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Laboratory and Design Experiences in the Introduction to Engineering Course at an Engineering and Physics Department

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Abstract

Our department, which offers an Engineering Physics program, with majors in Electrical Systems, Mechanical Systems, and Physics, as well as a Biomedical Engineering program, requires all of its majors to enroll in a two-hour "Introduction to Engineering and Laboratory" course that integrates lecture, laboratory, and design components. The objective of the laboratory and design experiences is to prepare freshmen and transfer students for upper-level engineering laboratory courses, as well as senior design courses, required for our majors. Each laboratory module, presented during two-hour laboratory sessions, at a rate of one module per week, provides either an introduction to concepts and tools required to complete the course design project, or an introduction to one of the software packages the students will use in their upper-level coursework.In this paper, we will present the content of the laboratory modules, and explain how the laboratory experiences are incorporated into the pedagogy of the course. The small-group design project, a central part of the course, requires students to develop and implement a mechatronics-based design project that they propose, utilizing the knowledge, skills gained during the laboratory sessions as well as engineering processes.A primary aim of the design project and laboratory experience is to introduces students, in the early stages of their engineering education, to a subset of the general ABET student outcome criteria (engineering skills, team work, leadership, communication, etc.) The course culminates with student project presentations, including a poster, a formal report, and a demonstration of their design project. We will describe how the experiences gained in the laboratory provide a foundation for a one-semester mechatronics-based design project.

Introduction

The academic success of engineering students can be positively impacted by introductory material that provides practical hands-on experience with design tools and concepts. Using an objective 'Introduction to Engineering' course as a tool to increase academic performance saw exceptional success as an outreach to underprivileged minority groups in the 1980s[1] and has since expanded to encompass students from all walks of life. This style of hands-on introductory engineering curriculum course has been advanced as one approach to improving retention[1]. Introduction courses are important because freshmen engineering students "have unclear goals and values", "are apprehensive and anxious about their unfamiliar surroundings and new experiences", and "are not well versed about the culture and expectations of engineering study and are unaware of optimum strategies for approaching it"[1]. It is believed that the introductory courses are a crucial part of addressing these psychological challenges for freshmen engineering students[1]. This is borne out by some data; intro courses with an emphasis on hands-on learning, helping students become accustomed to their new setting, have been shown to improve retention by as much as 17%[2]. The Introduction to Engineering course described in this paper has both a lecture and laboratory component, similar to programs from other universities[3]. Unlike some others, this course places a heavier emphasis and value on the development of a design project and associated presentation, in part to emphasize certain student outcomes in compliance with ABET's accreditation requirements as shown in Table 1..

		None	Low	High	Assessment
a	Ability to apply mathematics, science, and engineering principles.		x		
b	Ability to design and conduct experiments, analyze and interpret data	x			
c	Ability to design a system, component, or process to meet desired needs			x	Project
d	Ability to function on multidisciplinary teams.			x	Project
e	Ability to identify, formulate, and solve engineering problems.		x		
f	Understanding of professional and ethical responsibility.			x	Test
g	Ability to communicate effectively.			x	Presentation
h	The broad education necessary to understand the impact of engineering solutions in a global and societal context	x			
i	Recognition of the need for and an ability to engage in life-long learning.	x			
j	Knowledge of contemporary issues.		x		
k	Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.			x	Lab exercises

Table 1: ABET Student Outcomes in relation to Engineering Physics and Biomedical Engineering[4]

50 percent of the course grade is based on the evaluation of the aforementioned design project, which is the assessment tool used in the evaluation of student performance on outcome c and d in table 1. The project presentation relates to outcome g, and both the lab exercises and project design relate to outcome k. Lab exercises account for 25% of the course grade, and the remaining 25% is split between digitally-administered homework assignments and tests on a

variety of engineering concepts. The students also are given pretests to evaluate their incoming knowledge and understanding of mathematics and physics concepts.

Overall, the laboratory class and design project are intended to prepare students both for their academic endeavors in the upper level courses, as well as provide an early exposure of the design project expectations in the department's senior design course. Ultimately, the primary intent is to help the students with the journey of transformation from being an engineering student to become a practice engineer. Studies, which indicated factors that students associated with their sense of self-efficacy, produced a list of influences that were given by more than 20% of students interviewed. Major factors included understanding/learning, drive and motivation, teamwork, computing abilities, and outside assistance5. In order to overcome the psychological barriers to success posited by researchers, providing a sense of self-efficacy is a valuable tool to increasing program retention and student satisfaction.

In addition to the assignments, project, the students are exposed to a series of lectures given by guest speakers from both university and industry.

Methods

The class has an enrollment of 112 students, which are broken up into laboratory sections with a maximum of 24 students in each section. The laboratories are taught by an instructor with the aid of one sophomore student assistant, and are supported by the department's lab manager and lab associate. Each lab section meets for two hours each week during the 15 weeks of the semester. The students are encouraged to take the intro class in their first year, but as a result of transfers or scheduling conflicts, some sophomores and juniors end up in the course. To enroll in intro to engineering, the students are required to be declared in one of either the three Engineering Physics (EP) or two Biomedical Engineering (BME) concentrations, or be declared as a dual major within the EP and BME umbrella. Figure 1depicts the Student academic level, major distributions, and age categories for Fall 2012

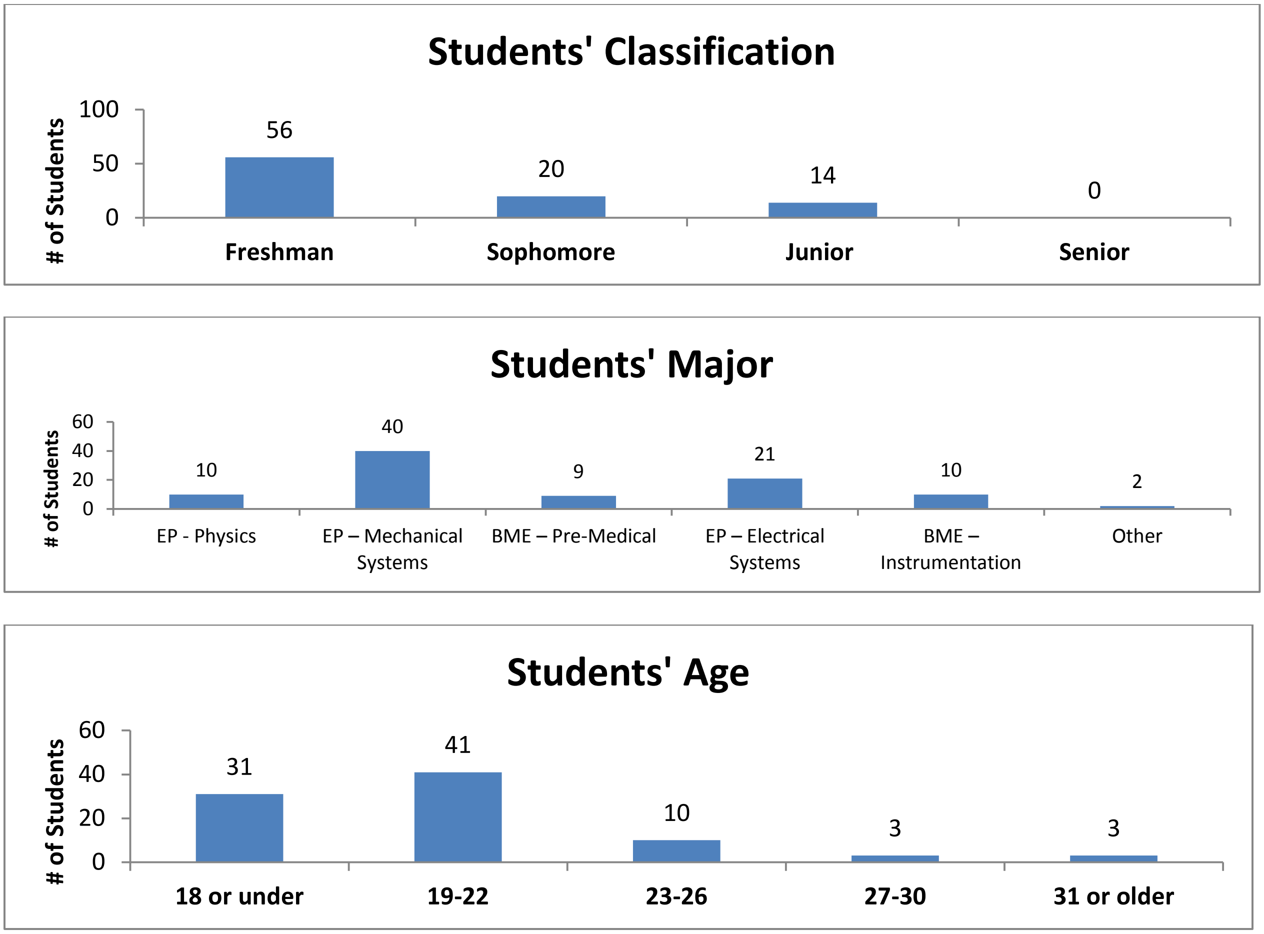


Figure 1: Student academic level, major distributions, and age categories for Fall 2012

Each station in the laboratory is equipped with a desktop computer loaded with Multisim, LabVIEW, SolidWorks, Microsoft Office, and Parallax Basic Stamp Editor. Hardware at each station includes both HY5003 and CSI5003x5 power supplies. Each station also has a corresponding lab box including connectors with alligator and clip leads, an Omega HHM17 Digital Multimeter (DMM) and an ExTech Industries MiniTec 26 DMM. The back of the lab has soldering stations, with irons, desoldering tools, and wire snips.

The overall goals of the laboratory sections are twofold: First, the course intends that the students should gain a basic introduction to the software and equipment they will be using throughout their education as engineer students, and second, the course helps students to build the basic skill and knowledge base needed for the student to complete their primary deliverable for the course: the design of an original mechatronic system. Since most laypersons possess a reasonable level of intuition with regards to the field of mechanics, more attention was paid to the ideas behind electromagnetism, of which college freshmen are less likely to have a firm grasp.

A custom manual was written for the laboratory which provides selected background material on physical principles, software and hardware, at a carefully considered level of presentation and depth sufficient to meet the goals of the laboratory. The manual is divided into a sequence of eight modules, labeled 101-108, given in the order that they are covered in the laboratory. Module topics were chosen either to give students the tools they would need to complete the course design project, or to introduce software and concepts that they would find important to their senior design and upper-level coursework.

Each module (Please refer to Appendix I) begins with an introductory discussion section, covering the basic ideas and concepts the lab is designed to explore. Relevant theory and equations are provided and briefly explained. Following the discussion section is a short pre-lab exercise, crafted to test the students on their understanding of the material. Following the pre-lab is the laboratory procedure, a step by step breakdown of what the student is expected to accomplish during the class period. After the lab procedure, there is a report page, featuring tables for experimental data as well as conclusion questions. This report serves as the deliverable for each lab section.

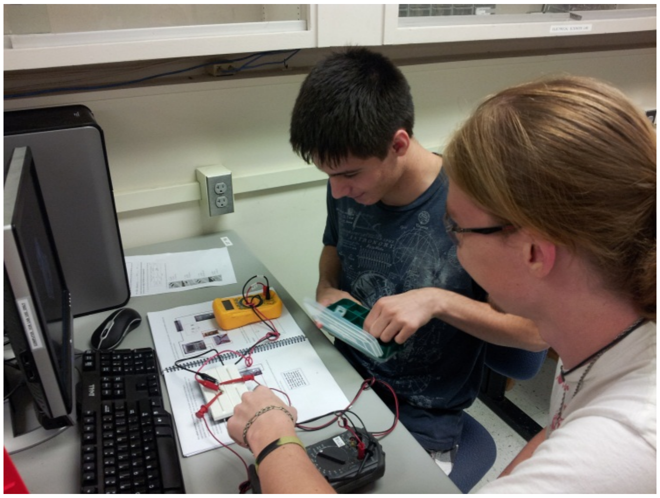
These lab modules are designed to be accomplished within the course lab period of two hours, meeting once a week, generally by a group consisting of two people. In cases where an odd number of students are enrolled in a section, a group of three is permitted, but only to avoid having anyone forced to work alone. Student lab pairings are assigned according to station. At the beginning of the semester, students choose where and with whom they sit, and a seating arrangement is created according to this. Later, if a student wishes to change partners or stations, they are required to authorize that change with the instructor.

The pre-lab is done between lab meeting periods and must be turned in at the beginning of the appropriate lab period. The students turn in their pre-labs, then after a short lecture/description of the equipment and concepts for the lab, they begin working on the lab procedure. At the end of the period, they are required to turn in whatever work they have in the form of their lab report form.

The following is a summary of the module contents:

The first module, 101, is a brief introduction to the physical concepts and relationships that govern electrical circuits. Special emphasis is placed on the understanding of the concepts of resistance, electrical potential, and current. Students are introduced to Ohm’s law, Kirchhoff’s rules, and the voltage and current divider formulas. The deliverables for this lab exclusively consist of calculations based on simple series and parallel circuits, with the intent of highlighting the relationship between current and series, and voltage and parallel.

Module 102 introduces the students to measuring instruments, and introduces the students to the process of measuring currents and voltages. Exercises are designed to highlight the functionality of the devices, and to reinforce the concepts introduced in the first module by giving students hands on experience taking measurements and allowing them to contrast those measured values with the expectation values determined from their calculations.



Module 103 introduces Multisim, an industry standard program utilized for the simulation of electrical circuits prior to physical construction. Students are guided through the process of simulating a circuit in Multisim, and are given an opportunity to compare and contrast the measured and simulated values, again reinforcing the concepts introduced through the previous modules. Deliverables for this lab include both the simulated circuit and its physical equivalent.

Module 104 brings students into contact with input and output devices that might be useful in their project. Sensors as a means of input are explored, with hands on experience dealing with LDRs and thermistors, as well as discussion of other types of sensors, such as IR and ping detectors. For output, the primary focus is on transducers, with hands on access to a DC motor. Students are also introduced to advanced components such as relays and transistors.

In Module 105, the students go through the process of assembling the Parallax Basic Stamp 2 OEM (BS2OEM) microcontroller kit. This features a tutorial in soldering, and places emphasis on the importance of making sure that components are placed into a circuit in the correct fashion. Although this section is relatively light in content, it gives students hands-on experience with various soldering tools and provides an opportunity for the instructors to assist the students in making certain their microcontrollers are properly assembled for the following module.

The following week, the students go through Module 106, which involves some introductory programming experience. Students utilize the BS2OEM, using the PBasic 2.5 programming language to construct some simple programs to demonstrate the basic functionality of the stamp. Simple circuits use LEDs as outputs, and the students learn how to use simple loops and to modify programs to achieve different effects.

Module 107 involves the program “SolidWorks”, which is an industry-standard computer aided drafting and design (CAD) software package. The lab consists of a simple tutorial designed to walk students through the use of several basic tools within the software. They learn how to use line and arc tools to create sketches, and then extend those sketches into 3 dimensional shapes. They also learn how to use the 3D tools such as the fillet, cut, and shell tools to modify those shapes. Two parts are created as deliverables, and the students are shown how to combine those parts into an assembly within the software. The final deliverable for the lab is the finished assembly.

The final lab module is an introduction to the “LabVIEW” virtual instrument design program. In this lab, the students learn to create Virtual Instruments (VIs) to simulate functional devices. They also learn to utilize these VIs as sub-Vis within another device. A large portion of the lab focuses on the use of a Data Acquisition device, or “DAQ” to take in data from an external source, in this case a thermal transducer. They connect a simple circuit, and the transducer registers the temperature level and outputs a corresponding voltage. The students take this voltage and feed it into their VIs to generate a temperature reading that corresponds to this value.

A sub-VI converts the temperature between the Celsius and Fahrenheit scales depending on the position of a virtual switch.

Once the lab modules have been completed, the remaining class periods are used to help the students design their mechatronic systems for their final group projects, which total 50% of the class score.

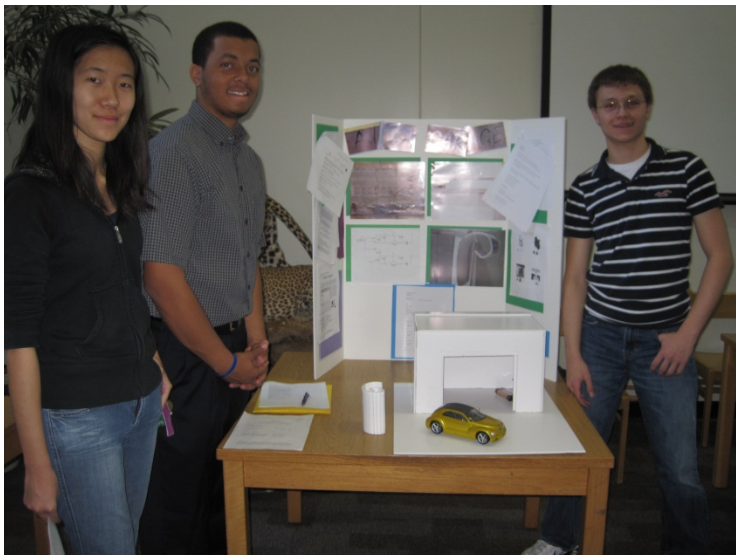
The project groups are distinct from the lab exercise groups, and consist of, ideally, three students. Groups are required to be comprised of students who share the same lab class period in order to ensure that they are forced to have an opportunity to interact with their partners. As with the lab partners, students are free to join whatever group they wish, and each group submits a membership form. If a student wishes to change groups then they must notify the instructor sufficiently in advance of the project due date. They are also personally responsible for notifying their group of the change, and both groups are required to submit updated group roster forms. This is to facilitate a feeling of personal responsibility and professionalism among the group members, in line with ABET objectives.

Each group is required to design and build a simple mechatronic system, consisting of at least one sensor, one actuator, and a Basic Stamp microcontroller. The system is required to take sensory input and use the microcontroller to direct a sensory response to accomplish some practical task. Beyond this simple requirement, the project is left up to the imaginations and problem-solving ability of the students. Students are encouraged to use the experiences they gained in the lab modules to drive and inform their creative processes, and additional information and support in the project development is available from faculty and staff. Students are also encouraged to research components to help them improve and complete their system designs.

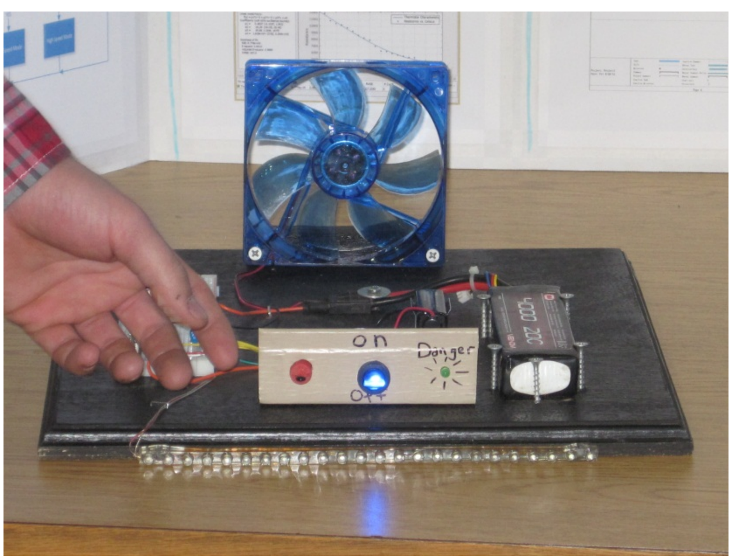
Five weeks into the semester, each group is responsible for submitting a simple proposal for their project concept. This proposal breaks down into a rudimentary budget, a Gantt chart, and a general single-paragraph description of the function and purpose for their device. This proposal accounts for 5% of their overall project grade, and is evaluated according to its conformity to the above formatting. The descriptions from these proposals are used to gauge how well they fulfill the stated requirements of the project, and the following advisement arrangements are made to help the students bring their designs in line with the project goals.

Six or seven weeks into the semester, each group must arrange a meeting time with the instructor, to receive advisement and direction on the state of their project. To account for differing schedules, at least one representative is required for the group to receive an advisement grade, however individual in the group who agrees to attend the meeting must be present or provide notification to their group mates. Advisement is 5% of the overall project score.

Near the end of the semester, each group of students must give a presentation of their project. This includes a poster illustrating the basic concepts of the device and their design process, as well as a verbal presentation and practical demonstration of their functioning device. They are also required at this point to turn in a project report that details their mechanical and electrical systems, code for their microcontroller program, budget, and the breakdown of their individual contributions. Projects are scored by a team of four evaluators in four categories: concept, implementation, performance, and documentation. Each category is assigned a value from 1 to 5, with 3 meaning that the project met expectations, while a 1 indicates that the project fell well short of expectations, and 5 means that the project greatly exceeded expectations in the category.



In the concept category, each project is scored according to its technical merits, such as the degree to which physical and engineering principles were used in the design, whether the hardware and software were used appropriately to produce the mechatronic system, and how well the system solves a realistic need.



Implementation refers to how well the design concept was realized in the actual product, the focus being on the project's workmanship and finished appearance.

The deliverables for the final project are a functional mechatronic device, a written report, and a poster presentation. Each group of team members must give a 15-minute presentation on their project, including a poster board. During the presentation, each team member is expected to be able to describe their contribution to the whole and describe and defend their device, and the performance of the completed system is demonstrated. At the end of the presentation, the team submits a report. The documentation category is scored based on the clarity, completeness, and general quality, of the report and poster board.

The presentations are spread out over a week, with each group presenting during its normal lab period. Each presentation is videotaped, and the evaluators meet after the presentations each day to score the projects based on the listed criteria. The project and all associated work accounts for 50% of the student's total grade. The lab reports, homework assignments, and quizzes account for the other 50%.

Before the presentations begin each day, the presenting students are given an anonymous survey to complete, which is collected after the presentations. An analysis of the survey responses is included in the Results section.

Results

In the fall of 2012 semester, 112 students were enrolled in the Intro class. Of those 112, 99 students were still enrolled at the end of the semester. To assess the course objectives, after the students performed their project presentations they were asked to fill out an exit survey (Please see Appendix II) consisting of 46 multiple choice questions, mostly rating statements on a 5 point scale from “strongly disagree” to “strongly agree”, in addition to 5 short-answer questions to gather more detailed feedback. Surveys were anonymous, and the students were informed that their responses would have no effect on their grade. A full copy of the survey is offered at the end of this paper.

The questions on the surveys were chosen to gather student opinions and attitudes about how well the course fulfilled certain objectives. On one hand, the survey was used to gather data about the fulfillment of ABET accreditation standards, and additionally it was used to gauge student attitudes and interest levels as they go deeper into the program.

There were also several short-answer questions used to gather anecdotal feedback and opinions from the students.

Following (Figs 2-6) is a selection of survey results relating to those standards, broken up according to their relation to ABET outcomes rated “high” for this course’s content:

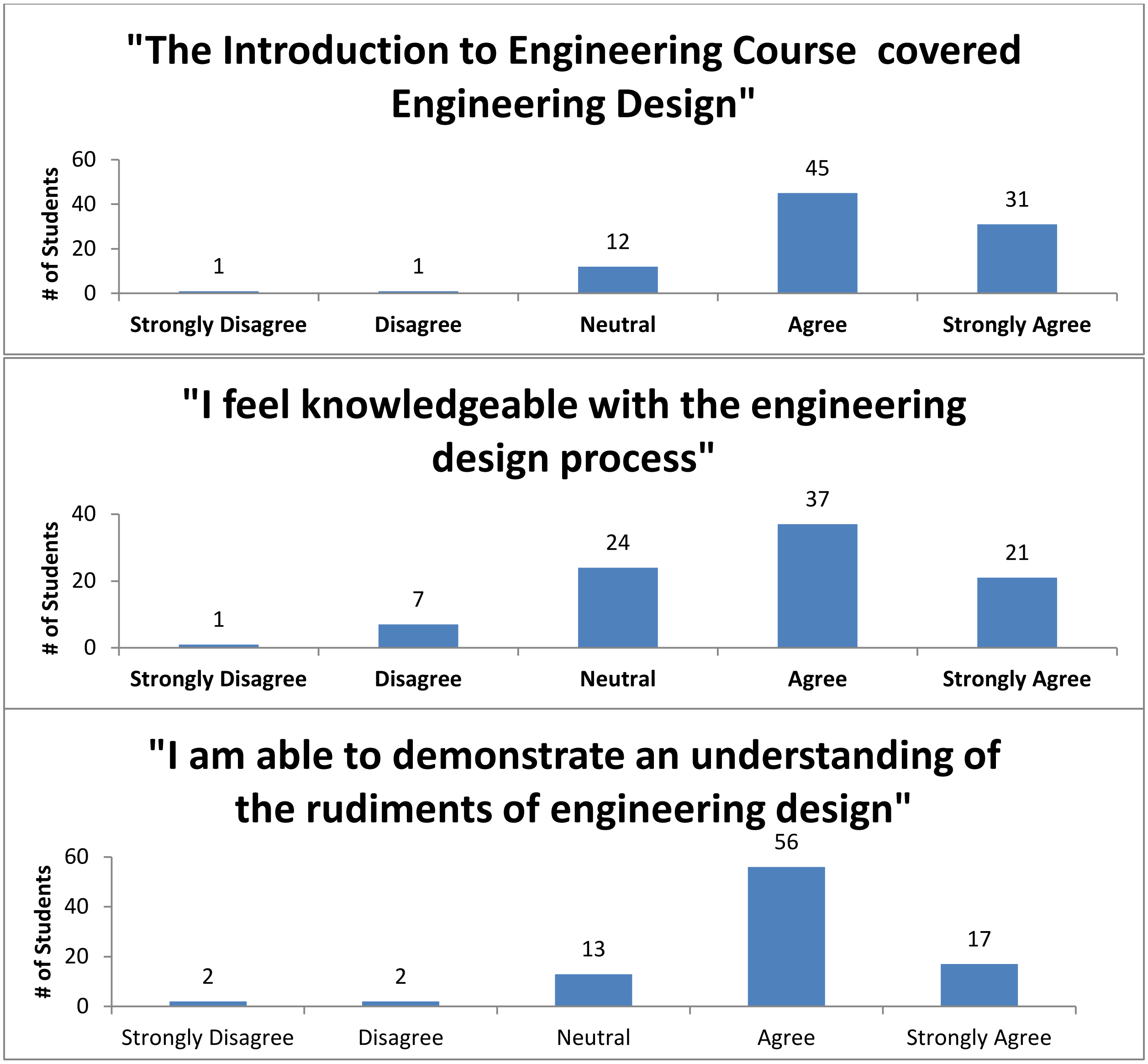


Figure 2: Survey results relating to ABET outcome c

Outcome c on the ABET criteria chart was the "ability to design a system, component, or process to meet desired needs". In general terms, this likens to the design process as a whole. Responses show that students feel the topic of Engineering design was adequately covered in the course, and that they are able to demonstrate a rudimentary understanding of the engineering design. Responses on knowledge of the design process as a whole are more spread out, with a larger number of neutral responses, indicating a possible area of potential future growth in the program.

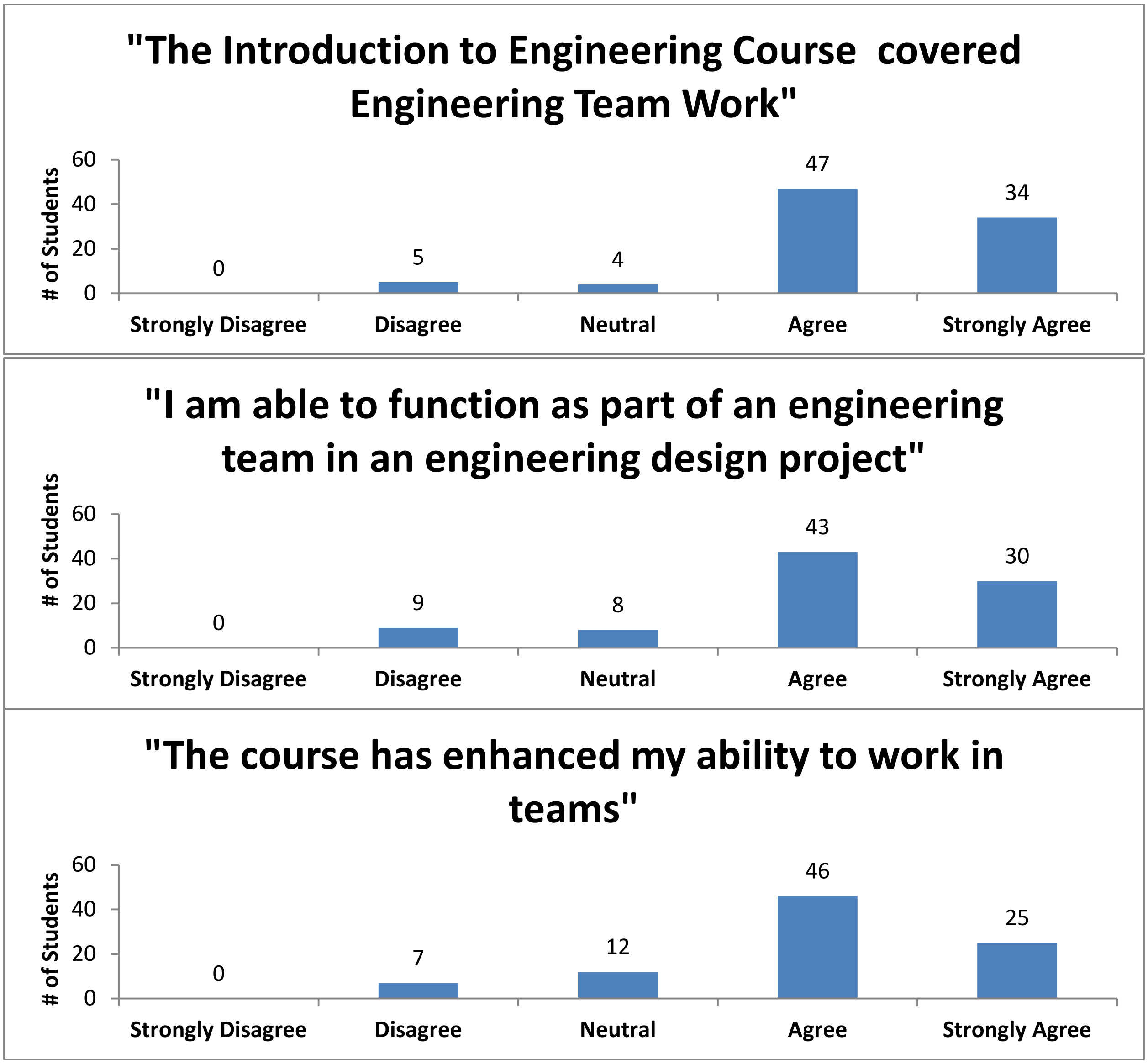
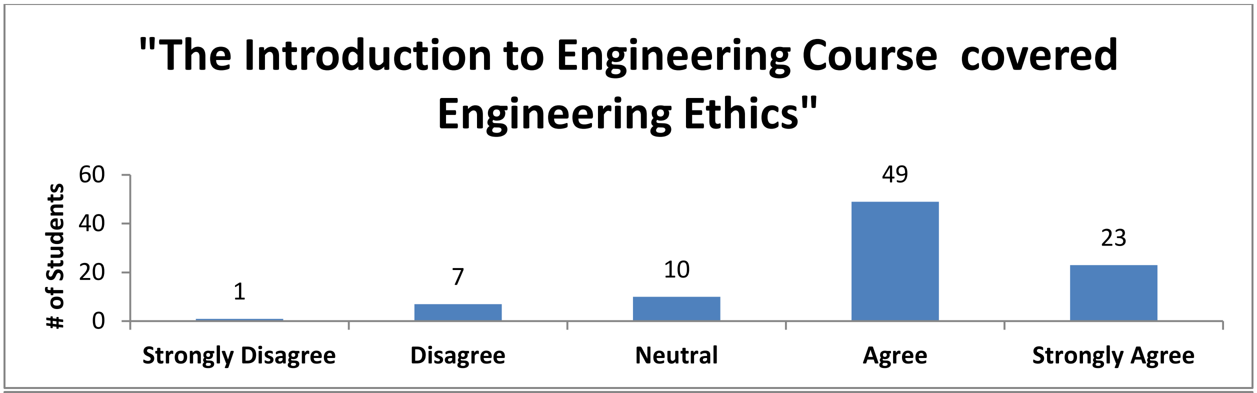


Figure 3: Survey results relating to ABET outcome d

Outcome d is the "ability to function on multidisciplinary teams." This is represented in the course by both the lab partners and project groups. Responses show that the students believe that the course had adequately covered working in teams, with most of the students feeling that they are able to function, and that their ability to work in teams has been enhanced by their experience.



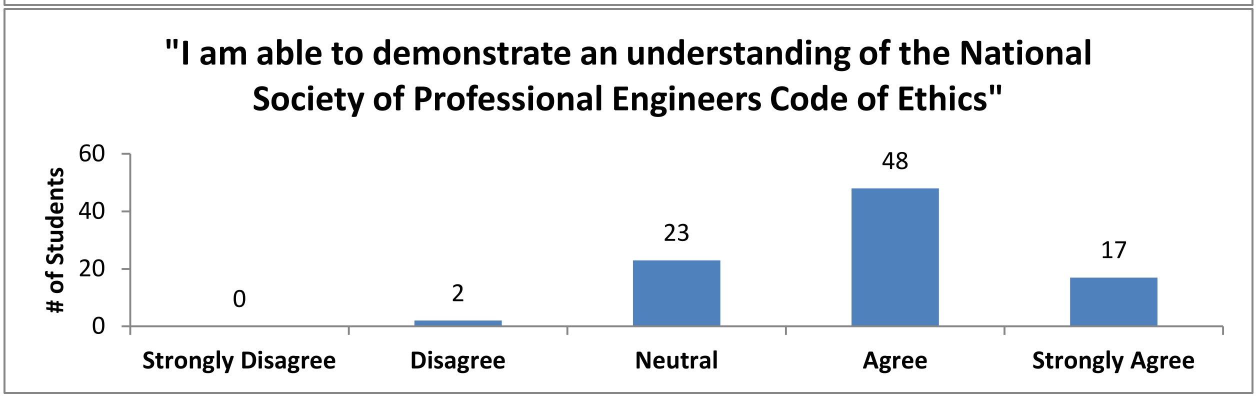


Figure 4: Survey results relating to ABET outcome f

Outcome f is the "Understanding of professional and ethical responsibility. Although this is primarily addressed in the lecture class and tested by an online quiz, The assignments associated with the project assessment process included elements designed to encourage students to consider their group members, and their professional and ethical responsibilities to their teammates. Since engineering ethics is offered and required as a separate course, this was less emphasized, which may account for the larger number of neutral responses in the 'ability to understand' chart, but detailed speculation would be unwise without a more detailed analysis.

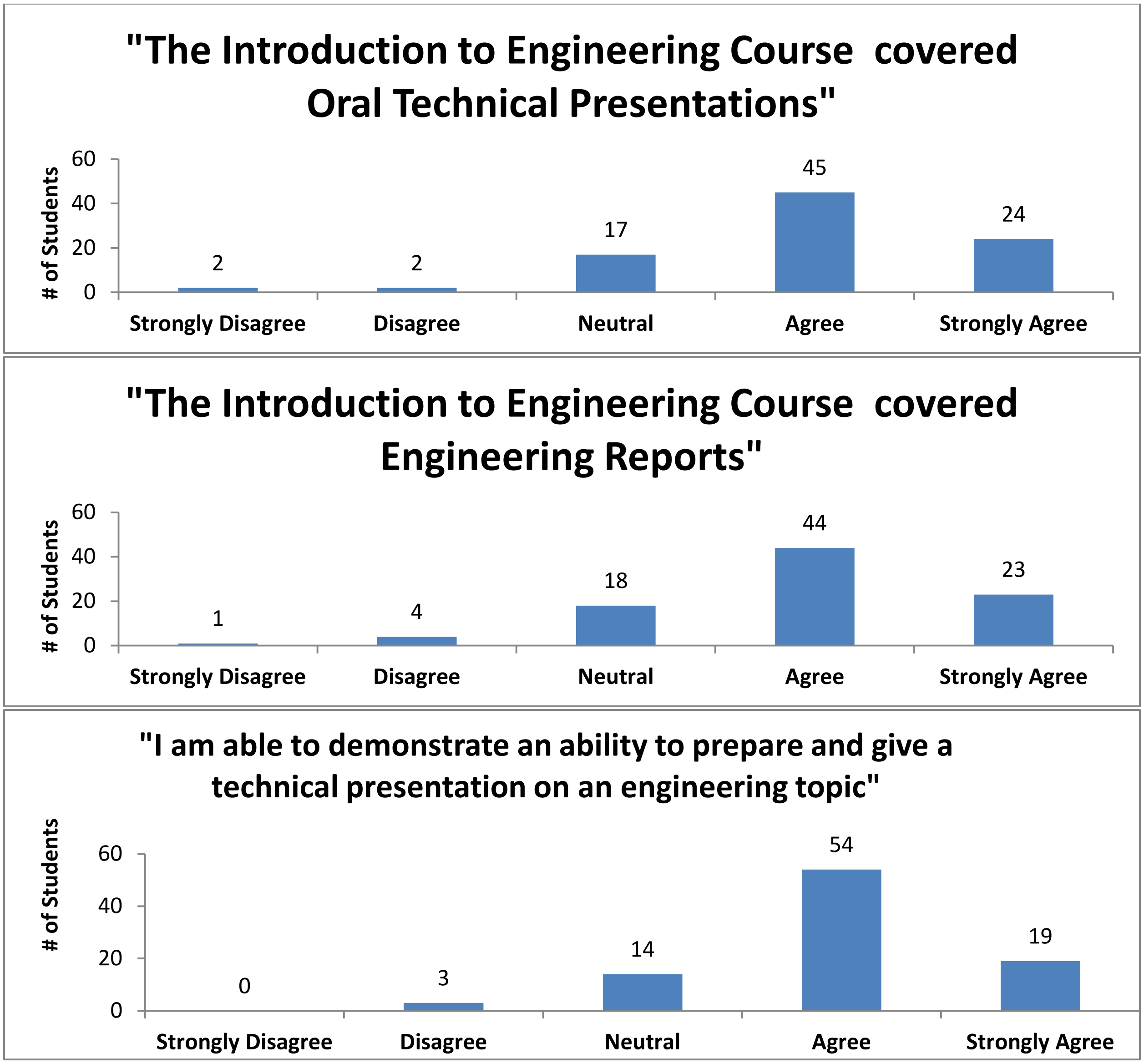
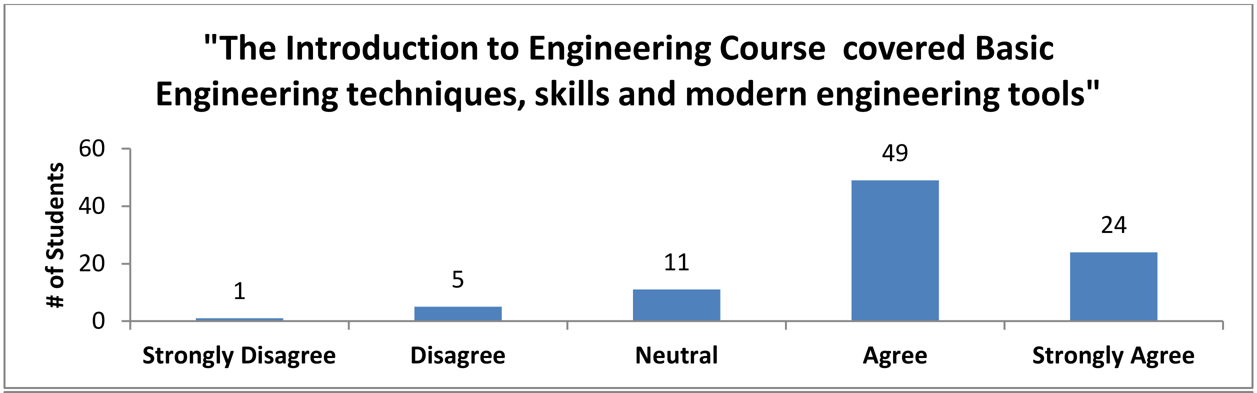


Figure 5: Survey results relating to ABET outcome g

Outcome g is the "ability to communicate effectively". In this course, communication was very important to the project presentation and reports. Oral and written communication were emphasized for these assignments, and all group members were expected to be present and involved in the presentation and demonstrations of their systems. The survey results imply that the students felt that these areas were covered adequately, and indicate a strong confidence in their ability to present.



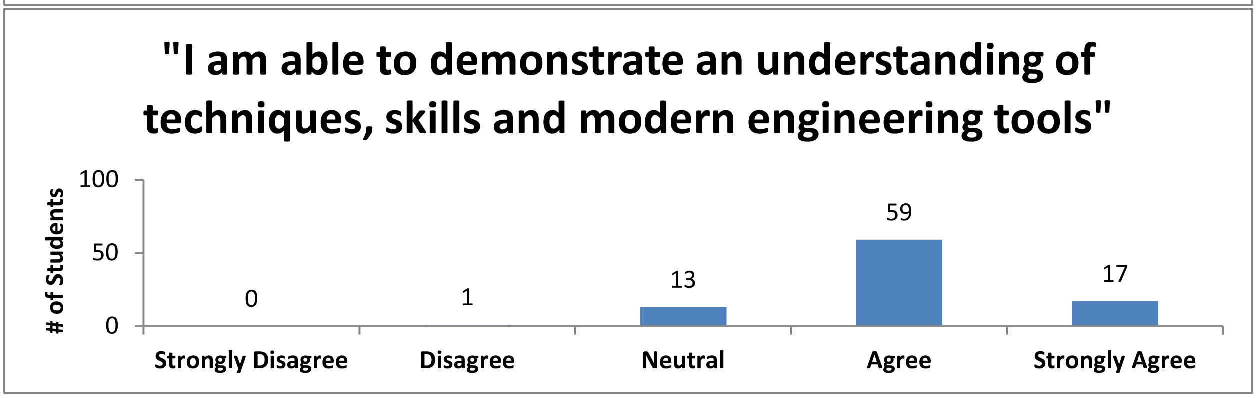


Figure 6: Survey results relating to ABET outcome k

Outcome k is the "ability to use techniques, skills, and modern engineering tools necessary for engineering practice." This was emphasized heavily in the lab exercises, where students were taught how to use a variety of common equipment and software that is in wide use in industry today. The results bear out this extensive experience, and show that the students feel confident in the use of the equipment, techniques, and skills taught in the class.

In addition to the surveys relating to ABET criteria specifically, the survey asked several other questions relating to student attitudes on their future success, since that has been shown to be a major factor in student retention and excellence.

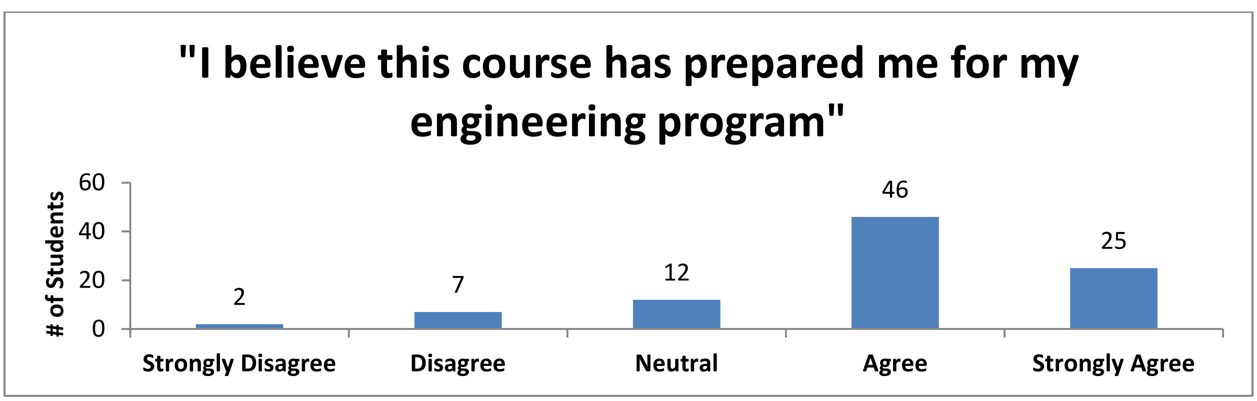


Figure 7: survey response on general preparedness

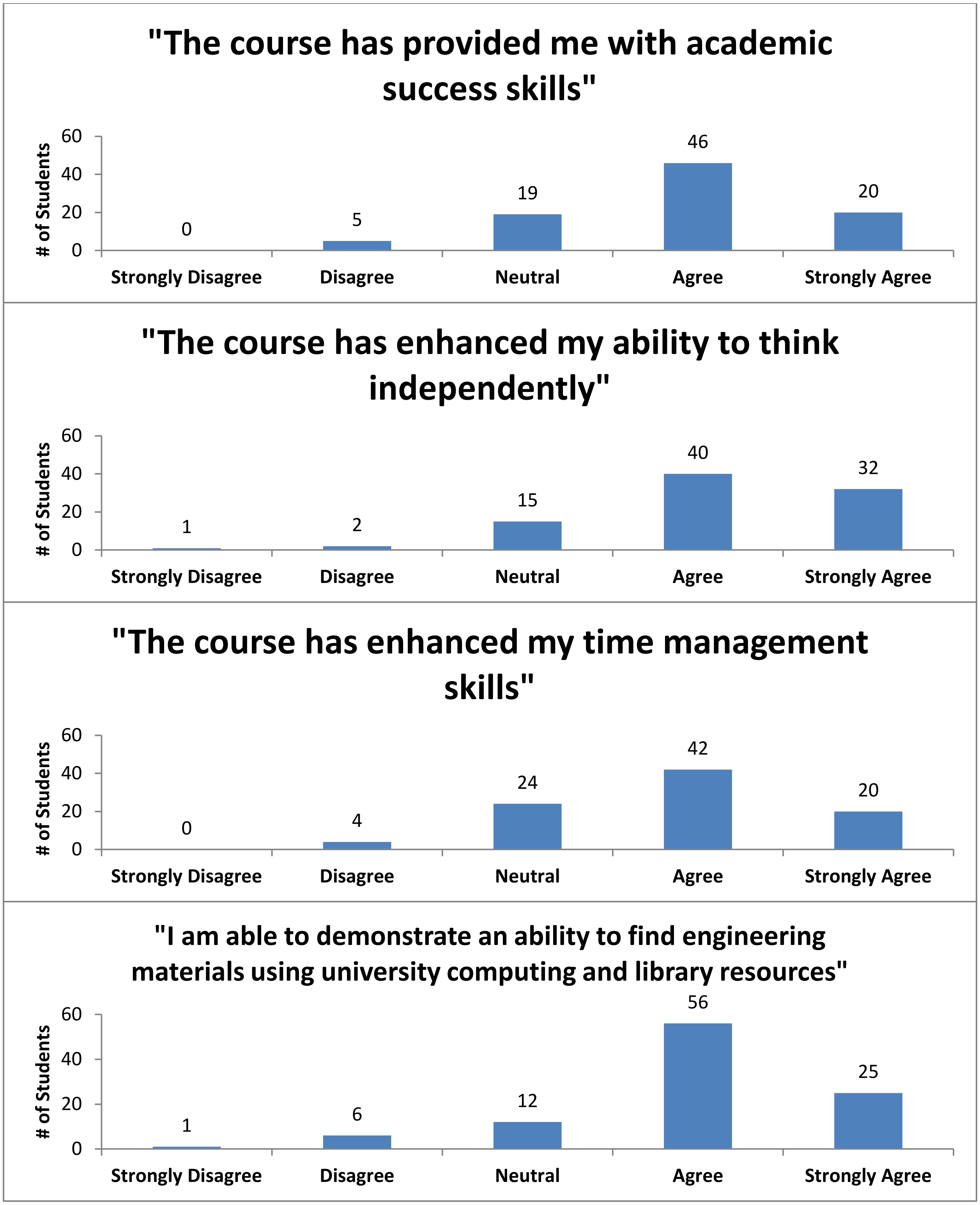


Figure 8: Survey responses on specific skill areas

These results show that the majority of the students have a fair degree of confidence in their abilities in these areas.

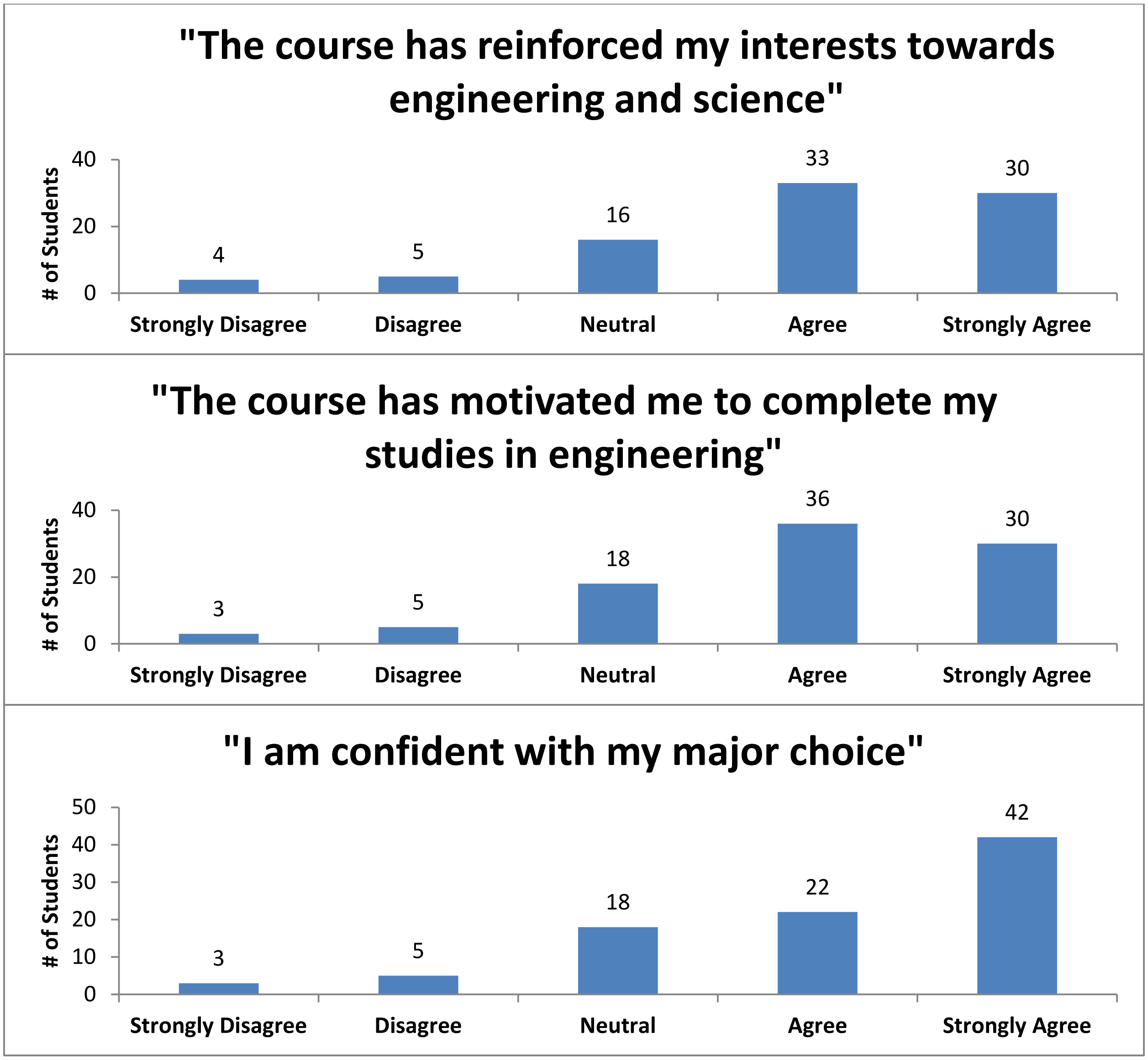


Figure 9: Survey responses on level of interest and motivation

These survey results (Figs. 7 and 8) demonstrate a generally positive attitude moving into the program. There are slightly higher numbers on the "disagree" side of the spectrum than in other, more objective survey results. The confidence in major choice also stands out from the other results in that a larger number of students strongly agreed rather than simply agreeing.

Very few patterns emerged from the short answer comment questions. Although anecdotal feedback may help with some details on future semesters, for the most part, few conclusions can be drawn. However in response to the short-answer question "What engineering skills/abilities have you developed upon taking the Introduction to Engineering Course?", a large number of students commented that they had learned a great deal about electrical circuits, programming, teamwork, and problem solving. This reinforces the previous survey results relating to the ABET requirements.

Conclusion

The survey results show an overall sense of satisfaction from the majority of the students. They indicate that overall, the students believe that the course has prepared them well for the challenges that they will face in their transformation to becoming an engineering, and general attitudes about their personal confidence seem to skew high. This indicates that the students feel good about moving forward onto upper level laboratory and design courses. The questions about attitudes indicate a high average level of confidence in learned skills, but a slightly increased polarity between levels of interest and motivation. This could indicate that the course is can be a gauge for a small number of students whether or not to pursue engineering.

These survey results generally seem to reflect a strong agreement with the overall goals of the course, and provide insight into areas that might be improved in future semesters. As the course goes forward, we intend to gather initial data to provide a baseline of comparison with students at the beginning of the semester in addition to the current end-of-semester survey. This will give us the ability to gauge how the course has shaped student perceptions and confidence levels more accurately. We also intend to implement a peer evaluation process to reinforce group participation and open communication, and are going to move up some of the deadlines for the early phases of the group projects, as well as adding a day early in the semester for the groups to form and begin planning for their projects.

The course program outlined in this paper takes an engineering student through a variety of different exercises and projects to inform, encourage, and involve the student in a sense of interactive hands-on learning. The use of the design project seems to successfully guide students into the creative experience of engineering design. The use of professional equipment and industry standard software helps create a sense of real involvement in the engineering discipline, and the group activities guide the students into a greater sense of community and interaction. This allows the students to learn more, to better share what they've learned, and to value their own contributions to a project that is beyond what any of them could do alone.

Acknowledgements

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Appendix I: Lab Module sample pages

MODULE 101 – ELECTRICAL CONCEPTS AND CIRCUITS

OBJECTIVES

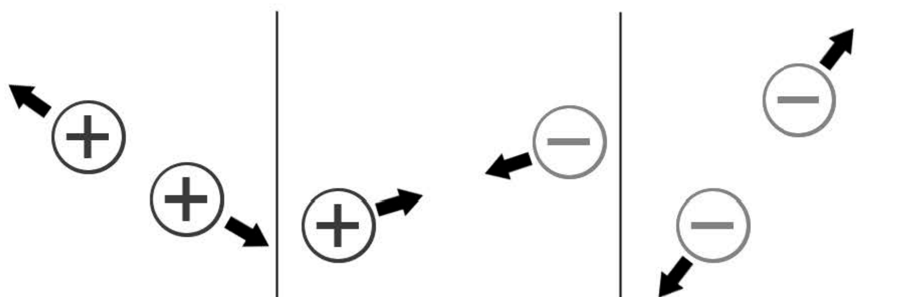
The purpose of this module is to familiarize you with basic electrical concepts and some of the most common equipment you may see in the lab. Finally, for in-class lab procedure, we will learn to use the circuit design program known as "Multisim".

DISCUSSION

Concepts

Charge

Electric charge is a basic property of matter. There are two types of charge, which we refer to as POSITIVE (+) and NEGATIVE (-). Objects with an electric charge exert force on other charged objects according to a simple rule: *Opposites attract, and like charges repel.*



The two charges are both positive. Since they share the same type of charge, they repel.

Here, one charge is positive and the other is negative. Since they are opposite charges, they will attract.

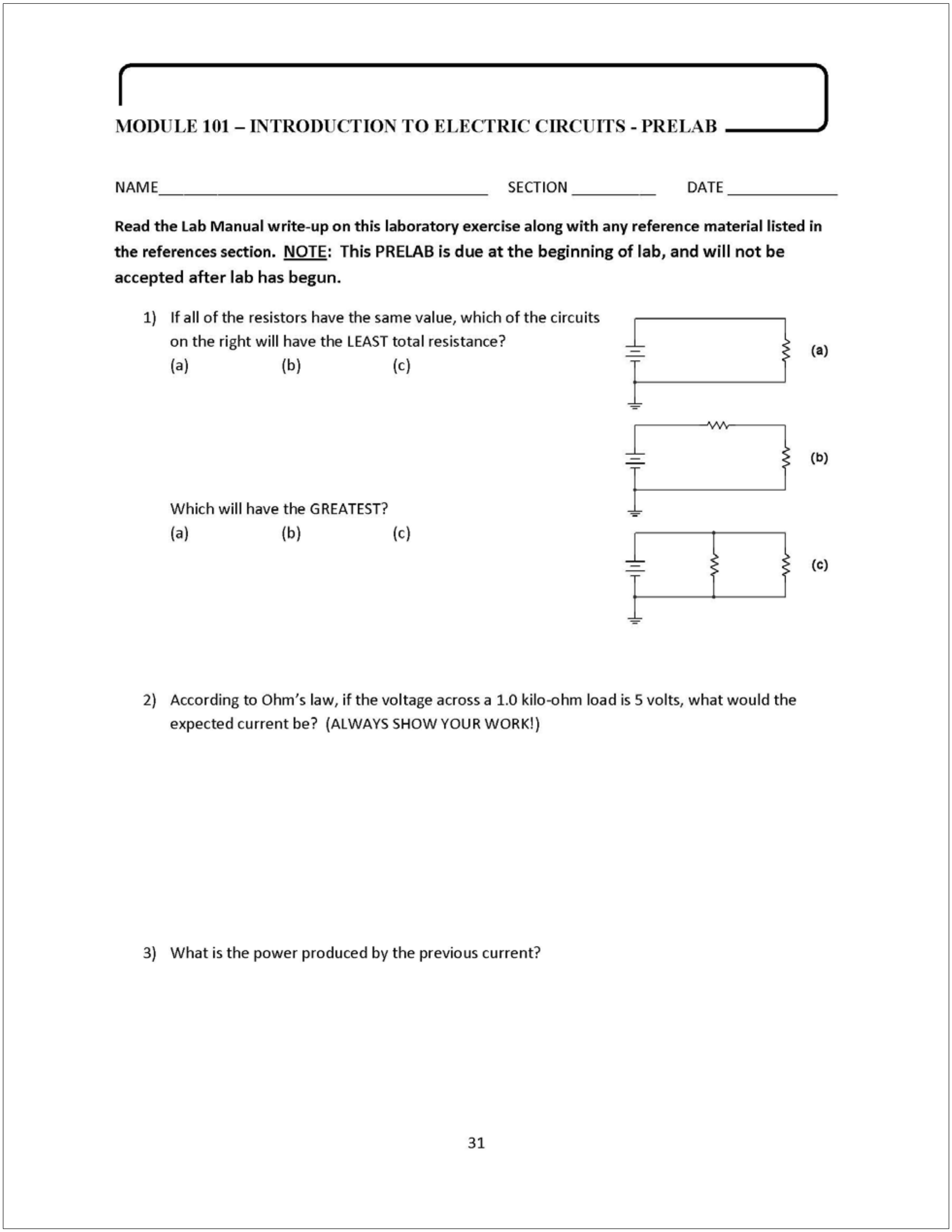
Now both are negative. Once again, they are the same charge, so they repel one another.

At the most basic level, charge in an object is usually produced by the protons (positive charge) and electrons (negative charge) that make up an atom. The charges of these particles are equal and opposite, but if an object is made of an uneven number of protons and electrons, it is said to have a net charge. This charge can be measured, and is specified in units called Coulombs, abbreviated C.

Voltage

If you consider holding an object at a certain height and letting it go, gravity will naturally pull it to the ground. If you hold it higher, it will fall farther, and will therefore have more energy when it gets to ground. In this way, the object's height can be thought to have a certain potential level of energy associated with it. The higher it goes, the more potential it has.

Figure 10: Module discussion page example



MODULE 101 – INTRODUCTION TO ELECTRIC CIRCUITS - PRELAB

NAME_______________________________________ SECTION __________ DATE _____________

Read the Lab Manual write-up on this laboratory exercise along with any reference material listed in the references section. NOTE: This PRELAB is due at the beginning of lab, and will not be accepted after lab has begun.

1) If all of the resistors have the same value, which of the circuits on the right will have the LEAST total resistance?
   (a) (b) (c)

   Which will have the GREATEST?
   (a) (b) (c)

2) According to Ohm's law, if the voltage across a 1.0 kilo-ohm load is 5 volts, what would the expected current be? (ALWAYS SHOW YOUR WORK!)

3) What is the power produced by the previous current?

31

Figure 11: Module prelab page example

MODULE 101 – INTRODUCTION TO ELECTRIC CIRCUITS – REPORT

NAME____ SECTION __________ DATE _____________

Exercise 1:

Voltage across R: ________

Resistance	Current	Power
R=500 Ω		
R=1.0 kΩ		
R=2.5 kΩ		
R= 3:0 kΩ		

Table 1

Conclusion:

As resistance in a simple circuit goes up, the current goes up/down. (circle one) Does the Power go up or down?

Exercise 2:

R_{eq}: _________ I_{tot}: ________

Resistor	Voltage	Current
R1		
R2		

Table 2

Conclusion:

What can be said about the currents through elements in series based on these results?

35

Figure 12: Module report page example

Appendix II: End-of-semester Survey sample

Introduction to Engineering
End-of-Course Survey
Fall 2012

Please read each question carefully and mark your answer. Mark only one answer.

My classification is:

○ Freshman	○ Junior
○ Sophomore	○ Senior

My major is:

○ Engineering Physics - Physics	○ Engineering Physics – Electrical Systems
○ Engineering Physics – Mechanical Systems	○ Biomedical Engineering – Instrumentation
○ Biomedical Engineering – Pre-Medical	○ Other: ______________________________

My age range is:

○ 18 or under	○ 27-30
○ 19 -22	○ 31 or older
○ 23-26	

Course Organization

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The course was well organized	○	○	○	○	○
The course load was manageable	○	○	○	○	○
The class topics, activities, reading, and assignments fit well together	○	○	○	○	○
The requirements of the course were made clear at the beginning of the course	○	○	○	○	○

Program Preparation

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I believe this course has prepared me for my engineering program	○	○	○	○	○
The course has provided me with academic success skills	○	○	○	○	○
The course has motivated me to complete my studies in engineering	○	○	○	○	○
The course has reinforced my interests towards engineering and science	○	○	○	○	○
I am likely to get a bachelor's degree in engineering	○	○	○	○	○
I am confident with my major choice	○	○	○	○	○
I am likely to finish my studies at the University of Central Oklahoma	○	○	○	○	○

Course Effectiveness

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The teaching that I received at the Introduction to Engineering Laboratories was effective	○	○	○	○	○
I feel knowledgeable with the engineering design process	○	○	○	○	○
I am confident with my understanding of the material presented in this course	○	○	○	○	○
The course has enhanced my ability to work in teams	○	○	○	○	○
The course has enhanced my ability to think independently	○	○	○	○	○
The course has enhanced my professional development	○	○	○	○	○
The course has enhanced my time management skills	○	○	○	○	○
The course has enhanced my judgment skills	○	○	○	○	○
The course has enhanced my discipline skills	○	○	○	○	○
The course has been effective in establishing a link between theory and practice	○	○	○	○	○

Course Objectives

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
After taking the Introduction to Engineering Course, I am able to:					
demonstrate an understanding of the various engineering disciplines and possible career paths in engineering	○	○	○	○	○
demonstrate an understanding of the National Society of Professional Engineers Code of Ethics	○	○	○	○	○
demonstrate an understanding of the process of obtaining professional engineering licensure	○	○	○	○	○
demonstrate an understanding of techniques, skills and modern engineering tools	○	○	○	○	○
demonstrate an ability to find engineering materials using university computing and library resources	○	○	○	○	○
demonstrate an ability to produce a properly formatted engineering report using a word-processor including tabular data, graphs or other figures, and references	○	○	○	○	○
demonstrate an ability to prepare and give a technical presentation on an engineering topic	○	○	○	○	○
demonstrate an ability to use the web for course assignments	○	○	○	○	○
demonstrate an understanding of the rudiments of engineering design	○	○	○	○	○
demonstrate an ability for transformation from being an engineering student to becoming an engineer	○	○	○	○	○
function as part of an engineering team in an engineering design project	○	○	○	○	○
demonstrate an understanding of techniques used to solve engineering problems	○	○	○	○	○

Course Topics

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The Introduction to Engineering Course covered the following topics:					
The Engineering Profession and Engineering Disciplines	○	○	○	○	○
Engineering Ethics	○	○	○	○	○
Engineering Licensure	○	○	○	○	○
Basic Engineering techniques, skills and modern engineering tools	○	○	○	○	○
Engineering-related university career and library resources	○	○	○	○	○
Engineering Reports	○	○	○	○	○
Oral Technical Presentations	○	○	○	○	○
Engineering Design	○	○	○	○	○
Engineering Team Work	○	○	○	○	○
Transformational Engineering Education	○	○	○	○	○

Short-Answer Questions

What engineering skills/abilities have you developed upon taking the Introduction to Engineering course?

What parts of this course, if any, did you enjoy or value the most? Please tell us why it was valuable for you.

Which parts of the course, if any, did you value the least?

What area of this course did you find the most challenging? Why?

Comments, Suggestions, and Concerns

References

1. Landis, R.B., "Improving Student Success Through a Model 'Introduction to Engineering' Course," Proceedings of 1992 ASEE Annual Conference, Toledo, Ohio, June, 1992.
2. Hoit, M., Ohland, M., "The Impact of a Discipline-Based Introduction to Engineering Course on Improving Retention", Journal of Engineering Education, January, 1998, pp. 79-85.
3. "Syllabus for ES110 Introduction to Engineering and Lab Experience" (Available from the Sonoma State University Department of Engineering Science, 1801 East Cotati Ave, Rohnert Park, CA 94928) http://www.sonoma.edu/users/k/kujoory/course_materials/es_110/
4. ABET Engineering Accreditation Commission, "Criteria for Accrediting Engineering Programs", June 2012, p.3 http://www.abet.org/uploadedFiles/Accreditation/Accreditation_Process/Accreditation_Documents/Current/eac-criteria-2012-2013.pdf
5. Hutchison, M. A., Follman, D.K, Sumpter, M., Bodner, G.M., "Factors Influencing the Self-Efficacy Beliefs of First-Year Engineering Students" Journal of Engineering Education, January 2006, pp 39-47