which provides an indirect measure of outcome attainment. They also identify some key assignments, projects, exams, or quizzes that provide direct evidence regarding the achievement of course outcomes that are linked to program outcomes.

Each semester, the Electrical and Computer Engineering Department faculty members review the course notebooks and worksheets from the previous semester and determine the level of achievement of the Program Outcomes that are addressed by each course, using the same rubric as was used to determine the targets. Appendix C provides a sample Course Review Form. When a course worksheet does not provide adequate evidence that the outcome targets were met, an action item is generated, and this feedback is provided to the instructor. Action items are tracked the next time the course is reviewed. All courses in the program taught by the department are subject to the processes of completing a Course Worksheet/Notebook and undergoing a periodic review by the department faculty, as are the courses taught by other engineering, mathematics and science departments, and to a lesser extent, by support departments such as English. It should be noted here that for the sake of consistency, all of the engineering programs at the University of Detroit Mercy have adopted similar Course Worksheet formats, so that the process of evaluating outcomes that depend on other engineering and science courses will be as uniform as possible.

Making the Process Sustainable

As stated earlier, the In-Course Assessment is by far the most labor-intensive of the program assessment strategies, requiring collection of relevant samples of student work, completion of the Course Worksheet, assembly of a Course Notebook, and rigorous review by the department faculty for every course offered in every semester. This was necessary in the two years prior to the 2004 visit, because we needed to show evidence that the assessment process resulted in program improvements.

Besides the general agreement in the engineering and technology education community about the need for faculty buy-in, ABET emphasizes that the assessment process must not create an undue burden on faculty.[1] Thus we began to discuss how we might streamline the In-Course Assessment process so as to provide thorough program review and assessment without requiring the faculty to continue at the same level of intensity as prior to the 2004 visit.

ABET does not prescribe specific processes or frequency of assessment activities; rather, they are concerned that a program present evidence that a continuous improvement plan is in place and is followed. Reviewing every course taught every semester under the process described above would quickly wear down the faculty and eventually deteriorate to a "rubber-stamping" of submitted worksheets and notebooks. Similarly, the compilation of compete course notebooks that include samples of student work is not something that is sustainable for every course every time it is taught.

The University of Detroit Mercy operates year round on a trimester schedule because of the compulsory cooperative education component, so our first attempt at spreading the in-course assessment load was to simply do course review on a three-year cycle. Fall courses would be reviewed, complete with full Course Notebooks, in Year 1. Winter and summer courses would be reviewed in Years 2 and 3 respectively. Department faculty agreed that while they welcomed the balancing of the load over the three years, they did not want to shirk the process of completing Course Worksheets every time a course was taught. They have found the worksheet to be a valuable vehicle for formalizing the process of making incremental improvements to their courses, even in years that they would not be reviewed.

Because a number of the courses addressing the Program Outcomes are taught by other departments, it was necessary to negotiate a streamlined process with these other stakeholders. There was some concern that despite the fact that other assessment processes addressed all of the outcomes on a yearly basis, the In-Course Assessment three-year cycle described above did not guarantee coverage of all outcomes every year.

Our second attempt at developing a streamlined process kept the concept of a three-year cycle for the preparation of full Course Notebooks and review, but used a less arbitrary method for selecting which courses were selected for each year of the cycle. The following section describes the approach finally agreed on by the department faculty. It is important to note that faculty from the other engineering programs became interested in adopting similar approaches to spreading the assessment workload, and have moved in that direction.

Program Outcome Assessment Process Revised to Achieve Sustainability
All of the assessment processes will continue to take place every year: College/Department Exam, Senior Exit Survey/Interview, Coop Employer Survey, Senior Design Project Jury, and In-Course Assessment. For the In-Course Assessment Process, individual courses will be reviewed on staggered three-year cycles, so that all courses will undergo the complete review process in a three year cycle. However, instructors will complete the course worksheets every time that the course is offered, so that course-level observations and action items can be tracked. The Annual Assessment Report, generated in October of each year, will report and draw conclusions on data that are available in the given year. Every third year, beginning with October 2006, the cumulative course review results from all three previous years will be used in the October Assessment Report, as this will be the first time data for all targeted courses will be available. We propose that courses common to other programs be reviewed (with Course Worksheets and samples of student work) at least once every three years, either on a staggered cycle, or all in the same year. The same is true for any Technical Elective courses that are not offered every year. This will ensure that the Annual Assessment Reports generated in October 2006 and October 2009 will cover the full complement of courses. This should streamline the production of the assessment section of the next Self-Study document, which will be written beginning in January 2010.

In all general engineering and service courses, we expect that instructors will continue to complete the Course Worksheet every time the course is taught and to provide any accompanying information that will provide guidance for the next offering of the course. The complete notebook including samples, on the other hand, will be prepared once every three years.

The scheduling plan for the review of complete course notebooks for courses taken by EE majors achieves three desired outcomes: (1) balanced coverage of program outcomes in each year, with heavier emphasis in the year immediately before the self-study is written, (2) multiple cohorts are tracked in a sequence of courses, and (3) the data collection workload is balanced over the three terms of each year. When the courses common to all majors are scheduled for complete material collection may alter this tentative schedule based on the desire for workload balance in the course review process. The Self-Study document will be in preparation soon after the October 2009 Annual Assessment Report.

Tables 1-3 below provide the schedule for review of all courses taken by EE majors that are subject to the review process. Note that there are approximately equal numbers of courses reviewed in any given year. This is a three-year cycle, so two full cycles are completed in the six years between accreditation visits. This table is meant to guide EE faculty as to what courses they should prepare full Course Notebooks for, and to make sure that Course Notebooks for all of the service courses are reviewed on a three year cycle as well.

Table 1: Year 1 Courses

CST101	Fundamentals of Speech (Core Course)
E302	Prof. World of Work II
E303	Prof. World of Work III
EE350	Network Theory I
EE364/365	Digital Logic Circuits I/Lab
EE366	Electromagnetics I
EE372	Electromechanical Energy Conversion
EE478/479	Embedded Systems
MTH241	Analytic Geometry and Calculus III
MTH451	Techniques of Advanced Calculus
PHY160	General Physics I
PHY161	General Physics I Laboratory
TE	

Table 2: Year 2 Courses

E100	Ethics and Politics of Engineering
E105	Introduction to Engineering Graphics & Design
E322	Control Systems I
EE352	Network Theory II
EE361	Networks Laboratory
EE386/387	Introduction to Microprocessors/Lab
ENL303	Technical Writing
MTH141	Analytic Geometry and Calculus I
MTH427	Applied Probability & Statistics
PHY162	General Physics I
PHY163	General Physics I Laboratory
PHY367/368	Modern/Solid State Physics
TE	
TE	

Table 3: Year 3 Courses

CEC300	Coop Preparation
CHM107	General Chemistry I
CHM110	General Chemistry I Laboratory
E204	Intro to Engineering Computing
E301	Prof. World of Work I
E315	Thermodynamics I
EE356	Electronics I
EE358	Electronics II

EE363	Electronics Laboratory
EE374	Communication Theory I
EE401/403	Electrical Engineering Design I/II
MTH142	Analytic Geometry and Calculus II
MTH372	Differential Eqns. & Linear Algebra

Update and Implementation Status

The staggered schedule for the In-Course Assessment part of the Outcome Assessment process was approved by the EE faculty in December 2004. When courses that are not taught by ECE faculty are scheduled for review, the Department Assessment Coordinator will choose the most recent notebook for the review process, with the understanding that the most recent notebook has been updated since the last three-year cycle. The Department Assessment Coordinator notified the faculty members at the beginning of January, 2005 what courses required the assembly of Course Notebooks. Courses taught in the Fall semester that were scheduled for review were reviewed at a meeting of department faculty in January 2005. Winter and Summer courses scheduled for review last year were to be reviewed in September 2005, and the results summarized in the Annual Assessment report that was to be prepared in October. The Department Assessment Coordinator was awarded a research leave for 2005-06, and briefed the Department Chair and colleagues on the activities needed to follow through with the assessment plan. Unfortunately, the Assessment Coordinator's absence, along with personnel shortages caused by two faculty members taking phased retirement, resulted in the suspension of some of the assessment activities. For example, collection of materials for Course Notebooks has been proceeding on schedule, as has the completion of Course Worksheets, but there was no formal review of the Course Notebooks scheduled for review in September. There was no meeting to review of the data that have been collected from the other assessment processes. There was no Annual Assessment Report produced in October 2005.

Conclusion

Despite the reduction in assessment workload resulting from the staggered cycle for In-Course Assessment, the process requires a strong commitment from every faculty member. The Department Assessment Coordinator plays a key role in reminding faculty members which courses are scheduled for review each semester, and in calling the meetings necessary for the review of course notebooks and data from the other assessment processes. The Department Assessment Coordinator also prepares the Annual Assessment Report. It has been our experience that if the Department Assessment Coordinator takes a research leave, and no fixed-term appointment is approved to pick up the courses usually taught by the coordinator, the remaining faculty deem it necessary to curtail or postpone some assessment activities in order to make sure all courses are covered. Clearly, a process that depends so much on the presence of one person to encourage faculty to follow the agreed on procedures is not advisable if no effort is made to make sure that the person's duties are assumed by another faculty member. If the Department Assessment Coordinator is not present in an academic year, another faculty member MUST be appointed, and MUST pursue the process by engaging department faculty. Administration must support the commitment to the assessment process by providing adequate staffing for departments who are left short-handed by sabbatical leaves and phased retirements.

References

[1] Accreditation Board for Engineering and Technology, *Criteria for Accrediting Engineering Programs*, download PDF document from http://www.abet.org/forms.shtml, accessed 3 March 2006.

[2] Rojas-Oviedo, R., Z.T. Deng, A. Jalloh, and A. Mobasher, "Engineering Education and the Continuous Improvement Process," *Proceedings of the 2000 American Society for Engineering Education Annual Conference and Exposition*, St. Louis, MO, June 2000.

[3] Schachterle, L., "Faculty Governance Embraces Outcomes Assessment," *Proceedings – 2004 Frontiers in Education Conference*, Savannah, GA, p T3G-3-T3G-6.

[4] Yokomoto, Charles F., Goodwin C., Williamson, D., "Development of a School Wide Assessment Plan - Questions Answered and Questions Raised," *Proceedings – 1998 Frontiers in Education Conference*, v 1, 1998, p 123-128.

[5] Yue, D. K. P., Masi, B., "Beyond ABET: A new school-wide process for continuous improvement in engineering education," *Proceedings of the 2003 American Society for Engineering Education Annual Conference and Exposition*, Nashville, TN, June 2003.

APPENDIX A – Electrical Engineering Program Outcomes

The Bachelor of Electrical Engineering Program must demonstrate that its graduates have:

a) an ability to apply knowledge of mathematics, science, and engineering principles to electrical engineering (Knowledge of mathematics encompasses advanced topics typically including differential and integral calculus, linear algebra, complex variables, discrete math, and differential equations.)
b) an ability to design and conduct experiments, as well as to analyze and interpret data relating to electrical systems
c) an ability to design electrical systems, components, or processes to meet desired needs (This includes systems containing hardware & software components.)
d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve electrical 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 a ability to engage in life-long learning
j) an awareness of current trends and global issues related to the electrical engineering profession
k) an ability to use the techniques, skills and modern engineering tools necessary for electrical engineering practice
l) knowledge of probabilities and statistics.

APPENDIX B – Sample Course Worksheet

Course Worksheet
E322: CONTROL SYSTEMS I
Term III, 2004-05
Sandra Yost, CSJ

1) List course outcomes, and describe how each outcome was assessed. Attach supporting student work and surveys.

   See attached table.

2) Discuss incorporation of action items from the last cycle of in-course assessment.
   - The change back to Kuo text was implemented.
   - The decision to focus on interpretation of Bode plots rather than on their construction by hand was implemented.

3) Discuss plans for subsequent offerings of this course based on assessment results.

   - No major changes recommended.

4) Describe any modifications to the outcomes – deletions, additions, and revisions.
   none

5) Comment on student evaluations (attach, if appropriate, copies of student evaluation forms).
   - All of the students completed a self-assessment pertaining to the course outcomes. Complete results are included as an attachment. No action items are implied from these survey results.

6) Are assessment methods appropriate for gauging student achievement of outcomes and objectives? Describe recommended changes.
   Yes.

7) Comment on linkages between course and program outcomes. Should specific linkages be added or deleted?

   The linkages described in the attached table are appropriate.

8) State whether the course has significant design content. If so, state what percentage of student grade is assigned to design-related material. Describe the project(s), including how the project addresses economic, environmental, sustainability, manufacturability, ethical, health and safety, social, and political considerations. Also, state whether and to what extent teamwork and communication were addressed.

   - The course is an introduction to control systems, and thus needs to introduce new concepts and analysis techniques before design can be started. Some of the assigned homework problems, and parts of the two projects addressed design and simulation issues. Overall, I would say that the course included a 15-20% design emphasis.

- Two projects were assigned, both of which required formal written reports. The first asked students to model an automotive suspension system, simulate it, and discuss how system parameters should be altered to result in a better ride. This was an individual project
- The second project was a case study of a printwheel from a computer printer. Most students worked in teams of two or three to complete this project. The project involved choosing system parameters that would achieve stability, steady-state accuracy. It also asked students to derive a second order approximation to a higher order system, and to compare the steady-state and transient response of the higher order system with its second order approximation.

Attachments:

1) Course Outcome and Assessment Table
2) Detailed Assessment Discussion
3) Listing of ECE Program Outcomes
4) Post-Course Survey Results
5) Syllabus
6) Homework assignments, project descriptions, exams, surveys/questionnaires (link each to relevant course outcomes)
7) Representative student work

Course: E322 – Control Systems I **Term III, 2003-2004**

Course Outcomes	ECE Criteria Addressed	Assessment	Student Performance (0-5 scale)
1. Identify control system types and components, and advantages/disadvantages of different strategies.	A	Final Exam, end-of-course survey	4.5 Most students were able to correctly claim that a PD controller was the best choice in a given design scenario.
2. Use Laplace transforms to solve differential equations of systems with non-zero initial conditions	A, e	Quiz #1, Final Exam, end-of-course survey	4 Somewhat inconsistent performance; good quiz results, worse final exam results, but I'm confident that without the time constraints most students could have solved the problem.
3. Reduce a block diagram of multiple subsystems to a single block representing the transfer function from input to output. (Signal flow graphs, Mason's gain rule)	E	Quiz #2, Project #2, Exam #2, Final Exam, end-of-course survey	4 Generally good ability to use SFG techniques to determine transfer functions of complex systems.
4. Derive transfer functions for linear electrical networks, and linear mechanical translational and rotational systems.	A, e	Project #1, Exam #1, Final Exam, end-of-course survey	4 Students demonstrated their ability to do this on the exams and Project 1.
5. Determine and describe quantitatively the transient response characteristics of first and second order linear systems.	A, e	Quiz #4, Project #1, Project #2, Exam #1, Final Exam, end-of-course survey	4.5 See detailed assessment discussion.
6. Determine the stability and steady-state error of a system from its transfer function and choose system parameters to achieve performance specifications.	A, c, e	Quiz #3, Quiz #4, Project #2, Exam #1, Exam #2, Final Exam, end-of-course survey	4 Generally good performance
7. Use time and frequency domain techniques (root locus, Bode plot) to analyze and design linear control systems.	A, c, e, k	Project #2, Exam #2, Final Exam, end-of-course survey	4 Generally good ability to use root locus. And to interpret Bode plots.
8. Use MATLAB/SIMULINK for the analysis and design of control systems	C, k	Project #1, Project #2, end-of-course survey	4

APPENDIX C – Sample Review Form

UNIVERSITY OF DETROIT MERCY
ELECTRICAL ENGINEERING PROGRAM
In-Course Assessment Review Results

Course Number, Title: EE386 – Microprocessors

Term, Year: I, 2004-05

Instructions to reviewers: In the table below, list the letter(s) of the Program Outcome(s) addressed by this course in the first column, and the target associated with each relevant outcome in the second column. In the third column, use the metric given to the right of the table to rate the degree to which each outcome was actually achieved. In cases where the target is not achieved, please recommend what action should be taken to remedy the situation.

Program Outcome Addressed	Target	Actual
a	1	1
c	2	1.5*
e	1	1
k	2	2

Comments, Action Items (continue on back if necessary):

Worksheet table should report overall average score for each outcome.

* - Material was appropriate – software design – but student performance did not measure up. The course target should really be "1" in this lecture course, and "2" in the companion lab course.

Reviewer(s): Mohan, Yost, Al-Holou