

An Interdisciplinary Hands-on Freshmen Engineering Course

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Abstract

The paper is designed to serve as a resource for faculty involved in the instruction of a freshmen level "Introduction to Engineering" course. It contains specific suggestions and course material for day-to-day lecture, hands-on and computer lab activities, along with the ideas behind curriculum topics selection and order. The course is particularly suitable to meet some unique needs of large metropolitan area commuting schools.

Introduction

The main motivation behind the development of a freshmen-level "Introduction to Engineering" course is to better retain engineering-bound students. Quite a few engineering freshmen and sophomores often decide to switch majors to a non-engineering discipline for reasons such as: a) Difficulties encountered during the Calculus and Physics courses, b) Failure to see useful applications to the theory, c) Lack of direct contact with the engineering faculty and d) Inability to see a global picture of the engineering profession in general and the specific engineering disciplines in particular. Many schools around the nation have long recognized that the "old system" of "two years of general background followed by two years of a specific engineering discipline courses" has been highly outdated. The trend nowadays is to connect the engineering-bound students with engineering faculty and academic advisors from Day One.

The course main objectives are therefore: 1) Welcoming the students to university life in general and to the College of Engineering in particular, 2) Development of better motivation for advanced mathematical concepts, through interdisciplinary hands-on applications, 3) Introduction to general engineering concepts and to specific engineering disciplines, again through hands-on experimentation, 4) Introduction to modern software tools for both technical computing as well as technical communication, 5) Introduction to engineering team work, and 6) Introduction to creative problem solving techniques.

Course Logistics

The Florida Atlantic University (FAU) freshmen engineering course, entitled "EGN1002 - Fundamentals of Engineering", is a three credits course, scheduled for four contact hours a week over a 15 weeks semester. Each course section is typically capped at 30 students. Three to four sections are offered each semester during the academic year, taught by instructors coming from different engineering departments.

Classes meet either twice a week for two hours session each, or three times a week, with one of the sessions being two hours long. Hands-on activities are conducted during a two-hour session. Some of these activities are done in a regular classroom, some are done outdoors, and some are done in engineering laboratories (such as an electronics lab or a robotics lab). A one-hour session a week is scheduled in an instruction computer lab, equipped with an instructor computer projection system.

A \$15 Lab Fee was approved by the FAU administration. This provides a modest budget for course consumable materials and for purchase of low-cost equipment. A 10 hours/week of TA time can adequately support students guidance needs during the lab and computer lab sessions for up to two sections.

Course Syllabus and Calendars

A sample course syllabus used in the Spring 2000 semester is in Appendix A. Two sample calendars, one that was used in Fall 1999, and the other, used during Spring 2000, are in Appendix B.

A few discussion points are due in order to better understand the reasons behind the specific ordering of the various course events:

- 1) Many planned activities require that the instructor be flexible and come ready with appropriate back-up activities: a) Outdoor activities may be rained out and require rescheduling. b) Computer

labs may have occasional glitches, as happened for instance on 2/4/2000 - PSPICE didn't run well on that day due to unforeseen software installation problems. The instructor had to quickly switch to another activity - a canned PowerPoint presentation about "How to Write Technical Reports". Projection system malfunctions can occur too.

- 2) The major hands-on experiments (robotics, land surveying, electronics etc) may be done at any order, as long as background lectures are properly scheduled to precede the respective experiments. Electronics Lab experiments are excellent back-up activities to the outdoors experiments and thus should be spread throughout the semester.
- 3) Creative Problem Solving techniques, such as brainstorming, decision analysis and potential-problem-analysis, are better received by the students if tied to the projects. So far, we tried to connect these activities only with the Solar Cooker project.
- 4) Some of the hands-on projects may require a certain amount of internet-based research, graphing, curve fitting and equations solution. This may dictate a certain order to the computer lab sessions, which otherwise may be offered at any order.

Things That Worked

The author has offered the course four times since Fall 1998 and the course is still evolving. Some of the course aspects that appeared to be particularly successful are listed below:

The Solar Cooker Project - Student teams are asked to construct a low-cost solar energy powered hotdog cooker. Safe outdoor meat cooking requires a temperature of at least 160°F maintained for at least 20 minutes. Internet research produces a wealth of design ideas and drawings, mostly along the lines of parabolic reflectors and "greenhouse effect" box-type cookers. It is however the additional insight that comes from actual home experimentation that eventually produces creative original solutions that overcome, for instance, excessive heat loss during a cloudy period. The best design in the Spring 2000 semester (which involved a box-type cooker surrounded by a vertical parabolic reflecting wall) was able to reach boiling temperatures despite the early morning class time. This project provides an excellent opportunity to engage students in technical writing, technical presentations and creative problem solving techniques. See Appendix C for sample course material.

The Land Surveying Experiments and Project - Student teams learn how to use (low-cost low-resolution) transits for measuring distance to a point or between two points and height of objects with an accessible base, using measurements of vertical and horizontal angles. They also learn to triangulate, using two transits, to measure the height of objects whose base is inaccessible. The educational lessons that are gained are many and include a) appreciation for good organization and the careful note-taking required when collecting actual field measurements, b) the need to calibrate instruments, c) the need to cross-verify every measurement, by some alternative means, d) the need to estimate measurement errors and determine the appropriate number of significant digits for the calculation results, e) the need for redundant measurements in order to reduce the error effects. The two-session unit is preceded by single background lecture, which gives also an opportunity to teach students proper note-taking skills. The sessions are followed by a project requiring the teams to conduct all the measurements necessary for preparation of a (hypothetical) campus construction project proposal, such as a rope bridge between two buildings, a water slide from one building to the campus swimming pool etc. See appendix D.

Homework #1 – an Essay “Why do I want to be an engineer?” - See appendix E. This is a wonderful way for the instructor to get to know every student personally right from the start. Our experience has been that students tend to be more than willing to really open up, share their dreams, hopes, ambitions and fears. The instructor's written response is an opportunity to provide good initial academic advising.

The Electronic Soldering Kit – It started as a back-up joke activity: Students pairs were given a \$5.95 soldering kit, in which a successful assembly of the components resulted in lights turning on and off and a siren sound. Inspired by the unexpected students' enthusiastic reaction, the activity was later expanded to include first how to use a digital oscilloscope, and then, following the electronic assembly, students were encouraged to probe the various signals, and modify the circuit. Assembly and soldering errors provide a good opportunity for real-life troubleshooting, using the oscilloscope.

The Logic Design and Electronic Amplifiers Experiments – In these experiments students use breadboards, common electronic chips and components, and basic electronics lab instruments (power supplies, function generators, oscilloscope) to implement very simple amplifier, comparator, and logic functions. Certain amount of active instructor (and TA) guidance and troubleshooting is essential for a successful conclusion of each activity.

The “Open Door Policy” for Computer Lab Assignments – The computer lab sessions are the prime vehicle to convey useful mathematical principles, as applied to engineering examples. We teach (with the aid of an outstanding textbook [1]) topics such as Curve-Fitting and Regression, Optimization with Constraints, Numerical Solution of Linear and Nonlinear Equations – All are new to most students, seem very abstract at first glance, and have theory that for most students (who take courses such as Calculus 1) is almost "totally incomprehensible". The instructor has to motivate, explain the applications and go very slowly, starting with guided step-by-step demonstrated examples, followed by in-class hands-on practice of the new ideas. Unfinished or imperfect works may be completed later at any time and submitted again and again, until it's done right. The educational rewards are enormous - students gain a sense of “power” seeing how strong commonly available computational tools can be, and may gain a much needed respect for “what calculus can do for you”. See Appendix F for sample class material, referring to the textbook [1].

Ideas That Still Evolve

As the course continues to evolve, some ideas that were originally deemed meritorious, still have not reached their final mature form.

The Industrial Robotics Experiment – The experiment involves multiple industrial robotic stations connected through a single conveyor belt. Each robot picks up Lego blocks from various bins, and adds them to an assembled group of blocks sitting on a tray that moves along the conveyor. The machine chooses from two tentative assembly plans according to a simple code residing on the trays. Much of the robotic programs are pre-programmed, with the exception of a few points that are left for each team to program using a teach pendant. Each team also controls the amount of delay time before the tray leaves the assembly station on its way to the next station [2]. Students learn about the importance of precision, and about the need for inter-team communication. Success of this activity depends critically on the instructor's training and ability to debug the process, and on good engineering maintenance support. Industrial robots are very maintenance-intensive. Schools that don't have such an elaborate manufacturing facility, but do have stand-alone robots, may still offer experiments that will require students to do robot programming.

The Mobile Robot Project – The Lego Mindstorms™ robots are enormously popular commercial toys, and they offer endless creative possibilities. Students learn about motors, gears, sensors and robot programming. The course budget was used to purchase a few of these robots during the Spring 2000 semester. A decision was made, because of the strong commuting nature of the class, against allowing the teams to take the robots home. Instead - 5-6 hours of class time were freed up to allow the students to do everything in-class. The activity is still evolving, but it appears that the class time is not used efficiently. It is one matter to have a group of knowledgeable team members debate in class the way to optimize a design to fit a given competition requirements. It is a different matter to only explore the basics in-class. In the future, it is imperative that the basics be covered by the instructor in one or two class sessions, to ensure that all the students are brought to the same base-level knowledge. Only then, students may be left alone to explore further possibilities. See Appendix G for the class assignment used in Spring 2000.

The Image Processing Unit – This activity is designed for two to three computer lab sessions. In the first session, students use Excel to study a simple 8x8 pixels matrix representing a hypothetical "image" of a 3x4 dark object against a light background. They learn about image binarization, object area, object centroid and edge detection. This session is also a good opportunity to educate students about vision-driven autonomous vehicles. What is still evolving from one semester to another are the follow-up sessions that involve the image processing of a real image (see Appendix H). In Fall 1998, students used a camera and ITEX PC VISION PLUS™ to take snapshot of familiar objects (key, pencil, screw, student's initials scribbled on a piece of paper). We created the BASIC program that extracted a (up to) 200x200 pixels text file. Students then converted it to an Excel format, learned about histograms and binarization thresholding, how to work with multiple worksheets and how to shrink a spreadsheet, so they could actually view the image. Main drawbacks were the lengthy photo session, and the quality of the images - there was lots of reflection effects and other lighting problems. In Spring 1999, we decided instead to create a web-based library of text file images, that students downloaded at the beginning of the second session. We found that the drawback was that most students could not recognize the canned images. This year, a new NSF funded undergraduate Image Processing Lab was created [3], and one plan is now to expose the students to real-life image processing hardware and software in place of Excel. Another possibility is to purchase a digital camera and the software that converts jpeg files to Excel format.

Integration of Lectures, Computer Lab Experiments and Hands-on Activities – From an educational viewpoint, it is important that the course does not degrade into a smorgasbord of disjoint activities. Ideally,

every skill gained in the computer lab and every creative problem solving technique, practiced at the interactive lecture sessions, must find their applications in some of the experimental hands-on activities. Practically, some skills/concepts that are covered may never be actually practiced during the course, but may come handy later on during the students engineering studies. The solar cooker project involves internet-based preparation, brainstorming and decision analysis sessions [4] (and Appendix C). The land surveying activities may require some graphing and equation solving. The electronics lab session is preceded by PSPICE simulation session (Appendix I). Students complain though that the textbook [4] is not utilized enough to justify the cost.

Introduction to the Engineering Disciplines – The original idea was that rather than the instructor lecture about the various engineering disciplines, let students teams research the topic, and present it to the class. The research may include interview of faculty, students and practicing engineers. (See Appendix J) Experience has been that many of these presentations lacked depth and breadth. In Fall 1999, students presentation were augmented by class discussions moderated by guest faculty from the various departments. This was done in only one course section, time did not permit replication of these meetings. It was found out that the guest faculty spent most of their time on lecturing about the disciplines, and only a fraction of the period was actually a dialogue with the class. This raises an idea for the near future - let the guest faculty videotape their presentations, so these can serve as permanent resource reference for the course instructors., possibly even as a web-material information. Implementation of this plan during Spring 2000 was delayed, so the job of post-students-lecture clarification fell on the course instructor's shoulders, but the issue is still open and awaiting a stable solution.

Teams Selection Strategy – In the first few semesters student teams were configured at random, and some severe problems arose. Some teams performed very well, and some teams did not function at all, which was very demoralizing to the respective team members. Commercially available questionnaires, designed for a more scientifically-based matching of people with complementary skills and "brain-type" exist but are too expensive and beyond the means of the course budget. In Spring 2000, the following team selection strategy was attempted: Students were divided first according to their intended major area, with the intent of creating multidisciplinary teams. Students with any type of leadership experience (of a sports team or on a past job) were identified and put as temporary group leaders. Students with special hands-on experience (computer whizzes, mechanics, electricians etc.) were identified, and spread evenly over the various teams. The remaining students were hand-picked by the group leaders on a rotation scheme. Despite all that some teams still did not function at an acceptable level. The issue is open and awaiting a solution.

Other Open Issues - Other unresolved issues, that keep changing form every semester, are the method of grading for attendance (How many points? If and how to penalize excessive absences? Should we distinct between active and passive attendance? See Appendix A for the method used in Spring 2000), the method of grading individuals for their team work effort (Should peer reviews be conducted? If so, should it be after each project, or should it be done at the end of all the projects? See Appendix K for the method used in Spring 2000), and the extent of coverage of Engineering Ethics. In Spring 2000, the latter topic was used only as a back-up filler for a rained-out outdoor activity. We ended up discussing engineering ethics case studies during the solar cooker hot dog party.

Ideas That Fizzled

- 1) Required weekly Project Progress Reports were attempted to make students spread their project efforts over the entire allotted period, rather than cramming the night before the deadline. In the solar cooker project, home testing prior to the big demonstration meeting is essential. (In Fall 1998 most groups said that "they could not test the project at home because it was dark outside..."). Results of the progress reports were poor, as these reports tended to be extremely uninformative.
- 2) Inter-section Pizza Party – The idea was to convene all the course sections to a big joint meeting, with agenda items such as Introduction to the Engineering Societies, Industry Speakers and Alumni Speakers. This forum can also serve as the Finals for student robotic competitions. The idea was tried once and failed due to low participation. This is typical of commuting schools, where most students engage in off-campus jobs.
- 3) Teams Contracts – Some schools attempted successfully the concept of a team-developed contract, to assure that all team members commit to whole-hearted good participation. The idea was tried and made no impact, as team members hesitated to "fire" non-functioning team members.
- 3) Make-up Times for Unfinished Experiments – Low attendance has convinced us to abandon the idea.

Open Educational Issues

Many educational issues will always remain highly controversial. This report will focus primarily on direct feedback obtained from the students themselves, using an essay-type questionnaire (See Appendix L). The end-of-semester essay counted as regular homework assignment, thus providing the motivation to all students to respond. Most responses appeared to be sincere – most students did not hesitate to strongly criticize course elements that, in their opinion, did not work.

Written Exams – Should the course contain written exams? Nearly 100% of the students think that the course should not. They all mention the introductory nature of the course, how exams may spoil the fun, the pressure that they experience in their calculus, physics and chemistry courses etc. Some argue that the project demonstrations and the technical presentations are like oral exams. So why is the issue considered controversial? It is the author's feeling that many students tend to treat the course as "relatively unimportant" even though it is a three credit course like the chemistry and physics courses. Project skipping and unmet deadlines due to other courses constraints, even though not widely spread, are not uncommon either. I am now convinced that statements like the one made at the end of the Spring 2000 syllabus (see appendix A) or "you should be a genius to fail this class" (said during the first orientation meeting) are out of place. Every semester I find to my chagrin several such "geniuses"... Passive participation can be widespread if the instructor does not vigorously fight against it: In a background lecture, students should be asked to turn in their class notes for grading, creative problem solving sessions must include in-class written assignments, lab demonstrations or experiments must include some brief written reports etc. The biggest drawback is the increased grading load and loose paperwork in the instructor's office, a small price to pay.

Industry Tours – Students repeatedly ask that such tours be organized, however schedule intersection of the class, which consists mostly of commuting students, many of whom work 20-30 hours a week somewhere, nearly certainly produces a null set. Arbitrary tour time scheduling often lead to low participation, something that we cannot afford with our industry friends. Need to combine the students of all courses sections to assure decent number of visitors. The tours organization should be delegated to the various engineering society student chapters.

How to Deal with Slackers and course quitters– Failing the course is almost always a result of poor attendance. Attendance problems may be a sign of severe personal/family problems, a result of technical or social misfit, or plain immaturity. It is important to involve at this point the designated college freshmen coordinator/liaison. Some students honestly do not belong in engineering, and finding out about it after one semester, rather than after two years is actually a big blessing for them. Some students ask for a second chance, and the author tended to be more lenient in awarding an Incomplete course grade in a course like that. Students then have a chance to retake the course the next semester without adverse GPA consequences. In some cases, the second experience proved to be a big success, in other cases, the students ended up failing again.

In this course the instructor gets to know each student by name, and by brief whereabouts, very early during the semester. It is a good idea to maintain a list of students' phone numbers and e-mail address, to facilitate instructor-initiated communication. Internet-based bulletin boards and chat rooms, even though not yet attempted in this course, is definitely a way of the future.

Author's experience with mid-semester course quitters has been that such a decision is almost always made by an impulse. It is amazing how often far-reaching career decisions, such as a change of an engineering major, or quitting engineering altogether, are made without or with very little consultation with faculty, advisors, peers, friends or anybody at all. Talking to the class about it, or even inclusion of statement in the course syllabus appear to produce no results. Issue is open.

"Meeting Deadlines 101" – Many high school teachers are unforgiving about late submission of homework. Yet, many freshmen experience severe difficulties in meeting deadlines. The problem is most evident during the scheduled team PowerPoint presentations – some students, whose presentation is not ready, often opt not to show up to class at all. Excuses such as "Freddy had the floppy disk, but he is not in class today", "The presentation ran fine on my computer, but the file is gone (not running, can't download etc.)", " We thought that you meant next Friday" are common. Some instructors fight against this phenomenon by creating grade incentives or penalties. I tried it with poor results. What worked better was to hammer to the students brains again and again the immortal Apollo-13 motto "Failure is not an option" – Have all the team members have each a copy of the presentation, Try the presentation on one of the cluster

computer to assure that it runs, Make back-up transparencies and/or hand-out notes for the audience, e-mail the instructor your presentation.

Faculty Training – One of the biggest problems with hands-on interdisciplinary course, is faculty reluctance to perform experiments outside of their own discipline. A mechanical engineering professor may feel extremely uncomfortable in an electronics lab, and vice versa – an electrical engineering professor may avoid a bridge design construction project, or an aerodynamics design, such as boomerangs, rockets or gliders. The sad result is an unnecessary fragmentation that may not work to the advantage of the students. The various section instructors should communicate on an on-going basis, and should train each other on the experimental aspect of their course. The issue is open.

Course Outcomes Assessment – We must judge the long-term outcomes. After teaching the course for two years, the author is beginning to meet some of his EGN1002 graduates in later courses. He encountered a few cases of students who received A in EGN1002, but ended up failing a course such as Networks Analysis I, a frustrating experience that leave you wondering whether or not students who go through the Fundamentals of Engineering course really get the right message and acquire the right study habits. The issue is open – statistics of failure or success in discipline courses, and in particular in senior design, will become more and more reliable as time goes by.

Conclusion

The paper is intended as a resource to professors. As such it needs to be placed on the web, and be maintained to include newly coming information. Plan is to keep adding actual course material appendices, and links to other similar course web sites.

Some schools have begun to experiment with a follow-up to such a course. A prime candidate is the Introduction to C (or C++) Programming course, that can be made more engineering hands-on problem solving course. Some schools experiment with an integrated mathematics/physics/engineering curriculum. All these efforts address the same fundamental problem. Time will tell which method works best.

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References

- [1] Byron S. Gottfried, "Spreadsheet Tools for Engineers - Excel 2000 Version", McGraw-Hill 2000.
- [2] "DARL Programming Manual",
<http://www.ee.fau.edu/esp/alternate/DARLMANUAL.html>
- [3] Hanqi Zhuang and R. Sudhakar, "Undergraduate Laboratory for Image Processing", NSF grant ILI Program, 8/1998-7/2000
- [4] H. Scott Fogler and Steven E. LeBlanc, "Strategies for Creative Problem Solving",

Appendix A: Sample course Syllabus

EGN1002 – Fundamentals of Engineering Spring 2000 (Course sequence 3274) COURSE SYLLABUS

Instructor: Dr. Zvi S. Roth
Professor, Department of Electrical Engineering
Florida Atlantic University

Campus Address: Science & Engineering Building (Bldg 43), Room 470

Campus Phones: (561)-297-3471 (from a campus phone dial 7-3471)
Fax – (561)-297-2336

e-mail: rothz@fau.edu

Class Time and Place: M 8:00-8:50 AM FLH319
W 8:00-9:50 AM FLH319
F 8:00-8:50 AM FLH422 (Computer Lab)

Other Meeting Places: Some of the hands-on activities on Wednesdays will be conducted in either the Electrical Engineering Electronics Lab (Science and Engineering 350) or the Robotics Lab (Science and Engineering 150). See attached calendar.

Office Hours: M F 9:00-10:00 AM, T Th 10:00-11:00 AM or call for appointment.

Course Objectives: 1) Roadmap to FAU 2) Introduction to the Engineering Profession and various Disciplines 3) Basic engineering concepts and tools 4) Development of proper study skills and time management habits 5) Introduction to Engineering Design and Creative Problem Solving, through hands-on experimentation and team work. 6) Technical Communication: Presentations and Reports.

Grading Policy:

There will be no written exams. Grade will be based on homework and classroom assignments, design projects and class presentations, as follows:

Homework assignments (7 assignments, 5% each)	35%
Computer lab classroom assignments (10 assignments, 1.5% each)	15%
Presentations (2 team presentations, 5% each)	10%
Projects Conduct and Team Work	20%
Class (other than Computer Lab) Assignments	20%

There will be no curving of the final grades. Instead the following linear scale will be used:

90-100%	A	,	85-89%	A-	,	80-84%	B+	,	75-79%	B
70-74%	B-	,	65-69%	C+	,	60-64%	C	,	55-59%	C-
50-54%	D+	,	45-49%	D	,	40-44%	D-	,	0-39%	F

A passing grade for all Engineering Core Courses is a C. All grades that fall 1% or less short of any grade threshold will be reviewed for possible "special consideration" grade increase.

Textbooks:

- 1) H. Scott Fogler and Steven E. LeBlanc , "Strategies for Creative Problem Solving", Prentice Hall 1995
- 2) Byron S. Gottfried, "Spreadsheet Tools for Engineers - Excel 97 Version", McGraw-Hill 2000. [The earlier 1998 Excel 97 version is ok too].

Homework:

All essays and reports must be typed and each is due one week from the day given. Some of the homework is individual and some is a team assignment. All team members are expected to contribute and be involved in any of the team assignments. The same grade per assignment will be shared by all team members.

Each homework assignment (if done perfectly) will worth 5% of the total course grade. Meeting deadlines is important. A 1% (out of 5%) of an assignment grade will be deducted for late submission.

The following is a tentative list of homework assignments:

- H.W.#1: 600 word essay "Why do I want to be an engineer?" (individual)
H.W.#2: Internet Search Project (600 words). Research for the Solar Cooker project. (individual)
H.W.#3: Solar Cooker - Brainstorming, Decision Analysis and Potential problem analysis. (team)
H.W.#4: Technical Report - Solar Cooker Project final report. (team)
H.W.#5: Engineering Disciplines Report (900-1200 words) and PowerPoint presentation. (team)
H.W.#6: Land Surveying Project Technical Report. (team)
H.W.#7: Essay - Course Evaluation (1200 words) (individual)

Computer Lab Classroom Assignments:

The instruction of the various technical topics and computer tools will involve guided independent work in class. All classroom assignments are individual. Each student is expected to bring to the computer class his own floppy disk and printer paper. All assignments are expected to be turned in at the end of the class. However students may finish the work or add supplements of unfinished work (completed at any of the FAU open computer clusters) at any time during the semester. There is an "Open Door" policy for all computer lab class assignment. That is, students may resubmit graded works again and again until each is done right.

Try very hard not to be late to the computer lab sessions. Late comers may experience severe difficulties in catching up with the class activity. The first half of a computer lab class is normally devoted to instructor's demonstration, whereas the second half is for individual hands-on work and practice of the newly learned concepts.

This is a tentative list of the expected class assignments:

- #1: EXCEL basic spreadsheet techniques
- #2: Internet Search.
- #3: EXCEL graphs and curve fitting.
- #4: EXCEL optimizations - maximum volume tank design project.
- #5: PSPICE - Electronic Amplifiers
- #6: EXCEL Introduction to Image Processing.
- #7: EXCEL Image Processing with real images.
- #8: EXCEL Equations with single unknown.
- #9: EXCEL Equations with multiple unknowns.
- #10: EXCEL Pie Charts; Projects Peer Reviews

Projects Conduct and Team Work

There will be two design projects - Solar Cooker and Land Surveying, as well as several other team activities. Ample class time will be provided for the teams to interact and plan. In addition teams are encouraged to communicate via the course's WebCT chat rooms and bulletin board. The address is <http://vu.fau.edu:8900/>. The student login is the first initial of the first name followed by the first three initials of the last name followed by the last four digits of the social security number (all in caps). The password is the first four digits of the social security number. [Example: George Washington with SS# 123-45-6789 will have a username GWAS6789 and a password 1234.]

Projects will be graded by the instructor on the quality of research done, originality and problem solving resourcefulness, design details and quality of construction (Solar Cooker only). Grades are individual and may add up to 10%.

The remaining 10% of this category will be determined by the team members' peer reviews of each member's effort and contributions. A student who receives less than a C grade in his peer review grade will forfeit the entire 20% Projects Conduct and Team Work grade.

Class Presentations

Teams will prepare and deliver two PowerPoint presentations. The first presentation (5 minutes long) will summarize the Solar Cooker project experience. The second presentation (20 minutes long) will inform the class about one of the engineering disciplines. Each presentation will be graded based on the demonstrated research done, quality of delivery of the presentation and quality of the handout notes. Perfect performance will earn each student up to 5% for each presentation. Grades for presentations are individual.

Each team is expected to e-mail the instructor their PowerPoint presentation at least 24 hours prior to the actual scheduled class delivery. A 1% (out of 5%) of a presentation grade will be deducted for failing to do so.

To assure that the presentation will definitely be delivered on time please 1) make sure that each team member holds a copy of the presentation floppy disk. 2) Try test running the presentation on any of the

campus computers, prior to class delivery. 3) Prepare back-up transparencies and/or handout prints, so that the presentation is delivered even in case of the computer lab equipment (computer, projector) failure.

Other Class Assignments:

Students are expected to attend all class sessions. Class attendance is not graded directly. However, most of the meetings will require active participation and some sort of individual written output. Students may miss up to 4 class assignments (for any reason) and still receive the full 20% grade. Missing 5-8 assignments will result in a loss of 10%. Missing more than 8 classes will forfeit all Other Class Assignment points.

Sign-up sheets will be circulated during the first 10 minutes of each class - It is the student's responsibility to make sure that his/her signature is on the sign up sheet.

In Summary:

- 1) It is relatively easy to get an A grade in this course. All it takes is to show up to all the meetings, participate actively in all the activities, be punctual and be a good team player.
- 3) If any difficulty of any sort is encountered, please talk about it with the course instructor as soon as possible, so that some solution to the problem can be worked out.
- 4) Avoid rush decisions: Dropping a course, Changing a Major – are all career affecting decisions with far-reaching implications. Think carefully before taking such actions. Talk to as many people as possible, including the course instructor, so any such decision is sound beyond any doubt.

Appendix B - Sample Course Calendars

EGN1002 - Fundamentals of Engineering (Fall 1999) (Revised 9/17/99)

COURSE CALENDAR

Classes are on W and F: First hour on W is Computer Lab, F- Hands-on

Week	Date	Topic	Assignment
1	W 8/25	Internet Search (FLH422) Course syllabus; Roadmap to FAU (ED123)	
1	F 8/27	More Roadmap to FAU; Construction Project - Candy Tower (ED123)	H.W.#1
2	W 9/1	EXCEL basics (FLH422)** Engineering Estimates: Data Collection (outdoors)(* in case it rains)	Class #1 Class #2(a)
2	F 9/3	Paper Bridge Project (ED123)	H.W.#2
3	W 9/8	EXCEL graphing (FLH422)** Engineering Estimates: Analysis (ED123)	Class #3 Class #2(b)
3	F 9/10	Electronics Lab - Soldering (SE350) AND Control Lab - DC Servo Motors (SE314)	
4	W 9/15	Hurricane Floyd	
4	F 9/17	Solar Cooker Design: Brainstorming and Decision Analysis (ED123)*	H.W.#3
5	W 9/22	PowerPoint - How to Write Technical Reports* (FLH422) Logic Design Tutorial (ED123)	
5	F 9/24	Electronics Lab - Logic Design (SE350)	
6	W 9/29	EXCEL Solver - Tank Design Project (FLH422)** Land Surveying Tutorial (ED123)	Class #4
6	F 10/1	Hotdog Party - Solar Cooker Demonstration (outdoors. Meet first at ED123)(* in case it rains)	H.W.#4
7	W 10/6	PSPICE: Electronic Amplifiers (FLH422) Problem Definition Techniques*	Class #5
7	F 10/8	Land Surveying Experiment (outdoors. Meet near SE150)(* if it rains)	
8	W 10/13	Solar Cooker PowerPoint Presentations I (FLH422) Introduction to Robotics (ED123)	
8	F 10/15	Electronic Amplifiers Experiment (SE350)	H.W.#5

		OR Robotics Experiment (SE150)	
9	W 10/20	Solar Cooker PowerPoint Presentations II (FLH422) How to Do Technical Presentations (ED123)*	
9	F 10/22	Robotics Experiment (SE150) OR Electronic Amplifiers Experiment (SE350)	H.W.#6
10	W 10/27	EXCEL Introduction to Image Processing (FLH422)** Troubleshooting Techniques (ED123)*	Class #6
10	F 10/29	Land Surveying Project (outdoors -meet near SE150)(* if it rains)	
11	W 11/3	Civil Engineering + Mechanical Engineering PowerPoint Presentations (FLH422) Civil Engineering + Mechanical Engineering : Faculty, Student Societies (ED123)	
11	F 11/5	EXCEL Image Processing (real images) (FLH422)** Computer Science + Industrial Engineering PowerPoint Presentations (FLH422)	Class #7
12	W 11/10	Electrical Engineering + Computer Engineering PowerPoint Presentations (FLH422) Electrical Engineering + Computer Engineering : Faculty, Student Societies (ED123)	
12	F 11/12	PSPICE Logic Design (FLH422) EXCEL Equations (FLH422)**	Class #8 Class #9
13	W 11/17	Ocean Engineering + Bioengineering PowerPoint Presentations (FLH422) Ocean Engineering + Bioengineering : Faculty, Student Societies (ED123)	
13	F 11/19	MATLAB Tutorial (FLH422)	Class #10
14	W 11/24	Engineering Ethics (ED123)* Potential Problem Analysis (ED123)*	H.W.#7
14	F 11/26	THANKSGIVING	
15	W 12/1	Course Wrap-up: More Roadmap to FAU and the Engineering Profession (ED123)	

* - Bring Textbook [1] (Creative Problem Solving)

** - Bring Textbook [2] (EXCEL)

EGN1002 – Spring 2000
Course Calendar [3/10/2000 Version]

Classes are on M,W,F : W - two-hours hands-on activities, F - Computer Lab

Week Dates	Mondays	Wednesdays	Fridays
1 1/10-1/14	Course Introduction	COOP Candy Tower Construction	Internet Search
2 1/17-1/21	M.L. King Jr. Day No School	Paper Bridge Construction Roadmap to FAU	Excel Basics **
3 1/24-1/28	Problem Definition*	Engineering Estimates (outdoors)	Excel: Graphing **
4 1/31-2/4	Robotics Tutorial	Robotics Lab Tour	PSPICE Introduction Tutorial: How to write Technical Reports
5	Solar Cooker Project:	Industrial Robotics	Excel: Optimization **

2/7-2/11	Brainstorming*	Experiment	
6 2/14-2/18	Solar Cooker Project: Decision Analysis*	Industrial Robotics (Continued) Electronics - Soldering	Excel: Equations with Single Unknown **
7 2/21-2/25	Special Computer Lab Session: PSPICE make-up ED117	Electronics Lab: Instruments Familiarization Soldering	Excel: Equations with Multiple Unknowns **
8 2/28-3/3	Tutorial: How to Deliver a Technical Presentation	Electronics Experiment: Amplifiers and Comparators	Excel: Introduction to Image Processing **
9 3/6-3/10	Tutorial: Logic Design	Solar Cooker Project Demonstration (outdoors)* Discussion of Engineering Ethics case studies	Excel: Image Processing with real images (Histograms, Binarization, Visualization)**
10 3/13-3/17	Spring Break	Spring Break	Spring Break
11 3/20-3/24	Troubleshooting*	Electronics Experiment: Logic Design	Solar Cooker PowerPoint Presentations
12 3/27-3/31	Tutorial: Land Surveying	Land Surveying: Theodolite Familiarization (outdoors)*	Excel: Image Processing with real images (Areas, centroids, edge detection)**
13 4/3-4/7	Electronics Lab: Mobile Robot Project	Land Surveying Experiment: Triangulation Concept (outdoors)*	Introduction to MATLAB: Solution of Equations, Graphing
14 4/10-4/14	Electronics Lab: Mobile Robot Project	Land Surveying Project (outdoors)*	Engineering Disciplines PowerPoint Presentations
15 4/17-4/21	Electronics Lab: Mobile Robot Project	Control Lab: DC Motors - Servo Control Electronics Lab: Mobile Robot Project	Engineering Disciplines PowerPoint Presentations
16 4/24-4/28	Electronics Lab: Mobile Robot Project Project Demonstration	Computer Lab: Peer Review** Engineering Ethics wrap-up; Course Wrap-up	

* - **Bring Creative Problem Solving Textbook** (Some Creative Problem Solving activities will serve as alternative activities in cases of cancelled outdoor activities due to weather conditions).

** - **Bring Excel Textbook**

Appendix C: Solar Cooker Project Handout Material

EGN1002 Fundamentals of Engineering Spring 2000 Homework #2

The results of the following Internet Search assignment will be useful as preparation for the upcoming Solar Cooker project.

Project Requirement: Need to cook a hot dog using a low cost portable device that utilizes the sun energy.

Web Search Requirements:

- 1) Search the web (using appropriate keywords) for any useful information about solar cookers.
- 2) Search the patents site (<http://www.patents.ibm.com>) for existing patent ideas on the subject.
- 3) Pay attention to issues such as: a) How are the sun rays focused? Are all devices use parabolic surfaces? What is the principle of operation? b) What materials are used? To make the device real low cost can one use cardboard paper, aluminum paper etc.? c) What are the recommended dimensions for the device to be able to achieve high enough temperature near the hot dog

- skewer? d) How is the heat retained inside the device during cloudy periods? Is there a recommendation for certain insulating material? What should be the device's exterior paint? e) How do we point the device toward the sun? f) Where inside the device should the thermometer(s) be placed?
- 4) Search the web for information on **recommended safe cooking temperature and time** for hot dogs. Hint: This information is a little tricky to find. Look for meat cooking in general and for appropriate standards.

Summarize your findings in a 600 words essay. Devote one page to the "how" part of the search: What search engine and keywords proved to be the most helpful? Which web site addresses contain the best information? Devote the second page of the essay to the actual search results. You may include copy of interesting data figures and drawings as an appendix to your essay.

Due Date: 2/4/2000

EGN1002 - Fundamentals of Engineering Brainstorming

Brainstorming is a group activity designed to generate creative solutions to a given problem. Three basic rules must be followed:

Rule 1: Generate as many solution ideas as possible. Quantity counts!

No long explanations - just "bullets". It's ok to "hitchhike" or build on other people's ideas. Share all your ideas - somebody else may use your idea as a stepping stone to another idea. The more ideas generated collectively, the better the chances of hitting an innovative solution.

Rule 2: Wild ideas are welcome.

Don't be afraid to throw in odd, weird, impossible or crazy ideas. Avoid however being potentially offensive to some of your team mates.

Rule 3: No criticism is allowed - judgement is deferred until later.

There is no such a thing as a dumb idea. There are no right or wrong answers in brainstorming. Humor, favorable cheering comments, encouragement are ok.

Brainstorming Procedure:

- 1) The team appoints a leader to moderate the brainstorming session. The leader is on charge of timing, note taking etc.
- 2) Session must start with a 5-minutes warm-up exercise. Need to pick up a topic for which everybody has something to say. Examples: "How should the rules of Football (or Basketball) be changed to make the game accessible to a wider group of players?" or "Find different uses to a given object (such as a Calculus book, a pen etc.)".
- 3) At the beginning of the real brainstorming session each team member need to spend 5-10 minutes thinking about solutions. Each individual must write down his/her ideas on a piece of paper.
- 4) The ideas are read aloud to the whole team. One member starts, while others review their notes. As the solution ideas are read, if one of your ideas have been mentioned by somebody - scratch it out to avoid duplicity. If somebody else's idea inspires you to a follow-up or another idea - quickly add it to your notes. The team leader is on charge of maintaining the cumulative list of all new ideas.
- 5) (optional) Repeat the thinking process for a very few minutes, and then repeat the reading-aloud process.
- 6) (optional) Free format group discussion

EGN1002 - Fundamentals of Engineering (Spring 2000)

Solar Cooker Project Brainstorming

By now you have all conducted the internet-based research of the topic. Each of you have some idea what does it take to construct a solar cooker. There are many open issues though. Brainstorming techniques may be appropriate in addressing one or more of the issues listed below:

- 1) 2D parabolic surfaces (i.e. Surfaces that have a fixed parabolic cross section along an axis) are very good in focusing the sun energy along a line that goes through the parabola focus point perpendicularly to the parabola surface. One may place a skewer along this line. It is critical though that the surface be constructed accurately. How should one build an accurate 2D parabolic surface?

- 2) A 3D parabolic dish can focus the sun rays in a point, however such surfaces are harder to construct than 2D parabolic surfaces. How should one build or acquire a parabolic dish?
- 3) Our class runs early in the morning - Need to tilt the device towards the sun. How is that to be done?
- 4) When clouds temporarily hide the sun, it is critical that the device be able to retain the heat generated up till that point. How is that done?
- 5) Each group will be given with one thermometer, but more thermometers may be used. Where inside the device shall the thermometers be placed for best feedback on heat distribution during the experimentation.
- 6) Past experience showed that groups had a hard time finding good group meeting times off-school. It is very important though that home experimentation is conducted prior to the hot dog party date. Discuss creatively what can be done to bring the group together and to assure that everyone shows up.
- 7) How should multiple hot dogs be cooked? Can the entire team be fed during the two hours of the hot dog party?
- 8) Does one need to constantly reorient the hot dog that is being cooked for best cooking effect? How to avoid heat loss when accessing the food during cooking?
- 9) If it is a very windy day - How should the light cardboard cooker be anchored or secured better from the wind?
- 10) A popular design is that of a covered box, taking advantage of the "greenhouse effect". How should one make sure that enough heat is captured and retained? What type of lid should be used?
- 11) The bigger the cooker the better are the chances of fast cooking. Big device however are more difficult to handle in terms of transportation to FAU. For a hypothetical big device, discuss how will the transportation be arranged.

What to do: (Homework #3 Part I)

- 1) Choose one of the topics above for a in-class brainstorming. Each student should (later at home) describe in writing his experience from this session.
- 2) Pick up one more topic from the above list and let the team run one more brainstorming off-class. Again, each team member should summarize the session process and results. You may use the class WebCT chat rooms to conduct the brainstorming.

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**Homework #3 Part II
Solar Cooker Decision Analysis**

The Solar Cooker project announcement (provided earlier) contains a list of "musts" and "wants" for the project.

The collective internet research effort (Homework #2) of all the team members must have produced several different design possibilities - 2D parabolic surfaces, 3D parabolic surfaces, box cookers and more. **It's important not to jump into the first idea that you liked.** Teams need to be open minded and assess what need to and can be done. This part of the homework was designed to force each team to honestly review multiple design choices.

Apply quantitative Decision Analysis (as described in Fogler and LeBlanc's book pages 98-103) to the problem of Solar Cooker Design Method Selection. Initially each team member should do it individually. Later the entire team needs to redo the exercise together. Both output sets, the individual sheets and the team sheet should be submitted collectively by the team.

Read the textbook's Cautions (at the bottom of page 103). The method is sensitive to intentional or subconscious biasing. It's possible to tilt the results by adding, for instance, too many "wants". Therefore, useful as such a study may be, it is not a substitute for good old common sense. It's ok for the team to choose to ignore the Decision Analysis results.

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The Solar Cooker Project (2/28/2000 version)

Refer to Homework #2 for background research on Solar Cookers. This is a team project. Each team needs to construct a low-cost (i.e. the total project budget for the entire team must not exceed \$30) Solar Cooker,

capable of cooking a hotdog outdoors. That is, the cooker, during a two-hour outdoor session, must be capable (at least once) of reaching a temperature of 165 °F and maintaining it for at least 20 minutes.

Desired (but not essential) features of the cooker are: 1) Ability to cook enough hotdogs to feed the entire team. This may be done by either cooking the hotdogs one at a time sufficiently fast each, or by cooking all the hotdogs simultaneously. 2) Ability to study the temperature distribution throughout the device - near the food as well as at other regions of the cooker. 3) Portability - Ease of transportation to FAU.

You may add more desired features such as aesthetic design, ability to cook other types of food, ability to distill water, but it is recommended that the team initially focuses on the "musts" and later on the important "wants" only.

Key Dates and Deadlines:

Monday 2/7/2000 - In-class brainstorming kick-off session. Homework #3 (Part I) given.

Friday 2/11/2000 - Solar Cooker Project Announcement.

Monday 2/14/2000 - In-class Decision Analysis session. Homework #3 (Part II) given.

Monday 2/21/2000 - Homework #3 is due. One thermometer is loaned to each team

Friday 2/25/2000 - Progress report #1 is due. Reports should be in writing, one per group. Format - free. Report should include a detailed final design and description of all design considerations.

Monday 3/6/2000 - Progress Report #2 is due. The report must contain details about the temperature measurements and other experimentation conducted earlier at home. Any design changes, with respect to the original design, described in the first report, should also be explained and illustrated. Include in the report a photo of the device

Wednesday 3/8/2000- Hot Dog Party. There will be an outdoors demonstration of the projects (weather permitting). Hot dogs and marshmallows will be provided by the instructor. Each team will be required to conduct temperature measurements during the cook-out process..

Wednesday 3/8/2000 - Homework #4 (Solar Cooker Technical Report requirement) and PowerPoint presentation requirements are given.

Wednesday 3/22/2000 - PowerPoint Presentations e-mail to Dr. Roth is due (rothz@fau.edu).

Friday 3/24/2000 - Homework #4 (Final Team Technical Report) is due. Reports must be written according to the Technical Reports Format discussed in class.

Friday 3/24/2000 - Team PowerPoint Project Presentations class delivery.

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Homework #4 - Solar Cooker Technical Report

This homework is a team activity. Following the "How to Write Technical Reports?" guidelines, generate a technical report about the solar cooker project **in a standard format**.

Follow the last four slides in the above PowerPoint presentation for specific instructions related to the solar cooker project technical report.

Report is due on Friday 3/24/2000.

PowerPoint Presentation #1

Each team must prepare a 5-minute PowerPoint presentation about the project. All team members must participate almost-equally in the actual delivery of the presentation. That amounts to 1-2 slides per person.

More specifically:

- 1) Try to include one photo of your project in your presentation. However, if you plan to show multiple photographs, be aware that all may not fit onto the same floppy disk.
- 2) If your presentation is on a floppy, make sure ahead of time that the presentation runs well on any of the campus computers. Also, let each team member have one copy of the floppy.
- 3) The computer lab is wired to accommodate laptop presentations. If you wish to deliver the presentation from a laptop (which allows for the inclusion of audio effects) you need to test it ahead of time to assure smooth running.
- 4) As a back-up option, prepare either one set of transparencies or enough copies of handout notes (six slides per page) for the class.
- 5) **The presentation must be e-mailed to Dr. Roth by the end of the day Wednesday 3/22/2000. Address is rothz@fau.edu.**
- 6) **Presentation delivery date is Friday 3/24/2000. No make-up presentations are possible.**

Appendix D: Land Surveying Handout Material

EGN1002 – Fundamentals of Engineering (Fall 1999)

How to Work With a Transit?

1) Tripod Set-up

- 1.1. Loosen the strap around the tripod legs.
- 1.2. Lift each of the three leg-extension clamps.
- 1.3. With the tripod still closed extend all three legs equally to roughly eye-level and tighten the leg extension clamps.
- 1.4. Open the three tripod legs sufficiently wide and position them on the floor/ground in a triangular shape. Make sure that the tripod head surface is approximately level.
- 1.5. (if setting the transit on the ground) Fix the tripod legs firmly into the ground by pressing on the tripod shoes.

2) Setting the Telescope Instrument on top of the tripod

- 2.1. Set the instrument box in an upright position and open it. Note how the instrument is packed so that it can be put back in the same position.
- 2.2. Do not remove the plumb bob. We are not going to use it this semester. This weight is used to make sure that the transit is positioned exactly above a surveying point (when doing precision mapping).
- 2.3. Take off the tripod's centering screw cover and store it in the instrument case.
- 2.4. Take out the instrument gently from its carrying case, and carefully position it at the center of the tripod head. Keep holding the telescope while you insert the centering screw into the base plate. Make sure to align the threads properly. Firmly screw the instrument until it fits tightly to the tripod. However don't over tighten (not to damage the threads.).
- 2.5. Take off the lens cover and store it too in the instrument case.

3) Recognize the Instrument's Knobs

- 3.1 Starting from the bottom: The four knobs sandwiched between the base plate and the instrument body are the leveling screws.
- 3.2. There are two screws located on the body of the instrument, both are related to the telescope horizontal motion; The screw that is located right underneath the eye piece is the Horizontal Clamp Screw. When tightened it prevents any

EGN1002 – Fundamentals of Engineering (Fall 1999)

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- 2.5. Take off the lens cover and store it too in the instrument case.

3) Recognize the Instrument's Knobs

- 3.1 Starting from the bottom: The four knobs sandwiched between the base plate and the instrument body are the leveling screws.
- 3.2. There are two screws located on the body of the instrument, both are related to the telescope horizontal motion: The screw that is located right underneath the eye piece is the Horizontal Clamp Screw. When tightened it prevents any

gross horizontal plane rotation. However, when the horizontal clamp screw is tightened, the other screw will allow a fine horizontal motion in the vicinity of the locked horizontal position. If the horizontal clamp screw is not tightened, the other screw does not do anything.

3.3. Now look at the telescope itself from the side of the horizontal fine motion screw: The two small screws on the arc left and center are related to the telescope vertical plane motion. The center screw locks the telescope at any desired vertical angle, while the left screw allows for fine vertical motion in the vicinity of the locked vertical angle.

3.4. On the right side of the arc there is a Lock Lever. Its purpose is to lock the telescope in a horizontal position (parallel to the floor).

3.5 The upper knob on top of the telescope is the Focusing Knob.

4) Leveling the Transit

4.1. Make sure that the Lock Lever is engaged to keep the telescope in a horizontal inclination.

4.2. Unlock the horizontal clamp screw.

4.3. Turn the telescope until it is lying over a set of opposing leveling screws.

4.4. Hold the two leveling screws that are underneath the telescope, one with each hand. Place each screw between you thumb and forefinger. The two leveling screws need to be moved simultaneously, either towards each other or away from each other. Watch the leveling air bubble as you move the two screws, to decide how to move the screws - Say that you started to move the screws away from each other, and you see that the air bubble is creeping towards the center, then you are doing fine. Keep rotating the screws in that manner. If the bubble goes in the opposite direction (from the center) - change the screws rotation direction. Move the screws until the bubble is centered.

4.5. Now rotate the telescope by 90^0 such that the telescope lies over the other two screws. Repeat the process of step 4.4 until the bubble is again centered.

4.6 Rotate the telescope by additional 90^0 , repeat the leveling, and finally rotate it by one more quarter of a circle and do the leveling (if necessary). In most cases this should be enough for the device to be properly leveled.

EGN1002 – Fundamentals of Engineering (Spring 2000) Homework #5 (Construction Project Proposal)

Each team must select one of the projects from the list below – One project per team, first choose - first get. Each project involves a significant amount of land surveying measurement data collection, some internet research, engineering planning and estimates and a formal project proposal (one per team). The proposal is to be the final product of the project – no actual construction is expected.

The initial set of measurements is to be conducted during the 4/5/2000 and 4/12/2000 class sessions, using a transit system checked out by one of the team members (a driver's license is required as a deposit, and

will be returned when the equipment is returned and inspected). The teams may check out the equipment, for additional measurements as many times as needed, during the week of 4/17/2000-4/21/2000, under the same terms. Please call Dr. Roth's office (7-3471) or Tom Kelly at the Robotics Lab (7-3489) to make the necessary arrangements.

Projects List:

- 1) **Rope Bridge** – Design a rope bridge spanned between the roof tops of the Administration and the Physical Sciences Buildings.
- 2) **Water Slide** – Design a water slide that starts the top of the Gym Building and spills into the FAU swimming pool.
- 3) **Bungee Jumping** – Design a small man-made pool and a bungee jumping structure above it. The structure base should stand at the top of the Social Science Building.
- 4) **Breezeway Extension** – Design a rain-cover breezeway extension structure north of the Biological Sciences Building leading to the Science and Engineering Building.
- 5) **Ski Lift** – Design a ski lift cable from the top of the Science and Engineering Building to Parking Lot 5 (the old runway north of the building).
- 6) **Alligator Pit** – Design an alligator pit surrounding the Old Engineering Building and a observation deck attached to the building's second floor.

Research Requirements:

Using the internet and library resources, explore the technology associated with the mechanical implementation. Electrical and electromechanical design considerations are beyond the scope of this project. What are the basic principles for mechanically/structurally designing such objects? Find explicit construction standards. Pay attention also to safety requirements.

Engineering Plans and Estimates:

Produce drawing **sketches** with explicit dimensions. How accurate are your estimates, based on the accuracy of your measurements and the amount of uncertain/unavailable information? How many significant digits should your figures contain?

Provide a very rough estimate of the amount of materials and labor needed, and produce a crude budget.

Proposal Structure:

The following sections are required (each headed by the following title):

- a) Abstract
- b) Introduction (for general background information, general principles and references listing).
- c) Measurement Data and interpretation.
- d) Proposed Work (include drawing sketches, explanation about the construction method and steps and an estimated time table).
- e) Proposed Budget (on an EXCEL spreadsheet) and Budget Explanation.

Due: Wednesday 4/26/2000

Appendix E: "Why Do I Want To Be and Engineer?" Essay

**EGN-1002 Fundamentals of Engineering
Spring 2000
Homework #1**

Write a 600 words essay on the topic "Why do I want to be an engineer?"

Due: Friday 1/21/2000.

Specific Instructions:

- 1) Essay must be typed.
- 2) Free format.
- 3) A suggested outline (devote one or two paragraphs to each of the following topics). If you decide to follow this outline, don't repeat the questions or divide the essay into sub-sections - just use these as "ideas-drivers" and keep the essay flowing.

- 3.1) Tell about yourself - Where do you live? Where did you go to school before coming to FAU? Are you a freshman or are you a transfer student? Do you plan to work full-time or part-time while studying at FAU?
- 3.2) Was your decision to study Engineering influenced by friends or family members? Do you personally know people who practice engineering? What is your opinion about engineers and the engineering profession?
- 3.3) Have you had any previous practical engineering exposure? For instance, have you worked in industry as technician?, or - Have you had some pre-engineering exposure in high school (i.e. engineering design competitions, JETS etc)?
- 3.4) Have you already selected an engineering major? Or- are you still undecided? If the former - Why did you choose this particular field and how much do you know about it? If the latter - What areas have you been considering? What do you need to find out prior to making a decision?
- 3.5) Do you feel ready and well prepared (math, science, computer skills etc) for engineering studies? Do you have a pretty good idea what lies ahead during the coming school years, or do you feel that plans might change depending on certain events or outcomes?
- 3.6) What are your post-graduation expectations and longer term career goals?

Appendix F: Excel Activities

EEL1002-Fundamentals of Engineering (Spring 2000)

EXCEL Basics

Example1: Simple financial calculation

The purpose of this example is to illustrate the power of the COPY command.

Do the following:

- 1) In cell A1 type the title of this example.
- 2) In cell A2 type "Amount"
- 3) In cells A3 through A8 enter numbers that represent bank deposits made on 1/1/97. So for instance put 1000 in A3, 2000 in A4, etc all the way to 6000 in A8.
- 4) We want now to convert all these numbers to \$. First select the column by clicking on the "A" titled cell at the top of the column. The entire A column will become dark. Next click on the Toolbar's \$ button. All the numbers will convert to a money format.
- 5) In cells B2 through F2 enter year numbers starting with 1998 in B2, 1999 in C2 etc all the way to 2002 in cell F2.
- 6) Let's assume that the interest rate is 7%. Let's also assume that all the cells in the range B3:F8 represent the account value on 1/1 of the respective year. We would like to quickly calculate these numbers. The key idea of the COPY command is that formulas very often need to be typed only once, as follows:
- 7) Go to cell B3 and type the formula
 $=a3*(1+0.07)$
 Press the Enter key and the result 1070 will show up. At this point click and drag to blacken the range B3:F8 and convert the format of all these cells to \$.
- 8) Click on cell B3 and from the Edit menu click on Copy. Next darken the cells B4:B8 and press Enter. The 1998 results appear along column B. Go to B4, for instance, and observe what happened to the formula as it was copied. The cell address a3 of the B3 formula has been automatically changed to a4, etc.
- 9) Select now the range B3:B8 and copy it to C3:F8.
 DONE

Example 2: Continuation of Example 1

At this point ,let's explore how to change the interest rate parameter.

- 1) Go to an arbitrary cell, say B12 and type "Rate=" and then type 0.07 in the neighboring cell C12. Going back to range B3:F8, replacing the 0.07 entry, that appears in each formula, by C12 will in principle allow us to change a parameter in only one location. But it requires some care.
- 2) Go to cell B3 and in the formula bar change 0.07 to c12.
- 3) Try now to copy B3 to B4. See what happens – the program automatically changed c12 to c13, which resulted in a wrong answer.

LESSON: Need to keep cell C12 "fixed" as follows:

- 4) Going back to step 2, we replace 0.07 by \$c\$12 (to keep it from changing due to copying actions.
 - 5) Now when we copy B3 to B4:B8 the results will be correct. See the copied formulas.
 - 6) Complete the table by copying B3:B8 to C3:C8.
 - 7) Now we can see the effects of changing the interest rate. Change C12 from 0.07 to 0.08, and observe the results.
- DONE Save your spreadsheet under a suitable name.

Practice Exercise

From the Gottfried's textbook on chapter 2

Create the grade report described in Exercise 2.3 (page 24, page 23 in the EXCEL 97 book) and compute the GPA as shown in exercise 2.7(Page 30, Page 29 in the old book)

EXCEL - Graphing

Example 3: Simple Graphing

Create a new small spreadsheet describing some parts inventory:

- 1) Type ITEM in B2 and QTY in C2.
- 2) Under ITEM (in B3:B5) type Screws, Nuts and Bolts (respectively).
- 3) In C3:C5 enter the numbers 8000,7500,6200.
- 4) Finally type TOTAL in B7 and put the formula
 $=SUM(c3:c5)$ in C7.
- 5) Highlight the range B2:C5.
- 6) Click on the Chart Wizard icon (in the Toolbar ,third place from the 100% box). Follow the menu for various graphing options.

Example 4: Graphing of Time Functions

To graph a function such as

$$V=10\exp(-0.5t)$$

we need first to create a detailed enough table of the function values.

- 1) Create a new spreadsheet and enter "Time" in A1, and "V" in B1.
- 2) Along the A column, starting from A2 enter the numbers 0,1,2,3,...,10.
- 3) In B2 type the formula
 $= 10*EXP(-0.5*a2)$
- 4) Copy B2 to B3:B12 and observe the number of digits after the decimal.
- 5) If the number of significant digits after the decimal point is, say, 3 we need to modify the formulas as follows:
 $=ROUND(10*EXP(-0.5*a2),3)$
Copy again.
- 6) You are now ready for graphing. Highlight the range A1:B12 and choose the Chart Wizard. Select the option XY (Scatter) and then select one of the options in which the data points are connected with smoothed lines.
- 7) For further editing of the graph you may now use Chart Options/Titles (from the Chart menu) and Selected Plot Area, Selected Data Series/Patterns and Selected Data Series/Options, all from the Format menu.

Example 5: Fitting Equations to Data - Line Fitting

- 1) Create a spreadsheet for the following (hypothetically) measured data:

Force Exerted By a Spring

<u>Distance [cm]</u>	<u>Force [Newtons]</u>
2.0	2.0
3.0	3.5
7.0	4.5
11.0	8.0
17.0	9.5

These measurements were subject to errors. Don't expect the points to fit a straight line (even though this is the correct theoretical relationship).

- 2) Plot the data as x-y graph, leaving the data points unconnected.
- 3) From the Chart menu select "Add Trendline". A dialogue box entitled "Add Trendline" will open up.

- 4) Click on the "Linear" option, but before you press OK do one more step:
- 5) Click on the "Options" button within the dialogue box. Then mark the bottom selections of "Display equation on Chart" and "Display R-Squared value on chart". Now click OK.
- 6) The "best straight line" (fitting the data in terms of least squared errors) will be plotted, along with its equation. The R^2 value is a number between 0 and 1, indicating how close the fit is ($R^2=1.0$ means a perfect fit).

Example 6: Fitting Equations to Data - Polynomial Curves

- 1) Create the following arbitrary data set:

\underline{x}	\underline{y}
2.0	2.5
3.0	11.0
6.0	3.7

Let's try to fit a parabola to this set of points.

- 2) Plot the points as unconnected x-y graph, and again open "Add Trendline" - This time choose the "Polynomial" option and specify "2" in the "order" box. Don't forget to request the equation and R^2 value.
- 3) The resulting parabola of course fits the three points perfectly ($R^2=1.0$).
- 4) Select the chart (by clicking on it) and then delete it.
- 5) Add another data point (say $x=8.0,y=5.0$). Repeat steps 2-3 and observe the "best fit" parabola. This time R^2 may be relatively small.
- 6) Delete the chart, and call again "Add Trendline" - Choose a third order polynomial and observe the perfect fit.

Class Assignment:

- 1) Textbook problem 5.5 (page 124). What would be the mileage of a hypothetical car weighing 2000 lb? Fit a straight line through the data and use this mathematical model in your prediction.
- 2) Recreate Example 5.8 in the textbook (page 135). If all we want is a curve fit that has a R^2 value of at least 0.9 but with the simplest possible equation, what polynomial order will you select?

**EGN1002 - Fundamentals of Engineering
EXCEL - Optimization**

Example 10: Production Planning

Example: (Scheduling Production to Maximize Profit)

A company manufactures two products – A, B.

Sale prices : A : \$120/unit , B : \$80/unit.

Construction Time: A: 5 hours/unit , B: 3 hours/unit

Management requirement: At least 1000 units be manufactured each month.

Labor Cost: \$12/hour

Available budget: 8000 labor hours per month.

How many units of A, B need to be made to maximize the company's profit?

Mathematical formulation of the problem:

Let: $x_1 = \#$ of A units per month.

$x_2 = \#$ of B units per month

$$y = \text{net profit} = (120 - 5 \times 12) x_1 + (80 - 3 \times 12) x_2 =$$

$$= 60 x_1 + 44 x_2$$

Constraints:

$$x_1 + x_2 \geq 1000 \text{ (Condition 1 – management requirement)}$$

$$5x_1 + 3x_2 \leq 8000 \text{ (Condition 2 – Available budget)}$$

$$x_1 \geq 0 \text{ (Condition 3 – only non-negative solutions are acceptable)}$$

$$x_2 \geq 0 \text{ (Condition 4 - only non-negative solutions are acceptable)}$$

Need to maximize, by choosing the right values for x_1 , x_2 , without violating any of the restrictions.

Do:

1. Create a spreadsheet that describes the above problem:
 - 1.1) Make column a wide enough, to fit the following text:

<u>Cell</u>	<u>Text</u>
a1	Maximum Profit Production Schedule
a3	Units of A per month (x_1):

	a4	Units of B per month (x2):
	a6	Profit (y):
	a8	Minimum Production Requirement:
	a9	Budget (labor hours) available:
1.2)	<u>Cell</u>	<u>Type:</u>
	b3	1
	b4	1
	b6	= 60*b3+44*b4
	b8	= b3+b4
	b9	=5*b3+3*b4

You are now ready for the Solver.

- Call the solver and put the following information in the "Solver Parameters" window:
Set Target Cell: \$b\$6
Equal To: Max
By Changing Cells: \$b\$3: \$b\$4
- To fill the Constraints window, press "Add". In the dialogue box type "\$b\$3", then choose >=, and put the value 0. Use "Add" repeatedly until all the constraints are listed :
\$b\$3 >= 0
\$b\$4 >= 0
\$b\$8 >= 1000
\$b\$9 <= 8000.
- Solve. What is the solution? (Ans. $x_1 = 0$, $x_2 = 2666.667 \rightarrow 2666$)
- Let us now add a new constraint: "At least 200 units of each product must be made". That is, the new constraints are { \$b\$3 >=200 and \$b\$4 >= 200 }. Modify the contents of the Solver window and find the new solution.

Example 11: Simple Plane Geometry - "Among all rectangles that have the same perimeter, a square has the largest area"

To illustrate this result let's look at all rectangles that have a perimeter of $P=20$ cm.

Let x_1 and x_2 be the length and width of such a rectangle. That is, for every x_1 and x_2 the following equality constraint must be satisfied:

$$P = 2*(x_1+x_2) = 20$$

We need to maximize the area A , expressed in terms of x_1 and x_2 as follows:

$$A = x_1 * x_2$$

Use Solver to solve this problem and show that the optimal solution is $x_1=5$ and $x_2=5$.

Class Assignment:

- For a given amount of material design a cylindrical tank that has a maximum volume.
For simplicity let us assume that the material constraint is equal to a surface area constraint (that is, no wasted material, which is of course not so realistic when cutting circular shapes from a planar sheet).
You need the following formulas: (Let r be the cylinder base radius and h be the cylinder height).

The surface area A of the cylindrical tank is:

$$A = 2\pi r^2 + 2\pi r h$$

The volume V of the tank is:

$$V = \pi r^2 h$$

Let's assume that $A \leq 50$ meter². Set up the problem for Solver to find the best values for r and h .

Change the area constraint to other values and for each case figure out the optimal radius and height -

Can you deduce the general rule?

Extra Credit Assignment: Textbook problem 13.14 (page 354) (Production planning)

Hints:

- There are 8 unknowns. Let's assume that the unknown values are in cells b1,...b8.
- Write formulas (in terms of the unknowns cell addresses) for the total sale price, the total time to produce, the total cost of materials, the total labor time, the total labor cost and the net profit.
- The problem in its most basic form has 9 constraints: The total labor time, and non-negative unknowns.
- Solve the basic problem and write your opinion if the solution makes any sense.

- 5) **(More extra credit)** As a manager, what additional constraints would you add to achieve a more practical solution? For instance, you may require that a table must be sold only with at least 4 matching chairs, etc. As you add constraints, observe how your projected profits decrease. Comment on the tradeoff between profit and sensible production schedule.

EGN1002 - Fundamentals of Engineering (Spring 2000)

EXCEL - Solving Equations

Part I - Equations with single unknown

Example 1: Solution of Algebraic equations

Consider the following polynomial equation:

$$x^3 + 7x^2 + 8x + 5 = 0$$

The Goal Seek function of EXCEL allows an effortless and speedy solution.

- 1) Type "x =" in cell A3 and "f(x)=" in A4. In B3 put for instance the value 1 (this will be an arbitrary initial guess for the solution).
- 2) Type the following formula in cell B4:

$$=(b3)^3+7*(b3)^2+8*b3+5$$
 The computed f(1) will show up as you press Enter.
- 3) From the Tools menu select Goal Seek. A dialogue box will open up.
- 4) To fill in the "Set Cell:" box click on B4. Next write 0 in the "To value:" box. Finally set the cursor in the "By changing cell:" box and click on B3.
- 5) As you ok the contents of the Goal Seek dialogue box, a new dialogue box will appear informing you if a solution was found. The solution itself is written in the B3 cell, along with the f(x) value at that point (shown in B4).

PROBLEM: How do we know if this is the only solution? Need to repeat the process with different initial guesses. To see how it works, let's try a different equation (with known solutions)

Example 2: Another polynomial equation.

In the previous example set up, let's change the formula of B4 to

$$=(b3+1)*(b3-10)*(b3+37)$$

Obviously the solutions of $f(x)=0$ are known. These are $x = -1$, $x=10$ and $x = -37$.

Run Goal Seek for different initial conditions in cell B3 (like for instance 1,20,100,-100 etc). See which of the solutions is obtained each time and how long it takes to "find" them all.

In practice we indeed don't know how many of the real solutions can easily be found (need to use common sense) and the finding of the complex solutions requires more powerful tools, such as MATLAB.

Additional Class Practice:

- 1) Textbook problems 7.9, 7.10 (pages 196-197)
- 2) Textbook Problem 7.17 (page 199)

EGN1002 - Fundamentals of Engineering (Fall 1999)

EXCEL – Equations Part II

Solution of Simultaneous Equations

Example 1 : Solution of Simultaneous Equations using Solver

Solver is a powerful tool for both solving equations and optimizing functions (maximum /minimum finding) subject to multiple constraints. Let us first see how to solve the following equations:

$$\begin{cases} 3x_1 + 2x_2 - x_3 = 4 \end{cases}$$

$$\begin{cases} 2x_1 - x_2 + x_3 = 3 \end{cases}$$

$$\begin{cases} x_1 + x_2 - 2x_3 = -3 \end{cases}$$

The Solver program starts at an arbitrary (user specified) guess, say :

$$x_1 = 1 \quad , \quad x_2 = 1 \quad , \quad x_3 = 1$$

Then it computes the functions

$$\left\{ \begin{array}{l} f(x_1, x_2, x_3) = 3x_1 + 2x_2 - x_3 - 4 \\ g(x_1, x_2, x_3) = 2x_1 - x_2 + x_3 - 3 \\ h(x_1, x_2, x_3) = x_1 + x_2 - 2x_3 + 3 \end{array} \right.$$

(In this case the values are $f(1,1,1) = 0$, $g(1,1,1) = -1$, $h(1,1,1) = 3$)

We create another function $y = f^2(x_1, x_2, x_3) + g^2(x_1, x_2, x_3) + h^2(x_1, x_2, x_3)$

and compute it too. What Solver later does is to adjust x_1, x_2, x_3 until $y \approx 0$. The idea is that because y is a sum of squares, each of its terms is non-negative. Therefore when y is forced to be 0, each one of the terms f, g and h is forced to be 0. That solves the equations.

Do the following steps:

1. In a3, a4, a5 type "x1=", "x2=" and "x3=", respectively.
2. Put the number 1 in cells b3, b4, b5.
3. In a7 type "f(x1,x2,x3)=" , and similarly "g(x1,x2,x3)=" and "h(x1,x2,x3)=" in cells a8, a9. You can widen the column width by dragging the boundary time as necessary.
4. In b7 type "= 3*b3+2*b4-b5-4". Similarly, copy the other equations in cells b8, b 9.
5. In cell a11 type "y=" , and put the formula =b7^2+ b8^2+ b9^2 , in cell b9. Everything is now ready to call the Solver:
6. Select "Solver" from the "Tools" menu. (If unavailable use "Add-Ins" to install it. However, it should be available in all the FAU Computer Labs.) A "Solver Parameters" dialogue box opens up.
7. Put \$b\$11 in "Set Target Cell:". Mark the "Value of:" choice and type 0 in the open box next to it.
8. In the "By Changing Cells:" box type (or click & drag) \$b\$3:\$b\$5.
9. In this problem there are no additional conditions (constraints), so leave the "Subject to the Constraints:" box empty. Click – Solve.

A "Solver Results" window opens up informing you whether a solution was found. In this problem there is a solution, and it shows in the b3÷b5 cells. ($x_1=1$, $x_2=2$, $x_3=3$). Note the very small values in cells b7÷b9 and in cell b11.

- I. EXCEL can also solve nonlinear simultaneous equations – finding one real solution, if it exists. It cannot find complex solutions.

Class Assignment:

- 1) Use Solver to find the solution of Textbook Problem 8.15 (b) (page 225)
- 2) Solve Textbook Problem 8.25 (page 240)

Appendix G: Mobile Robots Project

EGN1002 - Fundamentals of Engineering (Spring 2000)

Robotics Project

Project Requirements:

Need to build a high-speed mobile robot, equipped with a light sensor, for a two-robot race competition.

The racing track is placed in the lobby of the Science and Engineering Building, underneath the stairs, vertical to and touching the stairs wall. Track dimensions are approximately 11.5'L by 4'W. The track is painted black and there are two white area on both ends of the track. The white strip on the wall side is nearly two feet long, and the one on the opposite side is 17" long.

Motion Requirements:

- 1) Robots start on the white strip that is on the far-away-from-wall side of the track.
- 2) Each robot needs to move along a straight line parallel to the track axis.
- 3) When reaching the wall-side white strip the robot is expected to produce a brief beeping sound.
- 4) Robots may stop on the white strip before changing the motion direction, or they may hit the wall and bounce back.
- 5) Robots then need to return along a straight line to the entry white strip.
- 6) Upon reaching the white strip the robot needs to brake into a stand still position.

Points Chart:

Winning a race	20
Finishing the track	10
Failure to beep	-5
Failure to brake at the end	-5
Failure to move on a straight line	-5
Pushing/touching the other robot	-10 (unless it's the other robot's fault)

Race Information:

Races will be conducted on Wednesday 4/26/2000 at the Science and Engineering lobby, starting at 9:00 AM. [On that day we also have a special computer lab session at FLH422 from 8:00-8:50 AM]. Each team will race twice against each of the other teams, using the right side of the track in one race, and the left side in the second race.

Appendix H: Image Processing Handouts

EXCEL - Image Processing (Part II)

Assumption: You are given with a file of a real image. This file may be downloaded from the web (site address: <http://www.ee.fau.edu/courses/egn1002/>) or may be handed to you in a floppy disk. The image within this data file is a matrix of size that may range from 100x100 up to 200x200 pixels. Your task is first to view the image and then to process it using the algorithms that we discussed earlier. Have the previous Image Processing notes available.

Step 1: Transforming the image to the correct EXCEL format.

1) Go to the web site and click on one of the image files designated by the course instructor. In this demo the instructor will process the file named I2.dat. At the same time each student will process one of the other files. "Save As..." under the same name into the Temp Directory on the C: drive. If the file is on a floppy, go to the next step. Exit the internet.

2) Get into EXCEL and from "File: Open" select either "3.5 floppy (A:)" or the Temp Directory on the hard drive. At the bottom of the "open" dialogue box, go to "Files of type:" and select "All Files(*.*)". You will now see the name of the text file that you need to process. Select the file and click "open".

3) A "Text Import Wizard" window opens up (after a few seconds of waiting). Choose "Delimited" and click "Next". Then select "comma" and click "Next". Finally leave the column data format as "General". Press "Finish". The image pixels' light intensity values will appear in an EXCEL format.

4) Since image processing requires the use of multiple worksheets, you may easily saturate your floppy capacity. It is a good idea, at this point, to move the file from a floppy, if this has not been done already, into the hard drive. Do "File: Save As...". A "Save As" dialogue box appears. In the "Save in:" box scroll and select "(C:)", and then select the "temp" directory (if you work at home, you may choose "My Documents"). Open it, but don't yet save. In "File Name:", remove the quotes "... " from the file name, and also remove the ".DAT" prefix. In "Save as Type:" choose "Microsoft Excel Workbook". Now you can save.

Step 2: Find how big your image is.

1) To find how big is the matrix click on cell a1. Next, click and drag the mouse (roughly) along the diagonal. As soon as the darkened area exceeds the first EXCEL page, a small counter will show up at the bottom right corner of the page (showing how many rows and columns were selected so far). Continue to press the mouse until you arrive at the end of the data block. The counter will show you how many rows and columns are in your data file. Write down these numbers, while you are still pressing down the mouse button. Also copy the rightmost corner cell address. In the case of file I2, these numbers are 141R x 161C (that is - 141 rows and 161 columns). The lower right corner cell is FE141. Scrolling the screens like that requires a little patience and some practice – note that you can control the scrolling speed by placing the mouse cursor just past the page border (slow scrolling) or deep outside the border (fast scrolling). The moving side and bottom sliders also provide good clue as to how far you are from the end of the data block.

2) Go back to the top of the file (cell a1) by pressing the "Home" and then repeatedly the "Page Up" keys. As you do that you will observe that the previous selection of the data block is cancelled.

Step 3: Histogram of the data.

Prior to binarizing the image we need to determine the correct threshold level. This is done through observation of the data histogram. A histogram is a bar graph that shows how many data points are in each designated interval. We typically create 10-20 "bins" that uniformly divide the data values range into intervals. In our case each pixel holds a number from 0 to 255. This range needs to be divided uniformly,

say: 0,15,30,...,240,255. Note that each interval is represented by its left limit: "0" represents the interval 0-14, "15" represents the interval 15-29 and so on. Do the following:

- 3.1) Insert a new worksheet called "sheet1".
- 3.2) In a1 of Sheet1 type "bins". Put 0 in a2. Put the formula =a2+15 in cell a3. "Edit: Copy" cell a3 into cells a4:a19. The numbers 30,...,255 will show up.
- 3.3) Click on "Tools: Data Analysis" and select the "Histogram" option.
- 3.4) For the "Input Range" fill in the upper left and the lower right corners of the data block. According to I2 we input "I2!a1:I2!fe141".
- 3.5) In the "Bin Range" put "a2:a19".
- 3.6) For the Output Options select "New Workbook" and "Chart Output".
- 3.7) Click OK to obtain the histogram data: The table shows how many data points fall in each bin interval 0-14,15-29,30-44,...,240-255. Click on the chart window and move the cursor to the lower right corner to enlarge the figure.
- 3.8) Specifically, regarding the I2 image, it looks as if a binarization threshold of 230 would give the best image contrast.
- 3.9) Save the histogram worksheet and close it to return to the image worksheets.

Step 4: Creating a binary image.

You are now back at Sheet1 of your image. Do the following:

- 4.1) "Insert: Worksheet" entitled "Sheet2".
- 4.2) In a1 of Sheet2 put the formula
= IF (i2!a1 < 230, 1, 0), and "enter". Use your own data file name and the threshold level that you found in the previous step.
- 4.3) Select a1 and do "Edit: Copy".
- 4.4) Select the copy range to be according to the dimensions of your image. Here it is 141x161. Click-drag and observe the bottom right counter, until it shows "141R x 161C". Press "enter" to obtain the 141x161 binary image.

Note that the matrix remains darkened (selected) - ready for further processing (a click on any cell will cancel the selection).

Step 5: Can we "see" the image? Can we "shrink" the worksheet?

The answer is yes. To see the image, need to replace all the zeros by blanks and all the ones by some symbol, say #.

- 5.1) Insert a new worksheet "Sheet3".
- 5.2) In a1 of Sheet3 put the formula
= IF (Sheet2!a1=1,"#", " ")
and "enter". Cell a1 will most likely appear blank but it is not really empty – There is a formula there.
- 5.3) Copy a1 to a range sized 141x161 (Use the particular dimensions of your image). Leave the 141x161 block darkened.
- 5.4) Quickly slide the page position sliders to roughly half-way to see if there is any image contents at all.

Step 6: Shrinking of the entire worksheet.

We shall shrink the entire worksheet Sheet3 - font size, column width and row height. To select the entire worksheet press "Ctrl A".

- 6.1) Font Shrinking (Here we shrink the # font).
Use the two scroll boxes, located on the left top of the EXCEL page: Change "Arial" to "Arial Narrow". Change "10" to "8" (this is typically the smallest font size).
- 6.2) Column-width shrinking
Click "Format: Column: Width...". Try a small number, such as 0.5.
- 6.3) Row-height shrinking
Click "Format: Row: Height...". Need to experiment with the numbers. You can't choose it smaller than the font's height. For this particular font a value of 6 seems to work..

Step 7: removing the grid lines

Do "Format: Cells...", click "Border" and select "None" (in the Presets). The printout of the shrunk image will have no grid lines.

Class Assignment

- 1) Get a printout of your shrunk image. Can you identify the object? Most objects are small metal parts. Most are pretty hard to identify. The objects are solid though. What may appear in your binary image as tiny holes may actually be light reflections from the metal body.
- 2) Find the object's area and centroid (by following the steps of the previous Image Processing notes). Your starting point should be the un-shrunk binary image on Sheet2. You may use the mostly-vacant Sheet1 to record your computation results (Object area and object centroid).
To compute the area sum up all the cells of your binary image (Sheet2). To find the centroid - copy Sheet2 into new sheets 4 and 5. Shift each column and row by one. Don't forget to paste-special values only. Then create numerical x and y axes to Sheet4 and Sheet5. Sheet4 will be used to create a new sheet6 to perform an x-axis weighted sum of the cells values. Similarly, sheet5 will be copied to sheet7 to perform a weighted sum along the y axis.

Obtain a printout of the image edges obtained from the shrunk worksheet. From sheet3 create sheet8 in which # is replaced by 1 and blanks are replaced with 0. Then create sheet9 through edge operations performed on sheet8. Again, follow the steps of the Image Processing Part I notes

Appendix I: Electronics and Logic Design Activities and Material

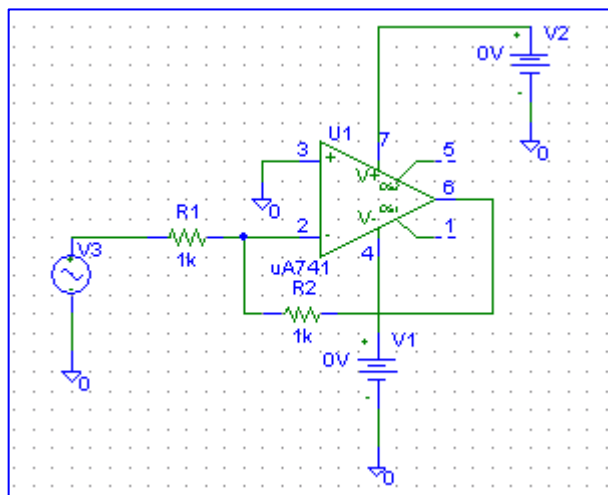
Electronic Circuits Simulation Using PSPICE Amplifiers and Comparators

II. Amplifiers

1. On the Windows screen double click on the PSPICE icon. Then click "Tools: Schematics". A blank PSPICE page will open up.
2. First we need to get the parts and lay them on the blank screen. In the top toolbar find the "Get New Part" icon (it looks like a set of binoculars lying on an electronic part symbol) and click on it. A window entitled "Part Browser Basic" will open on your left. It is a long alphabetic list and we will first scroll to the op-amp component entitled "uA741". Click on it.
3. Click "Place" and bring the op-amp symbol to the center of the screen. Left click to put it in the schematic. More left clicks would leave on the screen more of the same component but since we need only one, right click to stop the op-amps "production".
4. Next, we need two DC sources (VDC) to serve as supplies to the op-amp. Click on "VDC", then place two in the schematics. Put one below pin 4 of the op-amp and put the other to the right of pin 6. The program assigns the name V1 and V2 to these sources.
5. Select a sinusoidal voltage source VSIN and place it to the left of the op-amp. It becomes V3.
6. Select a resistor R and place two in the schematics. One (R1) between V3 and pin 2 of the op-amp and the other (R2) below the op-amp.
7. Finally, let us collect a few ground nodes. Select "GND-ANALOG" and "Place and Close" the parts menu. Place four grounds: below V3, near pin 3 of the op-amp, below V1 and below V2.
8. It is time now to wire the diagram. Click on the "Draw Wire" icon with the narrow-lined pencil drawing. Bring the pencil to the lower leg of V3, click and let go. Move the mouse cursor to the ground node below (a broken line is created), and click on the ground leg. The connection is established.
9. Wire the rest of the diagram according to the Figure below.

A few hints:

- i. When there is a need to neatly route the wire around an object, click in midway to establish routing points.
- ii. If you made a mistake, right click to leave the pencil node, then left click on the object to select it (it will turn red) and then press the Delete button on the keyboard for the unnecessary piece of wire or component to disappear.
- iii. Any "smearing" on the screen can be "bleached out" by moving the scheme out of the screen using the right arrow button and bringing it back.
- iv. You may draw a wire starting from another wire, in the same way as you draw a wire from a component. A heavy dot will appear at the wires connection point.



10. It is now time to assign values to all the components. Resistor R1 already has its correct value (1K=1000Ω), so we shall leave it alone. Let us start with resistor R2. Double clicking on the default 1K value opens up a window “Set Attribute Value”. Fill in 10K (for R2=10000Ω) and OK. In a similar manner change the value of V1 from 0V to 12V and that of V2 from 0V to -12V. The op-amp is now properly energized (positive DC voltage to pin 7 and negative DC voltage to pin 4) and the ratio of the two resistances determines the voltage gain. That is $\text{Gain} = -R_2/R_1$.
11. Double click on the V3 circle symbol to open up a window “V3 PartName:VSIN”. Click on VOFF, bring the cursor to the value box and write 0. Then click on “Save Attr”. Click on VAMPL and give the amplitude a value of 1V. Save the attribute. Finally, assign a frequency of 1K (meaning 1 KHz). Click "ok" to leave this window.
12. The Schematics is ready. “Save As”—“Amplifier” or any other name. File names can be as long as you wish.
13. We need now to specify the simulation parameters. Click “Analysis” followed by “Setup...” “Transient” allows you to observe waveforms. Enable “Transient” and then click on the “Transient” button. A “Transient” window opens up.
14. Need to decide about the appropriate “Final Time”. Since earlier (Step 11) we set the input frequency to 1 KHz, each sinusoidal period is 1 ms. Fill in 10 ms in the Final Time box.
15. The “Step Ceiling” parameter should be no more than 1/1000 of the Final Time for an accurate simulation. It should also not be too small, otherwise the simulation will be too slow. Therefore, put 10us(=10μs) in the “Step Ceiling” box. Ok and put the same number also in “Print Step”, then close the Analysis setup window.
16. You may simulate now (by choosing the "Analysis: Simulate" option or by clicking on the "simulate" icon) and decide later after the results are stored which variables to observe.. Prior to simulation though, it is always a good practice to label the nodes of interest. The labels will make it easier to find the right variables from the long list of computed variables generated by the program. Double click on the wire connecting to pin 6 of the op-amp. A label window opens up. Write “out”. Similarly label “in” on the input node. Now it is ok to simulate. A "PSpiceAD" window appears while the simulation is going on.
17. When the simulation is complete a blank "Probe" window opens up. All computations are done, the results are in. The program is waiting for your instructions. You are now in the "Probe Mode".
18. Click “Trace” followed by “Add”. The left menu that opens up entitled “Simulation Output Variables” is a long scroll menu of all the simulation variables. You may shorten the list prior to scrolling by clicking out “currents” and “subcircuit nodes”. You can always bring those back if you need to.
19. Find V(in) and click on it and find V(out) and click on it too. A list of variables (to be plotted) is created at the lower box entitled “Trace Expression”. OK to obtain both plots on the same scale. If

the two signals are not of the same order of magnitude, you may sometimes need to plot them separately, as shown next

20. In "Trace" click "Delete All" to clear the Probe screen. Plot first V(in) only. Now click "Plot" followed by "Add Plot". Room will be created on the screen for a second plot. Click again "Trace" and "Add" and choose V(out). The two plots now appear, each with its own scale.
21. Close the "Probe" screens and "PSpiceAD" window to return to the "Schematics" mode.

Class Assignment #1:

- 1.1 Change the amplifier gain from -10 to -50 by changing resistor R2. The gain is determined by the ratio of the resistors ($R2/R1$). Watch V(in) and V(out) on the same scale.
- 1.2 Prior to printing the plots make sure to type your name somewhere on the screen. Use "Tools: Label: Text" to print your name. Now print your circuit output.
- 1.3 The reason that V(out) is "clipped" (distorted) is that no voltage in this circuit can ever be larger (in absolute value) than the op-amp DC supply voltages. (So here a 1V amplitude AC signal amplified by 50 gets clipped at the $\pm 12V$ levels). What is the largest V(in) amplitude that yields an undistorted V(out)? Modify V(in) and plot both V(in) and V(out) on two different scales (on the same page)

II) Comparators

- 1) Go back to your circuit and delete the two resistors, their wires and the ground connection wire to pin 3 of the op-amp.
- 2) Bring in a new VDC source . You may use the "Get Recent Part" window on the right top corner. Connect it between pin 3 and the ground.
- 3) Set the voltage of this new DC source to $V4=5$ volts. Set V3 amplitude again to 1V.
- 4) Add a resistor R3 (of value 1k) to pin 6 of the op-amp, and connect its other side to ground.
- 4) Run the simulation and observe both V(in) and V(out).
- 5) Repeat this process for $V4= -5$ volts and $V4= 0.5$ volts. The op-amp no longer works as an amplifier. Instead it works as a comparator. Whenever the voltage at pin 3 is greater than the voltage at pin 2 the op-amp output is $V(out)=12 V$, and whenever the voltage at pin 3 is smaller than the voltage at pin 2 $V(out)=-12v$.

Class Assignment #2:

- 2.1. Replace the sinusoidal source V3 with a DC source V5. Set the voltages of V5 and V4 in such a way that $V(out)= -12v$. Then change the two voltages such that $V(out)= 12v$. Whenever all the voltages in the circuit are DC nothing really changes as a function of the time. "Transient" analysis is then quite unnecessary. From the "Schematics" screen go to "Analysis: Set-up". Click Transient Enable out and leave only the "Bias Point Detail" option. Now simulate. Close the PSpiceAD window. As you click on the "V" button all DC voltages in the circuit show up. Print out this screen. To add your name to the printout use "Draw: Text...".

Spring 2000

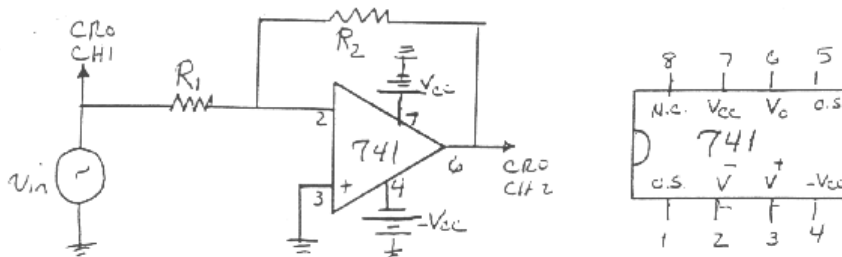
EGN1002 - Fundamentals of Engineering (Fall 1999)
Electronics Laboratory Experiment
(Amplifiers and Comparators)

I. Introduction

The purpose of this experiment is to introduce the student to use the operational amplifiers as amplifiers and comparators. The performance of the 741 will be compared with the simulation results of the previous experiment (PSPICE).

II. Amplifier Circuit

Set up the experiment as shown in figure 1. Please make sure to connect lambda power supply connections (Vcc and -Vcc) to the appropriate pin connections.



Try the following steps:

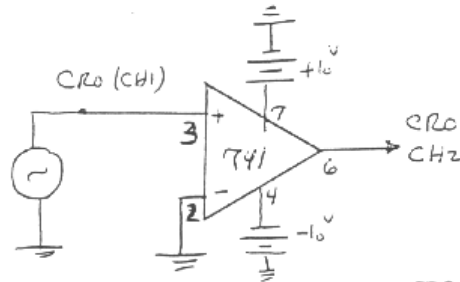
- 1) Using R1=R2= 1000 ohms, construct the above circuit (Vcc=10 v and -Vcc=-10 v).
- 2) Apply a sinusoidal input to the circuit. Set the 3310A amplitude to 1 V p-p as measured on CRO. Select the input frequency of 1000 HZ. Observe the amplitude of the output of the 741. Record your results and plot the output waveform.

Frequency = _____ Input Voltage(p-p) _____ Output Voltage(p-p) _____ Gain =Vo/Vi= _____

- 3) Try triangle wave at the input of the amplifier. Plot the output.
- 4) Replace R2=1K with R2=100K. Repeat step #2 and 3 with an input sinusoidal waveform of 100 mv (p-p) record your result.
- 5) Repeat step #4 for an input waveform with amplitude of 1v (p-p). Plot the output. Explain your observation.

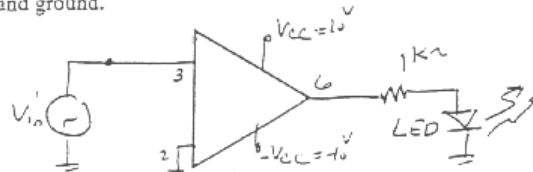
II. Comparators

Connect your circuit as shown on figure 2. Please don't forget your power supply connections.



1. Set the 3310A amplitude to 1 V (p-p) as measured on CRO for a sinusoidal input. Select the input frequency of 1000 HZ. Observe the output of the 741 with CRO. Record your results and plot the output waveform. Apply a triangle waveform at the input and plot your output also.

2. Repeat the above step with an LED connected between the OP. AMP output (pin #6) and ground.



3. Connect the output of amplifier circuit (figure 1) to the comparator input with the LED (figure 2). Change the input frequency, observe the LED light variations.

Spring 2011
EGN1002 - Fundamentals of Engineering (~~Fall 2009~~)
Electronics Lab
Use of Lab Instruments

Introduction

The purpose of this experiment is to introduce the student to the use of the Lambda d-c Dual Power Supply, the Hewlett-Packard 33120A Function Generator and a Tektronix Digital Oscilloscope.

Lambda Power Supply

Note that the Lambda Power Supply is actually two independent variable d-c power supplies in one package. It has two voltmeters, two ammeters, two voltage control knobs, two current control knobs and two sets of red/white/black connectors. The current and voltage control knobs are dual knobs, having outer (coarse) and inner (fine) adjustment capability. The left two meters indicate the current and voltage being supplied by the left half of the supply and the right two meters indicate the voltage and current being supplied by the right half of the supply.

Each half of the power supply has a maximum voltage of 40 volts, a maximum current of 1.0 amp, and a maximum power of 40 watts. (Some of the models have maximum voltages of 20.) The red terminal is the positive terminal, the black is negative, and the white is grounded.

To create +12V, -12V and ground lines on your breadboard, connect the black connector of one of the voltage supplies to the red connector of the second supply. This point will establish your zero reference voltage (ground). Connect this point to your ground line on your breadboard. Now, the first supply will generate positive voltage and the second supply will generate negative voltage with respect to the ground line. Connect the red connector of the first supply to your +12V line on the breadboard, and connect the black connector of the second supply to your -12V line on the breadboard. Set the two supplies to 12V each.

Hewlett Packard 33120A Function Generator, Digital Oscilloscope and SK-10 Breadboards

Connect the function generator to your breadboard, sticking the signal cable to any available slot on your board, and the ground cable to the ground line on the board (or to an available slot connected by a wire to the ground line). Connect a short wire to the signal slot and hook up the oscilloscope cable to this wire.

After hooking up the circuit, turn on all the equipment. Note that the 33120A display indicates a 1000 Hz sine wave. Your oscilloscope (or CRO in short) may or may not show an identifiable waveform. To display the signals applied to the two CRO inputs, press the AUTOSET button of the CRO.

The CRO has **vertical**, **horizontal** and **trigger** sections that are used to obtain an acceptable display of a waveform. The vertical section controls enable the user to adjust the vertical size and position of the waveforms on the two channels.

Press the CHI button. Then rotate the POSITION control and then rotate the SCALE control and observe the effects on the waveform. Then press the CH 2 button and note the effects of rotating the POSITION and the SCALE buttons. Press the CLEAR MENU button and look at the bottom of the CRT display.

The vertical sections also provide other control, such as ac or dc coupling and bandwidth limiting. To view the options, press the CHI button, then the VERTICAL MENU button. Various options appear at the bottom of the CRO screen (CRT). Note that when one of the options at the bottom of the CRT is selected, another group of options appears at the right of the CRT, similar to the selection of options on a computer running Windows.

The horizontal section controls the horizontal part of the display. Adjust the horizontal POSITION and then adjust the horizontal DISPLAY. Observe the effect on the CRT display and also note what happens to the pictures/words/symbols at the top and the bottom of the CRT. Is there a relationship between the frequency of the waveform and the number of divisions on the CRT needed to display one period? (Hint: The horizontal display shows the waveform in sec/div and frequency is measured in cycles/sec).

Now press the horizontal MENU button and observe the soft key options at the bottom and the side of the CRT. Most of these options are used for relatively sophisticated measurements.

Skip at first reading: The trigger section controls the stability of the waveform(s) on the CRT. Press the CLEAR MENU button. Adjust the trigger LEVEL knob and note how the little arrow on the right hand side of the CRT moves up and down. Note how when the arrow is not across from the waveform, the waveform is not stable.

Now check out the trigger menu by pressing the TRIGGER MENU button. Note that the CRT waveforms can be

stabilized (triggered) using either the waveform from Channel 1 or from Channel 2 or via external means. The external trigger signal is connected to the external trigger input connector on the bottom right of the CRO. Usually the external trigger signal will be obtained from a trigger output on a function generator, such as the output marked SYNC on the 33120A, by connecting a BNC cable from this output to the EXT TRIG input of the CRO.

Note the selection of SLOPE on the trigger menu. Select SOURCE CH1, and then select SLOPE. Note that it is possible to trigger on either a positive-going slope or a negative-going slope. Observe the way the beginning of the waveform on Channel 1 changes as these options are selected. **Stop skipping.**

Next, observe the choices on the MEASURE, CURSOR, DISPLAY and ACQUIRE menus. Some of these options will be used frequently in subsequent measurements.

Use of the 33120A

Now press the AUTOSSET button again. Then adjust the HORIZONTAL SCALE to obtain about two complete waveforms on each channel.

Adjust the knob located on the top right hand corner of the 33120A and observe the reading on the 33120A display. Then select MEASURE on the CRO and select FREQUENCY. Compare the reading on the 33120A and on the CRO.

What happens to the CRT display as the 33120A frequency is increased? Decreased?

Now observe the effect of the > and < arrows as the frequency knob is adjusted. Note that the frequency of the 33120A can be controlled very precisely by selecting smaller or larger increments with the arrows for adjustment with the rotating knob.

Next, observe what happens if any of the waveshape buttons on the top row of the 33120A are pressed.

The amplitude of the 33120A output signal is controlled by pressing the AMPL. button and adjusting the rotating knob. Again, the > and < arrows allow smaller or larger increments in the amplitude adjustment. Note the effect of amplitude adjustment on the CRT display. Then select MEASURE and find an option that will measure the peak-to-peak amplitude of the signals on the CRT.

Does the reading on the 33120A display agree with the amplitude measured by the CRO

Appendix J: Engineering Disciplines Research Assignment

EGN1002 – Fundamentals of Engineering (Spring 2000)

PowerPoint Presentation #2

Engineering Disciplines Research

Each of the following present (or near future) FAU Engineering Disciplines may be researched, one per team:

- 1) Bioengineering
- 2) Civil Engineering
- 3) Computer Science and Engineering
- 4) Electrical Engineering
- 5) Mechanical Engineering
- 6) Ocean Engineering

The research needs to translate into a 15 minute PowerPoint presentation..

Required Research Directions:

- 1) Interview at least at least three individuals: an FAU professor, an FAU graduate or undergraduate student and a practicing engineer.
- 2) Search the web for various university departments home pages. This is a good source about academic details – course requirements, overall graduation requirements, research areas and more.
- 3) Search the web for the discipline's Engineering Society Home Page. This is a good source about discipline general description, typical job requirements and the job market. Sometimes some of these web sites may contain actual interview video clips with practicing engineers and industry leaders.

Presentation Requirements:

- PowerPoint format, with back-up transparencies and/or handout sheet.
- The purpose of the presentation is to inform, not to sell. Be objective, thorough and easy to understand.
- Don't use technical jargon or terminology that no one in the audience (including you) may understand.
- All team members are expected to participate almost-equally in the presentation delivery.
- While contents format is free, need to maintain a logical structure and a logical flow of the presentation ideas. See below suggestions for topics to be covered.

Suggested Interview Questions:

- 1) What are the discipline's main sub-areas? Is it ok to specialize in only one of these areas?
- 2) What are the typical jobs that engineers perform in industry?
- 3) How is the market for fresh graduates? What are the typical salaries?
- 4) What are the hot research and development topics?
- 5) What are the long term challenges and future directions?

- 6) What are the academic prerequisites (science and math, software tools etc) and what are the key academic bottlenecks en-route to graduation?
- 7) What are typical topics for a senior design project?
- 8) What are typical job requirements for COOPs and interns?
- 9) How much of the engineer's work is done at the "systems level"?

Appendix K: Teamwork - Peer review

EXCEL - Pie Charts

Follow the simple procedure (below) for constructing a pie chart:

- 1) In cells a1:a5 type the names Alex, Betty, Chuck, Dana and Erin (one in each cell).
- 2) Let's assume that we need to divide \$20 bonus money among the team members according to the amount of effort devoted by each team member in a project named "Mousetrap Car". In cells b1:b5 put the numbers 3,5,9,1,2 (respectively).
- 3) Select the block a1:b5 (text and data) and click on the Chart Wizard icon.
- 4) From the Chart Type menu select "Pie". Choose any one of the left standard pies.
- 5) Click "Next" to step 2 and another "Next" to step 3. In "Titles" of step 3 put the project name "Mousetrap Car". Click on "Data Labels" of step 3 and select "Show Label and Percent". Click "Finish" to obtain the pie chart.

Class Assignment : Team Activities Peer Reviews:

10% of the course grade is allocated for team effort - Part of it is based on the instructor's impression of each individual team member's contributions. Part of it is based on peer reviews based on each student's confidential input to the instructor.

Requirements: Create four pie charts, one for each of the following team activities:

- a) Solar Cooker Project
- b) Engineering Disciplines Presentation.
- c) Land Surveying Project.
- d) Robotics Project.

For each of the charts list each team member (that was in your team in this particular activity) and your assessment of how to divide 20 points (for each activity) among each team member, according to their effort and contribution.

Be fair and honest. It is conceivable that some members did more in one activity and less in another. It is important to see the full picture.

See the instructor if you have difficulty remembering who were the team members in each activity, as we shuffled the teams here and there, for one reason or another.

Appendix L: Course Assessment Essay

Homework #6

Essay (600 words): Course Assessment and Evaluation

Please distinct (as much as possible) between **Course evaluation** and **instructor evaluation**. There will be other Instructor Evaluation forms that you will be soon asked to fill. The course, which has been offered several times in the last two years, is still evolving. Students' thoughtful comments play a major role in assessing **what works and what doesn't work** in the course.

Your essay should include constructive criticism, suggestions for the future, comments on activities that you liked and those that you liked less. Format is free. The following guiding questions are added for your convenience.

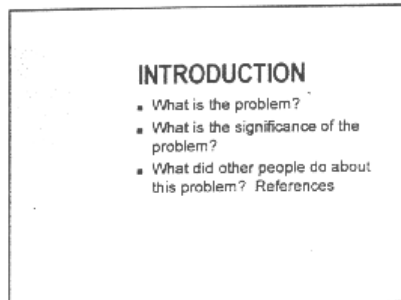
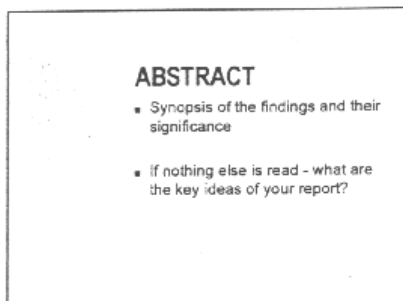
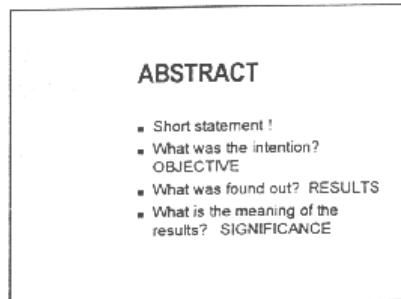
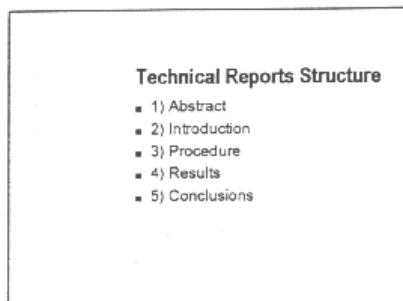
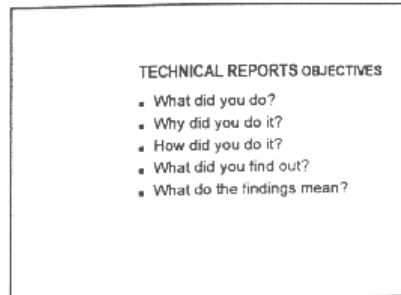
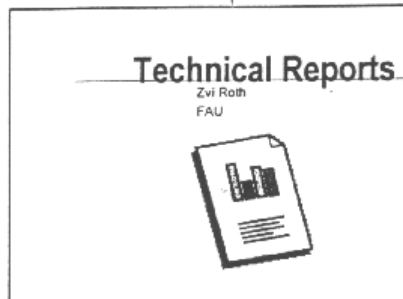
- 1) Was the course useful as "Introduction to Engineering"?
- 2) If you had to re-write H.W.#1:"Why Do I Want To Be an Engineer?", would your views be significantly different, after going through the course?
- 3) Did the course provide you with better university survival skills?
- 4) Did the course provide you with a good "roadmap to FAU"?
- 5) Do you now know more about the various engineering disciplines?

- 6) Did you like the weekly computer lab sessions? Was the theory sometimes too hard? Was enough time given to the in-class hands-on activities? Have you benefited from the "open door" work submission policy?
 - 7) Did you like the Solver, Chart Wizard and other EXCEL tools?
 - 8) Did you like the Image Processing sessions?
 - 9) Did you like PSPICE?
 - 10) Do you feel comfortable using PowerPoint?
 - 11) Are you for or against written exams in a course like this?
 - 12) What can be done to improve on the quality of team activities?
 - 13) Did you enjoy the team work, or was it often frustrating? Did all the team members work as hard as they should ?
 - 14) The class often suffered from a relatively low attendance - often up to 25-33% of the class were missing at some sessions. Was it because of the early course time (8:00 AM)? What else can be done to improve attendance?
 - 15) Which of the hands-on experimental activities did you like and which ones you didn't? See list below:
 - Candy Tower
 - Paper Bridge
 - Outdoors Engineering Estimate exercise
 - Industrial Robotics experiment
 - Electronics: Soldering and circuit testing using the oscilloscope
 - Electronics: Amplifiers and comparators
 - Logic Design
 - Solar Cooker Project
 - Land Surveying experiments
 - Land Surveying Project
 - MindStorm Robotics Project
 - 16) Did you like the textbooks? Have we used them enough to justify the cost?
 - 17) Did you like the Creative Problem Solving sessions (Brainstorming, Problem Definition, Decision Analysis, Troubleshooting)?
 - 18) Do you still want to be an engineer??
- Suggest any improvements to the course.

Appendix M: Technical Communication PowerPoint Presentations

Zvi Roth

2/9/99



INTRODUCTION

- 1-2 paragraphs long
- Background information

PROCEDURE

- Specific steps done in the experiment
- Description of the apparatus

Guidelines for a good procedure section

- Don't repeat material that is standard or already written in the experiment manual
- If the reader has the manual - tell what you did in relation to the printed procedure

Guidelines (Procedure)

- Refer to the standard procedure - have you deviated here and there? Focus on the differences.
- Can other skilled people follow your steps and replicate the results?

RESULTS

- Summarize the data collected
- Graphs
- Tables
- narrative: State the results in words

Discussion/Conclusions

- Did you solve the stated problem?
- Interpret the results
- Compare the results
- Point out special features
- Explain experimental difficulties relevant to conclusions
- Link conclusions to the objectives

General Advice

- Don't use "I" - Use "we" or passive voice
- Be objective
- Facts not feelings
- No jokes
- Be direct, clear and simple
- Be concise

Solar Cooker Project Introduction

- Reapply portions of your Homework #2 essay.
- Most of your references will be web addresses - In the introduction refer by numbers (say [5]), and in the bibliography (at the end of the report) list the addresses fully.

Solar Cooker Project Procedure

- Describe your cooker
- Include a photo and/or drawings
- List the materials used and their cost.
- Describe the construction steps (in enough detail to allow others to reconstruct the same cooker)
- Explain design considerations.

Solar Cooker project Results

- Tables of all temperature measurements.
- You may measure temperatures at several locations, not necessarily only where the food is.
- Graphs - optional (Temperature distribution within the device? Food temperature vs. time, etc)

Solar cooker Project Discussion/Conclusion

- Did it work at all?
- Did it work well?
- Best features of your cooker.
- Worst features of your cooker (if any).
- Explain difficulties (if any)
- Suggestions for future improvements.