ABET GUIDE

ASSESSMENT FOR ABET ACCREDITATION

In the United States, accreditation is a peer-review process. Educational institutions or programs volunteer to undergo this review periodically to determine if certain criteria are being met. The *Accreditation Board for Engineering and Technology*, ABET, is responsible for the specialized accreditation of educational programs in applied science, computing, engineering, and technology. ABET accreditation is assurance that a college or university program meets the quality standards established by the profession for which it prepares its students.

It is the responsibility of the program seeking accreditation to demonstrate clearly that the program meets a set of criteria. One of these criteria is the ``Criterion 3: Program Outcomes". Engineering programs must demonstrate that their students attain program outcomes (a) through (k). Much more information about this can be found in the ``Criteria for Engineering Accreditation" document ABET publishes on its website annually (http://www.abet.org).

For fulfillment of Criterion 3, a program must show that there is an assessment and evaluation process in place that periodically documents and demonstrates the degree to which the program outcomes are attained by their students. Most programs do this by mapping the outcomes (a) through (k) to the courses in the curriculum[1]. Then, these outcomes are assessed in the courses. Finally, the assessment results are collected from the courses and compiled into program-level data to demonstrate the ``degree to which the program outcomes are attained by their students".

If your course is part of a similar assessment effort in your program, you probably need to assess the following outcomes in your course:

(A) An ability to apply knowledge of mathematics, science, and engineering,

(B) An ability to design and conduct experiments, as well as to analyze and interpret data,

(G) An ability to communicate effectively, and

(K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

These outcomes can be assessed in your course using various assessment tools, such as student surveys and assignments or questions targeting specific outcomes. To measure achievement of an outcome (such as outcome ``A" in the list above), typically some performance criteria are defined for the outcome. The *performance criteria* are a set of measurable statements to define each learning outcome. They identify the specific knowledge, skills, attitudes, and/or behavior students must demonstrate as indicators of achieving the outcome.

For the purpose of this laboratory curriculum, we defined a set of performance criteria for each outcome. These criteria are labeled as ``A-1, A-2, B-3, ..., K-3" as indicated in the rubrics in Section below. We also embedded these performance criteria in the curriculum shown by indicators such as A-1, A-2 .

Assessment in your course

Assessment of outcomes is different than grading. A course grade (or a grade on an assignment or exam), is a composite indicator. For example, if a student receives "B" as a grade in your course, it is probably difficult to tell his/her level of achievement in outcome "A" versus "G". One of the purposes of assessment is to "measure" the level of achievement of these specific skills and knowledge so that improvements can be made in the future offerings of the course.

So, how should you introduce outcomes assessment into your course? The outcomes assessment approach described here can be applied to *each* pre-lab homework assignment and lab report of *each* student throughout the semester. This may or may not be feasible depending on your class size. In general, a *representative sample* of student work is assessed.

[1] Disclaimer: The opionions expressed or the assessment techniques described here have not been endorsed by ABET in any way.

You can continue to give assignments/exams and grade them in the traditional way. To introduce assessment into your course, you can pick a representative sample of student work and "score" their work using the scoring sheets and rubrics given in this manual. This is a good way to start introducing assessment into your course.

Recall that for fulfillment of Criterion 3, a program must ``document" the assessment process. Programs collect sample student work in the academic year prior to the site visit by an ABET team. You can retain the sample homeworks, lab reports, and the scoring sheet as ``evidence" for the ongoing assessment effort in your course. This collection can then be given to the assessment committee in your program to be incorporated into the program-level evidence they will compile prior to the ABET site visit.

How to score the lab reports

There are various ways in which you can use the material provided in this manual. In any case, the outcomes targetted by the lab experiments can be assessed from the lab reports submitted by the students. This will provide a basis to assess the outcomes easily.

The lab activities include "theory" and "applied" part of engineering. Therefore, outcomes "A" are mapped to activities that require students to apply their math and engineering science knowledge through calculations and problem solving strategies. The ``B" and ``K" were mapped to the practical lab activities through their performance criteria. The lab reports themselves match outcome ``G" on effective communication skills.

You can score the lab reports using the rubric for outcome ``G" given in Section and the scoring sheet provided for the experiment in that section. **Note** that each lab report scoring sheet directly corresponds to the lab report content template for that experiment.

Also, note that the rubric for outcome ``G" already contains rubrics for outcomes ``B" and ``K" since these outcomes appear as an integral part of the report.
To score the lab report of *one* student:

1. Use the ``Content" rubric (Section ) to assign a score for each of the assigned questions. The rubric gives the description of ``levels of achievement" (4 = exemplary, 3 = proficient, 2 = developing and 1 = beginning/incomplete) for each criterion.

2. You can then enter the ``Total" for each performance criterion into the scoring sheet as show in Figure 0.1.

	B	C	D	E	F	G	H	I	J	K
		Modelling								
		Lab Report Content						Report Format		
	ID	K-1	K-2	B-5	B-6	B-7	B-9	GS-1	GS-2	
	1	6	10	12	3	5	3	4	3	
	2	8	12	8	4	4	4	2	2	
	3	8	8	8	4	4	4	4	3	
	4	8	8	8	4	3	4	4	4	
	5	8	12	10	4	3	4	3	4	
	6	6	10	10	3	4	3	3	3	
	7	5	8	10	4	4	3	4	4	
	8	5	7	12	3	4	2	4	4	
	9	7	9	12	3	4	3	3	4	
	10	7	9	10	2	3	4	4	4	
	Total Possible	8	12	12	4	4	4	4	4	
	Scaled Average	3.40	3.10	3.33	3.40	3.80	3.40	3.50	3.50	
	Std. Dev.	1.23	1.70	1.63	0.70	0.63	0.70	0.71	0.71	

Figure 0.1: Lab report score entries in the workbook for one student.

Assessment of the outcomes for the course

As explained earlier, the performance criteria, such as A-1, A-2, A-3, are used to describe a set of measurable statements to define each learning outcome.

A *single* score for each outcome can be computed to indicate the level of attainment of that outcome by the entire class. One approach is to simply average the scores for the performance criteria for that outcome. For example, in case of outcome ``A", you can use:

$$SCORE_A = \frac{SCORE_{A-1} + SCORE_{A-2} + SCORE_{A-3}}{3} \tag{0.1}$$

Another possibility is to use a weighted-average where some of the performance criteria are considered to be more important than the others. In case of outcome ``A", you can use:

$$SCORE_A = \frac{w_1 \cdot SCORE_{A-1} + w_2 \cdot SCORE_{A-2} + w_3 \cdot SCORE_{A-3}}{w_1 + w_2 + w_3} \tag{0.2}$$

where w_1, w_2 and w_3 are weights you can assign (on the 0 to 1 scale) for the performance criteria A-1, A-2 and A-3, respectively. The total of all weights should equal 1.

Course Scores

A simple average approach is used for outcomes A, B, K and G. Referring to the rubrics in Section , it should be noted that outcome ``G" contains performance criteria for both ``B" and ``K" to assess the *content* of the report. In addition, there are two performance criteria, GS-1 and GS-2, to assess the *format* of the report. The scores for all of these performance criteria are averaged to arrive at the single score for outcome G. For example, the single score for outcome G in Figure 0.2 for the *Modelling* experiment was calculated using:

$$SCORE_G = AVERAGE(S_{K-1} + S_{K-2} + S_{B-5} + S_{B-6} + S_{B-7} + S_{B-9} + S_{GS-1} + S_{GS-2}) \tag{0.3}$$

where $S_{K-1} \cdots S_{GS-2}$ are the scaled average scores for K-1 through GS-2 in the workbook.

	B	C	D	E	F	G	H	I	J	K
		Modelling								
		Lab Report Content						Report Format		
	ID	K-1	K-2	B-5	B-6	B-7	B-9	GS-1	GS-2	
	1	6	10	12	3	5	3	4	3	
	2	8	12	8	4	4	4	2	2	
	3	8	8	8	4	4	4	4	3	
	4	8	8	8	4	3	4	4	4	
	5	8	12	10	4	3	4	3	4	
	6	6	10	10	3	4	3	3	3	
	7	5	8	10	4	4	3	4	4	
	8	5	7	12	3	4	2	4	4	
	9	7	9	12	3	4	3	3	4	
	10	7	9	10	2	3	4	4	4	
	Total Possible	8	12	12	4	4	4	4	4	
	Scaled Average	3.40	3.10	3.33	3.40	3.80	3.40	3.50	3.50	
	Std. Dev.	1.23	1.70	1.63	0.70	0.63	0.70	0.71	0.71	
	SCORE for K:	*3.25*								
	SCORE for B:	*3.48*								
	SCORE for G:	*3.43*								

Figure 0.2: Computation of single score for outcome ``G" in the scoring sheet.

Laboratory Scoring Sheets

The *scoring sheets* were developed using Microsoft Excel® . They are intented to give a general idea for how the assessment scores can be tracked and brought together. On purpose we designed the workbook to have no automatic features. You can use it as is or customize it in any way you like.

The scoring sheet workbook has a tab for each of the laboratory experiments. Only 10 students were listed assuming you would use samples of student work and not the entire class. If you want to add more students, you can insert rows into the spreadsheets.
Note: *If you insert new rows, make sure that the formula ranges in the cells with calculations are correct.*

At the bottom of each section, there is a row entitled ``Total Possible". To count an assignment in the calculation of the overall scores, you need to enter the correct totals here. For example, to count the modeling lab, you need to enter 12, 44 and 8. If you want to exclude an assignment from the overall calculation, enter ``0" as shown in Figure 0.3. Of course, if you are excluding a lab, then do not enter any scores for the students under those columns.

K	L	M	N	O	P	Q
ns	Beam and Ball Pre-Lab Questions			Overall Pre-Lab Questions		
A-3	A-1	A-2	A-3	A-1	A-2	A-3
6				3.25	3.27	3.60
8				2.88	3.09	3.80
8				2.00	3.91	2.60
6				3.25	3.64	2.00
4				3.75	2.82	2.40
8				3.63	4.00	3.20
4				3.00	3.18	2.40
7				2.13	4.00	3.80
7				3.00	3.18	3.40
8				3.00	3.00	3.40
8	0	0	0	32	88	20
3.30						
			Average	2.99	3.41	3.06
			Std. Dev.	0.56	0.44	0.65
		SCORE for A:		3.15		

Figure 0.3: Enter ``0'' to exclude or ``correct totals'' to include an assignment in the calculation of the overall scores.

	Code	Perf. Criteria	4 Exemplary	3 Proficient	2 Developing	1 Beginning or incomplete
Apply math, science and engineering	**A-1**	Has strategies to solve the problem	Uses a sophisticated strategy. Employs refined and complex reasoning to arrive at the solution.	Uses an appropriate strategy for solution. Content knowledge is used correctly.	Has a strategy for solution but content knowledge has some conceptual errors.	Uses a wrong strategy or there is no evidence of a strategy. Content knowledge has many errors.
	A-2	Performs calculations	Arrived at correct answer. Calculations are complete. Precise math language, symbolic notation, graphs diagrams, etc. are used.	Arrived at correct answer with correct calculations.	Arrived at correct answer. Calculations are mostly correct but there are some minor errors.	No answer or arrived at wrong answer. Calculations are mostly or completely wrong.
	A-3	Explains results	Explains the result in the context of the completed calculations by providing complex reasoning and interpretations. Clear logical conclusions are drawn.	Explains the result in the context of the completed calculations. Logical conclusions are drawn.	Some explanation of the result is provided but it does not demonstrate logical reasoning.	There are no explanations of the result or an attempt was made to provide an explanation but it is incomplete or wrong.

Table 0.1: **OUTCOME A**: An ability to apply knowledge of mathematics, science, and engineering

	Code	Perf. Criteria	4 Exemplary	3 Proficient	2 Developing	1 Beginning or incomplete
Design	**B-1**	Identifies hypothesis to test	Framed a testable question correctly and explained the anticipated cause-and-effect expectation leading to the question	Framed a testable question correctly	Framed a question that may or may not be testable	Incomplete or no testable question
	B-2	Identifies independent and dependent variables	All variables are identified correctly, explanations about their relations are provided	All variables are identified correctly	Most variables are identified correctly	None or only a few variables are identified correctly
	B-3	Lists assumptions made	All assumptions and their reasons are clearly listed	All assumptions are listed	Assumptions are listed but some are missing	No assumptions listed or most of them are missing
	B-4	Formulates experimental plan to investigate a phenomenon	Developed a sophisticated experimental procedure complete with details of every step to test the hypothesis	Developed correct experimental procedure to test the hypothesis	Attempted but could not completely develop an experimental procedure to test the hypothesis	Could not develop an accurate experimental procedure

(Continued on the next page)

	Code	Perf. Criteria	4 Exemplary	3 Proficient	2 Developing	1 Beginning or incomplete
Conduct	**B-5**	Follows experimental procedures	Follows experimental procedures carefully with great attention to detail. Makes precise measurements	Follows experimental procedures leading to correct measurements	Follows experimental procedures with some mistakes leading to mostly correct measurements	Follows experimental procedures with many mistakes leading to mostly wrong measurements
	B-6	Documents data collected	Systematically documents all data in an exemplary way and by using accurate units	Documents all data and with accurate units.	Documents data with some mistakes in the units or some data missing. Data organization needs improvement	No data are documented or there are major mistakes in the units
Analyze	**B-7**	Uses appropriate methods to analyze data	Excellent, in-depth analysis of the data using appropriate methods	Appropriate level of analysis of data using correct methods	Some data analysis but incomplete	No analysis or attempts to analyze with wrong methods
	B-8	Accounts for experimental uncertainties	Is aware of all potential experimental errors and can fully account for them with suggestions to improve them	Is aware of all potential experimental errors	Is aware of some of the potential experimental errors	Is unaware of any experimental errors
Interpret	**B-9**	Interprets results with respect to the original hypothesis	Provides clear, in-depth, accurate explanations, including trends, and arrives at logical conclusions based on data and results	Provides accurate explanations and logical conclusions based on data and results	Provides explanations and conclusions but with some errors	No explanation or conclusions are provided or they are wrong

Table 0.2: **OUTCOME B**: An ability to design and conduct experiments, as well as to analyze and interpret data.

Code	Perf. Criteria	4 Exemplary	3 Proficient	2 Developing	1 Beginning or incomplete
GS-1	Content presentation well organized	• Each of the required sections is completed. • If necessary, subsections are used • All necessary background principles and information for the experiment are given • All grammar/spelling correct • References are cited	Two of the conditions for the "exemplary" category were not met	Three of the conditions for the "exemplary" category were not met	Four or none of the conditions for the "exemplary" category were not met
GS-2	Professional appearance	• Has cover page with all necessary details (title, course, student name(s), etc.) • Typed • Report layout is neat • Does not exceed specified maximum page limit • Pages are numbered • Equations are consecutively numbered • Figures are numbered, axes have labels, each figure has a descriptive caption • Tables are numbered, they include labels, each table has a descriptive caption • No hand drawn sketches/diagrams • References are cited using correct format	Two of the conditions for the "exemplary" category were not met	Four of the conditions for the "exemplary" category were not met	Five or more of the conditions for the "exemplary" category were not met

Table 0.3: **OUTCOME G**: Ability to communicate effectively. (for Lab Report - **FORMAT**)

	Code	Perf. Criteria	4 Exemplary	3 Proficient	2 Developing	1 Beginning or incomplete
Use techniques, skills and modern eng. tools	**K-1**	Uses software tools for analysis	Can use various software tools and their advanced features correctly for analysis	Can use software tools correctly for analysis	Can use software tools for analysis with only a few mistakes	Cannot use software tools for analysis or attempts to use them but with many mistakes
	K-2	Uses software tools to present data in useful format (graphs, numerical, table, charts, diagrams)	Can use various software tools and their advanced features correctly for data presentation	Can use software tools correctly for data presentation	Can use software tools for data presentation with only a few mistakes	Cannot use software tools for data presentation or attempts to use them but with many mistakes (missing labels, etc.)
	K-3	Uses software tools to simulate physical systems	Can use software tools and their advanced features correctly for simulation	Can use software tools correctly for simulation	Can use software tools for simulation with only a few mistakes	Cannot use software tools for simulation or attempts to use them but with many mistakes

Table 0.4: **OUTCOME K**: An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice