

ME Department Student Learning Outcomes - Measurable Course Outcomes
(Revisions Approved 9/29/04)

Measurable course-level student learning outcomes are defined for all high-level outcomes such that demonstrating that students have achieved the course outcomes provides supporting evidence that students are achieving the high-level outcomes and are properly prepared to achieve the department's educational objectives.

This outcomes list flows down from the objectives to the high-level outcomes to the measurable course outcomes. For each measurable course outcome we define a performance level* (see attachment 1a), a tollgate course** (where the final assessment takes place), and an area of expertise committee*** (see attachment 1b). The area of expertise committee provides oversight and broad perspective in the review of the assessment evidence to ensure that assessment is a program-level activity rather than an individual instructor activity. A PI designation is used to identify those course-level outcomes that serve as program indicator outcomes. These high-level outcomes (primarily in the Sr. Design sequence) are checked for all students every year because we believe that tracking these select outcomes allows us to track both the quality of the overall program and ensure that all students meet all of the ABET a-k outcomes prior to graduation. The "Course design template and assessment form", the "Area of Expertise Committee report template", and the "High-level outcomes faculty review report template" control the actual assessment activities on the course level, the area of expertise level, and the program level and as such they are an integral part of the overall outcomes assessment plan.

Outcomes that directly support the technical skills (TS) objective

TS.Design) [ABET-c] OU ME graduates will demonstrate an ability to design a system, component, or process to meet desired needs

In order to demonstrate achievement of the technical skills - design outcome (TS.Design),
OU ME graduates will demonstrate

- TS.Design.1) Problem solving skills, including the ability to convert an open-ended problem statement into a statement of work and/or a set of design specifications [Competence*; ME470**; Design***]
- TS.Design.2) The ability to generate creative and feasible alternative solutions to open-ended design problems, using precedent, lessons learned, and methods such as brainstorming or functional block diagrams [Competence; ME470; Design; **PI**]
- TS.Design.3) The ability to use common methods such as decision matrices for comparing alternatives and making engineering decisions [Competence; ME470; Design]
- TS.Design.4) The ability to apply engineering analysis (including load and stress analysis) for the design/sizing of mechanical components based on likely failure modes and meaningful factors of safety [**Mastery**; ME403; Design]
- TS.Design.5) The ability to select machine elements (such as bearings, gears, or fasteners) to satisfy specific functional requirements [Competence; ME471; Design]
- TS.Design.6) The ability to apply useful tools for design refinement such as value engineering, design for manufacturing and assembly (DFMA), or similar tools [Competence; ME471; Design]

- TS.Design.7) A recognition of various methods for managing risk and quantifying and improving system reliability, and an ability to apply failure modes and effects analysis (FMEA) in a design project [Competence; ME471; Design]
- TS.Design.8) An ability to deal with engineering standards and most of the following constraints in engineering design: economic, manufacturability, health and safety, environmental, sustainable, ethical, social, political. [Competence; ME470/1/2; Design; **PI**]
- TS.Design.9) The ability to apply general project management tools such as Gantt charts, Pareto charts, and critical path analysis for planning, prioritizing, and scheduling tasks in a design project [Competence; ME470/1/2; Design]
- TS.Design.10) The ability to use basic manufacturing skills (such as machining, grinding and turning) and the ability to work with vendors / part suppliers to build and assemble prototypes of a product design [Competence; ME472; Design]
- TS.Design.11) The ability to evaluate and use test results for design improvement and validation [Competence; ME471/2; Design]
- TS.Design.12) The ability to design, implement and evaluate controllers for linear systems [Competence; ME401; Mechanical Systems]
- TS.Design.13) The application of heat transfer to thermal design [Awareness, ME412, Thermal Systems]

TS.Problemsolving) [ABET-e] OU ME graduates will demonstrate an ability to identify, formulate, and solve engineering problems

In order to demonstrate achievement of the technical skills - problem solving (TS.Problemsolving) outcome, OU ME graduates will demonstrate

- TS.Problemsolving.1) A working knowledge of estimation techniques, rules of thumb, and engineering heuristics [Awareness; ME471; Design]
- TS.Problemsolving.2) An ability to appropriately interpret calculated results in the context of uncertainty (in the data, the models, the assumptions, or the analytical methods) [Competence; ME403; Design]
- TS.Problemsolving.3) An ability to solve common engineering problems, including problems involving
- Linear system modeling and analysis of 1 DOF system responses due to free and forced input [**Mastery**; ME491; Mechanical Systems]
 - The ability to model and simulate single-input single-output linear systems [**Mastery**; ME401; Mechanical Systems]
 - First Law analysis of thermodynamic systems [**Mastery**; ME321; Thermal Systems, **PI**]
 - The application of the first law of thermodynamics to the design process [Competence; ME328; Thermal Systems]
 - The selection of materials for mechanical components based on design considerations [Competence; ME403; Design]
 - The selection of materials for mechanical components based on manufacturing issues [Competence; ME471; Design]
 - The application of numerical techniques (of differentiation and integration) for simulating the behavior of engineering systems [**Mastery**; ET240/MATH344; Computers, programming and Simulation]

- h. The application of statistical analysis to manufacturing, including the computation of process capability and the understanding of statistical process control [Competence; ME313; Mfg & Materials]
- i. Kinematic/Dynamic analysis skills, including: 1) Analysis of position, velocity and acceleration kinematics of mechanisms, 2) Analysis of inverse dynamics of mechanisms, and 3) Basic analysis of cams and gears [Competence; ME301; Mechanical Systems]
- j. The application of the fundamentals of fluid dynamics to the design process [Competence; CE340; Fundamentals & Service Courses]
- k. The application of the second law of thermodynamics to the design process [Competence; ME328; Thermal Systems]
- l. The application of the fundamentals of heat transfer in the analysis of thermal systems [Competence; ME412; Thermal Systems]
- m. Linear system modeling and analysis of 2 DOF system responses [Awareness; ME491; Mechanical Systems]

TS.Experimental.1) [ABET-b] OU ME graduates will demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.

In order to demonstrate achievement of the technical skills - experiments (TS.Experimental) outcome, OU ME graduates will demonstrate

- TS.Experimental.1) An ability to perform statistical data analysis of univariate and bivariate data sets [**Mastery**; ME398/288; Lab/Experimental Methods]
- TS.Experimental.2) An ability to perform curve-fitting of multivariate data sets [**Mastery**; ME398/288; Lab/Experimental Methods]
- TS.Experimental.3) An ability to calculate the error/uncertainty propagation for calculations that include multiple terms with uncertainties [**Mastery**; ME398/388; Lab/Experimental Methods]
- TS.Experimental.4) An ability to design and plan experiments using real-world hardware [Competence; ME398/**488**; Lab/Experimental Methods, **PI**]
- TS.Experimental.5) An ability to use common measurement equipment [Competence; ME398/388; Lab/Experimental Methods]
- TS.Experimental.6) An ability to describe basic *Design of Experiments* techniques [Awareness; ME498/288; Lab/Experimental Methods]
- TS.Experimental.7) An ability to apply previously-learned engineering concepts to compare theoretical predictions with actual experimental results in diverse, practical mechanical engineering experiments. [Competence; ME498/388; Lab/Experimental Methods]

TS.Technology) [ABET-k] OU ME graduates will demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

In order to demonstrate achievement of the technical skills - technology outcome (TS.Technology), OU ME graduates will demonstrate

- TS.Technology.1) Drafting skills for creating and interpreting manufacturing and assembly drawings, including the use of CAD tools to create 2D drawings and parts lists. [**Mastery**; IT101/ ME451; Design]
- TS.Technology.2) The ability to use CAD solid modeling software for engineering applications, including creating & assembling 3D models of simple engineering systems [**Mastery**; ME350/351; Design]

- TS.Technology.3) The ability to apply the concepts of geometric dimensioning and tolerancing for creating and interpreting manufacturing and assembly drawings [Competence; ME288 Data Analysis Lab; Lab/Experimental Methods]
- TS.Technology.4) The ability to correctly use finite element analysis software, including the ability to correctly mesh a solid model, apply meaningful loads and boundary conditions, complete a linear static stress analysis, and interpret the results [Competence; ME350/451; Design; **PI**]
- TS.Technology.5) The ability to use general engineering analytical software (for example MATLAB) as a tool for solution of common engineering problems (using capabilities such as numerical methods, vector analysis, and matrix operations) [Competence; ET240/MATH344; Computers, programming and Simulation]
- TS.Technology.6) The ability to program and use CNC machines to manufacture simple parts [Competence; ME498/388; Materials & Mfg]

TS.Fundamentals) [ABET-a and ASME-1,2,&3] OU ME graduates will demonstrate a familiarity with statistics and linear algebra, a knowledge of chemistry and calculus-based physics (with depth in physics), and an ability to apply their knowledge of advanced mathematics (through multivariate calculus and differential equations), science, and engineering.

In order to demonstrate achievement of the technical skills - fundamentals outcome, OU ME graduates will demonstrate

- TS.Fundamentals.1) An ability to apply knowledge of Mathematics
- a. Calculus and Analytic Geometry [MATH 263A,B,C,D; Fundamentals & Service Courses]
 - b. Differential Equations [MATH 340; Fundamentals & Service Courses]
 - c. Linear Algebra
 1. The ability to complete standard matrix manipulations. [**Mastery**; ME301; Fundamentals & Service Courses]
 2. The ability to use matrices for solving systems of linear equations [**Mastery**; ME301; Fundamentals & Service Courses]
 3. The ability to define eigenvalues and eigenvectors and describe how they are used in engineering analysis. [Awareness; ME491; Fundamentals & Service Courses]
 - d. Statistics
 1. An ability to complete a basic statistical analysis, including producing histograms, identifying probability distributions, and computing mean values, standard deviations, standard deviations of the mean, and confidence intervals [**Mastery**; ME398/288; Lab/Experimental Methods; **PI**]
 2. An ability to define regression analysis and correlation coefficients, and an ability to use the method of least squared error to define a best-fit curve. [**Mastery**; ME398/288; Lab/Experimental Methods]
 3. A recognition of real-world engineering applications of statistical analysis [Awareness; ME403/304; Design]
 - e. Numerical Methods
 1. The ability to define issues such as convergence, stability, computational cost, and error propagation as they apply to Numerical Integration and

Differentiation. [**Mastery**; ET240/MATH344; Computers, programming and Simulation]

2. The ability to use numerical techniques to solve systems of initial value Ordinary Differential Equations [Competence; ET240/MATH344; Computers, programming and Simulation]
3. The ability to use numerical techniques (such as Newton-Raphson) to solve systems of nonlinear algebraic equations [Competence; ET240/MATH344; Computers, programming and Simulation]
4. A recognition of numerical solution methods for differential equations [Awareness; ME412; Computers, programming and Simulation]

TS.Fundamentals.2) A knowledge of Physical Sciences

- a. Chemistry [CHEM 151,152; Fundamentals & Service Courses]
- b. Physics [PHYS 251,252,253; Fundamentals & Service Courses]

TS.Fundamentals.3) An ability to apply knowledge of Engineering Sciences

a. Engineering Materials

1. Physical metallurgy

- a. The ability to list major metal alloy systems and their physical characteristics [Competence; ME313; Materials and Manufacturing]
- b. The ability to use binary equilibrium phase diagrams and phase transformation diagrams to determine phase composition, elemental composition, and microstructure [Competence, CHE331; Materials and Manufacturing]
- c. The ability to explain heat treating principles [Competence; ME313; Materials and Manufacturing]
 1. Quenching and tempering
 2. Solutionizing and aging
 3. Annealing

2. The ability to define wear, fatigue, and fracture mechanics as they apply to engineering materials [Awareness; ME403; Materials and Manufacturing]
3. The ability to identify the uses and properties of engineering materials including metals, ceramics, polymers and composites. [Awareness; CHE331; Materials and Manufacturing]

b. Engineering Mechanics

1. Rigid body mechanics (Basic college-level Statics and Dynamics) [**Mastery**; ME224; Fundamentals & Service Courses]
 - a. Planar kinematics of rigid bodies, including general plane motion and relative motion analysis
 - b. Planar kinetics of rigid bodies, including drawing free body diagrams and writing equations of motion
2. Deformable body mechanics (Basic college-level Strength of Materials) [**Mastery**; CE222/ME303; Fundamentals & Service Courses]
 - a. Elastic material behavior (Hooke's law)
 - b. 2D Principal stresses and strains (Mohr's circle)
 - c. Yield criteria (von Mises and Tresca)
 - d. Engineering and true stress and strain
 - e. Beam theory

- f. Column buckling
- 3. Fluid Mechanics
 - a. An ability to describe and apply Bernoulli's equation [**Mastery**; CE340; Fundamentals & Service Courses]
 - b. An ability to describe and apply continuity equations [**Mastery**; CE340; Fundamentals & Service Courses]
- 4. An ability to interpret tensile test data [Competence; CE223; Materials and Manufacturing]
- 5. An ability to explain and calculate non-elastic (plastic) material behavior [Competence; ME313; Materials and Manufacturing]
- 6. An ability to calculate material deformation energy [Competence; ME313; Materials and Manufacturing]
- c. Manufacturing Methods
 - 1. An ability to identify basic manufacturing processes and to ascertain the types of products that are cost effectively produced with each process [Competence; ME313; Materials and Manufacturing]
 - 2. A ability to describe the use of adhesives and mechanical fastening methods [Awareness; ME403/304; Materials and Manufacturing]
- d. Thermal Sciences
 - 1. Applying the first and second laws of thermodynamics in the analysis of energy components and systems, including [Competence; ME328; Thermal Systems]
 - 1.1 Vapor power cycles
 - 1.2 Air power cycles
 - 1.3 Refrigeration cycles
 - 1.4 Psychometrics
 - 1.5 Combustion
 - 2. Applying the second law of thermodynamics in the analysis of availability [Competence; ME328; Thermal Systems]
 - 3. The fundamentals of convection, conduction and radiation. [Competence; ME412; Thermal Systems]
- e. Fundamentals of Electrical Engineering [EE313,EE314, EE304,EE305; Fundamentals & Service Courses]
 - 1. An ability to explain the operation and performance characteristics of electric motors [Competence; ME498/ ME388; Fundamentals & Service Courses]
- f. Fundamental Skills in Computer Methods
 - 1. An ability to describe and use object oriented programming [**Mastery**; ET181; Computers, programming and Simulation]
 - 2. An ability to write computer programs to perform engineering calculations. [Competence; ET181; Computers, Programming and Simulation]

Other Places where the technical skills - fundamentals outcome is addressed

ME470/471/472: Instructors / team advisors will assess the students' overall ability to apply their knowledge of the fundamentals (advanced mathematics, science, and engineering) throughout the design and analysis process.

Outcomes that directly support the work skills (WS) objective

WS.Team) [ABET-d] OU ME graduates will demonstrate an ability to function on multi-disciplinary teams

In order to demonstrate achievement of the work skills - teamwork outcome, OU ME graduates will demonstrate

WS.Team.1) An ability to work effectively on project teams in both member and leader roles, with team members who may have different backgrounds and technical skill levels. This may include the ability to:

- a. work cooperatively with others
- b. analyze ideas objectively
- c. encourage active participation of others
- d. build consensus
- e. deal productively with conflict
- f. take leadership roles as the need arises to accomplish the group's objective
[Competence; ME470/1/2; Design, **PI**]

WS.Communication) [ABET-g] OU ME graduates will demonstrate an ability to communicate effectively

In order to demonstrate achievement of the work skills - communication outcome (WS.Com), OU ME graduates will demonstrate

WS.Communication.1) Written and graphical communication skills appropriate to the profession of engineering, including:

- a. Writing and editing clear and effective engineering design reports, including technical content that is factually correct, supported with evidence, explained with sufficient detail, and properly documented [**Mastery**; ME470/1/2; Design; **PI**]
- b. Writing and editing clear and effective laboratory reports, including the creation of "professional quality" graphics for figures, tables, plots and charts. [**Mastery**; ME498/388; Lab/Experimental Methods]
- c. An ability to synthesize a large project report in the form of abstracts and executive summaries [**Mastery**; ME470/1/2; Design]
- d. Technical communication skills, including an ability to explain the importance of organization, purpose, and target audience. [Competence; COMS103; Fundamentals & Service Courses]
- e. Documenting project work properly in a design notebook [Competence; ME472; Design]
- f. Documenting experimental data properly in a lab notebook or on lab data sheets [Competence; ME398/388; Lab/Experimental Methods]

WS.Communication.2) Oral and visual communication skills appropriate to the profession of engineering, including:

- a. Preparing and making clear and effective formal presentations, including the preparation of "professional quality" visual aids [**Mastery**; ME470/1/2; Design; **PI**]
- b. The ability to participate in technical discussions [Competence; ME471; Design]

WS.LL Learning) [ABET-i] OU ME graduates will demonstrate a recognition of the need for, and an ability to engage in life-long learning

In order to demonstrate achievement of the work skills - life-long learning outcome, OU ME graduates will demonstrate

WS.LL Learning.1) An ability to find, evaluate and use resources to learn independently
[Competence; ME471; Design; **PI**]

WS.LL Learning.2) A recognition of the need to accept personal responsibility for learning and of the importance of lifelong learning [Awareness; ME471; Design]

Other Places where the work skills - life-long learning outcome is addressed

ME470/472: Through discussions and requirements for independent student research, and through the use of active listening and interviewing skills to gather information verbally from vendors and design "experts".

WS.Professional) [ABET-f] OU ME graduates will demonstrate an understanding of professional and ethical responsibility.

In order to demonstrate achievement of the work skills - professionalism outcome, OU ME graduates will demonstrate

WS.Professional.1) An awareness of the need to consider safety and an ability to apply methods for increasing safety in all aspects of the engineering profession, including safety in testing, safety during manufacturing, and product safety [**Mastery**; ME471; Design; **PI**]

WS.Professional.2) An ability to evaluate ethical issues that may occur in professional practice
[Competence; ME100/ME101; Design]

WS.Professional.3) An ability to describe the importance of patents and intellectual property rights [Awareness; **ME470**; Design]

WS.Professional.4) Interactions with industry and engineering professionals through industrial involvement in design projects and opportunities for participation in the co-op program, plant tours, and professional organizations such as ASME and SAE. [Awareness; ME472; Design]

WS.Professional.5) An ability to identify the applicable professional codes of conduct for engineers (such as the "Code of Ethics for Engineers" of the National Society of Professional Engineers and the "Canons of Ethics for Engineers" of the Engineer's Council for Professional Development) [Awareness; ME100; Design]

Other Places in Curriculum where the work skills - professionalism outcome is addressed

ET181: Discussion of copyright and plagiarism issues

ME470/471/472: There is a requirement to maintain design notebooks.

Outcomes that directly support the global & contemporary (GC) objective

GC.Global_Societal) [ABET-h] OU ME graduates will have the broad education necessary to understand the impact of engineering solutions in a global and societal context.

In order to demonstrate achievement of the global and contemporary - global and societal outcome, OU ME graduates will demonstrate

GC.Global_Societal.1) An awareness of the influence of science and technology on civilizations and an ability to explain how science and technology have been applied to the betterment of humankind [Competence; ME100/ME101; Fundamentals & Service Courses]

GC.Global_Societal.2) An ability to evaluate the impact of energy systems on our global society, including issues such as air pollution, climate change, and environmental regulations [Competence; ME 328; Thermal Systems, **PI**]

Other Places where the global and contemporary - global and societal Outcome 4-2 is addressed

ME313: Discussion of global trends in manufacturing industries

General Education Requirements (24 hours of humanities and social sciences with advanced work in each)

ME470/471/472: Discussions of the potential societal impacts of the design projects, and the identification of government agencies, regulatory bodies, codes and standards that govern the global, societal, and environmental impact of their design projects.

Junior Seminar - in development

GC.Contemporary) [ABET-j] OU ME graduates will demonstrate a knowledge of contemporary issues.

In order to demonstrate achievement of the global and contemporary - contemporary issues outcome, OU ME graduates will demonstrate

GC.Contemporary.1) An ability to describe the impact of at least one contemporary issue (such as renewable energy, clean coal technology, the hydrogen economy, global warming,) on the engineering profession or the practice of engineering [Competence; ME328; Thermal Systems; **PI**]

Other Places where the global and contemporary - contemporary issues outcome is addressed.

ME321 (& the ME498 Stirling cooling lab): Discussions of energy issues such as renewable energy and Freon elimination, and the identification of local industries which are world leaders in energy technology.

ME470: Contemporary issues are part of selection process for the Sr. design project.

Fundamentals & Service Courses - Detailed Outcomes

The following list of outcomes for our service courses provides a guide for curriculum development and improvement. We are working with the departments that offer the service courses in order to ensure that our outcomes are included within their course outcomes, and we are requesting that the departments offering these service courses provide assessment data demonstrating ME students' achievement of these outcomes. However, since these fundamentals are all applied and assessed at a higher level within our own program, direct assessment evidence for these outcomes is beneficial but not essential. Alternative assessment methods that are acceptable for these guideline outcomes include prerequisite inventories and prerequisite skills assessments.

TS.Fundamentals.1) Mathematics

a) Calculus and Analytic Geometry

Mastery of:

1. Basic differentiation skills, including the use of the product rule, the chain rule, and the ability to compute partial and total derivatives
2. Basic integration skills, including graphical interpretation of integrals and integration by parts

Competence in:

3. The use of numerical series and approximations
4. Linearization (Taylor Series)
5. Basic skills in 2D and 3D analytic geometry

Service Course(s): MATH 263A/B/C/D

b) Differential Equations

Mastery of:

1. The ability to analytically solve linear initial value problem ODEs, including homogeneous & non-homogeneous solutions
2. The ability to analytically solve boundary value problem ODEs

Competence in:

3. The use of Laplace Transforms to analytically solve ODEs

Service Course(s): MATH 340

TS.Fundamentals.2) Physical Sciences

a) Chemistry

Competence in:

1. Basic college-level Chemistry, including the periodic table, inorganic chemistry, and chemical reactions

Awareness of:

2. Organic structures

Service Course(s): CHEM 151/152

b) Physics

Competence in:

1. Basic college-level Physics, including Newtonian Mechanics; the principles of force, work and impulse-momentum; electricity & magnetism, waves and optics.

Service Course(s): PHYS 251/252/253

TS.Fundamentals.3) Engineering Sciences

e) Fundamentals of Electrical Engineering

Mastery of:

1. Basic electronic measurements
2. DC and AC circuit analysis fundamentals

Awareness of:

3. Digital logic and digital devices
4. Basic signal processing (filtering, amplification, etc.)
5. Basic microprocessor architecture
6. The physical foundation of semiconductor devices

Service Course(s): EE313, EE314, EE304, EE305

Attachment 1a: Performance Level Definitions

To define the required performance for each measurable learning outcome

1. Awareness/Exposure

- The awareness level corresponds to the “Knowledge” level in Bloom’s taxonomy, and the “Worth being familiar with” category in *Understanding by Design*.
- Learning activities related to the outcome must be a required part of the course, but there is no minimum performance requirement for the students to meet.
- To assess student achievement of awareness with respect to an outcome you must document that all students have been exposed to information related to the learning outcome – for example you might document that all students attended a presentation on a topic related to the outcome and wrote a short summary on the topic.

2. Competence/Ability

- The competence level corresponds to the “Comprehension and Application” levels in Bloom’s taxonomy, and the “Important to know and do” category in *Understanding by Design*.
- Learning activities related to the outcome must be a required part of the course, and there must also be clearly defined assessment activities with clearly defined minimum performance requirements that the students must meet to demonstrate ability with respect to the outcome.
- Student achievement of competence/ability for an outcome can be demonstrated by defining an acceptable level of performance on an appropriate assessment activity and directly assessing whether or not each student meets or exceeds that level of performance. For example, to demonstrate effective oral communication you could set the assessment activity as a formal presentation and you could set several performance criteria including items like “speaks clearly and with sufficient volume” and “responds effectively to questions and comments”, then when each student makes their presentation you can assess with a simple yes/no rating whether or not each student meets each performance criteria and you can track the percentage of students who met all (or some acceptable number) of the performance criteria. This percentage should be recorded and used for comparison with previous and future results for this outcome to track continuous improvement.

3. Mastery/Understanding

- The mastery level corresponds to the “Analysis, Synthesis, and Evaluation” levels in Bloom’s taxonomy, and the “Enduring understanding” category in *Understanding by Design*.
- Learning activities related to the outcome must be a required part of the course, there must be assessment activities with clearly defined minimum performance requirements that the students must meet to demonstrate both ability and understanding, there must be significant formative feedback given to the students on the learning activities and/or assessment activities, and there must be some required reflection to force the students to synthesize and process information related to the outcome.
- Student achievement of mastery for an outcome can be demonstrated by defining an acceptable level of performance on an appropriate assessment activity (the activity must extend beyond doing to include evaluating) and documenting that all students who passed the course met or exceeded that level of performance. For example, an appropriate assessment activity could be a project that requires the student to solve an open-ended problem by synthesizing information learned in other contexts and critically evaluating the result rather than merely reporting an answer, and a mastery learning procedure could be followed requiring recycling until understanding is clearly demonstrated. For additional ideas on assessing understanding see *Understanding By Design* (in particular see the Rubric for the Six facets of understanding - Explanation, Interpretation, Application, Perspective, Empathy, Self-Knowledge - on pages 76-77).

*** From Bloom’s Taxonomy (For Reference):**

Evaluation (Employment of internal or external criteria for making critical judgments); **Synthesis** (Combining elements into a whole); **Analysis** (Breaking down a problem into its component parts); **Application** (Solving new problems with familiar principles); **Comprehension** (Translation of a concept into a somewhat different form); **Knowledge** (Recall of factual material in similar form)

Attachment 1b: “Area of Expertise” Committee Lists

Each committee will address the outcomes associated with their area of expertise with quarterly discussions (documented in a status report) and end-of-year formal reviews (documented in a formal Area of Expertise yearly report). The faculty member listed first is the acting chair of the committee.

1. Design

- a. Greg Kremer
- b. Ken Halliday
- c. Izzi Urieli
- d. Bhavin Mehta
- e. Andy Foley

2. Mechanical Systems

- a. Bob Williams
- b. Ken Halliday
- c. Greg Kremer (temporary, until new Mechanical Systems faculty member starts)

3. Thermal Systems

- a. Izzi Urieli
- b. Khairul Alam
- c. Dave Bayless

4. Materials and Manufacturing

- a. Frank Kraft
- b. Bhavin Mehta
- c. Khairul Alam
- d. Jay Gunasekera

5. Computers, programming and simulation

- a. Bhavin Mehta
- b. Israel Urieli
- c. Bob Williams

6. Lab / Experimental Methods

- a. Frank Kraft
- b. Greg Kremer
- c. Andy Foley

7. Fundamentals & Service Courses (Math/Chemistry/Physics, Mechanics, Intro to Engineering, ...)

- a. Ken Halliday
- b. Rudy Pasic
- c. Gary Graham
- d. Jay Gunasekera