# ABET Preparation Handout #3

Yale Method for Program Assessment of Student Outcomes Achievement

> *This guide is provided to the DUS to explain the comprehensive method to assess how the Student Outcomes are achieved within a SEAS program.*

1. Establish which courses contribute to specific outcomes. See table from ME Self-Study 2008 on page 6 of this handout as an example.

"STUDENT OUTCOMES ASSESSMENT SPREADSHEET" FOR EACH COURSE

2. Assign relevant graded activities (HW, projects, exams) in each course to each outcome.

3. Establish contribution of that course to each outcome.*

4. Quantify the levels of performance in a specific course for each outcome: (Unsatisfactory/Acceptable/Exemplary). *

5. Calculate the "Total Course Credits" in the major for each outcome (summation of item 3 above for all courses listed in item 1).**

*Fall 2008 Courses* — bar chart of Total Course Credits for categories a–k.

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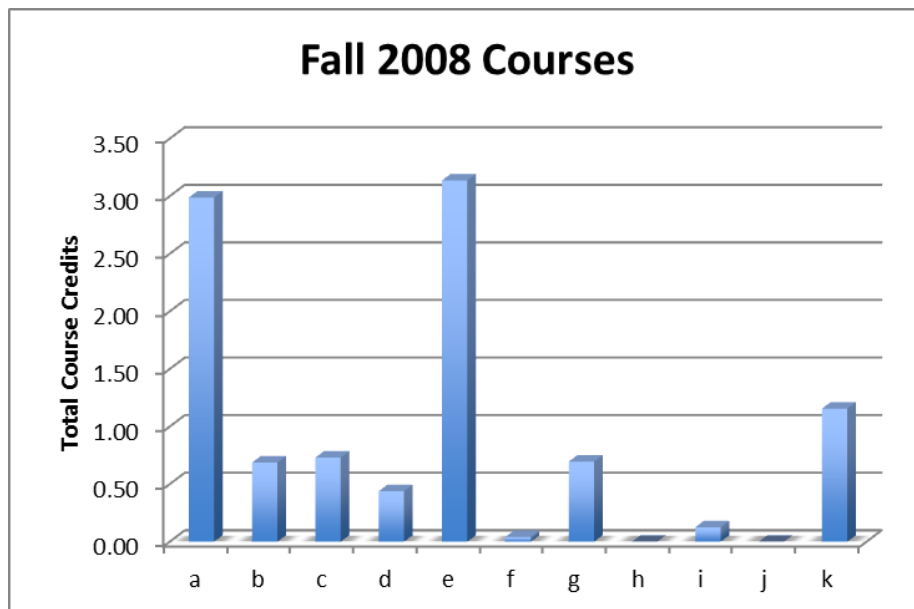
* These calculations are automatically determined using the "STUDENT OUTCOMES ASSESSMENT SPREADSHEET"

** The 2019/2020 Self Study will use the new Outcomes (labeled 1-7) in the assessment

6. Calculate the overall levels of performance (Unsatisfactory/Acceptable/Exemplary) for each outcome for the entire program (average of item 4 for all courses listed in item 1).

Student Performance, Fall 2008 Courses
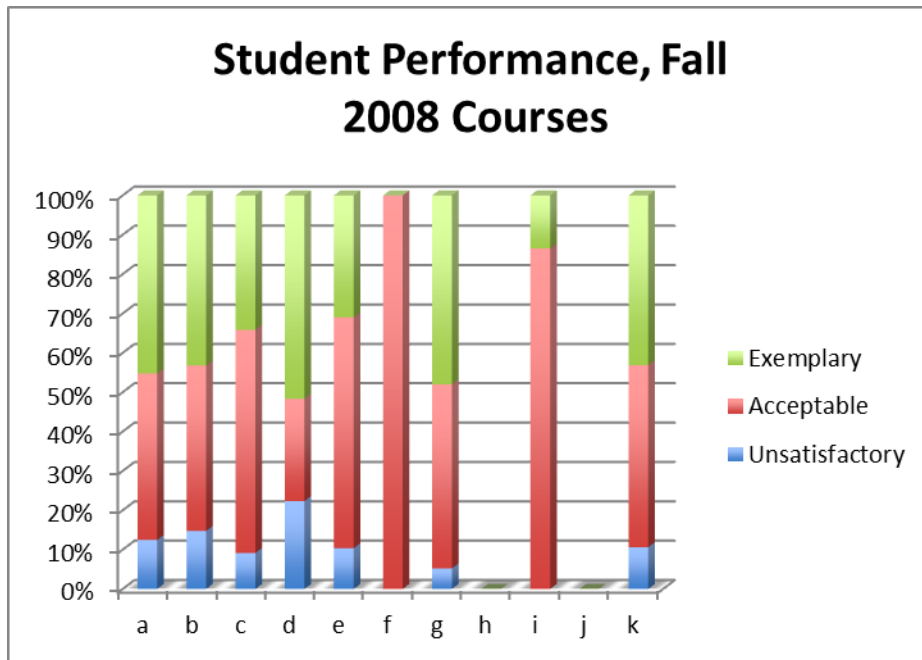
7. As a Program, review the results of steps 5 and 6 to make needed improvements documenting your changes in the Self-Study.

8. Document changes to the program courses and assignments/projects/exams (perhaps using any previously established performance criteria detailed in previous Self-Studies).
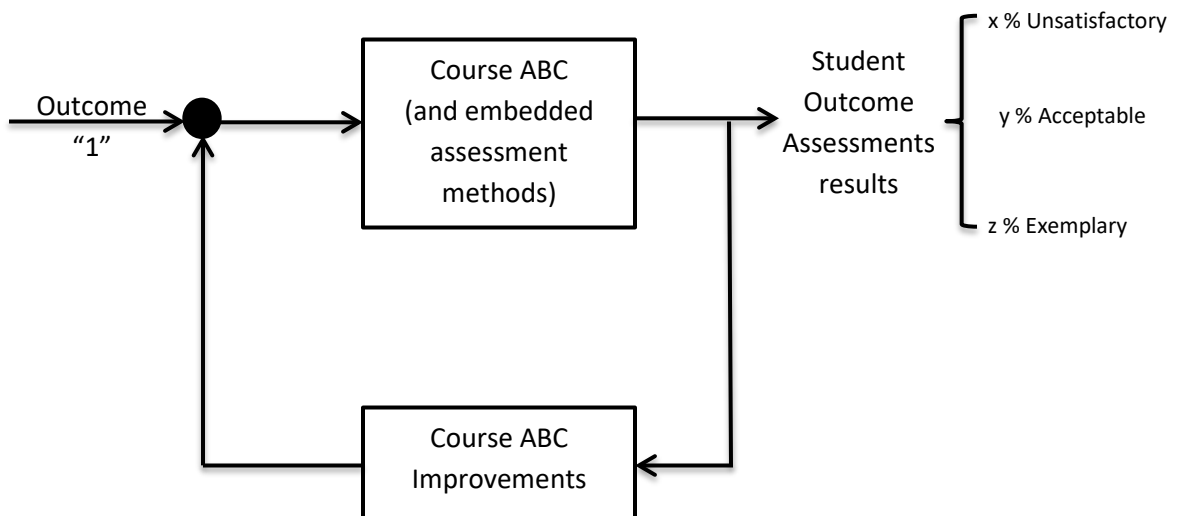
PROGRAM OUTCOMES ASSESSMENT
SPREADSHEET ANALYSIS

The spreadsheet details the relationship between assignments associated with outcomes and determines the level of achievement of outcomes for a single course in a program.

1. Use your normal grading system for the class with the Student Outcomes Assessment Spreadsheet.

ABET Student (Yes/No)	Student Name	HW1 Descriptive Title of HW [100]	HW2 Descriptive Title of HW [100]	HW3 Descriptive Title of HW [100]	HW4 Descriptive Title of HW [100]	HW5 Descriptive Title of HW [100]	HW6 Descriptive Title of HW [100]	HW7 Descriptive Title of HW [100]	HW8 Descriptive Title of HW [150]	HW9 Descriptive Title of HW [100]	HW10 Descriptive Title of HW [100]	HW11 Descriptive Title of HW [100]	FINAL EXAM [300]	Assigned Grade	Overall Percent
		92	93	98	93	90	90	89	130	92	88	87	275		91%
		92	86	88	90	40	80	0	0	94	0	70	240		61%
		100	94	100	98	90	98	81	130	95	90	95	280		93%
		92	88	94	93	97	95	93	130	94	90	95	285		93%
		90	95	97	94	90	95	93	134	95	92	94	282		93%
		100	95	90	86	0	93	94	120	90	0	92	275		78%
		92	86	85	88	95	88	90	135	92	93	85	261		83%
		83	80	86	93	91	88	90	130	93	95	87	265		88%
		95	90	100	98	0	88	90	137	95	100	96	295		89%
		100	96	90	91	90	92	78	135	93	90	90	270		91%
		80	94	98	97	0	94	98	145	93	100	95	282		88%
		100	95	100	98	91	97	94	135	93	100	100	288		96%
	weighting factor	1	1	1	1	1	1.0	1	1.5	1.0	1.0	1.00	3.0		

2. Assign a fractional component of the outcomes associated with this particular course to each relevant graded exercise.

ABET Outcome	HW1	HW2	HW3	HW4	HW5	HW6	HW7	HW8	HW9	HW10	HW11	FINAL EXAM	Percent of Course	
1					0.5		0.5				0.5		10.3%	This last column shows
2													0.0%	how much of outcomes 1-7
3		0.5				0.5		0.5	0.5			0.1	17.6%	go into the course grade.
4	1	0.5	1	0.5	0.5					0.5			27.6%	This will be useful information
5				0.5			0.5					0.4	15.2%	for evaluating our program.
6								0.5	0.5		0.5	0.4	20.3%	
7						0.5				0.5		0.1	9.0%	
(should sum to 1)	1	1	1	1	1	1	1	1	1	1	1	1	100%	

3. These fractional components determine the percentage of the course devoted to each outcome.

Example:

The percentage of outcome 1 (assessed) in this course =

$$\frac{(HW1\ factor)(wt.factor\ HW1)+(HW7\ factor)(wt.factor\ HW7)+(HW11\ factor)(wt.factor\ HW11)}{Total\ of\ wt.factors}$$

$$=\frac{(0.5)(1)+(0.5)(1)+(0.5)(1)}{14.5} = 10.3\%$$

4. Establish numerical threshold for Unsatisfactory/ Acceptable/ Exemplary performance in this course.

Please enter performance cutoff percentages below. These are the numbers that determine the cutoff between Unsatisfactory, Acceptable, and Exemplary.

Cutoff Percentages

80	Unsatisfactory
95	Exemplary

Breakdown of Student Performance by Assignment

*Each column should add up to the number of students in the course.

	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [150]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	FINAL EXAM [300]
Unsatisfactory	0	0	0	0	4	0	2	1	0	2	1	0
Acceptable	7	8	6	8	6	8	9	10	9	6	6	9
Exemplary	5	4	6	4	2	4	1	1	3	4	5	3

5. The number of students in each performance category is calculated by the spreadsheet for each graded assignment/exam.

6. A summary of the class performance in each relevant outcome is calculated by the spreadsheet based on scores in the relevant assignments as:

Overall Result - Unsatisfactory Performance for Outcome 1 =

$$\frac{\sum(\#unsat\ students\ in\ ea.\ relevant\ assig)(fract.\ component\ of\ this\ assig.\ of\ this\ outcome)(wt\ factor\ of\ the\ relevant\ assig)}{(total\ \#\ students)(\%\ of\ outcome\ in\ the\ course)(total\ weighing\ factor)}$$

$$= \frac{(4)(0.5)(1)+(2)(0.5)(1)+(1)(0.5)(1)}{(12)(0.103)(14.5)} = 19\%$$

7. The spreadsheet quantifies the levels of performance for each outcome in the course:

Results: Course Summary for: MENG-123

*If the chart does not appear, please select the tabular data on the right of the chart and insert your own column chart.

Mechanical Analysis

Legend: Exemplary, Acceptable, Unsatisfactory
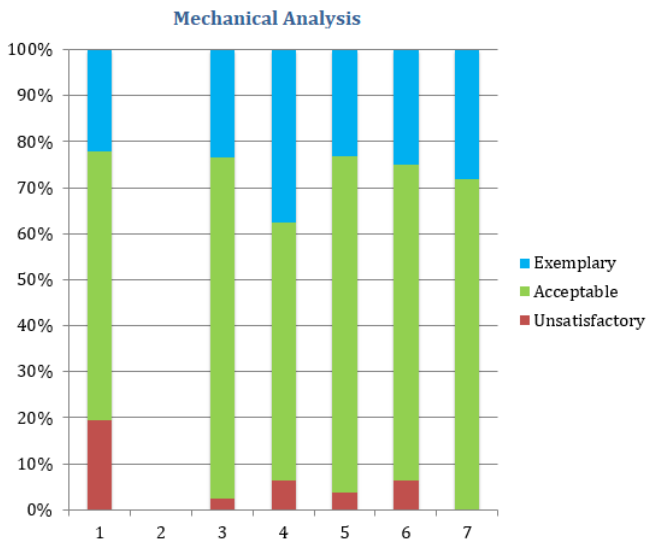
Outcome	Unsatisfactory	Acceptable	Exemplary	Total
1	19%	58%	22%	100%
2	0%	0%	0%	0%
3	2%	74%	23%	100%
4	6%	56%	38%	100%
5	4%	73%	23%	100%
6	6%	69%	25%	100%
7	0%	72%	28%	100%

Note that 1-7 items not evaluated (i.e., no entries in the matrix) do not have a column in the graph.

Other Student Outcome Assessment tools:

1. Performance Criteria & Rubrics can serve as (established for previous ABET Reviews) a detailed explanation of evaluation and potential improvements.
2. Student Outcomes questions in the Online Course Evaluation can also be included.
3. Feedback from external visitors on specific outcomes in Capstone Projects.

"ME 2008 Response (partial) to ABET Draft Statement"

Introduction

We have instituted a new means of directly measuring our success in achieving our outcomes. Following up on some of the ideas that came up during the ABET visit, the faculty were sent an annotated excel spreadsheet showing how they might track their outcomes on a per-assignment basis. In implementing the spreadsheet for their courses, instructors come up with a matrix representing the fraction of each assignment or exam that relates to each program outcome. This information is then used to determine the relative amount of each outcome that goes into the final grade. This will be useful across the curriculum to ensure that there is adequate coverage of each a-k outcome. The matrix, along with the usual grade list, also allows us to generate meaningful data on the percentage of student work that was exemplary, acceptable, and unsatisfactory for each of the course outcomes. Like the custom question for each course, once the spreadsheet is set up, maintaining it should be straightforward.

Table from ME Self Study 2008:

Relationship between ABET Outcomes and Course Objectives											
ABET Outcomes→ *Course Objectives↓*	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Required Courses											
ENAS 130 - Introduction to Computing for Engineers and Scientists	x	x	x	x	x						x
ENAS 194 - Ordinary and Partial Differential Equations with Applications	x				x				x		
MENG 211 - Thermodynamics for Mechanical Engineers	x		x		x			x	x	x	x
MATH 222 - Linear Algebra with Applications	x										
EENG 226 - Intro to EE: Electronic Circuits and Devices	x										
EENG 227 - Circuits and Electronics Laboratory	x	x	x	x	x		x		x		x
MENG 280 - Strength and Deformation of Mechanical Elements	x				x	x					
MENG 285 - Introduction to Materials Science	x			x	x						
MENG 286 - Solid Mechanics and Materials Science Laboratory	x	x	x	x	x	x	x				
MENG 361 - Fluid Mechanics	x				x						x
MENG 363 - Fluid Mech. and Thermo. Lab	x	x			x	x	x	x	x	x	x
MENG 383 - Dynamics	x			x	x		x				x
MENG 389 - Fluid and Thermal Energy Science	x		x		x		x				x
MENG 390 - Mechatronics	x	x	x	x	x		x			x	x
MENG 489 - Mechanical Design: Process and Implementation	x	x	x	x	x	x	x		x		x
MENG 471/472 - Special Projects	x	x	x	x	x	x	x				x
Electives (3 required)											
MENG 185 - Mechanical Design	x	x	x	x	x	x	x	x	x	x	x
MENG 365 - Propulsion and Energy Conversion	x	x	x		x	x		x	x		x
MENG 385 - Materials Science of MEMS	x	x	x		x					x	x
MENG 400 - Computer-Aided Engineering	x		x		x		x		x		x
MENG 440 - Applied Numerical Methods I	x	x			x		x				x
MENG 441 - Applied Numerical Methods II	x	x			x		x				x
MENG 457 - Biomechanics	x	x	x	x	x			x			x
MENG 463 - Theoretical Fluid Dynamics	x				x						x

Sample Spreadsheet for MENG 285 (Introduction to Material Science)

YALE SCHOOL OF ENGINEERING AND APPLIED SCIENCE

MECHANICAL ENGINEERING ABET OUTCOME REVIEW

This spread sheet template tracks achievement of the ABET Student Outcomes.
To use this spreadsheet, fill out the parts in green - everything else should take care of itself.

ABET Student Outcomes:

1. An ability to identify, formulate, & solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members provide leadership, create collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Number:	MENG-123
Course Name:	Mechanical Analysis

To use this spreadsheet, fill out the parts in green - everything else should take care of itself.

The grade sheet uses faculty assigned weighting factors for each test and homework assignment. The maximum possible points is the weighting factor * 100.

ABET Student (Yes/No)	Student Name	HW1 Descriptive Title of HW [100]	HW2 Descriptive Title of HW [100]	HW3 Descriptive Title of HW [100]	HW4 Descriptive Title of HW [100]	HW5 Descriptive Title of HW [100]	HW6 Descriptive Title of HW [100]	HW7 Descriptive Title of HW [100]	HW8 Descriptive Title of HW [150]	HW9 Descriptive Title of HW [100]	HW10 Descriptive Title of HW [100]	HW11 Descriptive Title of HW [100]	FINAL EXAM [300]	Assigned Grade	Overall Percent
		92	93	98	93	90	90	89	130	92	88	87	275		91%
		92	86	88	90	40	80	0	0	94	0	70	240		61%
		100	94	100	98	90	98	81	130	95	90	95	280		93%
		92	88	94	93	97	95	93	130	94	90	95	285		93%
		90	95	97	94	90	95	93	134	95	92	94	282		93%
		100	95	90	86	0	93	94	120	90	0	92	275		78%
		92	86	85	88	95	88	90	135	92	93	85	261		89%
		83	80	86	93	91	88	90	130	93	95	87	265		88%
		95	90	100	98	0	88	90	137	95	100	96	295		89%
		100	96	90	91	90	92	78	135	93	90	90	270		91%
		80	94	98	97	0	94	98	145	93	100	95	282		88%
		100	95	100	98	91	97	94	135	93	100	100	288		96%
	weighting factor	1	1	1	1	1	1.0	1	1.5	1.0	1.0	1.00	3.0		

Please assign a fraction of each of the ABET student outcomes (see 1-7 above) to each test and homework assignment. The percent of course devoted to each ABET outcome is calculated, accounting for the maximum possible points and the weighting factor.

ABET Outcome	HW1	HW2	HW3	HW4	HW5	HW6	HW7	HW8	HW9	HW10	HW11	FINAL EXAM	Percent of Course
1					0.5		0.5				0.5		10.3%
2													0.0%
3		0.5			0.5			0.5	0.5			0.1	17.6%
4	1	0.5	1	0.5	0.5					0.5			27.6%
5				0.5			0.5					0.4	15.2%
6									0.5	0.5	0.5	0.4	20.3%
7						0.5			0.5			0.1	9.0%
(should sum to 1)	1	1	1	1	1	1	1	1	1	1	1	1	100%

This last column shows how much of outcomes 1-7 go into the course grade. This will be useful information for evaluating our program.

Please enter performance cutoff percentages below. These are the numbers that determine the cutoff between Unsatisfactory, Acceptable, and Exemplary.

Cutoff Percentages

80	Unsatisfactory
95	Exemplary

Breakdown of Student Performance by Assignment

*Each column should add up to the number of students in the course.

	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [150]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	FINAL EXAM [300]
Unsatisfactory	0	0	0	0	4	0	2	1	0	2	1	0
Acceptable	7	8	6	8	6	8	9	10	9	6	6	9
Exemplary	5	4	6	4	2	4	1	1	3	4	5	3

Results: Course Summary for: MENG-123

*If the chart does not appear, please select the tabular data on the right of the chart and insert your own column chart.

Mechanical Analysis

Outcome	Unsatisfactory	Acceptable	Exemplary	Total
1	19%	58%	22%	100%
2	0%	0%	0%	0%
3	2%	74%	23%	100%
4	6%	56%	38%	100%
5	4%	73%	23%	100%
6	6%	69%	25%	100%
7	0%	72%	28%	100%

Note that 1-7 items not evaluated (i.e., no entries in the matrix) do not have a column in the graph.

Table from "ME 2008 Response (partial) to ABET Draft Statements"

Percentage of the grade for each course that corresponds to a-k outcomes

|	211	280	285	286L	361	383	400	402L	440	489	Total Course Credits
a	17%	34%	33%	14%	39%	38%	12%	12%	83%	17%	2.99
b				31%				21%	6%	11%	0.69
c	2%	8%		4%		12%	20%	8%		20%	0.73
d				14%				18%		12%	0.44
e	78%	33%	67%		61%	39%	15%	14%	2%	5%	3.14
f							0%			4%	0.04
g		12%		20%			8%	14%		16%	0.70
h											0.00
i								3%		9%	0.13
j											0.00
k	3%	13%		17%		11%	42%	14%	9%	7%	1.16

Student Performance

Unsatisfactory

	211	280	285	286L	361	383	400	402L	440	489	Average
a	20%	8%	36%	27%	3%	0%	19%	0%	11%	0%	12%
b				12%				12%	13%	22%	15%
c	20%	14%		0%		0%	2%	17%		11%	9%
d				45%				0%		22%	22%
e	20%	9%	23%		6%	0%	4%	9%	11%	11%	10%
f										0%	0%
g		13%		13%			0%	0%		0%	5%
h											#DIV/0!
i								0%		0%	0%
j											#DIV/0!
k	20%	6%		21%		0%	7%	0%	9%	22%	11%

Acceptable

	211	280	285	286L	361	383	400	402L	440	489	Average
a	60%	33%	25%	12%	65%	73%	57%	31%	55%	11%	42%
b				21%				36%	55%	56%	42%
c	60%	79%		0%		64%	77%	50%		67%	57%
d				12%				21%		45%	26%
e	60%	35%	55%		62%	73%	78%	28%	69%	67%	59%
f										100%	100%
g		50%		33%			78%	18%		55%	47%
h											#DIV/0!
i								73%		100%	87%
j											#DIV/0!
k	60%	37%		13%		73%	64%	18%	49%	56%	46%

Exemplary

	211	280	285	286L	361	383	400	402L	440	489	Average
a	20%	58%	39%	61%	32%	27%	23%	69%	34%	89%	45%
b				67%				52%	32%	22%	43%
c	20%	7%		100%		36%	21%	33%		22%	34%
d				43%				79%		33%	52%
e	20%	56%	21%		32%	27%	18%	63%	20%	22%	31%
f										0%	0%
g		37%		54%			22%	82%		45%	48%
h											#DIV/0!
i								27%		0%	14%
j											#DIV/0!
k	20%	57%		67%		27%	28%	82%	42%	22%	43%

Table from "ME 2008 Response (partial) to ABET Draft Statements"

Fall 2008 Courses
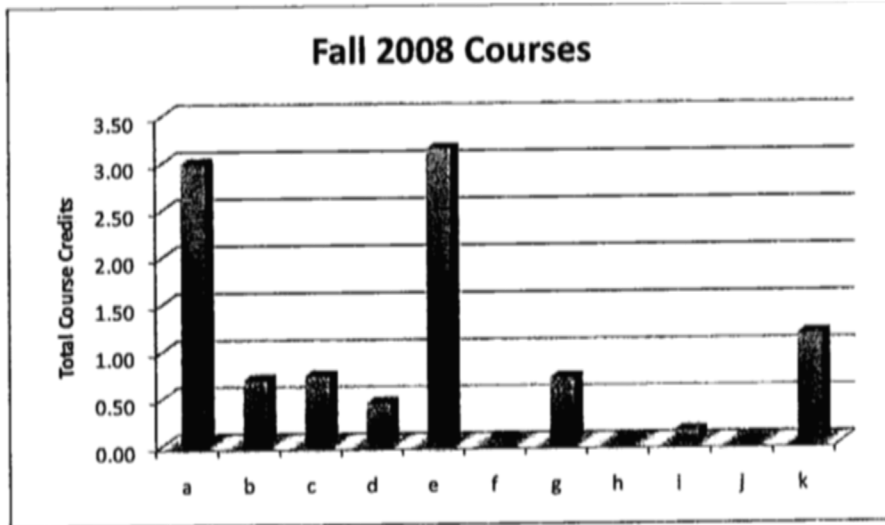
	Unsatisfactory	Acceptable	Exemplary
a	12%	42%	45%
b	15%	42%	43%
c	9%	57%	34%
d	22%	26%	52%
e	10%	59%	31%
f	0%	100%	0%
g	5%	47%	48%
h	#DIV/0!	#DIV/0!	#DIV/0!
I	0%	87%	14%
j	#DIV/0!	#DIV/0!	#DIV/0!
k	11%	46%	43%

Student Performance, Fall 2008 Courses