OREGON INSTITUTE OF TECHNOLOGY
Mechanical Engineering Program

Mechanical Engineering Assessment Report 2010-11

September 16, 2011

INTRODUCTION

This report documents the assessment done within the Mechanical Engineering (ME) program at Oregon Institute of Technology for the 2010-11 school year. Some of the assessment was done during the 2009-10 school year due to an ABET visit during fall of 2010.

The ME program is using a three year assessment cycle. In this, each outcome is assessed at least once every three years. The document "Mechanical Engineering Program Assessment Plan" documents this plan over the three year cycle. The outcomes being assessed for the 2010-11 school year are summarized here, both the assessment being done and results of these assessments. For the overall three year cycle the reader is referred to the program's assessment plan.

PROGRAM MISSION STATEMENT AND EDUCATIONAL OBJECTIVES

The mission statement of the ME Program is in line with and built upon the mission statements of the Institution and the Department. The ME program's Mission Statement and Program Educational Objectives are stated as:

Mechanical Engineering Program Mission Statement

The Mechanical Engineering Program at Oregon Institute of Technology is an applied engineering program. Its mission is to provide graduates the skills and knowledge for successful careers in mechanical engineering.

Mechanical Engineering Program Educational Objectives

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The Program Educational Objectives of OIT's mechanical engineering program are to produce alumni who:

- *are able to analyze, design and improve practical thermal and mechanical systems.*
- *communicate effectively and work well on team-based engineering projects.*
- *succeed in entry-level mechanical engineering positions regionally and nationally.*
- *pursue continued professional development, including professional registration if desired.*
- *have the skills and knowledge to pursue engineering graduate studies and research, if desired.*

EDUCATIONAL OUTCOMES

The ME program's Student Learning Outcomes are aligned with ABET EAC outcomes. These are stated as:

(a) an ability to analyze and model physical systems or components using (apply knowledge of) mathematics (including multi-variable calculus and differential equations), basic science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design and realize a physical system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve 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, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(m1) Graduates will be able to work professionally in the area of thermal systems
(m2) Graduates will be able to work professionally in the area of mechanical systems.

These outcomes mirror those of the EAC of ABET. Outcomes (a) and (c) have been slightly modified to better represent ABET's Mechanical Engineering program specific criteria. Also, outcomes (m1) and (m2) have been added also to address ABET's Mechanical Engineering program-specific criteria.

ASSESSMENT CYCLE

Assessment within the MMET Department is done on a three-year cycle. Each outcome is assessed at least once every three years. The schedule for assessment activities for the ME Program is shown in Table 1.

Note that ME Program Mission and Program Educational Objectives are to be assessed along with program Student Learning Outcomes.

The MMET Department consists of both engineering and engineering technology programs. The ABET outcomes for engineering and engineering technology are quite similar. The engineering technology outcomes (a-k) are listed in Table 1 for reference.

Table 1: Assessment Cycle

Educational Outcome	*2008-09*	*2009-10*	*2010-11*	*TAC*
Review Program Mission and Educational Objectives	x			
Assess Program Educational Objectives		x		
a) Graduates will have the ability to analyze and model physical systems or components using (apply knowledge of) mathematics (including multi-variable calculus and differential equations), basic science and engineering	x			b
b) Graduates will have the ability to design and conduct experiments, as well as to analyze and interpret data.			x	c
c) Graduates will be able to design and realize a physical system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	x			d
d) Graduates will be able to function on multi-disciplinary teams.		x		e

Educational Outcome	*2008-09*	*2009-10*	*2010-11*	*TAC*
e) Graduates will be able to identify, formulate, and solve engineering problems. Graduates will be able to analyze and model physical systems or components using principles of engineering, basic science and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems or components.	x			f
f) Graduates will have an understanding of professional and ethical responsibility.		x		i
g) Graduates will have the ability to communicate effectively.			x	g
h) Graduates will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context.		x		j
i) Graduates will recognize the need for, and have the ability to engage in life-long learning.			x	h
j) Graduates will have a knowledge of contemporary issues			x	j
k) Graduates will be able to use the techniques, skills, and modern engineering tools necessary for engineering practice.			x	a
m1) Graduates will be able to work professionally in the area of thermal systems.	x			
m2) Graduates will be able to work professionally in the area of mechanical systems.	x			

SUMMARY OF 2010-11 ASSESSMENT ACTIVITIES

It should be noted that the ME program is undergoing an ABET visit in the fall of 2010. Due to this many of the assessments scheduled for 2010-11 and covered here were undertaken in 2009-10.

OUTCOME (b) Experimentation

Graduates will have the ability to design and conduct experiments, as well as to analyze and interpret data.

The Performance Criteria to consider in assessing this outcome are:

1. Design experiments to gather stated information regarding a physical system
2. Carry out experiment set-up and execution to obtain valid data
3. Gain physical understanding through analysis and interpretation of experimental data

These performance criteria are stressed in our ME Program's hands-on education. Each course containing a laboratory adds to this SLO. Appendix I shows the courses and where they occur in the curriclum.

Assessment method: Direct assessment of student work.

Selected instrumentation intensive lab reports will be reviewed by the faculty member(s) giving the assignment. Reports from Instrumentation (MECH 363), Heat Transfer II (MECH 437) and Vibrations (MECH 480) are assessed. A rubric is used to assess the students' ability to meet the Performance Criteria. This rubric is shown in Appendix II.

A laboratory relating to temperature was selected from MECH 363. Eleven labs were assessed using the experimentation rubric. Similarly a lumped mass convection laboratory was selected from MECH 437. Ten laboratory reports were assessed using the same rubric. Finally, a lab from MECH 480, forced vibration of a cantelever beam, was assessed. Here ten labs were reviewed and assessed. In each case the percent of students performing at least satisfactorily is reported in Table 2.

Table 2: Assessment Results for SLO b, Experimentation

Performance Criteria	Minimum Acceptable Performance	MECH 363	MECH 437	MECH 480
Design Experiments	80% score 3 or 4	91%	70%	90%
Execute Experiments	80% score 3 or 4	100%	80%	100%
Understand Experimental Data	80% score 3 or 4	82%	80%	50%

In general the students are adept at designing, executing and analyzing experiments. The experiments in the senior level courses are much less structured which probably gives a better evaluation of their abilities in this area. Also, designing and analyzing experiments are closely tied together. If an experiment is well designed the chances of getting understandable data increases.

Assessment Method: MMET Undergraduate Exit Survey

During the spring term each graduating senior completes an exit survey. The survey includes questions on how well the program prepared the student on each SLO. This survey data is reviewed by faculty to determine any strengths or weaknesses as perceived by students on this SLO.

In spring of 2010 nine of the ten students in senior projects completed an exit survey. Students were asked to *"Please rate how well the Mechanical Engineering Program prepared you in the following areas: To design and conduct experiments, as well as to analyze and interpret data."* Table 3 shows the results of this inquiry.

Table 3: Senior Project Exit Survey, Experimentation

	Highly Prepared	Prepared	Inadequately Prepared
Design and conduct experiments, as well as to analyze and interpret data	89.00%	11.00%	0%

The students feel they are prepared or highly prepared to carry out experiments and interpret the resulting data.

OUTCOME (g) Communicate Effectively

Graduates will have the ability to communicate effectively.

Assessment of this SLO parallels the Institutional SLO for communication. This assessment is done campus wide once every three years in line with the ME program's assessment. The SLO is broken into oral communication and written communication. In addition an exit survey given during senior projects was considered.

The Performance Criteria to consider in assessing this outcome are:

Oral Communication:

- Support thesis adequately with detail and/or research, and documents support correctly and responsibly.
- Organizes oral material effectively.
- Presents appropriately for audience and purpose.
- Speaks clearly and correctly, using standard English.
- Uses visual communication effectively.

Written Communication:

- Clearly conveys purpose and main ideas.
- Organizes written material effectively.
- Supports main ideas adequately with detail and/or research.
- Uses appropriate voice, word choice and sentence structure.
- Uses standard English.
- Documents support correctly and responsibly.

Assessment method: Direct assessment of student oral presentation

Paralleling the institution's assessment, the ME program used the performance criteria (listed above) and an institutional rubric created by OIT. In the ME program, faculty assess individual student presentations in MECH 360 Materials I. The rubric for this assessment is shown in Appendix II.

In winter term 2010, 24 students gave presentations and were assessed in MECH 360. Table 4 shows the results of this assessment. Student presentations were judged to be more than adequate in all areas.

Assessment Method: Direct assessment of student written report

Paralleling the institution's assessment, the ME program used the performance criteria (listed above) and an institutional rubric created by OIT. In the ME program, faculty assessed an individual student paper from a senior level class. The rubric is shown in Appendix II.

For the 2010-11 assessment a paper assigned in ENGR 485 was collected. This assignment was used for assessing written communication as well as lifelong learning. Scores from rubric evaluation of this assignment are shown in Table 5. Ten ME students are respresented in this data.

Table 4: Oral Presentation Assessment

Performance Criteria	Minimum Acceptable Performance	ENGR 485
Content	80% score 3 or 4	100%
Organization	80% score 3 or 4	100%
Style	80% score 3 or 4	96%
Delivery	80% score 3 or 4	88%
Visuals	80% score 3 or 4	100%

As seen in Table 5 the students performed well. The only area which could be considered weak is in organization. The evaluator felt these papers were all done quickly with little hard research. He felt the effort put forth by the students was less than that shown on most technical papers prepared by the same students. The paper was given weight in course grading, however the course is only one credit and has a pass-fail grading structure. This may account for the low priority the students apparently applied to this assignment.

Table 5: Assessment of Written Assignment

Performance Criteria	Minimum Acceptable Performance	ENGR 485
Purpose and Ideas	80% score 3 or 4	90%
Organization	80% score 3 or 4	70%
Support	80% score 3 or 4	80%
Style	80% score 3 or 4	90%
Conventions	80% score 3 or 4	80%
Documentation	80% score 3 or 4	100%

Considering the shortcomings of the assessed assignment, the results are encouraging.

Assessment Method: MMET Undergraduate Exit Survey

During the spring term each graduating senior completes an exit survey. The survey includes questions on how well the program prepared the student on each SLO. This survey data is reviewed by faculty to determine any strengths or weaknesses as perceived by students on this SLO.

In spring of 2010 nine of the ten students in senior projects completed an exit survey. Students were asked to *"Please rate how well the Mechanical Engineering Program prepared you in the following areas: To have the ability to communicate effectively."* Table 6 shows the results of this inquiry.

Table 6: Senior Project Exit Survey, Communication

	Highly Prepared	Prepared	Inadequately Prepared
Have the ability to communicate effectively	78%	22%	0%

The students feel they are prepared or highly prepared to communicate effectively.

OUTCOME (i) Life-long Learning

Graduates will recognize the need for, and have the ability to engage in life-long learning.

Assessment of this SLO parallels the Institutional SLO for lifelong learning. This assessment is done campus wide once every three years in line with the ME program's assessment.

The Performance Criteria to consider in assessing this outcome are:

- Describe short- and long-term career plans.
- Identify and discuss desired credentials and avenues for continuing education.
- Demonstrate awareness of appropriate professional societies and organizations and discuss their relationship to career development.
- Identify and discuss the concept of lifelong learning.

Assessment Method: Direct assessment of student work

Paralleling the institution's assessment, the ME program used the performance criteria (listed above) and a institutional rubric created by OIT. Assessment within the ME program involved an individual student paper from ENGR 485 Fundamentals of Engineering Exam. For this assessment cycle the papers to be used were collected spring term 2010. The rubric used for this assessment is given in Appendix II.

Results from this assessment are shown in Table 7. This represents papers from 10 students.

Table 7: Assessment of Lifelong Learning Paper

Performance Criteria	Minimum Acceptable Performance	ENGR 485
Lifelong Learning	80% score 3 or 4	70%
Professional Societies	80% score 3 or 4	70%
Credentials	80% score 3 or 4	80%
Continuing Education	80% score 3 or 4	80%
Career Paths	80% score 3 or 4	90%

The assessment results fell short of that desired in two areas. It was hoped the students would have a better understanding of lifelong learning possibilities and the details of professional society membership. This may be in part due to the nature of the paper assessed. The evaluator felt less effort was put forth on this paper than on most technical papers prepared by the same students. Although this paper counted towards grades, it is for a one credit pass-fail course. It was hoped the students would do more research into the topic than they obviously did.

Assessment Method: MMET Undergraduate Exit Survey

During the spring term each graduating senior completes an exit survey. The survey includes questions on how well the program prepared the student on each SLO. This survey data is reviewed by faculty to determine any strengths or weaknesses as perceived by students on this SLO.

In spring of 2010 nine of the ten students in senior projects completed an exit survey. Students were asked to *"Please rate how well the Mechanical Engineering Program prepared you in the following areas: To recognize the need for, and have the ability to engage in life-long learning"*. Table 8 shows the results of this inquiry.

Table 8: Senior Project Exit Survey, Lifelong Learning

	Highly Prepared	Prepared	Inadequately Prepared
Recognize the need for, and have the ability to engage in life-long learning	67%	33%	0%

The students feel they are prepared or highly prepared for lifelong learning.

OUTCOME (j) Knowledge of Contemporary Issues

Graduates will have knowledge of contemporary issues

Contemporary issues form a very broad topic which can be assessed only in broad terms. Performance criteria used by the program to assess this outcome are[1]:

- Ability to address the major socio-economic issues facing the US and the world.
- Ability to address political issues at national, state and local levels.

Students learn about contemporary issues through a composite of their education. It is anticipated that they have a basic knowledge before starting their college studies. Once at college the culture and atmosphere of the school will add greatly to this knowledge. The general education elements of our engineering education also add. Even courses such as history will relate subject matter to contemporary times. In many technical courses contemporary issues related to engineering are discussed. The knowledge compiled by each student will be different and therefore be hard to quantify. However an attempt is being made to assess the above performance criteria.

Assessment method: Direct assessment of student work

The program assesses student knowledge of contemporary issues through a structured discussion with the students in senior projects. A series of questions relating to contemporary issues was prepared but not made available to the students before the discussion period. The list of questions as provided in Appendix

III. During the discussion each student was asked to address a question of their choice. After each student had participated the discussion was opened up for any student to address other questions.

The discussion included MET and MFG technology students as well as ME students. Twelve ME students participated. The senior project faculty assessed the responses from each participating student. The faculty used the rubric supplied but were otherwise free to use their judgement. Results from this assessment are shown in Table 9

Table 9: Results from Contemporary Issues Discussion

Faculty Member	Accepted Performance	Contemporary Knowledge Discussion
Hugh Currin	80% score 3 or 4	67%
Brian Moravec	80% score 3 or 4	17%
Joe Stuart	80% score 3 or 4	58%
David Culler	80% score 3 or 4	75%

The discussions were enlightening and gave some insight into student knowledge outside the field of engineering. However, the evaluations from faculty varied widely. Review of the assessment showed the low evaluations and large discrepancies came from the assessment tool and its application. The students were simply asked to comment on a question of their choice. They, understandably, gave their opinions with some justification. The rubric however asked for compairsons and the ability to understand varying viewpoints. The rubric also is to assess both major socio-economic and U.S. political issues. It was suggested that the directions to the students be changed requiring them to give varying viewpoints, not just one side of an issue. Also, the scope of the requested response should be more clearly defined.

Assessment Method: MMET Undergraduate Exit Survey

During the spring term each graduating senior completes an exit survey. The survey includes questions on how well the program prepared the student on each SLO. This survey data is reviewed by faculty to determine any strengths or weaknesses as perceived by students on this SLO.

In spring of 2010 nine of the ten students in senior projects completed an exit survey. Students were asked to *"Please rate how well the Mechanical Engineering Program prepared you in the following areas: To have knowledge of contemporary issues."* Table 10 shows the results of this inquiry.

Table 10: Senior Project Exit Survey, Contemporary Issues

	Highly Prepared	Prepared	Inadequately Prepared
Have knowledge of contemporary issues	44%	56%	0%

The students feel they are prepared or highly prepared with knowledge of contemporary issues.

OUTCOME (k) Modern Engineering Tools

> *Graduates will be able to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

The Performance Criteria to consider in assessing this outcome are:

1. Use computers and a wide range of programs effectively
2. Understand 2D and 3D CAD modeling and use example programs effectively
3. Select and use laboratory and instrumentation equipment effectively
4. Understand manufacturing methods adequately to design manufacturable products

The use of computers is now central to the engineering profession. Students must have an understanding of general computer use and CAD design to be effective. They must also have an understanding of laboratory and test equipment as well as instrumentation. However, assessment of criteria 3 above is covered in SLO b Experimentation and is not re-addressed here. We also feel students need an understanding of manufacturing methods and their limitations to develop useful designs.

These skills are spread throughout the ME Program. Computer usage is introduced in freshman courses and the knowledge is built upon through subsequent courses. Computer programming is taught in a sophomore course, Computer Programming for Engineers (ENGR 266). CAD is thought very important for our applied program and is taught in four classes. 2D CAD is taught in CAD for Mechanical Design I and II (MET 241/242) while 3D modeling is taught in Solid Modeling (MET 375) and Finite Element Analysis (MECH 351). Use of test equipment and instrumentation are taught through many laboratory courses. Manufacturing methods are introduced through courses in machining and welding (MFG 120/103) as well as through subsequent design courses and senior projects. A curriculum map showing when elements of the SLO are taught is shown in Appendix I.

Assessment method: Direct assessment of student work

The courses in which assessment was done include Finite Element Analysis (MECH 351), Heat Transfer II (MECH 437) and Senior Projects. These should give a good sampling to assess the performance criteria above. An analytic rubric was applied to select student work and reviewed by the faculty. This rubric is shown in Appendix II. Assessment in MECH 351 and MECH 437 asked the faculty member teaching the particular course to evaluate a lab assignment using the rubric. Assessments were obtained from 5 students in MECH 351 and 10 students in MECH 437. In senior projects the involved faculty were asked to assess each ME student through observation of their performance on the project. In senior projects 10 students were assessed. Table 11 shows the results of these evaluations. They represent the percent of students performing at or above a satisfactory level.

Table 11: Assessment Results for SLO K, Engineering Tools

Performance Criteria	Minimum Acceptable Performance	MECH 351	MECH 437	Senior Projects
Computer Use	80% score 3 or 4	40%	100%	90%
CAD Use	80% score 3 or 4	60%	N/A	100%
Design for Manufacturability	80% score 3 or 4	N/A	N/A	100%

As seen in Table 11 the results are somewhat scattered. Evaluations made in MECH 351 shows performance below what we'd like to see, while assessments in senior projects are very good. This scatter, and several assessments finding the assginment used to be “not applicable,” point to weaknesses in the assessment scheme.

Assessment Method: MMET Undergraduate Exit Survey

During the spring term each graduating senior completes an exit survey. The survey includes questions on how well the program prepared the student on each SLO. This survey data is reviewed by faculty to determine any strengths or weaknesses as perceived by students on this SLO.

In spring of 2010 nine of the ten students in senior projects completed an exit survey. Students were asked to *"Please rate how well the Mechanical Engineering Program prepared you in the following areas: To use the techniques, skills, and modern engineering tools necessary for engineering practice."* Table 12 shows the results of this inquiry.

Table 12: Senior Project Exit Survey, Engineering Tools

	Highly Prepared	Prepared	Inadequately Prepared
Use the techniques, skills, and modern engineering tools necessary for engineering practice	56%	44%	0%

The students feel they are prepared or highly prepared to use modern engineering tools.

SUMMARY OF STUDENT LEARNING OUTCOMES & ACTIONS TAKEN

Assessments done for 2010-11 have been reviewed by the faculty. A set of recommendations were developed to address shortcomings or areas where room for improvements is recognized. These recommendations are listed below.

OUTCOME (b) Experimentation

Although improvements can always be made, the faculty is not overly concerned with this outcome. The low scores in "Understanding Experimental Data" in MECH 480 is likely due to the very open ended nature of those labs. The faculty felt efforts could be better applied in other areas.

OUTCOME (g) Communicate Effectively

Communication assessments showed students to be proficient in both oral and written communication. The faculty felt no additional emphasis should be given to this outcome at this time.

OUTCOME (i) Life-long Learning

Students performed well in most areas assessed. The faculty felt areas which showed shortcomings related more to the effort the students gave the assignment than to their abilities. The next time this assessment is given more emphasis should be given to the assignment. This assessment fits so well into ENGR 485 that the faculty felt this assessment should remain there even though this class is pass/fail.

The faculty teaching this class have been asked to stress the intent and effort required. If this is not adequate to motivate the students it may be necessary to make the course in which this assessment is done, ENGR 485, a graded course rather than pass/fail. The faculty felt we should try the less drastic approach first.

OUTCOME (j) Knowledge of Contemporary Issues

The faculty felt the poor performance on this assessment is due more to the assessment tools than to the students knowledge. The directions to the students will be updated before this assessment is given again. It was also suggested that this assessment be tried again before it is again due in the three year cycle.

OUTCOME (k) Modern Engineering Tools

The faculty felt a rework of the assessment tool, or a change in the assignments used for assessment should be considered.

SUMMARY OF ACTION ITEMS

- Put more emphasis on the assignment used for Lifelong Learning
- The assessment tool for "Knowledge of Contemporary Issues" needs to be revised. This should be done, along with a trial run of the assessment during winter term 2012.
- The assignments used for "Modern Engineering Tools" should be reviewed and possibly revised before this assessment is given again.

RESULTS FROM PREVIOUS YEARS ASSESSMENT ACTIVITIES

Actions recommended from previous years and the results achieved from those recommendations are detailed below.

- A review of assignments used for "Mathematics, Science & Core Engineering" assessment was recommended prior to the next cycle. The MMET faculty met May 17, 2011 and reviewed the assignments used. It was decided to continue using pre-exams as the primary direct measurement tool. It was also decided to administer these in the same classes as previously done. The only change was to use Vibrations, MECH 480, in place of Advanced Dynamics, MECH 312, as dynamics is now an elective class. (ISLO A)
- A review of assignments used for "Identify, Formulate and Solve Engineering Problems" assessment was recommended. The MMET faculty met May 17, 2011 and reviewed these assignments. After some discussion it was decided to keep the same assignments used in prior years. In spite of Finite Element Analysis, MECH 351, not addressing some of the outcomes, no other course on the mechanics side of the curriculum was felt to be better. Thus, assessment in this course was retained with the realization that some some outcomes won't be addressed here. (ISLO E)
- A review of pre-exams was recommneded before these are again used for assessment in 2011-12. (ISLO A)
- The effects of adding projects to MET 111-112, MECH 316 and MECH 318 will be assessed during the 2011-12 school year. (ISLO C)

References:

1. ABET IDEAL Institute, Phoenix, AZ, Jan 7-11, 2008.

APPENDIX I
Student Learning Outcomes - Curriculum Maps

The curriculum maps below show the courses in which each SLO is introduced, emphasized or reinforced. This is a continuum as most SLOs are considered in all courses. However, the maps presented indicate the courses most instrumental in obtaining each SLO.

OUTCOME (b): Experiments and Data

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221	I	MATH 252		MATH 253N		MECH 323	
	MET 111	I	MET 242		MFG 314		MECH 351	
	WRI 121		PHY 221	R	MECH 318	E	MECH 490	R
	Hum/Soc Sci		WRI 227		MECH 363	E	WRI 321	
			Econ Elec		MET 375		MECH Elec	
							Hum/Soc Sci	
Winter	CHE 222	I	ENGR 211		ENGR 212		MECH 417	E
	MET 112	I	MATH 254N		ENGR 355		MECH 480	E
	MFG 103		MATH 361	R	MECH 315		MECH 437	E
	WRI 122		PHY 222	R	MECH 360	R	MECH 491	R
					MET 326	R	WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125		IMGT 345	
	MFG 120		ENGR 213	E	MATH 451	R	ENGR 485	
	MET 160	R	ENGR 236		MECH 312		MECH 436	R
	MET 241		MATH 321		MECH 313		MECH 492	R
	SPE 111		PHY 223	R	MECH 316		WRI 323	
							MECH Elec	
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (g): Communicate Effectively

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	
	MET 111	I	MET 242		MFG 314		MECH 351	
	WRI 121	E	PHY 221	R	MECH 318	E	MECH 490	R
	Hum/Soc Sci	R	WRI 227	E	MECH 363	E	WRI 321	E
			Econ Elec		MET 375		MECH Elec	
							Hum/Soc Sci	R
Winter	CHE 222		ENGR 211		ENGR 212		MECH 417	
	MET 112	I	MATH 254N		ENGR 355		MECH 436	R
	MFG 103		MATH 361		MECH 315		MECH 437	R
	WRI 122	E	PHY 222	R	MECH 360	R	MECH 491	R
					MET 326		WRI 322	E
					SPE 321	E	PHIL 331	R
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125	R	IMGT 345	
	MFG 120		ENGR 213		MATH 451		ENGR 485	R
	MET 160		ENGR 236		MECH 312		MECH 480	E
	MET 241		MATH 321		MECH 313		MECH 492	R
	SPE 111	E	PHY 223	R	MECH 316	R	WRI 323	E
							MECH Elec	
							Hum/Soc Sci	R

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (i): Life Long Learning

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	
	MET 111	I	MET 242		MFG 314		MECH 351	
	WRI 121		PHY 221		MECH 318		MECH 490	R
	Hum/Soc Sci	R	WRI 227		MECH 363		WRI 321	
			Econ Elec		MET 375		MECH Elec	
							Hum/Soc Sci	R
Winter	CHE 222		ENGR 211		ENGR 212		MECH 417	
	MET 112	I	MATH 254N		ENGR 355		MECH 436	
	MFG 103		MATH 361		MECH 315		MECH 437	
	WRI 122		PHY 222		MECH 360		MECH 491	R
					MET 326		WRI 322	
					SPE 321		PHIL 331	E
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125	E	IMGT 345	
	MFG 120		ENGR 213		MATH 451		ENGR 485	R
	MET 160		ENGR 236		MECH 312		MECH 480	
	MET 241		MATH 321		MECH 313		MECH 492	R
	SPE 111		PHY 223		MECH 316		WRI 323	
							MECH Elec	
							Hum/Soc Sci	R

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (j): Contemporary Issues

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	
	MET 111	I	MET 242		MFG 314		MECH 351	
	WRI 121	I	PHY 221		MECH 318		MECH 490	R
	Hum/Soc Sci	R	WRI 227	R	MECH 363		WRI 321	R
			Econ Elec		MET 375		MECH Elec	
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211		ENGR 212		MECH 417	
	MET 112	I	MATH 254N		ENGR 355		MECH 436	
	MFG 103		MATH 361		MECH 315		MECH 437	
	WRI 122	I	PHY 222		MECH 360		MECH 491	R
					MET 326		WRI 322	R
					SPE 321		PHIL 331	E
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125	E	IMGT 345	
	MFG 120		ENGR 213		MATH 451		ENGR 485	R
	MET 160		ENGR 236		MECH 312		MECH 480	
	MET 241		MATH 321		MECH 313		MECH 492	R
	SPE 111	R	PHY 223		MECH 316		WRI 323	R
							MECH Elec	
							Hum/Soc Sci	R

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (k): Techniques, Skills & Modern Engineering Tools

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	
	MET 111	I	MET 242	E	MFG 314	R	MECH 351	E
	WRI 121		PHY 221		MECH 318	E	MECH 490	R
	Hum/Soc Sci		WRI 227		MECH 363	E	WRI 321	
			Econ Elec		MET 375	E	MECH Elec	
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211		ENGR 212		MECH 417	R
	MET 112	I	MATH 254N		ENGR 355		MECH 436	E
	MFG 103		MATH 361		MECH 315		MECH 437	E
	WRI 122		PHY 222		MECH 360	E	MECH 491	R
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266	E	HUM 125		IMGT 345	
	MFG 120		ENGR 213		MATH 451	R	ENGR 485	
	MET 160	E	ENGR 236		MECH 312		MECH 480	E
	MET 241	E	MATH 321		MECH 313		MECH 492	R
	SPE 111		PHY 223		MECH 316		WRI 323	
							MECH Elec	
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

APPENDIX II
Rubrics

The following rubrics are used in assessing associated SLOs.

Rubric for Experimentation

TAC SLO c:
EAC SLO b: Graduates will have the ability to design and conduct experiments, as well as to analyze and interpret data.

Performance Criteria	(1) Limited or No Proficiency	(2) Some Proficiency	(3) Proficiency	(4) High Proficiency	Score
Design experiments to gather stated information regarding a physical system	Is unable to select appropriate sensors, signal conditioning and recording equipment to collect useful experimental data.	Understands data collection methods when explained. Can select appropriate instrumentation equipment with some direction.	Able to design experiments with minimal direction. Able to select appropriate experimental equipment with little or no direction.	Able to design valid experiments given an understanding of the goals. Able to select appropriate experimental equipment with no direction.	
Carry out experiment set-up and execution to obtain valid data	Is not able to set up experimental equipment and collect data without close supervision.	Able to set-up experimental equipment with supervision and collect useful data with minimal supervision. Has trouble recognizing when an experiment isn't producing useful results.	Able to set-up experimental equipment and collect useful data with no or minimal supervision. Able to recognize when an experiment isn't producing valid data.	Able obtain and set-up an experiment as well as collect useful data with no supervision. Able to recognize problems and offer improvements in the experimental process.	
Gain physical understanding through analysis and interpretation of experimental data	Has trouble applying known data reduction techniques to experimental data.	Able to apply know data reduction techniques with minimal supervision. Has trouble interpreting and making use of analysis results.	Able to apply known data reduction techniques without supervision. Can interpret and make use of analysis results with minimal supervision.	Able to apply data reduction techniques and come up with unique approaches without supervision. Able to interpret analysis results and extend those results to general use without close supervision.	

Communicate Effectively

TAC SLO
EAC SLO g: Graduates will have the ability to communicate effectively

OIT Essay Rubric

Performance Criteria	No Proficiency (0)	Limited Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)
Purpose and Ideas	Writing lacks focus. Purpose and main ideas are unclear and require extensive inferences from the reader.	Writing has limited focus. Purpose and main ideas are unclear and require some inferences from reader.	Reader can discern the purpose and main ideas although they may be overly broad or simplistic.	Writing is clear and focused. Reader can easily understand the purpose and main ideas.	Purpose and main ideas are exceptionally focused, clear, and interesting.
Organization	Writing lacks organizational structure or is too short to demonstrate organizational skills. Introduction, body, or conclusion may be missing.	Organizational structure is present but unclear. Introduction and conclusion may be underdeveloped or too obvious.	Order and structure are present but overly formulaic. Introduction and conclusion may be underdeveloped or too obvious.	Order and structure are clear and easy to follow. Introduction draws in the reader and conclusion brings satisfying closure.	Order and structure are compelling and move the reader through the text easily. Introduction draws in the reader and conclusion brings satisfying closure.
Support	Development is insufficient. Most supporting details are irrelevant or repetitious.	Development is minimal. Some supporting details are irrelevant or repetitious.	Supporting details are relevant, but are limited or rather general. Support may be based on clichés, stereotypes, or questionable sources or evidence.	The main ideas are well developed by supporting details. When appropriate, use of outside sources provides credible support.	Main ideas are well developed by strong support and rich details. When appropriate, use of outside sources provides strong, credible support.
Style	Voice is inappropriate for topic, purpose, and audience. Wording is incorrect and detracts from meaning. Overall, sentences are choppy, rambling, and awkward.	Voice is inappropriate for topic, purpose, or audience. Wording is monotonous or detracts from impact. Sentences tend to be choppy, rambling, and awkward.	Voice is inconsistent for topic, purpose, and audience. Wording is quite ordinary, lacking interest, precision, and variety, and may rely on clichés. Sentences tend to be mechanical rather than fluid with an overuse of simple sentence structures.	Voice is generally appropriate for topic, purpose, and audience. Generally, wording conveys message in an interesting, precise, and natural way. Sentences are carefully crafted with variations in structure.	Voice is appropriate for topic, purpose, and audience. Wording is fresh and specific, with a striking and varied vocabulary. Sentences are highly crafted, with varied structure that makes reading easy and enjoyable.
Conventions	Errors often impede readability. Substantial editing needed.	Numerous errors in usage, spelling, punctuation, and/or grammar. Errors sometime impede readability. Substantial editing needed.	Writing contains punctuation, spelling, and/or grammar errors, but they do not impede readability and are not extensive. Moderate need for editing.	Writing demonstrates control of standard writing conventions and uses them effectively to enhance communication. Few errors.	Writing demonstrates strong control of standard writing conventions and uses them well to enhance communication. Very few or no errors.
Documentation	Documentation is not present.	Documentation has major errors.	Documentation has frequent errors.	Documentation is correct except for a few errors.	Documentation is meticulous.

OIT Public Speaking Rubric				
Performance Criteria	**No/Limited Proficiency (1)**	**Some Proficiency (2)**	**Proficiency (3)**	**High Proficiency (4)**
Content	Few or no attributed sources. Supporting materials lack credibility and/or don't relate to thesis. Limited or no attempt to inform or persuade.	Some attributed sources used. Supporting materials are somewhat credible and/or don't clearly relate to thesis. Attempt to inform or persuade.	Adequate number of credible and appropriately attributed sources used. Supporting materials relate to thesis. Informs or persuades.	A variety of credible and appropriate sources used. Supporting materials relate in an exceptional way to a focused thesis. Informs or persuades.
Organization	Lacks organizational structure. Introduction and/or conclusion missing. No transitions used.	Organizational structure present but unclear with underdeveloped introduction and conclusion. Transitions are awkward.	Appropriate organizational pattern used and easy to follow with developed introduction and satisfying conclusion. Main points are smoothly connected with transitions.	Organizational pattern is compelling and moves audience through speech with ease. Introduction draws in the audience and conclusion is satisfying. Main points are smoothly connected with transitions.
Style	No understanding of audience regarding topic or purpose of speech. Little enthusiasm and passion for topic. No regard for time constraints.	Some understanding of audience regarding topic or purpose of speech. Some enthusiasm and passion for topic. Some regard for time constraints.	Competent understanding of audience regarding topic and purpose. Enthusiasm and passion for topic. Speech given within time constraints.	Thorough understanding of audience regarding topic and purpose. Clear enthusiasm and passion for topic. Speech given within time constraints.
Delivery	No gestures or eye contact. Monotone voice or insufficient volume. Little poise. Reading of notes only. Abundant oral fillers and nonverbal distractions.	Some gestures and eye contact. Ineffective use of language and voice. Little poise. Heavy reliance on notes. Multiple oral fillers and nonverbal distractions.	Adequate use of gestures, eye contact, language, and voice. Poised with minor reliance on notes. Limited oral fillers and nonverbal distractions.	Effective use of gestures, eye contact, vivid language, and voice to add interest to speech. Poised with use of notes for reference only. No oral fillers and nonverbal distractions.
Visuals	No visuals or poorly-designed and documented visuals that distract from speech or do not create interest. Limited reference to visuals or so much reference delivery is hindered.	Visuals present, but simply designed with limited use of documentation. Visuals are referred to but do not create interest. Visuals may interfere with delivery.	Well-designed and documented visuals that clarify speech and create interest. Visuals are referred to and sufficiently discussed, while not interfering with delivery.	Well-designed and documented visuals that clarify speech, create interest, and hold attention of the audience. Visuals are sufficiently discussed and effectively integrated into speech.

Life-long Learning

TAC SLO
EAC SLO i: Graduates will recognize the need for, and have the ability to engage in life-long learning

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)	Score
1. Lifelong learning	Fails to identify the need for "lifelong learning" and/or omits discussion of their own learning and relevant examples.	Misses important elements in discussing "lifelong learning," applying concepts to their own learning or providing a relevant example.	Defines and discusses at least one concept of "lifelong learning" and the need for it. Applies concept and gives an example related to their own learning.	Defines and discusses various concepts of "lifelong learning" and the need for it. Applies these concepts to their own learning now and in the future. Demonstrates self-awareness by accurately identifying strengths/ weaknesses in their own ability to learn independently. Gives relevant example(s).	
2. Professional societies and organizations	Fails to discuss an appropriate professional society, advantages of joining or disadvantages of not joining, and/or possible involvement/participation.	Misses important elements in identifying appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and/or possible involvement/participation.	Identifies and discusses appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and possible involvement/ participation.	Identifies and thoroughly discusses appropriate professional societies or organizations, the advantages of joining and disadvantages of not joining, and possible involvement/participation. Demonstrates detailed understanding of relevant requirements.	
3a. Credentials	Fails to recognize the need for credentials or further degrees and/or omits information on how to obtain/maintain them.	Identifies available credentials or further degrees, but important elements or details on how to obtain/maintain them are missing.	Identifies and discusses the different types of credentials or further degrees that are available and how to obtain/maintain them.	Identifies and thoroughly discusses the different types of credentials or further degrees that are available and how to obtain/maintain them. Demonstrates detailed understanding of relevant requirements.	
3b. Continuing education	Fails to recognize the need for continuing education (formal or informal) or omits information on how to obtain it.	Misses important elements in identifying appropriate continuing education (formal or informal), how to obtain it, and the need for it.	Identifies and discusses appropriate continuing education (formal or informal), how to obtain it, and the need for it.	Identifies and thoroughly discusses appropriate continuing education (formal or informal), how to obtain it, and the need for it. Demonstrates detailed understanding of relevant requirements.	
4. Short- and long-term career plans	Vaguely describes career goals and/or includes no realistic plan to meet them.	Career goals after graduation do not include both long and short term plans and/or the plan to meet these goals is missing important details or is unrealistic.	Describes realistic career goals after graduation and long-term career aspirations. Includes a plan to meet these goals and aspirations.	Describes realistic career goals after graduation and long-term career aspirations. Includes a thorough and thoughtful plan to meet these goals and aspirations.	

Knowledge of Contemporary Issues

TAC SLO
EAC SLO j: Graduates will have knowledge of contemporary issues

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)	Score
Address major socio-economic issues	Little or no understanding (or interest). Unable to put forth more than one side to an issue.	Moderate understanding of national and international issues. Can follow but has trouble expressing more than one side of an issue.	Good understanding of many issues. Understands and can express more than one view point.	Deep understanding of the immediate and longterm implications. Articulately expresses arguments from several view points including the historical perspective.	
Address US political issues	Little or no understanding (or interest). Unable to put forth more than one side to an issue.	Moderate understanding. Rudimentary understanding of current political issues.	Good understanding. Can express and explain different sides of political issues.	Deep understanding. Can knowledgeably explain current political issues, the underlying problems, and historical perspective.	

Rubric for Use of Techniques, Skills, and Modern Engineering Tools

TAC SLO
EAC SLO k: Graduates will be able to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Performance Criteria	(1) Limited or No Proficiency	(2) Some Proficiency	(3) Proficiency	(4) High Proficiency	Score
Use computers and a wide range of programs effectively	Marginal ability with word processor and spreadsheet use. Struggles with other programs and programming	Able to use word processors and spreadsheets to produce reports. Has difficulty with other programs	Able to use word processors and spreadsheets to produce well formated reports. Able to use other programs and write computer programs	Skilled at word processing and spreadsheet use. Skilled with other programs and able to write longer intricate programs	
Understand 2D and 3D CAD modeling and use example programs effectively	Able to develop drawings and CAD models with close supervision. Marginal understanding of drawings, dimensioning and tolerancing.	Able to develop drawings and models with supervision.	Able to develop drawings and models with minimal supervision. Able to develop CAD models and use for analysis with supervision.	Able to direct others in drawing preparation and checking. Skilled at modeling and related analysis.	
Understand manufacturing methods adequately to design manufacturable products	Has little or no understanding of manufacturing processes and their strengths/weaknesses.	Some understanding of manufacturing processes but has trouble selecting appropriate methods and designing parts for these methods.	Understands basic manufacturing methods and can, with assistance, design parts which are easily manufacturable.	Has a broad understanding of manufacturing methods. Able to design parts easily manufactured using an appropriate manufacturing method.	

APPENDIX III
Conteporary Issue Questions for Discussion

1. Should the USA and its allies have invaded Afghanistan?

2. Should African disputes and conflicts be handled by African countries themselves, rather than by external international organizations?

3. Should assisted suicide be legal?

4. Should the government bailout banks and financial institutions?

5. Are biofuels a better alternative to fossil fuels? Should their use be encouraged by government regulations and subsidy?

6. Does China give the rest of the world reasons for fear, in political, economic or social terms? Or is the 'Terror from the East' merely a myth?

7. Should the United States promote democracy internationally? Can, and should, democracy be imposed on countries?

8. Has the rise and spread of trans-national companies exacerbated global economic inequalities?

9. Should the United States introduce a universal health care system?

10. Should the United States do more to prevent illegal immigration and seek to identify and expel illegal aliens? Or should it pursue immigration reform, for example by granting an amnesty for existing illegal immigrants, and offering legal guest worker programs?

11. Should governments censor material on the world wide web?

12. Does the Islamic Republic of Iran have the right to develop nuclear weapons, or are the USA and its allies justified in placing sanctions on Iran as a result of suspicions about its nuclear program?

13. Should the USA and its allies withdraw their forces from Iraq immediately?

14. Should Microsoft be broken up into two or more separate companies?

15. Should the United States allow more drilling for oil in inshore coastal waters?

16. Are security measures justified to the extent that civil liberties can be sacrificed?