PEC workshop on

ASSESSING STUDENT LEARNING

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Organized by:

Outline

- Accreditation?
- Accreditation Criteria
- Team Visit Program
- Assessment Process for ME Programs
- Continuous improvement
- Role of Faculty

Engineering

- Engineering is an activity that is essential to meeting the needs of people, economic development and the provision of services to society. Engineering involves the purposeful application of mathematical and natural sciences and a body of engineering knowledge, technology and techniques. Engineering seeks to produce solutions whose effects are predicted to the greatest degree possible in often uncertain contexts. While bringing benefits, engineering activity has potential adverse consequences. Engineering therefore must be carried out responsibly and ethically, use available resources efficiently, be economic, safeguard health and safety, be environmentally sound and sustainable and generally manage risks throughout the entire lifecycle of a system.

What is Accreditation

- **Accreditation** is a non-governmental, peer-review process that assures the quality of the post-secondary education students receive.

- It is a form of **external review** that leads
  - Institutions to look at themselves.
  - Faculty to look at their programs.
  - Institutions, colleges, schools, and faculties to “sharpen” their own assessment methodologies (Continuous Improvement)

Types of Accreditation

- **Institutional accreditation** evaluates overall institutional quality. One form of institutional accreditation is regional accreditation of colleges and universities (**NCAAA, HEC**).

- **Specialized accreditation** examines specific programs of study, rather than an institution as a whole. Specific programs (e.g. Engineering) are often evaluated through specialized accreditation such as **ABET, PEC**.

Why Is Accreditation Important?

- Gives **colleges and universities** a structured mechanism to assess, evaluate, and improve the quality of their programs.

- Helps **students and their parents** choose quality college programs.

- Enables **employers** to recruit graduates they know are well-prepared.

- Is used by **registration, licensure, and certification boards** to screen applicants.

Washington Accord

OVERVIEW

- The Washington Accord is a mutual recognition agreement (MRA) which pertains to engineering programs accredited by its signatories in their jurisdictions since 1989.
- Signatories to the Washington Accord are organizations responsible for accrediting engineering programs in Australia, Canada, Chinese Taipei, Hong Kong, Ireland, Japan, Korea, Malaysia, New Zealand, Singapore, South Africa, Turkey, the United Kingdom, and the United States.
- The Washington Accord assists in determining if an engineering program in one signatory's jurisdiction is recognized for purposes of licensure and registration, employment, or admission to graduate school in another jurisdiction.

….Washington Accord

JURISDICTION

- The Washington Accord only recognizes engineering programs accredited within the signatories' own jurisdictions. Signatories to the Washington Accord may accredit programs outside of their jurisdiction, but only those programs accredited within their jurisdictions are recognized by the Accord. For example, although ABET accredit programs in countries outside of the U.S., the Washington Accord recognizes only ABET-accredited programs within the U.S.

RECOGNITION DATES

- The year in which the signatory joined the Washington Accord determines recognition. For example, ABET was a founding member of the Washington Accord in 1989. Graduates of U.S.-based ABET-accredited programs beginning in 1989 are covered by the Washington Accord.

….Washington Accord

- The signatories have exchanged information on, and have examined, their respective **processes, policies and procedures for granting accreditation** to engineering academic programs, and have concluded that these are comparable.
-
- The admission of new signatories to the Accord will require the unanimous approval of the existing signatories, and will be preceded by a prescribed period of **provisional status**, during which **the accreditation criteria and procedures** established by the applicant, and the manner in which those **procedures and criteria are implemented**, will be subject to comprehensive examination..

….Washington Accord

GRADUATE ATTRIBUTES & PROFESSIONAL COMPETENCIES

- International accrediting, regulatory, and educational organizations develop statements of **graduate attributes and professional competency profiles**.
- The **International Engineering Alliance**, which administers the Washington Accord for engineering, the Sydney Accord for engineering technology (4-year), and the Dublin Accord for engineering technology (2-year), has prepared a document that details the background of these statements, their purpose, methodology, and limitations; and describes the graduate attributes and professional competency profiles for engineers and engineering technologists.

….Washington Accord

5.2 Graduate Attribute Profiles

References to the Knowledge Profile are shown thus: (WK1 to WK4)

Differentiating Characteristic	... for Washington Accord Graduate	... for Sydney Accord Graduate	... for Dublin Accord Graduate
Engineering Knowledge:	**WA1**: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to the solution of complex engineering problems.	**SA1**: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.	**DA1**: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in DK1 to DK4 respectively to wide practical procedures and practices.
Problem Analysis Complexity of analysis	**WA2**: Identify, formulate, research literature and analyse *complex* engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (WK1 to WK4)	**SA2**: Identify, formulate, research literature and analyse *broadly-defined* engineering problems reaching substantiated conclusions using analytical tools appropriate to the discipline or area of specialisation. (SK1 to SK4)	**DA2**: Identify and analyse *well-defined* engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity. (DK1 to DK4)
Design/ development of solutions: Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified	**WA3**: Design solutions for *complex* engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)	**SA3**: Design solutions for *broadly- defined* engineering technology problems and *contribute to the design* of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (SK5)	**DA3**: Design solutions for *well-defined* technical problems and *assist with the design* of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (DK5)
Investigation: Breadth and depth of investigation and experimentation	**WA4**: Conduct investigations of *complex* problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	**SA4**: Conduct investigations of *broadly-defined* problems; locate, search and select relevant data from codes, data bases and literature (SK8), design and conduct experiments to provide valid conclusions.	**DA4**: Conduct investigations of *well-defined* problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
Modern Tool Usage: Level of understanding of the appropriateness of the tool	**WA5**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *complex* engineering problems, with an understanding of the limitations. (WK6)	**SA5**: Select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *broadly-defined* engineering problems, with an understanding of the limitations. (SK6)	**DA5**: Apply appropriate techniques, resources, and modern engineering and IT tools to *well-defined* engineering problems, with an awareness of the limitations. (DK6)

....Washington Accord

The Engineer and Society: Level of knowledge and responsibility	**WA6**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7)	**SA6**: Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technology practice and solutions to broadly defined engineering problems. (SK7)	**DA6**: Demonstrate knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice and solutions to well defined engineering problems. (DK7)
Environment and Sustainability: Type of solutions.	**WA7**: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)	**SA7**: Understand and evaluate the sustainability and impact of engineering technology work in the solution of broadly defined engineering problems in societal and environmental contexts. (SK7)	**DA7**: Understand and evaluate the sustainability and impact of engineering technician work in the solution of well defined engineering problems in societal and environmental contexts. (DK7)
Ethics: Understanding and level of practice	**WA8**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (WK7)	**SA8**: Understand and commit to professional ethics and responsibilities and norms of engineering technology practice. (SK7)	**DA8**: Understand and commit to professional ethics and responsibilities and norms of technician practice. (DK7)
Individual and Team work: Role in and diversity of team	**WA9**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	**SA9**: Function effectively as an individual, and as a member or leader in diverse teams.	**DA9**: Function effectively as an individual, and as a member in diverse technical teams.
Communication: Level of communication according to type of activities performed	**WA10**: Communicate effectively on *complex* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	**SA10**: Communicate effectively on *broadly-defined* engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	**DA10**: Communicate effectively on *well-defined* engineering activities with the engineering community and with society at large, by being able to comprehend the work of others, document their own work, and give and receive clear instructions
Project Management and Finance: Level of management required for differing types of activity	**WA11**: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	**SA11**: Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.	**DA11**: Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a technical team and to manage projects in multidisciplinary environments
Lifelong learning: Preparation for and depth of continuing learning.	**WA12**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	**SA12**: Recognize the need for, and have the ability to engage in independent and life-long learning in specialist technologies.	**DA12**: Recognize the need for, and have the ability to engage in independent updating in the context of specialized technical knowledge.

….Washington Accord

- ABET was a founding member of the Washington Accord in 1989.
- ABET accreditation **processes, policies and procedures for granting accreditation** fulfills the requirements of Washington Accord
- An **alternate approach** is to learn requirements through ABET compliance requirements.

What is ABET ?

- **1932**: Founded as **Engineers' Council for Professional Development (ECPD)** in 1932 as an engineering professional body dedicated to the education, accreditation, regulation, and professional development of engineering professionals and students in the United States.
- **1936**: Evaluated its first Engineering degree programs.
- **1947:** ECPD had accredited 580 undergraduate engineering programs at 133 institutions.
- **1979**: ECPD Started their international activities with an agreement with the Canadian Engineering Accreditation Board.
- **1980**: ECPD was renamed the **A**ccreditation **B**oard for **E**ngineering and **T**echnology (**ABET**) to more accurately describe their emphasis on accreditation.

Member Societies

- More than 33 member societies
- Member Societies:
  - AIAA: American Institute Of Aeronautics And Astronautics
  - AICHE: American Institute Of Chemical Engineers
  - ASCE: American Society Of Civil Engineers
  - **ASME: American Society Of Mechanical Engineers**
  - CMAA: Construction Management Association Of America
  - CSAB: Computing Sciences Accreditation Board
  - IEEE: Institute Of Electrical And Electronics Engineers
  - IIE: Institute Of Industrial Engineers
  - INCOSE: International Council On Systems Engineering
  - SPE: Society Of Petroleum Engineers

… and 25 other member societies.

ABET Accreditation

- ABET accreditation is **ISO 9001:2008** certified.
- ABET accreditation provides assurance that a university program meets the **quality standards of the profession** for which that program prepares graduates.
- Accreditation is **voluntary,** and to date, approximately **3,600 programs** at over 700 colleges and universities in **29 countries** have received ABET accreditation.
- Approximately **85,000 students graduate each year** from ABET-accredited programs each year, and millions of graduates have received degrees from ABET-accredited programs since 1932.

ABET Guiding Principle

- ABET's Criteria for Accrediting Engineering Programs is based upon:

  What students learn in the course of their program of studies as opposed to **what they are presented in a curriculum**.

- Consequently, institutions are required to have educational objectives and to make use of outcomes assessment techniques to determine the degree to which program goals and objectives are being attained.

- " The assessment, in turn, is used in an ongoing process of **improving student learning** through enhancements to the program"

ABET accreditation

Requires compliance with:

General Criteria

1. Students
2. Program Educational Objectives
3. Student Outcomes
4. Continuous Improvement
5. Curriculum
6. Faculty
7. Facilities
8. Institutional Support

Program Criteria for Mechanical Engineering

Accreditation Policy and Procedures Manual (APPM))

ABET	PEC
Criterion 1. Students	Criterion 4 - Students
Criterion 2. Program Educational Objectives	Criterion 1 - Program Educational Objectives (PEOs)
Criterion 3. Student Outcomes	Criterion 2 - Program Learning Outcomes (PLOs)
Criterion 4. Continuous Improvement	*Criterion 3 - Curriculum and Learning Process *Criterion 8 - Continuous Quality Improvement
Criterion 5. Curriculum	Criterion 3 - Curriculum and Learning Process
Criterion 6. Faculty	Criterion 5 - Faculty and Support Staff
Criterion 7. Facilities	Criterion 6 - Facilities and Infrastructure
Criterion 8. Institutional Support	Criterion 7 - Institutional Support and Financial Resources
	Criterion 9 - Industry Linkages
Program criteria	
APPM	* Section 1.8

Criterion 1. Students

- Student Admissions
- Evaluating Student Performance
- Transfer Students and Transfer Courses
- Advising and Career Guidance
- Work in Lieu of Courses
- Graduation Requirements

Criterion 2. Program Educational Objectives

- **Program educational objectives (PEOs)** are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies.

- Consistency of the PEOs with the Mission of the Institution

- Program Constituencies
  - Employers, IAC, Faculty, Alumni
  - PEOs meet the needs of the constituencies.

- Process for Review of the Program Educational Objectives

Criterion 3. Student Outcomes

- **Student outcomes** describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.

(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

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

…. Student Outcomes

(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.

Criterion 4. Continuous Improvement

- The program must regularly use appropriate, documented processes for **assessing and evaluating** the extent to which the **student outcomes** are being attained.

- The results of these evaluations must be systematically utilized as input for the **continuous improvement** of the program.

- **Other available information** may also be used to assist in the continuous improvement of the program.

Criterion 5. Curriculum

- One year of a combination of college level **mathematics and basic sciences**.
- One and one-half years of **engineering topics**, consisting of engineering sciences and engineering design appropriate to the student's field of study.
- A **general education component** that complements the technical content of the curriculum.
- Students must be prepared for engineering practice through a curriculum culminating in a **major design experience**.

Criterion 6. Faculty

- Faculty members are of **sufficient number** and they have the **competencies** to cover all of the curricular areas of the program.

- The program faculty must have **appropriate qualification**s to develop and implement processes for the evaluation, assessment, and continuing improvement of the program.

Criterion 7. Facilities

- **Classrooms, offices, laboratories, and associated equipment** must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning.

- **Modern tools, equipment, computing resources**, and laboratories appropriate to the program must be available, accessible, and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs.

- The **library services and the computing and information infrastructure** must be adequate to support the scholarly and professional activities of the students and faculty.

Criterion 8. Institutional Support

- **Institutional support and leadership** must be adequate to ensure the quality and continuity of the program.
- Resources including **institutional services, financial support, and staff** (both administrative and technical) provided to the program must be adequate to meet program needs.
- The resources available to the program must be sufficient to attract, retain, and provide for the continued **professional development** of a qualified faculty.
- The resources available to the program must be sufficient to acquire, maintain, and operate **infrastructures, facilities, and equipment** appropriate for the program, and to provide an environment in which student outcomes can be attained.

Program Criteria -ME

- **Curriculum:** The curriculum must require students
  - to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations);
  - to model, analyze, design, and realize physical systems, components or processes; prepare students to work professionally in either thermal or mechanical systems while requiring topics in each area.

- **Faculty**: The program must demonstrate that faculty members responsible for the upper-level professional program are maintaining currency in their specialty area.

Accreditation Process

- **Self-Study Report** is written and submitted.

- Objectives of the **Campus Visit**
  - Make a qualitative assessment of factors that cannot be documented in the written Self-Study report.
  - Conduct a detailed examination of the materials compiled by the institution.
    - What do the students actually do?
    - Are the processes described in SSR well documented?
  - Provide the institution with a preliminary assessment of its strengths and shortcomings
  - Assist the institution and its programs in quality improvement efforts

VISIT SCHEDULE FOR PEV

Day 0 - Sunday

Time	PEVs
13:30-17:00	**Meet and Greet on campus** Meeting with program chairs **Short lab tour** - Laboratories, computer rooms, classrooms, etc., - Availability of equipment, teaching staff, maintenance and safety **Evaluation of materials** – Course material – Assessment data and analysis – Continuous improvement – Revision of PEOs

….VISIT SCHEDULE

Day 1 - Monday

Time	PEVs
09:30-10:00	Meet with Program Leadership
10:00-1200	**Meet with faculty, staff and students**
1200-14:00	L U N C H ABET Team, Steering Committee, department chairs, representatives from student organizations, alumni and industrial advisory boards
14:00-17:20	**Continue meeting with program faculty, etc. and review of materials**

….VISIT SCHEDULE

Day 2 - Tuesday

Time	PEVs
08:00-09:00	Follow-up meetings with faculty and staff as needed
11:00-12:00	Debrief Chairs

Types of Criterion Shortcomings

- **Deficiency** – program does NOT satisfy criterion, policy, or procedure.
- **Weakness** – program lacks strength of compliance with a criterion, policy, or procedure to ensure that the quality of the program will not be compromised.
- **Concern** – program satisfies the criterion, policy, or procedure; however, the potential exists for the situation to change such that the criterion, policy, or procedure may not be satisfied.
- **Observation**: general commentary not related to compliance with the criteria, and not explicitly linked to criteria

Outcome Based Assessment Process

Consistency of PEOs with Institution Mission

Example 1

Mission: To pursue excellence in higher education through quality academic programs and research and engage positively with all stakeholders to maintain a sustainable growth of the society at large

PROGRAM EDUCATIONAL OBJECTIVES	
Graduates of the ME program will be expected to:	
PEO 1	Apply knowledge and develop skills to work effectively as productive mechanical engineers;
PEO 2	Work and communicate proficiently in order to develop practical, technically-sound, cost effective solutions to mechanical engineering problems;
PEO 3	Enhance self-confidence, ability to make proper decisions, and adherence to professional ethics; and
PEO 4	Pursue advanced knowledge, research and development, and new technologies in mechanical engineering fields.

…. Consistency of PEOs with Mission

Mission can be extracted as follows:	PEO 1	PEO 2	PEO 3	PEO 4
Excellence in higher education	√	√	√	
Quality academic programs and research	√	√	√	√
Engage positively with all stakeholders	√	√		
Maintain a sustainable growth of the society at large			√	√

…. Consistency of PEOs with Mission

Example 2

PEO	University Mission	College Mission	Department Mission
1. Graduates will meet the expectations of employers of mechanical engineers.	To create new knowledge that makes a scholarly impact, provides innovative solutions, and contributes to the national economy.	To graduate well-educated engineers capable of leading and managing change through integration, application and transfer of engineering knowledge.	To provide the highest quality education in mechanical engineering.
2. Graduates will pursue/assume leadership roles in their profession and/or communities.	To graduate leaders who are knowledgeable, skillful, and productive members of society.	To graduate well-educated engineers capable of leading and managing change through integration, application and transfer of engineering knowledge.	
	To engage our society, alumni, and partners, in valuable endeavors.		To support the development of more competitive, and new, industry in the Kingdom of Saudi Arabia.
3. Qualified graduates will pursue advanced studies, if they so desire.			To conduct world-class basic and applied research, addressing the evolving needs of industry and society.
			To provide the highest quality education in mechanical engineering.

Student outcomes

(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

(c) an ability to design a 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.

Mapping Student Outcomes to PEOs

STUDENT OUTCOME (SO)	PEO 1: Expectations	PEO 2: Leadership	PEO 3: Advanced Study
a-math/science	■		■
b-experiments	■	■	■
c-design	■		■
d-teams	■		■
e-problem solutions	■	■	■
f-ethics	■	■	■
g-communication	■	■	■
h-broad education	■		■
i-life-long learning	■	■	■
j-contemporary issues	■	■	■
k-engineering tools	■	■	■

Student outcomes, not same as a-k

Table 3-1 ME Student Outcomes.

The graduates of Mechanical Engineering [redacted] shall demonstrate that they are able to:	
SO 1	Acquire proficiency in mechanical engineering including design and realization of thermal and mechanical systems;
SO 2	Design and conduct experiments relating to mechanical engineering and to critically analyze and interpret data;
SO 3	Identify, formulate and solve practical mechanical engineering problems;
SO 4	Be conversant with the latest trends in engineering and the role of computers, controls systems and instrumentation in automation of mechanical systems;
SO 5	Perform mechanical engineering design by means of design experiences integrated throughout the professional component of the curriculum;
SO 6	Be Proficient in Mathematics and basic science through multivariate Calculus, Differential Equations, Applied Mathematics, Probability and Statistics, Calculus-based Physics, and General Chemistry;
SO 7	Function effectively in teams to accomplish a common goal;
SO 8	Understand professional, ethical and social responsibilities;
SO 9	Employ effective communication skills consistent with the professional environment;
SO 10	Pursue lifelong learning and continued professional development; and
SO 11	Get the broad education necessary to understand the impact of engineering solutions in a global, economical and societal context.

Table 3-2 Relationship Between ABET a-k Outcomes and ME Student Outcomes.

ABET a-k Outcomes		ME Student Outcomes	
(a)	an ability to apply knowledge of mathematics, science, and engineering	SO1	Acquire proficiency in mechanical engineering including design and realization of thermal and mechanical systems;
		SO6	Be proficient in mathematics and basic science through multivariate calculus, differential equations, applied mathematics, probability and statistics, calculus-based physics, and general chemistry;
(b)	an ability to design and conduct experiments, as well as to analyze and interpret data	SO2	Design and conduct experiments relating to mechanical engineering and to critically analyze and interpret data;
(c)	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	SO5	Perform mechanical engineering design by means of design experiences integrated throughout the professional component of the curriculum;
		SO8	Understand professional, ethical and social responsibilities;
(d)	an ability to function on multidisciplinary teams	SO7	Function effectively in teams to accomplish a common goal;
(e)	an ability to identify, formulate, and solve engineering problems	SO3	Identify, formulate and solve practical mechanical engineering problems;
(f)	an understanding of professional and ethical responsibility	SO8	Understand professional, ethical and social responsibilities;
(g)	an ability to communicate effectively	SO9	Employ effective communication skills consistent with the professional environment;
(h)	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	SO11	Get the broad education necessary to understand the impact of engineering solutions in a global, economical and societal context;
(i)	a recognition of the need for, and an ability to engage in life-long learning	SO10	Pursue lifelong learning and continued professional development;
(j)	a knowledge of contemporary issues	SO4	Be conversant with the latest trends in engineering and the role of computers, controls systems and instrumentation in automation of mechanical systems;
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	SO1	Acquire proficiency in mechanical engineering including design and realization of thermal and mechanical systems;
		SO4	Be conversant with the latest trends in engineering and the role of computers, controls systems and instrumentation in automation of mechanical systems;

Mapping of SOs to PEOs

Table 3-3 Mapping of ME Student Outcomes to ME Educational Objectives.

ME Program Educational Objectives	SO										
	1 a,k	2 b	3 e	4 j,k	5 c	6 a	7 d	8 c,f	9 g	10 i	11 h
1. Apply knowledge and develop skills to work effectively as productive mechanical engineers	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2. Work and communicate proficiently in order to develop practical, technically-sound, cost-effective solutions to mechanical engineering problems	✔	✔	✔	✔	✔			✔	✔		✔
3. Enhance self-confidence, ability to make proper decisions, and adherence to professional ethics			✔	✔	✔			✔	✔		✔
4. Pursue advanced knowledge, research and development, and new technologies in mechanical engineering fields				✔						✔	✔

Mapping of SOs to required courses

Courses	Student Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
ME 201 Dynamics	√				√						√
ME 203 Thermodynamics I	√		√	√	√	√	√	√			
ME 204 Thermodynamics II	√		√								
ME 210 Mechanical Engineering Drawings and Design			√				√			√	√
ME 216 Materials Science and Engineering	√	√			√	√					
ME 217 Materials Science Lab		√					√				
ME 218 Introduction to Mechanical Engineering Design	√	√	√	√			√				√
ME 307 Machine Design I	√		√		√		√				√
ME 308 Machine Design II	√		√				√				
ME 309 Mechanics of Machine	√		√								
ME 311 Fluid Mechanics	√	√			√				√		
ME 315 Heat Transfer	√			√	√						√
ME 316 Thermo Fluids Lab	√	√					√	√			√
ME 322 Manufacturing Processes	√		√		√			√			
ME 323 Manufacturing Processes Lab	√	√			√		√	√			√
ME 399 Summer Training	√			√	√	√	√				√
ME 411 Senior Design Project I	√	√	√	√	√	√	√	√	√	√	√
ME 412 Senior Design Project II	√	√	√	√	√	√	√	√	√	√	√
ME 413 System Dynamics and Control	√		√	√							√
ME 451 Design and Analysis of Engg Experiments	√	√		√	√	√			√		√
ME 452 Measurement and Lab Project		√	√	√							√

Mapping of SOs to required courses

Courses	Student Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
ME 201 Dynamics	S				M						M
ME 203 Thermodynamics I	S		M	S	S	M	S	S			
ME 204 Thermodynamics II	S		M								
ME 210 Mechanical Engineering Drawings and Design			M				S			M	S
ME 216 Materials Science and Engineering	S	M			S	M					
ME 217 Materials Science Lab		S					S				
ME 218 Introduction to Mechanical Engineering Design	M	M	M	S			S				M
ME 307 Machine Design I	S		M		M		M				M
ME 308 Machine Design II	S		S				M				
ME 309 Mechanics of Machine	S		M								
ME 311 Fluid Mechanics	S	S			S				M		
ME 315 Heat Transfer	M			S	S						M
ME 316 Thermo Fluids Lab	M	S					M	M			S
ME 322 Manufacturing Processes	S		S		S			S			
ME 323 Manufacturing Processes Lab	S	S			M		M	M			M
ME 399 Summer Training	S			M	M	S	S				M
ME 411 Senior Design Project I	S	S	M	M	S	M	S	M	M	M	S
ME 412 Senior Design Project II	S	S	S	S	S	M	S	M	S	S	S
ME 413 System Dynamics and Control	M		S	S							S
ME 451 Design and Analysis of Engg Experiments	S	S		M	S	M			M		M
ME 452 Measurement and Lab Project		S	M	S							S

Continuous Improvement

The mechanical engineering department continuously improves upon the effectiveness and the quality of its programs, courses, and facilities through numerous other improvement mechanisms such as:

- **Student Outcomes self-assessment**
- Employer and alumni surveys
- Course evaluations
- Senior design/Co-op presentation evaluations
- Periodic PEO reviews
- Faculty members' judicious advice
- Department council meetings
- Department workshops

SO Assessment Process

- **Assessment** ***is one or more processes that identify, collect, and prepare data to evaluate the attainment of student outcomes*****.** Effective assessment uses relevant direct, indirect, quantitative and qualitative measures as appropriate to the outcome being measured. Appropriate sampling methods may be used as part of an assessment process.

- **Evaluation** ***is one or more processes for interpreting the data and evidence accumulated through assessment processes.*** Evaluation determines the extent to which student outcomes are being attained. Evaluation results in decisions and actions regarding program improvement

Student Outcome	Course	Method of Assessment	Tool used	Method of Assessment	Tool used
(a)	ME 309	Direct	Rubric / Quiz	Indirect	End of course survey
	ME 311	Direct	Rubric / Quiz	Indirect	End of course survey
(b)	ME 316	Direct	Rubric / Quiz	Indirect	End of course survey
	ME 451	Direct	Rubric / Quiz	Indirect	End of course survey
	ME 452	Direct	Rubric / Quiz	Indirect	End of course survey
(c)	ME 308	Direct	Rubric / Quiz	Indirect	End of course survey
	ME 412	Direct	Rubric / Project	Indirect	End of course survey
(d)	ME 412	Direct	Rubric / Project	Indirect	End of course survey
(e)	ME 315	Direct	Rubric / Quiz	Indirect	End of course survey
(f)	ME 399	Direct	Rubric / Quiz		
(g)	ME 412	Direct	Rubric / Project-Presentation	Indirect	End of course survey
(h)	ME 322	Direct	Rubric / Quiz	Indirect	End of course survey
(i)	ME 412	Direct	Rubric / Project	Indirect	End of course survey
(j)	ME 412	Direct	Rubric / Project		
(k)	ME 413	Direct	Rubric / Project		

Academic Year		2012	2013	2013	2014	2014	2015
Semester		121	122	131	132	141	142
ME Student Outcomes							
a	an ability to apply knowledge of mathematics			xx			
b	an ability to design and conduct experiments,			xx			
c	an ability to design a system, component, or process to meet desired needs within realistic			xx			
d	an ability to function on multidisciplinary teams				xx		
e	an ability to identify, formulate, and solve engineering problems				xx		
f	an understanding of professional and ethical responsibility				xx		
g	an ability to communicate effectively					xx	
h	the broad education necessary to understand the impact of engineering solutions	xx				xx	
i	a recognition of the need for, and an ability to engage in, life-long learning	xx				xx	
j	a knowledge of contemporary issues		xx				xx
k	an ability to use the techniques, skills, and modern engineering tools necessary		xx				xx

ME Program Assessment Results

Sem	SO	Course	Method of Assessment	Sample Size	Student Outcome Result
121	h	ME322	Direct	119	Not Satisfied
	i	ME 412	Direct	103	Not Satisfied
122	j	ME 412	Direct	119	Satisfied
	k	ME 413	Direct	81	Satisfied
131	a	ME 309	Direct	87	Satisfied
			Indirect	60	Satisfied
		ME 311	Direct	85	Not Satisfied
			Indirect	49	Satisfied
	b	ME 316	Direct	36	Satisfied
			Indirect	47	Satisfied
		ME 451	Direct	31	Not Satisfied
			Indirect	25	Not Satisfied
		ME 452	Direct	28	Satisfied
			Indirect	28	Satisfied
	c	ME 308	Direct	39	Not Satisfied
			Indirect	36	Satisfied
		ME 412	Direct	49	Satisfied
			Indirect	29	Satisfied

…. Results

Sem	SO	Course	Method of Assessment	Sample Size	Student Outcome Result***
132	d	ME 412	Direct	100	Satisfied
			Indirect	36	Satisfied
	e	ME 315	Direct	31	Satisfied
			Indirect	27	Satisfied
	f	ME 399	Direct	84	Satisfied
141	g	ME 412	Direct	63	Satisfied
			Indirect	23	Satisfied
	h	ME 322	Direct	60	Satisfied
			Indirect	57	Satisfied
	i	ME 412	Direct	20	Satisfied
			Indirect	68	Satisfied

Assessment Results

Outcome (d): Students shall have an ability to work effectively in multidisciplinary teams, to solve engineering problems relevant to mechanical engineering.

Direct

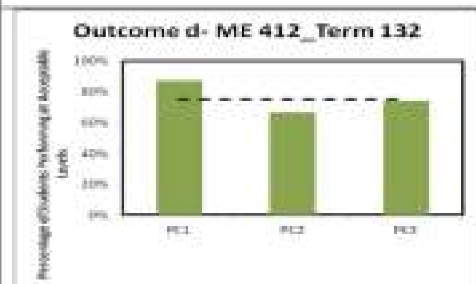
Tool	Rubric
Course	ME 412 Senior Design Project II
Evaluated by	Instructors
Sample size	100
75 % of students achieved score of ≥ 2.5 (average)	76 % (Satisfied)
75 % of students achieved score of ≥ 2.5 for all PCs.	PC2 and PC3 need improvement

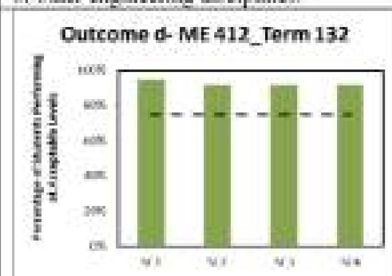
Indirect

Tool	Survey end of course evaluation
Course	ME 412 Senior Design Project II
Evaluated by	Students
Sample size	36
75 % of students achieved score of ≥ 2.5 (average)	97.22 % (Satisfied)
75 % of students achieved score of ≥ 2.5 for all SCs.	All OK

PC1: Ability to work cooperatively in a team to solve mechanical engineering design problems.
PC2: Ability to break down a complex problem in parts, distribute responsibilities, and combine team members' works into the solution.
PC3: Ability to seek out background knowledge from diverse mechanical engineering fields or other engineering disciplines.

SC1: The course serves as an important part of my degree objectives.
SC2: The course enhanced my ability to work cooperatively in a team to solve mechanical engineering design problems.
SC3: The course enhanced my ability to break down a complex problem in parts, distribute responsibilities, and combine team members' works into the solution.
SC4: I am capable of seeking out background knowledge from diverse mechanical engineering fields or other engineering disciplines.





Observations on assessment results:

- Direct measures indicate that the SO is not satisfied. However, indirect measures indicate that the SO is satisfied.
- Direct assessment indicates that PC2 and PC3 needs improvement

Observations on assessment process:

- Both assessment tools, rubric and student survey, are satisfactory.

Corrective actions for CI

Course: ME308 Coordinator: Dr. Samir Mekid Outcome (c) Term 131

Corrective Actions:

- Trained instructors in ME308 Labs were requested.
- Modifications and additional resources in the lab were requested.
- There were meetings in 132and 141 with instructors to discuss the way the lab should be conducted with the current resources. The practice this term 141 has slightly improved and we would like to evaluate outcome (c) by the end of 141. So the lab instructors will conduct this direct assessment by the end of 141.

Course: ME451 Coordinator: Dr. Abdul Samad Outcome (b) Term 131

Corrective Actions:

- Strengthen the students’ statistical knowledge and experiment design techniques.
- Order new textbooks with supplementary material in addition to the lecture notes.
- Improve the coordination between the lecture and the lab sessions.
- Introduce a comprehensive project between the lecture and the lab.
- Install the new Stratigraphic software in the classroom PCs and teach it to the students in the first three weeks in the labs.

PEC requirements

3.2.2 Criterion 2 - Program Learning Outcomes (PLOs)

In particular, the program must demonstrate the following:

a) Well-defined and published Program Outcomes
b) Program Outcomes linked to the Program Objectives
c) Program Outcomes encompass desired outcomes listed above
d) Mapping of Program Outcomes to Course Learning Outcomes (CLOs)
e) Teaching-learning and assessment methods appropriate and supportive to the attainment of Course Learning Outcomes
f) Quality of assessment mechanism to evaluate achievement levels for all the Program Outcomes by each student
g) Process in place by which assessment results are applied to further refine the assessment mechanism and/or redefine the program / course outcomes, thus leading to continuous improvement of the program

3.2.3 Criterion 3– Curriculum and Learning Process

3.2.3.5 Assessment of Learning Outcomes

The program must ensure that each student has achieved all PLOs to acceptable level through assessment of CLOs. The appropriateness of the assessment methods along with the level of achievement against the targeted outcomes must be evaluated. Mapping of program outcomes to individual courses, nature of assessment tools (direct/ indirect/rubrics) and the process of evaluation to determine the attainment of PLOs should be demonstrated through reasonably convincing evidences.

Role of Faculty

Faculty awareness and contribution:

- Accreditation and its importance
- Mission, PEOs and SOs
- Assessment process
- Continuous improvement

Issues affecting student learning:

- Availability of books, notes, lecture material
- Graded HWs, quizzes, exams and reports
- Availability of faculty during office hours
- Lab cancellation (due to unavailability of instructor or equipment)
- Coverage of course syllabus

Discussion on issues

- PEO (statement, measureable, review, constituents)
- PLOs
- Mapping (S, M, L)
- Assessment (Frequency, sampling)
- CQI (assessment based + others)
- Design projects
- Material organization (Course file, PLO files)
- Any other

THANK YOU