# 2006-2372: A MULTI-DISCIPLINARY MODELING COURSE AS A FOUNDATION FOR STUDY OF AN ENGINEERING DISCIPLINE

**Jean Nocito-Gobel, University of New Haven**

Jean Nocito-Gobel, an Assistant Professor of Civil & Environmental Engineering at the University of New Haven, received her Ph.D. from the University of Massachusetts, Amherst. She is currently serving as the Coordinator for the First Year Program. Her professional interests include modeling the transport and fate of contaminants in groundwater and surface water systems, as well as engineering education reform.

**Michael Collura, University of New Haven**

**Samuel Daniels, University of New Haven**

SAMUEL BOGAN DANIELS Samuel Bogan Daniels, Associate Professor of Mechanical Engineering, University of New Haven, received his Ph.D. in Mechanical Engineering from Boston University and has a P.E license in CT. He is currently the freshman advisor for Mechanical Engineering, ASME & SAE Faculty Advisor, PLTW UNH Affiliate Professor, and has interests in solid modeling, electric vehicles and composites.

# A Multidisciplinary Modeling Course as a Foundation for Study of an Engineering Discipline

A new sequence of first and second year courses has been established at our university to develop a strong foundation for programs in various engineering disciplines. The ***Multi-Disciplinary Engineering Foundation Spiral*** is a four-semester sequence of engineering courses, matched closely with the development of students' mathematical sophistication and analytical capabilities and integrated with course work in the sciences. Students develop a conceptual understanding of engineering basics in this series of courses which stress practical applications of these principles. In the first semester of the sophomore year all engineering students take the course Introduction to Modeling of Engineering Systems (EAS211). For students in some majors, such as Electrical Engineering and Computer Engineering, this is the last required engineering course outside of their major area of study. For other majors, such as Chemical, Civil and Mechanical Engineering, this course will provide a foundation for more advanced study in disciplinary courses.

EAS211 introduces students to the modeling of simple engineering systems in different fields using the balance principle and empirical laws. The course presents the modeling process to solve problems that concern conservation of mass, charge, linear and angular momentum and energy, introducing such concepts as Kirchoff's current and voltage laws, linear momentum in fluids, applications of the energy equation in thermodynamics, heat transfer and fluid flow problems. In addition to the use of conservation or balance principles, several other common themes provide a unifying construct for the varied topics. These include the development of an organized approach to solving problems, the use of common computer tools, such as spreadsheets and appreciating the complexity of concepts that converge in realistic problems.

Upon completion of the course, students should be able to:

- Apply the balance principle in the solution of simple engineering problems.
- Develop models by applying the balance principle and selecting the appropriate empirical relationships.
- Understand and apply the modeling process
- Model problems involving mass conservation.
- Model resistive circuits using a variety of analysis techniques.
- Model linear momentum problems, such as those involving forces on surfaces.
- Model the flow of fluids in simple situations using the energy balance and empirical relationships.
- Model problems involving a change in thermodynamic state properties using the first law of thermodynamics.
- Model one dimensional steady state heat conduction problems.

In a traditional engineering program, students generally learn an organized approach to problem-solving in a sophomore level introductory course in a specific subject area, such as a first course in statics, electric circuits or material balances. The pace and approach in such a course is dictated more by the need for students to develop a set of problem-solving skills than by the complexity of the subject matter. Development of such skills is slowed down by conceptual roadblocks which are common among students from different disciplines. For example, students resist the discipline of drawing a diagrammatic representation of a problem, an essential step for organizing information and internalizing the problem. Similarly, students have great difficulty defining symbols to represent unknown variables and treating these symbols as they would the numbers they represent. We believe that such difficulties are common across most engineering disciplines. In this course we will investigate the idea that curricular efficiency may be increased by helping students develop these skills in a common course which includes introductory concepts drawn from many areas. In addition, students will gain a broader multidisciplinary background through exposure to the variety of topics. For some, it will be the only exposure to several of the areas included, but may serve as sufficient background to work with professionals outside of their discipline.

This paper will report on the experience of teaching this course for the first time. Two sections were team-taught in the Fall 2005 semester by faculty members from civil/environmental engineering and chemical engineering. The paper will report on student achievement, student perceptions, faculty observations and the processes involved in teaching the course. Data from follow-up courses will be presented in an attempt to assess how well students achieved the course outcomes.

## Introduction

It is the contention of the authors that the pace of a first course in engineering analysis (Statics, Electric Circuits, Material Balances, etc.) is dictated less by the mastery of engineering concepts and more by mastery of skills needed for engineering problem-solving. In large part, the skills required in fundamental courses from different engineering disciplines are very similar, including the following activities:

- development of a diagram to represent the problem situation
- transfer of quantitative information from the problem statement to the diagram
- definition of symbols to represent unknown quantities
- development and/or selection of appropriate relationships
- obtaining needed data not directly given in the problem statement
- conversion of input data to assure unit consistency
- recognizing assumptions implicit in data and relationships
- solution of equations to find values for unknown quantities
- estimation of solution range - minimum, maximum, order of magnitude
- interpretation of results, including sign and value, for reasonableness
- presentation of result in appropriate form, including number of significant figures

Within this list are several items which present roadblocks along the path to problem-solving proficiency. Consider the development of a diagram. When presented with a problem, the typical early-sophomore-level student will immediately begin performing detailed calculations, such as converting units, without first assessing the information given to formulate a problem statement or a solution strategy. Drawing a diagram, if done at all, is often an after-thought, provided for the sake of the instructor. This critical first step, universally taken by seasoned engineers to understand a problem, is considered a waste of time by this student, in his hurry to get a numerical answer, no matter how absurd the calculation may turn out. Clearly, this first hurdle to problem-solving requires more attitude adjustment than learning of facts and methods. Perhaps it is only through repeated experience that students come to appreciate the merit of this activity and adopt it as a core component of their problem-solving methodology.

Another significant roadblock is the need to treat symbols (representation of unknown numerical values) the same way, mathematically, as numbers are treated. The difficulty with this particular activity is less a matter of attitude than diagrams and more a matter of developing confidence. Again, however, to move this activity to the level of a core component of problem-solving requires significant repetition in various contexts so as to avoid the pattern-matching behavior which has served students well in early math and science courses.

Undoubtedly each reader will interpret this discussion from the perspective of his or her own discipline, fondly recalling experiences in those first disciplinary courses. Despite differences in the concepts being studied, analysis of currents in a resistive circuit network or the composition of a stream leaving a reactor, the skills that must be developed to become adept at solving engineering problems are the same.

In EAS211, Introduction to Modeling of Engineering Systems, students are introduced to concepts that would traditionally be found in the early part of courses in Material Balances, Electric Circuits, Statics, Thermodynamics and Fluid Mechanics. The underlying philosophy of the course is to stress the application of fundamental principles rather than to teach efficient methods of solution for a given class of problems. For example, in analyzing circuit problems, solutions were developed using Kirchoff's Current and Voltage laws (based on conservation of charge) and Ohm's law. For circuits with several branches, this approach leads to sets of simultaneous linear algebraic equations, generally solvable with matrix methods on a spreadsheet, whereas the use of mesh analysis, as typically taught in a first circuits course, provides a more efficient approach.

**Curricular Context - The UNH Multidisciplinary Engineering Foundation Spiral**

To operate effectively in today's workforce engineers need to have a mutidisciplinary perspective along with substantial disciplinary depth. This broad perspective cannot be achieved by merely taking two or three engineering courses outside of the major, but rather will require a significant change in the way we educate engineers. The faculty of the Tagliatela School of Engineering at the University of New Haven developed the ***Multidisciplinary Engineering Foundation Spiral*** to develop breadth and depth, while also building the desired professional skills, by providing carefully crafted, well-coordinated curricular experiences in the first two years.

The ***Multidisciplinary Engineering Foundation Spiral*** is a sequence of courses for all engineering students which begins in the first semester and extends through the sophomore year. Courses in the spiral are matched closely with the development of students' mathematical sophistication and analytical capabilities and integrated with coursework in the sciences, math and English. Figure 1 provides a graphical depiction of the location of the courses (EAS prefix)

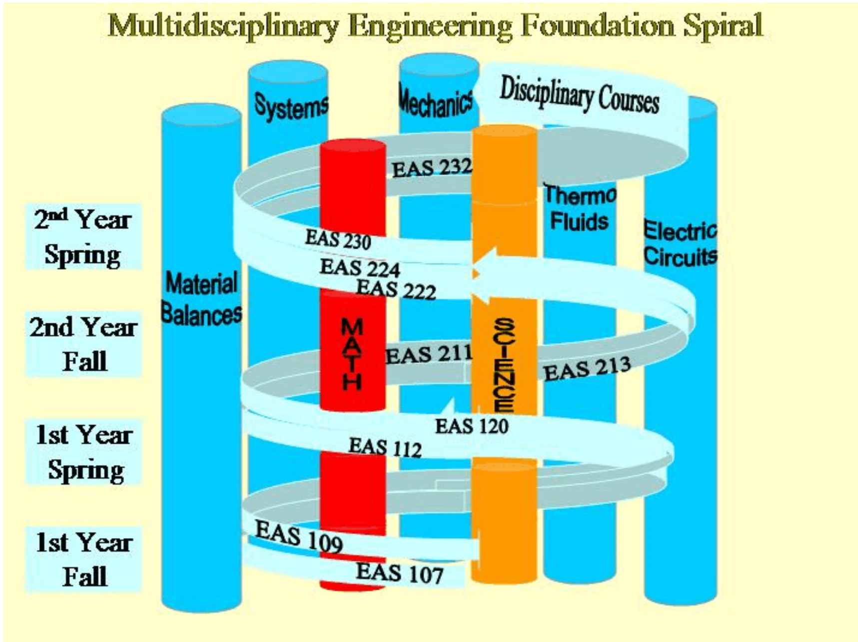



**Figure 1**

in the spiral. Ten courses were developed as part of the spiral Spiral curriculum. The specific courses required in each engineering major varies from a minimum of 5 to a maximum of 10, with most programs including 9. Course titles and program requirements are summarized in Table 1.

**Table 1 - Foundation Courses in UNH Engineering Programs**

| Course | Engineering Program –> | ChE | CE | CP | EE | IE | ME | GE |
|---|---|---|---|---|---|---|---|---|
| EAS107P | Introduction to Engineering (Project-based) | R | R | R | R | R | R | R |
| EAS109 | Project Planning and Development | R | R | N | R | R | R | R |
| EAS112 | Methods of Engineering Analysis | R | R | R | R | R | R | R |
| EAS120 | Chemistry with Applications to BioSystems | R | R | N | N | E | E | R |
| EAS211 | Intro. to Modeling of Engineering Systems | R | R | R | R | R | R | R |
| EAS213 | Materials in Engineering Systems | R | R | N | N | R | R | R |
| EAS222 | Fundamentals of Mechanics & Materials | E | R | N | N | R | R | R |
| EAS224 | Fluid-Thermal Systems | R | R | N | N | N | R | R |
| EAS230 | Fundamentals & Applications of Analog Devices | R | N | R | R | R | R | R |
| EAS232 | Project Management & Engineering Economics | R | R | R | R | R | R | R |
| Legend | R-required, E-elective, N-not used | | | | | | | |
| | **Engineering Disciplines:** ChE - Chemical, CE - Civil, CP - Computer, EE - Electrical, IE - Industrial, ME - Mechanical, GE - General | | | | | | | |

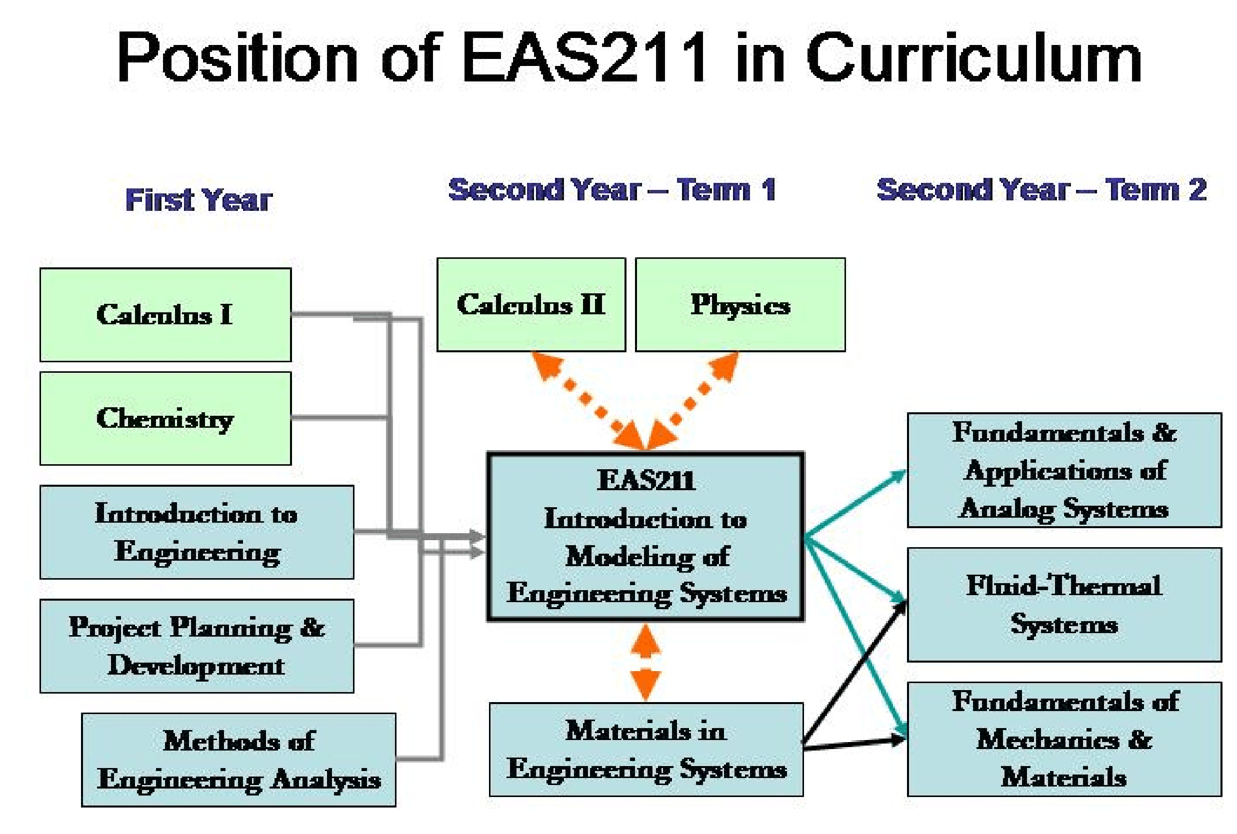
Students develop a conceptual understanding of engineering basics in a series of courses which stress practical applications of these principles. Topics in these courses include electrical circuits, fluid mechanics, heat transfer, material balances, properties of materials, structural mechanics and thermodynamics. Unlike the traditional approach, however, each of the foundation courses includes a mix of these topics, presented in a variety of disciplinary contexts. A solid background is developed by touching key concepts at several points along the spiral in different courses, adding depth and sophistication at each pass. Each foundation course also stresses the development of several essential professional skills, such as problem-solving, oral and written communication, the design process, teamwork, project management, computer analysis methods, laboratory investigation, data analysis and model development. Students go on to build substantial depth in some of the foundation areas, while other topics may not be further developed, depending on their chosen discipline. Thus the foundation courses serve both as the basis for depth in disciplinary study and as part of the broad multidisciplinary background.

During a three year period, a team of faculty at the University of New Haven has developed the ***Multidisciplinary Engineering Foundation Spiral*** curriculum concept, including a set of ten new courses. Several of the first year courses were run in pilot form in the 2003-2004 academic year. The new curriculum has been fully adopted by programs in Chemical, Civil, Mechanical and General Engineering, effective for all freshmen entering in the fall of 2004. A significant component was selected for the Electrical Engineering program and several courses are included in the Computer Engineering and the Information Technology programs. The ten courses and all program changes have been approved by departmental faculty, school and university committees and the university administration. Early results were reported at the American Society of Engineering Education Annual Meetings in June 2004[1,2,3,4,5] and 2005 [6,7]. An NSF planning grant[8], along with over half a million dollars of private gifts (specifically for multidisciplinary curricular development) have been instrumental in development efforts to date.

Many of the curricular elements in our new model come from the pioneering work of the NSF Engineering Coalitions, such as use of active and cooperative learning strategies and the integration of math and science with engineering foundation courses. Novel elements include the explicit development of professional skills in a coordinated fashion across several courses and clear definition of the engineering topical development using a spiral curricular model. Another important element is the clear definition of the interface between foundation courses and discipline courses which build upon them. All the foundation courses will be taught by faculty who also teach upper-level courses in the disciplines, providing an active link between courses at both levels. All foundation courses use contemporary teaching techniques, such as active/cooperative learning, case studies and hands-on projects. Planning classroom activities for these courses requires more explicit consideration of learning objectives and methods for assessing these objectives. We expect that these methods and the associated planning will spill into the upper-level courses as a consequence of their use in the foundation courses.

Introduction to Modeling of Engineering Systems, EAS211, is intended to be taken in the first semester of the sophomore year, concurrent with Physics (Mechanics, Heat and Waves) and Calculus III (or Calculus II as a minimum). Connections to Chemistry (taken earlier), physics and math are reinforced by the EAS211 instructors. Engineering faculty worked with faculty from Physics in the development of EAS211 to set the sequence of topics in EAS211 such that many of the concepts covered in Physics are used, within days or weeks in engineering problems encountered in EAS211. Figure 2 summarizes the relationship of EAS211 to other courses.

**Figure 2**




**COURSE DESCRIPTION**

The initial offering of EAS211 during Fall 2005 consisted of two sections, with enrollments of 14 students and 11 students. A team-teaching approach was used in which the course materials (including lectures, in-class exercises, homework, quizzes/exams) were jointly developed by the two instructors who taught the course. Often both instructors were present during class, contributing to discussions and assisting students with in-class problem exercises. This ensured that students had similar experiences regardless of the section they attended. It also allowed for students to easily make-up missed classes. Although one instructor was responsible for each section, students seemed comfortable seeking help from either one, regardless of which section they attended.

The three credit-hour course met twice a week for 2 hours. The additional hour allowed for the course to be taught using an active learning style that relied on student participation during mini-lectures and problem solving exercises. Concepts were discussed in the context of practical engineering applications. Typically each class period consisted of a brief lecture to introduce concepts, followed by in-class problem exercises. Students worked along with the instructor to solve problems using computer tools such as Excel. This helped students to develop their skills and begin to gain confidence in solving engineering problems.

An overall objective of EAS211 is for students to develop the ability to apply the modeling process in the solution of common problems from a variety of engineering disciplines. The underlying principle common to these problems is the conservation laws. Thus an emphasis in EAS211 on application of the conservation laws allowed for transition from topics in a particular engineering discipline to another.

In addition to developing students' problem solving skills, another objective of this course is to introduce and provide grounding in fundamental concepts from a variety of fields. The course is structured around five foundation areas: mass balances, electrical circuits, statics, fluids and energy balances (thermodynamics). For some students, this may be the only course they will take in a particular foundation area; e.g. circuits. However, for others the knowledge gained in EAS211 will allow for the development of depth in specific foundation areas in subsequent courses.

With an emphasis on the development of students' problem solving skills, the first week of the course focuses on the steps in the modeling process: problem definition, specifying assumptions, developing and/or choosing equations, solution of the equations, interpreting results and iterating if necessary. For many students, formulating the problem presents the most difficulty for them. Thus, the steps needed to properly define the problem were emphasized including developing a properly labeled diagram with units, and identifying the known quantities along with variables for unknowns. Discussions highlight the importance of using an organized approach in order to properly formulate the problem. The remainder of the course allowed students to gain experience applying the modeling approach to solve a variety of engineering problems and to further develop their problem solving skills.

Problems and concepts related to each of the foundation areas are discussed for a 2-3 week period. Some of the topics discussed in a particular foundation area are first introduced to students in the Freshman Engineering courses while others are new. EAS211 builds on students' understanding of these concepts, but is not meant to provide a complete understanding that a student would gain from a disciplinary specific course. Common to all foundation areas are the use of conservation laws and constitutive relationships to represent the physical behavior of a engineering system. Summarized in Table 2 are some of the common features associated with the foundation areas. The following section highlights the breadth of topics discussed in each foundation area.

Conservation of mass was the underlying principle for discussions on mass balances. Students were first introduced to simple balances with no reactions for single component systems and then multi-component systems. Both steady-state and transient problems were solved involving balances on total mass in the system as well as species balances. Problems involving simple first-order reactions were solved using total mass and/or atom balances. Fuel cells and batteries were used to discuss electrochemical reactions, problems that use both mass and charge balances. Electrochemistry was used to transition to the next foundation area discussed, namely electrical circuits.

Students solved a variety of simple resistive D.C. circuits through application of Kirchoff's laws. Problems involving independent and dependent sources, both voltage and current sources, were discussed, before introducing students to source transformations using Norton and Thevenin equivalents. Students solved simple RC circuits, involving both charge and discharge capacitors.

The underlying principles in the statics module were conservation of linear and angular momentum as applied to particles and rigid bodies. Students gained further experience in resolving forces into components (rectangular coordinates) as they solved both problems involving trusses and frames. Topics discussed include determination of compressive and tensile forces in trusses, and analyzing structures when point and distributed loads are applied. Distributed loads were the transitional topic to the module on fluids.

**Table 2 - Common Features Across Engineering Fundamental Areas**

| **Fundamental Area** | **Conservation Laws** | **Diagram** | **Constitutive Laws/Empirical Relationships** | **1st Order Transient Example** |
|---|---|---|---|---|
| Mass Balances | Applied to Total Mass, components and atoms | Process Flow Diagram | Ideal Gas, flow relationships | Level in a tank |
| Electrical Circuits | Kirchoff's Voltage Law (KVL), Kirchoff's Current Law (KCL) | Circuit Schematic | Ohm's Law, Power Equation | Flash charge & discharge |
| Statics | Linear and Angular Momentum | Free Body Diagram | Newton's 2$^{nd}$ Law | Reaching terminal velocity |
| Fluids | Linear and Angular Momentum | Process Flow or Free Body Diagram | Drag Force | |
| Energy Balance | | Free Body or process flow Diagram | Heat Capacity | Total Energy of System |

The foundation area on fluids included both problems related to fluid statics and moving fluids. Discussions initially focused on static fluids, particularly determination of the equivalent pressure force acting on a submerged surface. Students solved various pressure distribution problems, including those involving different fluids (water and air). Determination of buoyant force was discussed and allowed for transition to moving fluids, specifically problems related to the terminal settling velocity of particles.

The final foundation area focused on problems related to the conservation of energy in the system. The general energy balance was introduced and used to solve problems related to the work performed by or on a system. Problems included work done by a car engine to accelerate and decelerate a vehicle (closed system). Bernouilli and the mechanical energy equations were developed as simplifications to the general energy equation and applied to various fluid problems involving turbines and pumps. Students gained some experience using steam tables to solve thermodynamic problems

**Course Assessment**

The outcomes for this course are as follows:

1. Apply the balance principle in the solution of simple engineering problems.
2. Develop models by applying the balance principle and selecting the appropriate empirical relationships.
3. Understand and apply the modeling process.
4. Model problems involving mass conservation.
5. Model resistive circuits using a variety of analysis techniques.
6. Model linear momentum problems, such as those involving forces on surfaces.
7. Model the flow of fluids in simple situations using the energy balance and empirical relationships.
8. Model problems involving a change in thermodynamic state properties using the first law of thermodynamics.
9. Model one dimensional steady state heat conduction problems.

The assessment plan is summarized in Table 3.

**Table 3 - Assessment Plan for EAS211**

| Metric | Outcomes | Comment |
|---|---|---|
| Student Course Evaluation | Student assessment of value of course in addressing 1 - 9 | Standard Evaluation form used in all courses in school |
| Post Course Student Survey | Self-assessment of student meeting Course Outcomes | Form developed for this course, sent to students via email |
| Student Performance Indices - from EAS211 | Improvement in Problem-Solving Ability | Index based on comparison of performance on test problems early in semester to end |
| Student Performance Indices - from subsequent courses | Outcomes 4 - 9 | Feedback from instructors in subsequent courses |

The standard evaluation form used for all courses in the (Insert name of school in final paper) includes a section in which students are asked to assess the value of the course in helping them meet the stated outcomes. An attempt is made in the instructions for this section to make it clear that students are to evaluate the potential of the course and the way it was conducted rather than their own performance. This section lists the specific outcomes for each course and thus is distinct for every course. In addition, several other questions from the generic sections may be relevant as well.

Some results are summarized below for each of the two sections:

| **Table 4 - Selected Questions from Student Evaluation of Course** | | | |
|---|---|---|---|
| Section (All refers to EAS courses taken in the previous year) | All | sec1 | sec2 |
| The objectives of the course were clearly outlined. | 4.4 | 4.0 | 4.0 |
| The objectives of the course were fulfilled. | 4.3 | 3.7 | 3.8 |
| The course is/will be helpful to you in your anticipated career. | 4.1 | 3.4 | 3.7 |
| | | | |
| What percentage of the reading/writing assignments did you complete? (5=100%) | 4.3 | 4.3 | 4.2 |
| On average, how many hours per week (outside of class) did you spend on this course? (4=>10) | 1.7 | 2.9 | 2.7 |
| Outcome 1 - Apply the balance principle ..... | | 4.0 | 4.3 |
| Outcome 2 - Develop models ..... | | 3.8 | 4.1 |
| Outcome 3 - Understand and apply the modeling process | | 3.8 | 4.6 |
| Outcome 4 - Model problems involving mass conservation .... | | 3.8 | 4.2 |
| Outcome 5 - Model resistive circuits | | 3.6 | 3.7 |
| Outcome 6 - Model linear momentum problems ... | | 3.6 | 4.1 |
| Outcome 7 - Model the flow of fluids ... | | 3.2 | 4.1 |
| Outcome 8 - Model problems involving thermodynamic ... | | 3.0 | 3.6 |
| Outcome 9 - Model heat transfer ... | | 2.8 | 3.7 |
| Average for All Course Objectives | 4.3 | 3.7 | 4.2 |

The column labeled “All” in the table above shows average data for first year EAS courses taken by students in this group. By most measures, EAS211 was rated about 10% lower than other courses. The amount of work outside class reported by the students is considerably higher for EAS211 than for the other courses. However, the comparison is to first year courses that involve significant in-class project work, so the nature of the courses makes the comparison difficult to interpret. In general the lower rating is probably an accurate reflection of the student's opinions. They found the course challenging and were not accustomed to seeing the variety of topics in a single course that they found in EAS211. It was also the first heavy dose of engineering mathematics for most of the students. Finally, as it was the first time offered, there were many opportunities for improvement.

A post course survey was sent to students who completed the class asking for their input on several items:

to directly assess their own performance on the course outcomes
to assess the integration of EASA211 with other courses, including Math, Physics
to express opinions on the importance of key steps in solving problems
(development of a sketch, including units and defining symbols for unknowns)
to express opinions on the degree to which this course changed their approach to problems

Post surveys were completed by 60% of the students in the course. Details of the results are included in the appendix. Results indicate that students saw a strong relationship between EAS211 and Physics, with EAS further developing their understanding of topics covered in Physics. A similar relationship was seen to one of the previously taken EAS courses (EAS112 Methods of Engineering Analysis). Strong relationships were not seen to math or to other EAS courses. Only a few students reported that the overlap of material caused confusion with topics in Physics.

Students were asked to rate the importance of the following problem-solving steps:

Developing a sketch or diagram of the situation
Including units for all constants and variables
Defining symbols to represent unknowns

The vast majority rated each of these as "critical" or "very important". A majority of students also reported that their approach to problem-solving changed significantly and that they used a more organized approach.

In rating their understanding of the various engineering areas, the electrical area stood out as having the lowest improvement in understanding. The other areas of material balances, structural mechanics, fluid statics and thermodynamics were rated as improved by about the same number of students.

Student performance indices were created to measure student progress over the semester in problem-solving and in understanding of some specific engineering areas. The indices were based on student performance on quizzes and on the final exam. One quiz was given on each of the five engineering fundamentals areas. Each quiz had 3 to 5, multi-part problems. The final exam was comprehensive, covering all five areas, with a set of short questions (about half the exam) covering the full range of topics and 4 individual problems in the first fout topics covered: mass balances, electric circuits, statics and fluids.

Each test problem (quiz and final exam) was classified on a 1 to 3 scale as to its level of problem-solving complexity. On the scale, problems in category 1 were primarily focused on concepts and involved relatively little ambiguity in their solution. Problems in category 3 were more open-ended and required more problem-solving skill to complete. The assignment of categories was made by a faculty member other than the course instructors, to provide some objectivity. It turned out that each quiz and the final had at least one category 3 problem. A problem-solving index was then created based on student performance on a specific problem from the first quiz (mass balances) and a specific problem from the final exam, which also dealt with mass balances. The ratio of correctness was calculated for each student for the final exam problem to the quiz problem. It should be noted that these tests were separated by about 2 months time. Values of the index less than 0.8 were interpreted as meaning the student's problem-solving ability got worse, values

**Table 5 - Problem-Solving Index Results**
Performance on a complex problem on final versus performance on a complex problem early

| Index Value | Interpretation | Number of Students |
|---|---|---|
| < 0.8 | Decrease in problem-solving ability | 2 |
| 0.8 < I < 1.2 | No change in problem-solving ability | 7 |
| > 1.2 | Increase in problem-solving ability | 12 |

Since the questions involved were in the same general area, the measurement should indicate either improved understanding of the area and/or improved problem-solving ability. No further work was done on mass balances after the initial quiz was given, so the expectation is that the better performance by a significant number of students is, in fact, due to improved problem-solving skills. If students also gained a better understanding of the topical area, through study of other engineering topics, that too is a positive result.

## SUMMARY & CONCLUSIONS

A new course, EAS211 Introduction to Modeling of Engineering Systems, was introduced in the first semester of the sophomore year. The objective of the course is to introduce students to a variety of topics normally seen in introductory courses in several disciplines and to develop skill in solving engineering problems. Self-assessment data indicate that students gained an understanding of topics in several areas and that they improved their approach to problem-solving. Analysis of results from quizzes confirmed that there was an improvement in problem-solving over the period of the course for about half of the students.

Considerable work remains to be done to further assess and refine the course. Information will be sought from instructors who teach follow-up courses to determine how students who have taken EAS211 compare to students they have seen previously. Student feedback will be used to make adjustments in the operational aspects of the course.

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# EAS211 - Introduction to Modeling in Engineering Systems

## Post Course Student Survey

| | Indicate when you took each course. | Prior to EAS211 | Concurrent with EAS211 | Not Taken |
|---|---|---|---|---|
| 1 | EAS107 or EAS107P | 15 | | |
| 2 | EAS109 | 11 | | 4 |
| 3 | EAS112 | 12 | | 1 |
| 4 | M118 | 4 | 6 | 3 |
| 5 | PH150 | 5 | 7 | 1 |

| | Indicate how EAS211 integrates with these courses (check all that apply) | EAS107 / 107P | EAS109 | EAS112 | Math | Physics |
|---|---|---|---|---|---|---|
| 6 | EAS211 reinforced understanding of material in: | 6 | 3 | 11 | 6 | 10 |
| 7 | EAS211 further developed the material covered in: | 5 | 2 | 10 | 3 | 11 |
| 8 | Significant overlap with material, but not particularly helpful | 2 | | 1 | 3 | |
| 9 | Overlap in material created confusion with coverage in: | 1 | 1 | | 1 | 3 |
| 10 | No significant overlap of material with these courses: | 4 | 7 | 3 | 2 | 2 |

| | Rate the importance of each of the following steps in solving engineering problems: | Critical | Very Useful | Useful | Of Little Use | Of No Use |
|---|---|---|---|---|---|---|
| 11 | Developing a sketch or diagram of the situation | 9 | 5 | 1 | | |
| 12 | Including units for all constants and variables | 8 | 5 | 2 | | |
| 13 | Defining symbols to represent unknowns | 8 | 7 | | | |

| | | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| 14 | My approach to problem-solving has changed significantly as a result of taking EAS211? | 5 | 7 | 1 | 2 | |
| 15 | Work in EAS211 has helped me approach problems in a more organized manner. | 4 | 9 | 2 | | |
| 16 | Most realistic problems require knowledge from several different areas of engineering. | 6 | 9 | | | |
| 17 | My understanding of material balances has been improved by work in EAS 211. | 5 | 8 | 1 | 1 | |
| 18 | My understanding of electric circuits has been improved by work in EAS 211. | 4 | 4 | 7 | | |
| 19 | My understanding of structural mechanics has been improved by work in EAS 211. | 6 | 8 | 1 | | |
| 20 | My understanding of fluid statics has been improved by work in EAS 211. | 7 | 6 | 2 | | |
| 21 | My understanding of thermodynamics/energy balances has been improved by work in EAS 211. | 6 | 7 | 1 | 1 | |

# COURSE/INSTRUCTOR ASSESSMENT
## Tagliatela School of Engineering

COURSE: **EAS211 INTRO TO MODELING IN ENGINEERING SYSTEMS** INSTRUCTOR: MICHAEL COLLURA
SECTION 01
SEMESTER: FALL ______________ YEAR: ____2005________________ CLASS STANDING: FR / SO / JR

**Using the scale below, indicate the extent to which you agree or disagree with each of the following statements. Please use the "Not Applicable" answer only if you feel you do not have enough information to answer the statement accurately.**

**Strongly Agree (SA), Agree (A), Neither Agree nor Disagree (N), Disagree (D), Strongly Disagree (SD), Not Applicable (NA)**

| **Course Evaluation** | SA ↓ | A ↓ | N ↓ | D ↓ | SD ↓ | NA ↓ |
|---|---|---|---|---|---|---|
| 1. The objectives of the course were clearly outlined. | O | O | O | O | O | O |
| 2. The objectives of the course were fulfilled. | O | O | O | O | O | O |
| 3. The course is/will be helpful to you in your anticipated career. | O | O | O | O | O | O |
| 4. The course met as scheduled. | O | O | O | O | O | O |
| 5. The text book/reference materials were useful for this course. | O | O | O | O | O | O |
| 6. Outside assignments were relevant to the subject material. | O | O | O | O | O | O |
| 7. Exams were related to the subject material (lectures, readings, etc.). | O | O | O | O | O | O |
| 8. Teamwork played an important role in assignments/projects. | O | O | O | O | O | O |

| **Instructor Evaluation** | SA ↓ | A ↓ | N ↓ | D ↓ | SD ↓ | NA ↓ |
|---|---|---|---|---|---|---|
| 9. Instructor presented material in an organized fashion. | O | O | O | O | O | O |
| 10. Course policies (attendance, grading scales, etc.) were sufficiently outlined. | O | O | O | O | O | O |
| 11. Student performance was evaluated fairly. | O | O | O | O | O | O |
| 12. Assignments and exams were returned promptly. | O | O | O | O | O | O |
| 13. Instructor was well prepared for class. | O | O | O | O | O | O |
| 14. Instructor encouraged student participation. | O | O | O | O | O | O |
| 15. Out-of-class assistance was available. | O | O | O | O | O | O |
| 16. Lectures were informative and interesting. | O | O | O | O | O | O |
| 17. Instructor was responsive to student questions and concerns. | O | O | O | O | O | O |

| **For Lab Courses Only:** | SA ↓ | A ↓ | N ↓ | D ↓ | SD ↓ | NA ↓ |
|---|---|---|---|---|---|---|
| 18. Lab or computer facilities were adequate. | O | O | O | O | O | O |
| 19. Lab equipment functioned properly. | O | O | O | O | O | O |
| 20. The lab assignments helped me to understand the course material. | O | O | O | O | O | O |
| 21. Safety practices were presented and followed by the instructor and students. | O | O | O | O | O | O |

# COURSE/INSTRUCTOR ASSESSMENT

## Tagliatela School of Engineering

### EAS211 INTRO TO MODELING IN ENGINEERING SYSTEMS

22. What grade do you expect to receive in this course?

| | |
|---|---|
| O | A |
| O | B |
| O | C |
| O | D |
| O | F |

23. What percentage of the reading/writing assignments did you complete?

| | |
|---|---|
| O | 100% |
| O | 75-99% |
| O | 50-74% |
| O | 25-49% |
| O | Less than 25% |

24. On average, how many hours per week (outside of class) did you spend on this course?

| | |
|---|---|
| O | 3 or less |
| O | 4-6 |
| O | 7 to 9 |
| O | 10+ |

25. What is your cumulative GPA?

| | |
|---|---|
| O | 4.0 – 4.3 |
| O | 3.0 – 3.99 |
| O | 2.0 – 2.99 |
| O | 1.0 – 1.99 |
| O | Below 1.0 |

26. What did you like most about this course and/or instructor?

27. List any suggestions for improvement for this course and/or instructor.

28. Additional comments about the course and/or instructor:

# COURSE OUTCOMES ASSESSMENT

## Tagliatela School of Engineering

### EAS211 INTRO TO MODELING IN ENGINEERING SYSTEMS

## Course Objectives:

1) *Introduce students to a set of equations used to represent the physical behavior of engineering systems, including the balance principal and empirical relationships.*
2) *Develop the ability to apply the modeling process in the solution of common problems from a variety of engineering disciplines.*
3) *Provide a grounding in fundamental principles from a variety of fields to allow for the development of depth in some areas in later courses.*

## Course Outcomes:

In order to satisfy these course objectives, the course content and the manner in which course material was presented should have given you the opportunity to demonstrate specific outcomes or abilities and apply them to the solution of complex engineering problems. You are asked to **rate the course, not your own performance,** in addressing these objectives as demonstrated by the listed outcomes.

| **Course Assessment:** **Rate the usefulness of this course in helping students achieve the following:** | Very High ↓ | High ↓ | Moderate ↓ | Low ↓ | Very Low ↓ | NA ↓ |
|---|---|---|---|---|---|---|
| 1. *Apply the balance principle in the solution of simple engineering problems.* | o | o | o | o | o | o |
| 2. *Develop models by applying the balance principle and selecting the appropriate empirical relationships.* | o | o | o | o | o | o |
| 3. *Understand and apply the modeling process.* | o | o | o | o | o | o |
| 4. *Model problems involving mass conservation.* | o | o | o | o | o | o |
| 5. *Model resistive circuits using a variety of analysis techniques.* | o | o | o | o | o | o |
| 6. *Model linear momentum problems, such as those involving forces on surfaces.* | o | o | o | o | o | o |
| 7. *Model the flow of fluids in simple situations using the energy balance and empirical relationships.* | o | o | o | o | o | o |
| 8. *Model problems involving a change in thermodynamic state properties using the first law of thermodynamics.* | o | o | o | o | o | o |
| 9. *Model one dimensional steady state heat conduction problems.* | o | o | o | o | o | o |

10. How could this course be changed to better meet the stated objectives?