

Linking Student Achievement to Program Outcomes Assessment

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Abstract

In recent years, there have been numerous publications outlining the assessment plans that various institutions have put into place in response to the ABET EC 2000 criteria. In this paper an outcomes assessment process which includes direct measures of student achievement in engineering classes is described. It is postulated that in a well-designed course, the student learning objectives for that course will necessarily have a high correlation with overall program outcomes. Further, faculty teaching such courses will naturally gather data relating to student performance on these course objectives. Therefore, it is logical to propose that this data be used independently of the classroom grading for the purpose of program outcome assessment.

Based on available literature, relatively few schools appear to be using student work in a formal way to assess program outcomes. This may be due to a variety of reasons, including legitimate questions that have been raised in the assessment literature regarding the validity of using transcript data to assess program outcomes. However, by not using graded course work, it is possible that a large quantity of potentially valuable assessment data that is routinely gathered by faculty is being overlooked. Exam and quiz problems, laboratory and project reports, oral presentations, and homework assignments, which are standard in virtually all engineering courses, generate assessment data that can be used not only for computing a student's course grade, but also in a quantitative way for program level assessment and feedback. In fact, a few schools have reported that grades on assignments and examinations in individual courses has been the single most useful assessment instrument, providing feedback both to the student and to the instructor.

Important differences between the method suggested herein and the practice of using raw course grades (transcript data), average class grades, or other "smeared" data are described. The system for collecting and analyzing the data obtained by faculty and how this information is used to within the feedback loop is also illustrated.

Introduction

The EC 2000 accreditation criteria require that an institution have in place a comprehensive outcomes assessment program to ensure the quality and continuous improvement of the educational process¹. There have been many papers published in the last few years on the topic of assessment as it relates to the new criteria. Assessment may take place at the course level or at the program level². Course level assessment attempts to ensure that in a particular course the required material is sufficiently well taught and understood. Program level assessment addresses the program outcome indicators as well as assessing the content, sequence, and integration of all courses within a program. Ressler and Lenox³ provide a program assessment model with integrated course level assessment that is being used at their institution. They correctly assert that these two levels of assessment are clearly not independent, and that "in a well integrated

curriculum, course assessment can never take place in isolation.” For instance, the inability of students to meet a particular course objective may be due to difficulties with a previous course. Thus, in an integrated assessment plan course level assessments should feed into the overall program assessment.

Program Outcomes Assessment

The philosophy of EC 2000 represents a shift from the “bean-counting” of the so-called conventional criteria to a system which includes and focuses on outcomes assessment. Each program has the opportunity to define its’ mission and objectives, which should be consistent with institutional goals and representative of the needs of constituent groups. Accordingly, each program must have in place detailed published educational objectives, a process by which these objectives are periodically evaluated, a curriculum that ensures the achievement of these objectives, and a system of evaluation of these objectives that uses the results to improve the program. Another mandate of EC 2000 is an outcomes assessment process that is used for continuous quality improvement of the program.

Program outcomes assessment for EC 2000 requires that, as a minimum, engineering programs demonstrate that their graduates have achieved the “(a) through (k)” items listed in Criterion 3. Further, each program must have an assessment process with documented results, and evidence must be given that these results are used in a continuous improvement loop. Finally, the assessment process must demonstrate that the program outcomes are being measured.

Since the outcomes assessment process requires that the outcomes be measured, there is a need to gather supporting data. Most institutions’ outcomes assessment plans rely heavily on data obtained using instruments explicitly suggested in early versions of the EC 2000 criteria, including surveys that are administered to seniors, graduates, employers, or other constituents, placement data, capstone senior design projects, portfolios of student work and scores on the FE exam⁵. It is noteworthy that the 2004-05 version of EC 2000 omits any reference to particular instruments that may be used for outcomes assessment, instead leaving the choice entirely up to the institution.

Outcome assessment tools may be loosely classified as either pre-graduation or post-graduation indicators, depending upon when they are administered⁶. One possible shortcoming of the assessment program at the surveyed institutions is that most of the tools used to measure the outcomes of the program take place either at the end of the senior year or post graduation. In the opinion of George Peterson¹⁹, ABET’s executive director, “implementation of continuous quality improvement may be easier at the course level than at the program level.” Therefore it may be prudent to investigate the increased use of pre-graduation assessment tools as input to program level assessment.

Pre-Graduation Assessment Tools

Pre-graduation indicators can include transcript data (courses attempted by students and corresponding grades)⁶, student portfolios (multiple courses), and course portfolios (individual courses). Course portfolios are currently being used at several institutions. The theory behind the use of portfolios is that by accumulating a student’s work over

time one can demonstrate whether or not a student is progressing towards and achieving educational goals⁷. However, at least one school that began using portfolios has discontinued the practice⁸. This was due to the large effort involved in maintaining the portfolios as well as the difficulty of obtaining quantifiable data. Clearly, available resources and utility of obtained data must be considered when designing any assessment program.

The concept of using course grades as an assessment tool is attractive since this information is already being collected so in theory there is no undue burden added to faculty by the assessment process. For example, Conner and Goldman⁹ report the use of a weighted average of student course grades linked to program objectives as a program assessment tool. Georgia Institute of Technology¹⁰ also uses assignment of grades by professors as one of their outcomes assessment tools. If a student is assessed in the context of a course, the instructor has a large number of graded assignments including tests, homework, and projects upon which to base the summative assessment. Thus each instrument does not have to stand the same rigorous tests of validity and reliability as would instruments in a single measure environment¹¹.

These assessments are based on a linkage between the program level and the course level that is usually established through the coupling of the course objectives to various program outcomes. Tacitly implied is the assumption that a student has achieved the course objectives simply by completing a course with a passing grade. However, this assumption may not be valid.

Indeed, summative course grades provide little insight regarding whether or not all or even most of the course objectives have been met, and thus limit their usefulness for providing feedback to individual students or to the program as a whole. It seems reasonable to suppose that some students who earn a “C” in a course may not have mastered all of the course objectives. In fact, there is really no guarantee that even an “A” student has met all of the course objectives. Shaeiwitz¹² astutely states “with partial credit, it is possible for a weak student to go through an entire engineering curriculum and receive a degree without having solved one problem correctly on a test.” Clearly, while the use of final course grades as input to program assessment is inviting, a clear link between grades and objectives must first be established.

There are at least two reasons that there may be no concrete link between course grades and course objectives. First, after faculty set up (or are handed) objectives for a particular course, they may not refer back to them while conducting the course, resulting in assignments and tests which may have little to do with the stated course objectives. Secondly, even if the instructor does teach with a view to the course objectives, it is not unreasonable to find students who fail to master one or more of the stated objectives of a course yet still manage to pass the course. Further, it is conceivable that even in a class with a Gaussian grade distribution centered on C to have a majority of students fail to demonstrate mastery of one of the course objectives. These possibilities beg the questions: How many course objectives must a student master to be successful? How do we know if individual course objectives are consistently being met?

Addington and Johnson¹³ describe an approach that uses grades on individual assignments to measure program outcomes. They link particular homework assignments directly to program outcomes and record the mean and standard deviation of the all students' grades. This method has the benefit of not looking only at summative course assessment data. However, by averaging class performance, information regarding the actual number or percent of students meeting an outcome is lost. For example it would be important to know that seventy percent of the students mastered an assignment, while the statistic that the class average for the assignment was seventy percent is less informative.

In the next section a course level assessment model is presented that attempts to address the questions and concerns described above. The primary focus of the method proposed herein is to strongly align the relationship between the course objectives, the various tasks that a student performs during a course, and the methods that are used to assess those tasks. Specifically, for each course objective, distinct assessment measurements are identified. A quantitative evaluation of these assessment measurements provides statistical data that can be used in a variety of ways for course and program assessment.

Linking Course and Program Assessment

Although the implementation of EC 2000 is still in its' early stages, the results from some of the first accreditation visits is beginning to become available. One document¹⁴ reports that the visiting teams are placing emphasis on the practice of continuous improvement, specifically including three items: input of constituencies, process focus, and linking outcomes and assessment to objectives. This same source finds that a major weakness areas in 2000-01 cycle to be "lack of substantiation/evidence of achievement of Criterion 2 (Objectives) and Criterion 3 (Outcomes)." Another key finding of this report, relating to assessment tools and measures, is that:

- The primary assessment of student outcomes should be based on student work, e.g. student portfolios, assessment of student projects, assignments, and exams.
- Senior exit surveys, alumni surveys, and employer surveys are qualitative evidence based on opinion and should not be relied on as the primary means of assessment.

However, very few programs appear to be using student assignments, exams, or projects (other than senior design) as part of their assessment plan. This may be due to these instruments being omitted from the EC 2000 list, while the others are explicitly mentioned. On the other hand, the paucity of use may be due to legitimate questions that have been raised in the assessment literature regarding the validity of using transcript data to assess program outcomes.

However, by not using graded course assignments and exams, it is possible that a large quantity of potentially valuable assessment data that is routinely gathered by faculty is

being overlooked. Homework assignments, projects, quizzes, and exams, which are standard in virtually all engineering courses, generate assessment data that can be used not only for computing a student's course grade, but also in a quantitative way for program level assessment and feedback. In fact, a few schools have reported that grades on assignments and examinations in individual courses has been the single most useful assessment instrument, providing feedback both to the student and to the instructor.

In the past, some assessment proponents have asserted that institutions cannot use grades for assessment. This position may have evolved in part to prevent faculty from saying that they already assess student work by grading and then going about their business as usual. The American Council on Education has gone as far as defining assessment as "any measure – other than end-of-course grading – by which the college evaluates its students or programs". This statement appears to say in no uncertain terms that course grades should not be used in an assessment program.

It is clear that grades awarded to students upon completing a course, *in isolation*, are not well suited as assessment tools. However, these final grades are normally computed based on grades earned by the student during the course on assigned tasks such as homework, exams, quizzes, and reports. If grades on these tasks are linked to the learning goals of the course then it is appropriate to also use them in the assessment process¹⁸. This is why summative course grades, which are smeared measures of performance, provide little insight into mastery of individual course objectives.

Some authors have proposed using grades earned by students on course work for assessment purposes. King and Schimmel²¹ describe using a variety of assessment instruments, including exam question results. Their target was the average score on a regular exam question designed to measure accomplishment of the objective. They use a level of 70% met, 50% partially met, less than 40% not met. However, by using the average exam score, rather than percent of students meeting a certain level, actual achievement is masked. For example, assuming a Gaussian distribution with an average grade of 70, one-half of the students will be below this level, and not achieving the objective. A better measure would be the percentage of students reaching this minimum level.

Ressler and Lenox³ describe the use of "graded requirements" and other undefined "data-measurements of course effectiveness acquired through the application of a wide range of course-level assessment tools during the previous semester" to answer two fundamental questions:

- Where the course objectives achieved?
- Do the course objectives (1) contribute appropriately to the program objectives and (2) lend themselves to effective assessment?

According to Aldridge and Benefield², examinations and grading methods should include a strong focus on a course's learning objectives. However, they caution to not rely

entirely on the results of a single examination to assess achievement of assigned learning objectives.

Defining Course Objectives

If any instruction is to be successful, one must first define the objectives that the instruction is intended to accomplish. For individual courses, this entails defining *course objectives* that describe what students will know and be able to do after successful completion of the course. Course objectives are sometimes called “intended learning outcomes,” “learning objectives,” or “performance criteria.” One of the first proponents of the development and use of explicit statements of course objectives was Mager¹⁷, who published the first edition of *Preparing Instructional Objectives* over forty years ago. In spite of this, until recently it would have been unusual to find engineering faculty familiar with this work or with course objectives in general. However, with the advent of EC 2000, the process of faculty developing and using course objectives is becoming an integral part of an engineering curriculum.

An objective is a description of a performance you want learners to be able to exhibit before you consider them competent. According to Mager, there are at least three reasons that objectives are important:

- When clearly defined objectives are lacking, there is no sound basis for the selection or designing of instructional materials, content, or methods.
- Unless objectives are clearly and firmly fixed in the minds of both students and faculty, tests are at best misleading; at worst, they are irrelevant, unfair, or uninformative.
- Clearly defined objectives provide students with the means to organize their own efforts towards accomplishment of those objectives.

An important distinction is the difference between a list of topics covered in a course and a set of course objectives. The former tells what the course includes, but does not say anything about student achievement.

It is also important to state course objectives clearly and concisely. Simply put, a well stated course objective leaves no doubt as to what the faculty intends the student to do. Therefore, words that may be interpreted in multiple ways should not be used. For example, a phrase like “students will be able to understand free body diagrams” is open to interpretation – how can one tell if a student “understands” something? This objective would be better stated as “students will be able to draw free body diagrams.” Some other phrases that should be avoided include “to learn”, “to know”, “to appreciate”, “to grasp”, and “to believe.”

Developing course objectives involves answering the following three questions:

- What will my students know?
- What will they understand?

- What will they be able to do with their knowledge at the end of the course that they could not do at the beginning?

The course objectives developed should have the following three characteristics:

- Linked to course goals
- Represent concepts central to the course
- Should not attempt to encompass all course material

According to Huba¹⁶, there are four fundamental elements of learner centered assessment:

1. Formulate statement of intended learning outcomes.
2. Developing or selecting assessment measures.
3. Creating experiences leading to outcomes.
4. Discussing and using assessment results to improve learning.

Linking Course Objectives to Program Outcomes Assessment

Individual professors naturally tend to focus on their own courses, and may be only peripherally aware of other courses within an engineering program. However, students experience the program as a whole, and it may therefore be beneficial to look at the courses in an engineering curriculum holistically, rather than as isolated components. Certainly, the knowledge, skills, and abilities that students achieve upon completion of their programs are affected by how well courses and other experiences in the curriculum fit together and build on each other¹⁶.

Ideally, a curriculum should be constructed starting first with a statement of goals, followed by a definition of program objectives and outcomes, ultimately leading to development of individual courses and course objectives¹⁵. Unfortunately, this process assumes that institutions initiating a program and are starting with a blank slate, as opposed to the more common situation of creating program objectives and outcomes for existing programs. Thus, most institutions have developed an assessment process and program outcomes that are overlain on existing courses and curricula. The result is usually an ad hoc mapping of course content to program outcomes, the result of which is often courses that seem to have little match, or outcomes that are not adequately addressed by courses.

If each course is a single piece of the curriculum and if in turn the curriculum is a major part of the program that is being assessed, it is crucial that course objectives and program outcomes be aligned. This key step seems to be often overlooked.

An Example of Program Outcomes Assessment

The proposed assessment program provides a much closer link between the program outcomes, the course objectives, and the activities for which faculty measure student achievement (e.g. tests, homework, etc.). The following sample assessment plan illustrates this assessment.

Course Level Assessment for ME 251: Engineering Statics

A typical course is used to illustrate the setup and execution of the use of student course work in program assessment. The process begins with a faculty committee who are charged with creating objectives for this course. The course objectives must be specific, measurable items that are confirmable through evidence¹⁴. The development of course objectives is a difficult task, and requires significant effort on the part of faculty. One benefit of this step, however, is that it forces faculty to think deeply about what a particular course should accomplish, as well as its relation to other courses in the program. Upon approval by the entire faculty, these objectives become binding for all faculty teaching this course. Of course, the faculty is free to choose whatever teaching methods they prefer as long as the objectives are being achieved.

The objectives of a course should resonate with those of the program in which it resides. Further, the totality of the courses in a program should be interwoven in such a way to ensure that there is adequate and uniform coverage of topics related to all program outcomes. Therefore, the objectives of an individual course must directly address the program outcomes to which the course is expected to contribute. However, the course objectives should not simply be a restatement of the program outcomes. Rather, they should be tailored to fit specific courses. It is important to note that these course objectives cannot encompass all that an instructor plans to teach or that students are expected to learn in a given course². They should represent the concepts and materials that are central to the course, rather than peripheral content.

The course objectives for Engineering Statics are listed in Appendix I. The bold italics letters and numbers in parenthesis (e.g. ***PO-5***) relate a particular course objective to a program outcome (where for convenience the ABET a-k are numbered 1-11). In this instance, five of the program outcomes are cross-referenced to our example course, ME 251 Engineering Statics. However, it is evident that the course focuses on some outcomes more than others. Thus, a rubric has been developed and is used to judge the contribution of courses to program outcomes. The rubric for ME 251 is shown in Table 1. By creating similar rubrics for all courses in a program, evidence of the adequacy of coverage of program outcomes in the curriculum can be determined.

Table 1: Outcomes/Course Rubric for ME 251

		<i>Program Outcomes</i>
0	Course does not contribute to outcome	
1	Course contributes slightly to outcome	<i>3,4,7</i>
2	Course contributes moderately to outcome	
3	Course contributes significantly to outcome	
4	Course contributes greatly to outcome	<i>1,5</i>

Program Outcomes addressed by ME 251

1. An ability to apply knowledge of mathematics, science, and engineering.
3. An ability to design a system, component, or process to meet desired needs.
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve engineering problems.
7. An ability to communicate effectively.

It is not generally possible to assess all course objectives. However, the key is that various homework sets, exam question, etc., have an evaluation purpose to determine if a student has a specific skill or can perform a specific task. Each test question is evaluated to determine areas of competency or weakness. Final exam questions are then chosen based on areas where the majority of students have not demonstrated competence, thus giving students another opportunity to demonstrate mastery of course objectives. There is little to be gained by putting questions on a final exam that students have already demonstrated ability and mastery. Testing for testing's sake does not advance student learning.

Formative assessment is designed to provide information for the purpose of improving the course. It does this by providing continual feedback of academic performance to individual students. With this assessment method, course assessment is being done continuously during the course. In essence, the assessment consists of the following:

1. Keeping track of students' grades on tests, homework, reports, oral presentations, projects, etc. Scores for individual test problems, not just total test scores, are recorded to provide the most useful feedback and assessment. A spreadsheet works best to record this information. Recall that these subset scores have been linked to performance criteria. Homework sets that encompass multiple performance criteria must also be broken down and recorded separately. Assignment of problem sets to assess particular performance criteria avoids this bookkeeping problem and allows students an opportunity to focus on specific learning objectives.
2. Running scores on particular performance criteria during the course gives the feedback needed to guide midcourse changes—which is the essence of formative assessment.

The scores for all tasks evaluated are tabulated at the conclusion of the course. A seventy percent (70%) average is selected as the minimum competency level that a student must attain in order to achieve an objective. For instance, suppose course objective 1.1 is measured by homework assignments 1 and 2, hour exam #1—problem 1, and final exam—problem 2. These four measures would be averaged to determine if a seventy percent average has been achieved and the course objective passed. This, in turn, is linked to the appropriate program outcomes, in conjunction with all other courses.

The determination as to whether a student has mastered the program outcome can be made after calculations have been done for all courses. When seventy percent (70%) of the course objectives relative to a particular program outcome are passed an outcome is assumed to be mastered.

Continuous Improvement Loop

There are multiple feedback channels that direct information regarding student performance in a course to faculty teaching other related courses (including other departments), the department administration, and the students. Feedback can be thought of in a ladder format with the rungs being represented by the upstream faculty (those

teaching prerequisite courses), the current course faculty, and the downstream faculty (those teaching follow up courses), all of whom have different concerns:

- Upstream faculty – What is the positive and negative feedback on student skills?
- Current course teacher – Which topics need more or different treatment?
- Downstream faculty – What topics need more / less coverage than usual?

A formal method of exchange is needed, rather than the anecdotal evidence that is sometimes used. An annual or semi-annual meeting may be used for this purpose. If a particular course objective is not met by a large number of students, faculty should try to determine if this could be remedied via internal or external changes to the course or in preparatory courses. Prerequisite courses could be investigated if external changes are needed. If the prerequisite course is from another department (e.g. math) a meeting should be set up to discuss possible solutions. Further, subsequent course instructors could be alerted that students might be weak in an area of the particular objective.

Evaluation is accomplished by computing statistics regarding student achievement in each course objective and program outcome. Table 2 provides an example of these statistics for a course with three exams, each having three questions that correspond to different course objectives.

The information contained in this table can be used in a variety of ways. In the above example, only 40% mastered course objective 2.2. There is also possible trouble with course objective 1.3(60% passing) and 2.3(60% passing). These results should be tracked longitudinally over a period of time to determine areas that are truly problematic. Repetitive weaknesses in meeting a particular course objective could be due to problems in a prerequisite course or lack of adequate understanding in the current course. Feedback, both to the upstream and downstream faculty, should occur. Re-evaluation of current course teaching techniques should also be analyzed.

Table 2
Sample Assessment

Student	Course Objective 1.1	Course Objective 1.2	Course Objective 1.3	Course Objective 2.1	Course Objective 2.2	Course Objective 2.3	Course Objective 3.1	Course Objective 3.2	Course Objective 3.3
1	x	x	x	x		x	x	x	x
2	x	x		x			x	x	x
3	x	x	x	x	x	x	x		x
4		x	x		x	x	x		x
5	x	x	x	x		x	x	x	x
6			x			x		x	x
7	x	x		x			x	x	
8	x				x		x		
9	x	x		x			x	x	
10		x	x	x	x	x		x	x
Total %	70%	80%	60%	70%	40%	60%	80%	70%	70%

x ⇒ indicates that a course objective has been met at the 70% level

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Biographical Sketch

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Appendix I

Course Learning Objectives for ME 251 Engineering Statics, and their relationship to Mechanical Engineering Program Outcomes (PO's):

Upon successful completion of this course the student will be able to:

1. General

- 1.1 Convert data between and use both SI and US customary units to perform calculations. *(PO-5)*
- 1.2 Ensure that equations are dimensionally homogeneous. *(PO-5)*
- 1.3 Use the correct number of significant figures when solving problems. *(PO-5)*
- 1.4 Present problem solutions in an organized, logical and neat format. *(PO-7)*

2. Force Vectors

- 2.1 Show how to add forces and resolve them into components using the Parallelogram Law. *(PO-1)*
- 2.2 Express force and position in Cartesian vector form. *(PO-1)*
- 2.3 Determine a vector's magnitude and direction. *(PO-1)*
- 2.4 Use the dot product to determine the angle between two vectors. *(PO-1)*
- 2.5 Use the dot product to determine the projection of one vector onto another. *(PO-1)*

3. Equilibrium of a Particle

- 3.1 Sketch a complete free-body diagram for a particle. *(PO-5)*
- 3.2 Solve particle equilibrium problems using the equations of equilibrium. *(PO-5)*

4. Force System Resultants

- 4.1 Calculate the moment of a force in both two and three dimensions. *(PO-5)*
- 4.2 Calculate the moment of a force about a specified axis. *(PO-5)*
- 4.3 Calculate the moment of a couple. *(PO-5)*
- 4.4 Determine the resultant of non-concurrent force systems. *(PO-5)*
- 4.5 Reduce a simple distributed loading to a resultant force having a specified location. *(PO-5)*

5. Equilibrium of a Rigid Body

- 5.1 Sketch a complete free-body diagram for a rigid body. *(PO-5)*
- 5.2 Solve rigid body equilibrium problems using the equations of equilibrium. *(PO-5)*

6. Structural Analysis

- 6.1 Determine the forces in the members of a truss using the method of joints. *(PO-5)*
- 6.2 Determine the forces in the members of a truss using the method of sections. *(PO-5)*

- 6.3 Determine the forces in the members of frames and machines composed of pin-connected members. **(PO-5)**
- 6.4 Design and construct a simple truss structure to meet specified criteria. **(PO-3, PO-4)**

7. Internal Forces

- 7.1 Determine the internal loadings in a member using the method of sections. **(PO-5)**
- 7.2 Determine an equation for and plot the internal shear force in a member. **(PO-5)**
- 7.3 Determine an equation for and plot the internal moment in a member. **(PO-5)**

8. Friction

- 8.1 Analyze the equilibrium of rigid bodies subject to dry friction. **(PO-5)**
- 8.2 Solve friction problems involving wedges. **(PO-5)**

9. Center of Gravity and Centroid

- 9.1 Determine the center of gravity and centroid for a system of discrete particles. **(PO-1)**
- 9.2 Use integration to determine the center of gravity and centroid for a body of arbitrary shape. **(PO-1)**
- 9.3 Use the method of composite bodies to determine the center of gravity and centroid for a body of arbitrary shape. **(PO-1)**
- 9.4 Determine the area and volume of a surface of revolution using the theorems of Pappus and Guldinus. **(PO-1)**

10. Moments of Inertia

- 10.1 Use integration to determine the area moment of inertia for a cross section of arbitrary shape. **(PO-1)**
- 10.2 Determine the area moment of inertia about non-centroidal axes using the parallel axis theorem. **(PO-1)**
- 10.3 Use the method of composite bodies to determine the area moment of inertia for a cross section of arbitrary shape. **(PO-1)**
- 10.4 Use integration to determine the mass moment of inertia for a body of arbitrary shape. **(PO-1)**
- 10.5 Use the method of composite bodies to determine the mass moment of inertia for a body of arbitrary shape. **(PO-1)**