The First Year Engineering Program at the University of Southern Indiana

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Abstract -

In 2002 the University of Southern Indiana started a new engineering program leading to a Bachelor of Science degree in Engineering. Three freshman engineering courses have been developed to allow incoming students immediate contact with both the engineering program and faculty. Students take Engineering Seminar during their first semester. The seminar is designed to expose students to engineering as a career, the various engineering specialties and details about the curriculum. The students also get to meet the faculty both during weekly presentations and during the annual Engineering Picnic. The two other freshmen courses, Introduction to Engineering and Introduction to Design, are offered during the students' first and second semesters, respectively. Introduction to Engineering introduces students to a systematic, engineering problem solving method. Problems have been selected to preview many of the engineering courses that the students will take as sophomores, including statics and circuits. Additionally students learn computer applications including EXCEL, MATLAB and VISUAL BASIC. Finally, Introduction to Design, taken during their second semester, consists of mechanical, civil, and electrical design projects. Simultaneously, the students learn graphics and CAD, and develop skills in engineering communications, including technical writing and oral presentations.

Keywords: engineering. freshmen, introductory, first-year, design

INTRODUCTION

The University of Southern Indiana (USI) has administered a successful, accredited program in Engineering Technology since 1979. By the start of the 21st century, however, the need for a regional, public engineering program strongly emerged; so in 2002, the University of Southern Indiana started a new engineering program that culminates in a Bachelor of Science degree in Engineering. Designing this new curriculum gave faculty and administrators very unique opportunities. This paper will focus on the details and characteristics of the first-year curriculum.

It is well known that many times students are encouraged to enter engineering because they are "good at math and science" in high school; however, they may know very little about engineering as a career [Moll, 5]. Furthermore, college freshman students not only have to decide if they want to be an engineer, but by their sophomore year must decide which engineering discipline they want to pursue. It is not uncommon for students select their engineering discipline based on decisions such as nominal salary differences or gossip regarding the relative difficulty of each program. Luckily these poor decision practices have been identified and engineering programs now create

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opportunities for students to explore various engineering disciplines through introductory freshmen classes [Cone, 2].

USI offers a Bachelors of Science degree in Engineering with three possible emphases: civil, electrical and mechanical. Two programs are offered in the engineering curriculum, depending upon the student's entry math level. The '*four-year engineering program*', shown in Figure 1 is designed for students who enter the program ready to take differential calculus, MATH 230. Students that are at the pre-calculus level, enrolled in college-level algebra and trigonometry, MATH 118, are offered a '*five-year engineering program*'. The first two years of these programs are available for comparison in Figure 2. Additional details about the five-year program are offered by R. Ruhala [6]. Students that enter USI to become engineers but are not ready for college-level mathematics are referred to as "pre-engineering" students, and must pass intermediate algebra before they are eligible for the five-year program. Unfortunately it is highly unusual that pre-engineers are able to successfully complete the engineering curriculum [Jacquez, 3]. Note that all math classes mentioned require a C to proceed.

The USI Bachelor of Science degree in Engineering offers the graduates a breadth of knowledge, while still mandating the depth of knowledge consistent with an engineering degree. The students select their emphasis during their second year in the four-year program. USI offers emphases in civil, electrical or mechanical engineering through the engineering electives courses shown in Figure 1. As an example of the breadth of the program, students with an emphasis in electrical engineering must take a fluid mechanics class, while civil engineers take a class in circuits. Input from our Engineering Advisory Board, consisting of engineers from regional companies, indicates that the employers of our graduates value this breadth of knowledge in the employees that they hire with bachelor's degrees.

CURRICULUM for BACHELOR of SCIENCE IN ENGINEERING DEGREE

ENGINEERING, MATH & PHYSICS COURSES

Four-Year Program

	Fall		Spring
	First Year		
ENGR 101	*ENGINEERING ORIENTATION*	ENGR 108	*INTRODUCTION to DESIGN*
ENGR 107	*INTRODUCTION to ENGINEERING*	MATH 330	CALCULUS II
		PHYS 205	INTERMEDIATE PHYSICS I
MATH 230	CALCULUS I		
	Second Year		
ENGR 225	THERMODYNAMICS	ENGR 225	ELECTRICAL CIRCUITS
ENGR 225	STATICS	ENGR 275	DYNAMICS
MATH 335	CALCULUS III	MATH 433	DIFFERENTIAL EQUATIONS
PHYS 206	INTERMEDIATE PHYSICS II		
	Third Year		
ENGR 335	STRENGTH of MATERIALS	ENGR 335	ENGINEERING ECONOMICS
	3 - ENGR ELECTIVES	ENGR 375	FLUID MECHANICS
			2 - ENGR ELECTIVES
	Fourth Year		
ENGR 435	ENGINEERING STATISTICS	ENGR 491	SENIOR DESIGN
	2 - ENGR ELECTIVES		3 - ENGR ELECTIVES

Figure 1: Engineering & Science Curriculum - Four-Year Program

CURRICULUM for BACHELOR of SCIENCE IN ENGINEERING DEGREE

ENGINEERING, MATH & PHYSICS COURSES

First Two Years: Five-Year Program

First Year			
	Fall		Spring
ENGR 101	*ENGINEERING ORIENTATION*	ENGR 104	*APPLIED PROBLEM SOLVING*
ENGR 103	*PRINCIPLES of PROBLEM SOLVING*	MATH 230	CALCULUS I
MATH 118	COLLEGE ALGEBRA & TRIGONOMETRY		
PHYS 101	INTRODUCTION to the PHYSICAL SCIENCES		
Second Year			
	Fall		Spring
ENGR 107	*INTRODUCTION to ENGINEERING*	*ENGR 108*	*INTRODUCTION to DESIGN*
MATH 330	CALCULUS II	MATH 335	CALCULUS III
PHYS 205	INTERMEDIATE PHYSICS I	PHYS 206	INTERMEDIATE PHYSICS II

Figure 2: Engineering & Science Curriculum - Five-Year Program

While developing the curriculum, five freshmen engineering courses were specifically designed to bring students into immediate contact with both the engineering faculty and student peers [Catalano, 1]. Two courses were designed exclusively for students on the five-year plan. These are ENGR 103 Principles of Problem Solving and ENGR 104 Applied Problem Solving. Detailed information about these two classes can be found in [Ruhala, 6].

Three courses were designed for all students; they are ENGR 101, Engineering Orientation, ENGR 107, Introduction to Engineering, and ENGR 108, Introduction to Design. These courses are taken by both incoming four-year students and five-year students that have passed ENGR 103 and 104.

OVERVIEW OF THE FIRST YEAR: COURSE DESCRIPTIONS AND LEARNING OBJECTIVES

The five freshman courses that were added to the curriculum are shown, italicized, in both Figure 1 and Figure 2. ENGR 103, 104, 107 and 108 are typically offered each semester and occasionally during the summer, depending upon need. The orientation class, ENGR 101, however, is only offered during the fall semester. Note that grades of C or above are required to proceed in the sequence. This paper will discuss the three classes that students in the 4-year program take their first year: ENGR 101, 107 and 108.

Engineering 101, Engineering Seminar

Engineering Seminar is a weekly colloquium with the primary goal of exposing first-semester engineering students to the various fields of engineering. The class is intended to illustrate what engineers do, how they do it, and why. With this information, students can make an informed decision when selecting their engineering major, or even deciding whether engineering is the field that they want to enter. The course is comprised of discussions about the major engineering disciplines, engineering ethics, professionalism, and life-long learning. Guest lecturers routinely join the class to discuss relevant topics.

The course schedule has been designed to allow time to introduce freshmen to upperclassmen; this is ensured by combining the annual engineering picnic with ENGR 101. Also, three class sessions are reserved for student clubs. During the first “student club” day, members from each club give presentations to illustrate their various activities

such as the BAJA car, concrete canoe and robot for SAE, ASCE and IEEE clubs, respectively. The ENGR 101 class, with mandatory student attendance, breaks into professional clubs twice again, in the middle and end of the semester. Note that by allowing three class sessions for student clubs the students are exposed to all of the clubs and then able to twice attend club meetings of either the same or different clubs.

The course learning objectives are evaluated annually, and most recently have included:

1. Gain an understanding of professional responsibility and workplace ethics.
2. Gain and understanding of the impact of engineering solutions in society.
3. Recognize the need for life-long learning.
4. Gain an awareness and knowledge of contemporary problems in industry.
5. Recognize the role of student clubs in the role of an engineering student at USI.
6. Learn about the civil, electrical and mechanical engineering professions.
7. Recognize the importance of professional registration in the engineering profession.
8. Recognize the role of the Engineering Department in providing modern tools, equipment and technology to enhance the student's experience at USI.

Engineering 107, Introduction to Engineering

Introduction to Engineering meets for three hours, twice per week, and students must be co-registered in at least differential calculus. This course is the first in a sequence that introduces students to engineering and design. Combined, Introduction to Engineering and Design (ENGR 107 and 108) teach structured problem solving methods by previewing core engineering topics and involve student in team-oriented, hands-on, reverse and forward design projects, using modern computer programs such as AutoCAD, Solid Works, MATLAB, Excel and Visual Basic. Similar to the State University of New York at Binghamton, academic survival skills such as time-management, class preparation and test preparation skills are also emphasized [Catalano, 1].

One of the primary objectives of Introduction to Engineering is for the students to learn a rigorous problem solving method that they can use on virtually any problem. The problem solving method includes using engineering paper, evaluating the problem statement to extract both the information that is given and what they need to find, drawing a schematic as needed, and using units throughout the calculations. Since the context is secondary, a preview of common engineering topics was chosen. These topics include equilibrium, strength, energy and DC circuits problems. By selecting applications that the students will see in future classes, it is possible to teach them some of the fundamentals in these important topics. This gives them an idea of what to expect in their engineering core classes, which may help them decide if engineering is the right major.

Approximately half the semester is spent on problems solving skills in the 'engineering preview' portion of the class. During the remaining weeks the students begin to learn about using computer solutions to solve problems, including the fundamentals of logic and programming. To compare computer and hand solutions, many problems are used in the computer sessions that were initially used in the engineering preview section [Mahadevan-Jansen, 4].

The computer portion begins with MS Excel. However, it is noted that the majority of students have used that program by the time that they arrive in Introduction to Engineering [Mahadevan-Jansen, 4]. The next program taught is new to the majority of students, MS VBA: Visual Basic. VBA is taught instead of Visual Basic 6.0 since the majority of the regional companies do not have VB, but have MS VBA as a part of MS EXCEL. The last weeks of the course are used to introduce MATLAB.

The course learning objectives are evaluated annually, and most recently have included:

1. understand Engineering as a career and the importance of Engineering ethics;
2. know how to use a structured method for solving problems, including what to do if you are stuck or don't know how to begin;

3. appreciate the importance of using a structured problem solving method;
4. learn how to work as a member of an engineering team;
5. sketch a free-body diagram of a coplanar force system;
6. use a static equilibrium analysis to solve for an unknown force in a coplanar force system;
7. have an elementary knowledge of the concepts of engineering stress and strain;
8. in DC electrical circuits, understand the Laws of Kirchhoff's and Ohm;
9. understand the various forms of stored energy;
10. have a working knowledge of the 1st and 2nd Laws of Thermodynamics;
11. use Microsoft Excel to perform repetitive engineering calculations and create quality engineering charts;
12. use Microsoft Visual Basic to create a user interface computer program;
13. create a script file for MATLAB that will generate, manipulate, and plot engineering data.

Engineering 108, Introduction to Design

ENGR 108 is the second in the two-course engineering & design sequence, and meets for 3 hours, twice per week. This course has two identities running simultaneously. The first identity is that of a CAD course, while the second is that of a project-based design course.

The semester begins with fundamentals of engineering graphics; including teaching the students sketching techniques, tolerance, and how to read blueprints. Once those basic skills are taught, the class focuses on computer aided design as the students learn AutoCAD. Though instruction is offered, most students learn the software by completing tutorials. Their progress is monitored with in-class quizzes.

After engineering graphics is introduced, the students begin working on team-oriented, hands-on engineering projects, using both reverse and forward design, while concurrently continuing to learn AutoCAD and Solid Edge. Students use Microsoft Project to manage projects, AutoCAD 2006 for the computer aided design of projects, and Microsoft PowerPoint and Word for the dissemination of their results. Students also get practice documenting and defending their projects.

The students enjoy the reverse-engineering project assigned early in the semester. Small kitchen appliances such as can openers and mixers are typically used for the reverse design projects. The students are required to write a report and give a presentation describing how their appliance works, including sketches of key components and design improvement suggestions.

The forward-design projects are chosen carefully to ensure that civil, electrical and mechanical engineering disciplines are included. Some projects result in paper-only designs, such as a steel bridge. However, with the recent addition of a 3-D printer, they now also have the opportunity to create physical models of some designs. Furthermore, some projects involve kits where the students get a chance to build and test a design, such as an autonomous Lego robot. In 2003 the freshmen ENGR 108 class developed the hull-design that was used that year by the ASCE concrete canoe team.

The students present their reports orally with slides created by MS PowerPoint. To teach the students how to speak to a variety of audiences with different degrees of technical backgrounds, each student team is given a group to which they pretend they're speaking to. By the end of the semester, students learn to cater their presentations to their audience, such as superiors, colleagues or subordinates.

The course learning objectives are evaluated annually, and most recently have included:

1. understand and appreciate engineering design and the design process;
2. read and understand engineering graphics;

3. describe and specify an engineering design using a computer aided graphics package such as AutoCAD;
4. use computer tools, such as MS Project, to plan, schedule, and track projects;
5. apply engineering principles and mathematics to a design;
6. work with a team of your peers to successfully complete an engineering design project;
7. use the library, the Internet, or other sources of knowledge to aid in an engineering design;
8. disseminate your engineering design in a technical report with graphics;
9. present your engineering design in a technical presentation to your peers;
10. decide if engineering is the right career choice for you; and which engineering area of interest you wish to study at USI: Civil, Electrical, or Mechanical.

It is hoped that by the end of this three-course sequence students should be able to make an informed choice about whether they want to become engineers, be able to decide which of the major branches of engineering interest them the most, and be better prepared for future engineering courses.

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Laura Ruhala earned her BSME from GMI Engineering & Management Institute (now Kettering University) in 1991 (as Laura Wilson) and her PhD in Engineering Science & Mechanics from The Pennsylvania State University in 1999. She has three years industrial experience at General Motors, served as Director of Safety at Pride Mobility, and taught at Lafayette College. She has been an Assistant Professor rank in the Engineering Department at USI since 2002, and has developed and taught many of the freshmen engineering courses, including ENGR 107 (Intro to Engineering) and ENGR 108 (Intro to Design). Other courses she is teaching are Dynamics, Dynamics of Machinery, and Engineering Materials. She is a member of ASEE and is developing a biomechanics laboratory as a center for research in bone and joint care.

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Richard Ruhala earned his BSME from Michigan State in 1991 and his PhD in Acoustics from The Pennsylvania State University in 1999. He has three years industrial experience at General Motors and three years at Lucent Technologies. He has been an Assistant Professor rank in the Engineering Department at USI since 2002, and has taught some of the freshmen engineering courses, including ENGR 103, 104, and 108, and has been involved in curriculum development. Currently course load includes Introduction to Design, Statics, Vibrations, Modeling Dynamic Systems, and Machine Design. He is a member of ASEE, the Acoustical Society of America, and the Institute for Noise Control Engineering, and does research in acoustics and mechanics.

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Eric Sprouls has been the Chair of the Department of Engineering at the University of Southern Indiana (USI) since 2002, where he has been teaching engineering technology and engineering courses since 1977. He holds a MS in Civil Engineering from the University of Illinois. Prior to coming to USI he was at Dames & Moore Consulting Engineers in Denver, Colorado. He has been an Associate Professor of Engineering since 1983. Current course load includes soil mechanics, engineering materials and estimating, and geotechnical design. He also does consulting work for the local coal industry in the area of testing and underground mine design. He is a member of ASEE and the Society of Mining Engineers.