AME 441aL Senior Projects Laboratory
Spring 2017

Laboratories:	**MW 10:00 – 12:50** BHE 310
Lectures:	**T 11:00-12:20** BHE 310

Professor:	Dr. Matthew Gilpin PHE 314 (T) 8-11:00a (F) 1-2p gilpin@usc.edu	
Laboratory Manager:	Ritwik Ghosh BHE 301, (213) 740-4304 dgalindo@usc.edu	
Laboratory Technicians:	Rodney Yates BHE 310, (213) 740-4304 rodneyya@usc.edu	Denise Galindo BHE 310, (213) 740-4304 dgalindo@usc.edu

Recommended Texts (not required):

Beckwith, T.G. & R.D. Marangoni. *Mechanical Measurements*, 6th ed., Addison Wesley.

Holman, J.P. *Experimental Methods for Engineers*, 7th ed., McGraw Hill.

Figliola & Beasley, *Theory and Design for Mechanical Measurements,* Wiley.

Important note to all students registered for AME 441aL & 441baL:

During the Spring semester, the senior projects course will consist of students enrolled in both 441a and returning students from the fall who are enrolled in 441b. For most of the class, including lectures, meeting times, and the deliverables schedule, everything will be identical. However, there are some key differences that I will highlight here.

AME 441a: New Projects

Welcome! I'm excited that you've decided to spend the semester investigating something that interests *you*. In contrast to the Fall semester, groups will be smaller. Pair up into a **group of two** and start thinking about what you want to investigate.

Being in a smaller group is not a greater burden – in fact, it allows you to be more targeted in your project scope. Think about a project that ideally suits your interests and attack it head on. With the resources available, you can achieve more that you think! This is chance to tangibly explore something fascinating and demonstrate to future employers your engineering capabilities.

AME 441b: Returning Projects

Welcome! In 441a, you and your group have already solved the easy problems – now, you *must* tackle the hard ones. Your group will be working together, as you were last semester, and is expected that the quality of deliverables reflects the extra manpower.

Returning groups will be held to a very high standard. Simply enhancing previous data sets is not sufficient and proposals will be graded on how they interpret the previous semester and apply the knowledge learned. It is expected that 441b groups produce publication quality experimental results.

Senior Projects in Aerospace and Mechanical Engineering
Spring 2017

I. Introduction

The aim of this course is to complete an original project which takes you through the entire engineering process. The semester starts with planning and design, and ends with experimental validation. An emphasis on novel experimental work means that one's ingenuity and initiative are a major factor in success. This course gives students the responsibilities associated with an industrial research project while keeping them within a teaching environment. Students will experience similar problems and challenges that will be faced upon graduation and develop a more thorough understanding of the steps involved to complete an actual engineering project.

Students work in groups of **two** on a project of their choice for the entire semester. Ideally, topics for these projects are provided by the students themselves. However, projects can be selected from a number of ideas suggested by the faculty in the packet supplied on Blackboard. **Think about where you want to be next year and make this project the centerpiece of your academic and budding professional portfolio.** A well-executed senior project is an excellent interview topic!

The extent of the subjects covered is quite broad. Project topics have ranged from traditional areas such as fluid dynamics, structural mechanics, heat transfer, and dynamic control, to rather obscure and arcane studies on fishing line motion, plant growth in varying pressure environments, anti-lock brakes and the like. The primary requirement in the selection of a topic is that the student must have a strong personal interest. More pragmatically, design, construction and testing should be possible within one semester given the constraints of the lab facilities and a set financial budget.

We also encourage students to contact any of the faculty listed in Appendices G and H at the end of this handout directly for ideas in their respective fields of interest and expertise.

The AME 441 schedule compresses an entire design project into a 16 week period. So, we need to hit the ground running! You will have an assignment due the **first day of class, Monday January 9th at 10am.** Prior to beginning the semester you need to form your team, select your project, and submit a literature review. The requirements for this can be found in Appendix A. This will enable us to being the semester with educated discussions on your topic.

The next deliverable is the project proposal. Before work can begin on any project, acceptance of this formal, written proposal is required. The proposal is due **Friday, January 20th at 12 pm in RRB 101**. The proposal will be promptly returned with feedback so work may begin. In the event that a project is not approved, required changes must be made promptly before proposal re-submission. Work on the project <u>*cannot*</u> begin until project approval has been given.

Starting Friday, January 20th written group progress reports are due every 3 weeks at 12 pm in RRB 101. These will be graded not only on technical content and progress made, but also on quality, clarity and professionalism.

One **Final Report** of publishable quality will be required by each *group* at the end of the term on <u>**Friday, April 28th before 5pm in RRB 101**</u>. Also, each group will give one formal presentation on their work to the rest of the class; presentations will take place during the lecture section. Students will be evaluated upon the quality and content of their reports and presentation as well as their performance in the laboratory; this includes cleanliness of work areas and attendance in the scheduled lecture/laboratory sessions.

II. AME Lab Procedures and Protocol

Safety and Space Management

- ***CLOSED-TOE SHOES*** **AND** ***LONG PANTS*** **ARE REQUIRED IN THE LAB AT ALL TIMES.** ***NO EXCEPTIONS!*** Shoes need to provide protection; hence, "Toms", boat shoes, flats, slippers, etc. don't qualify. Pants need to be pants.
- Safety precautions (gloves, eye protection, hair ties, etc.) are mandatory. Ask a staff member if you are unsure of any safety precautions you should be taking when working in the lab.
- According to University rules, students are not allowed in the lab without supervision. Therefore, all experiments must be performed within the scheduled lab times.
- Store your personal belongings out of walking paths – under work tables for instance. It is important to keep a clear and safe walkway through the laboratory.
- Keep the lab clean. ***No food or drinks*** in the lab area. You are welcome to have food or drinks in the hallway, near the stairs, or in the BHE 301 presentation room (outside of AME 341 lab hours).
- **Return all lab equipment to its original location** after use (cables, beakers, drill bits, etc.).
- There is a small engineering library in the BHE 301 presentation room. These resources are to be shared and ***are not to leave the BHE 301 presentation room.***

Supply Room and Device Access

- Access to the BHE 301a supply room is allowed only with approval of an AME 441 staff member.
- Any/all resources and devices that leave the Supply Room ***must*** be approved, checked out, and signed for by an AME 441 staff member.
- Please report any/all broken or non-functioning equipment and devices to the staff. This is *extremely* important, and will save everyone time and trouble in the future!
- When requesting equipment, students must be prepared to give all the pertinent characteristics they require so that the staff can act on the requisition effectively.
- On some occasions, it becomes necessary to share some equipment with other groups. Under these circumstances all parties involved are expected to be considerate and cooperative.
- **When requesting to have parts fabricated/machined, ensure that your designs are complete** – design by trial and error will not be allowed. Be prepared to thoroughly present and explain your design in order to facilitate the approval and scheduling of part fabrication/machining. See manufacturing notes in Section IV.

Computer/Printing Rules

- Do ***not*** customize any computer workstations. This includes modifying the desktop, any/all computer settings, or installing any software without staff approval.
- Save files **only** in the following directory: **D:\home\JStude**. *Other locations will be deleted!*
- Remember to save your work to the computer's hard drive before moving it to a USB key or portable storage device. This serves as a backup.
- Printers are available only for printing of assignments, reports, and required materials for AME 441 **only**.
- When done with a computer workstation, log off and turn off the monitor.

III. Facilities

The AME Lab in BHE has served *decades* of AME 441 classes. The lab is well stocked with the *majority* of the tools needed to support a successful project. The lab will provide PC's, data acquisition devices and software for design, data capture and analysis. Common instrumentation is also available including low-power lasers, digital image and video recorders, high-speed cameras, various pressure transducers, thermocouples, etc. If the required instrumentation is not readily available in the lab, it can often be procured from other departments on a loan basis (*e.g.*, a micropipette could be borrowed from the Biology department).

In addition to basic scientific equipment, the BHE labs have larger test facilities. The AME Lab has a low-turbulence, open-circuit wind tunnel located in BHE 301. The test section measures 46 x 46 x 91 cm, and can provide freestream velocities from 3 m/s to 46 m/s with less than 1% variation from the mean. The turbulence level is less than 0.25%. It is equipped with two, two-component force balances: one is capable of measuring lift and drag forces of up to 67 N and 35 N, respectively, and the other to 12 N. Two water channels are also available for experiments in water. The low-speed BHE water channel, located in room BHE 110, was constructed as part of a 441 project a few years ago. The test section of this water channel measures 0.18 m x 0.20 m x 0.91 m, and has a test velocity range of 0.05 to 0.15 m/s. Flow visualization can be performed through the transparent, acrylic test section walls. Data acquisition is also possible through a multifunction DAQ device and LabVIEW.

Other facilities available for use are: a pipe flow apparatus to study convective heat transfer (in pipes); a cross-flow heat transfer apparatus to determine the properties of various heat transfer devices (heat exchangers) mounted in-line; a device for applying precise buckling and bending loads to rods and beams; instrumentation to determine the dynamic vibration of various beam configurations; and an oscillating pendulum apparatus for studying second order system dynamics, and for studying coupled modes of vibration of various compound pendulums.

For well-planned projects, advanced AME department facilities can also be made available for AME 441. One such facility is the large water channel in RRB 107. The test section of this water channel has a cross-section of 0.91 m x 0.14 m, and has a usable length of approximately 3.50 m. Test velocities range from 0.12 m/s to 0.40 m/s. Flow visualization is possible through the transparent side walls and drag force measurements can be performed using the existing force balance setup. An advanced Particle Image Velocimetry (PIV) system, capable of measuring 2-D velocity fields, may also be made available for well-designed projects which require this capability. Due to the limited availability, operational complexity and safety requirements of the PIV system, students who intend to use this system are required to discuss their project with AME 441 instructors and Dr. Luhar before including its use in their project proposal.

Newly available this year are the facilities in USC's CHAFF lab. Available facilities include the USC Solar Furnace which is capable of delivering 800 W into a 1 inch diameter spot. Vacuum chambers of various sizes are also available with the required feed-throughs and diagnostics. Any student groups interested in this equipment should contact Dr. Gilpin immediately to check both project feasibility and facility readiness.

IV. Manufacturing

Every AME 441 project will require some fabrication in order to physically test designs. The AME lab has multiple facilities allowing you to create custom fabricated components for your project. Note, that this is a design course, so all parts must be justified with quantitative reasoning about key design decisions.

The AME lab has a pair of laser cutters. Each cutter has a 2ft x 1ft bed and is capable of cutting 2D shapes out of both balsa wood and acrylic. When designing parts for AME 441, the laser cutters should be your ***FIRST*** thought. Unlike other manufacturing facilities, the laser cutters are capable of producing <u>same day</u> parts for your project. Think about how you can build up multiple 2D shapes into 3D structures. Also think about your structural requirements and if cast acrylic can be a viable material.

The AME lab also has multiple MakerBot 3D printers. While additive manufacturing is an exciting topic in all disciplines of engineering, it is asked that students restrict 3D print jobs to parts and designs that actually ***need*** to be 3D printed. The 3D printers have a long lead time and successful prints typically require multiple iterations. 3D printers are *not* a tool for lazy design. Typically, the majority of jobs submitted for additive manufacture can be produced faster and with higher quality using conventional techniques.

Finally, the AME lab has a full machine shop enabling in-house manufacturing. Rod Yates has decades of machining experience, if you can think of it – it can likely be made. Students must be involved in the manufacture of their components and training is available enabling students to craft their own parts.

ALL machine shop jobs must be scheduled through Rod Yates and will be completed on a first-come first-served basis. The **<u>DEADLINE</u> for machine shop approval is February 22nd**. Parts approved and submitted by this deadline will be scheduled and completed before the week of April 13th. It is *strongly* encouraged that parts be submitted before this deadline.

For all of the above facilities, manufacturing will not be scheduled until the part has been approved by both “Engineering” (AME 441 Instructors) and “Manufacturing” (Denise Galindo: Laser Cutter & 3D printer, Rod Yates: Machine Shop). Drawings must be submitted *in-person* and initialed by both “Engineering” and “Manufacturing” staff for complete approval.

Drawings must be professional quality, computer generated and have at minimum

- 3-View
- Dimensions
- Necessary tolerances
- Part material
- Signature block for approvals

Additional manufacturing facilities are available including the Fab Lab in RRB 114 and the USC machine shop in KAP B-1B (M-F, 6:30 AM – 2:30 PM). If these facilities are used, it is the responsibility of the student to submit and schedule parts.

V. Budget

Each student is allotted approximately $75 for the purchase of expendable materials. While this appears to be a small amount, nearly all of the required components for successful projects are already available in the AME Lab. Typically, project groups will only need to charge 1-2 items to their project budget and the *majority* of groups do not exceed their allotment. The total amount of funding for a project will be based on the budget submitted with the proposal and may exceed the specified amount if it is deemed necessary for the project's success. Should you need to make a purchase, follow the guidelines below:

Prior to making any purchase, approval is required by your instructor. The detailed procedure for making purchases from online retailers will be discussed during the first week of class. In general, you will prepare an order, print the detailed summary but **do not** submit the order confirmation. Bring the printout to your instructor for a signature and give the order summary to the TA in charge of placing the orders.

Students may make smaller cash purchases and they will be reimbursed upon presentation of an original receipt. *Pre-approval is required from an AME 441 instructor prior to making small cash purchases.* Items from the Engineering Machine Shop (KAP Basement), Electronic Store (OHE 246), and Chemistry Store (SGM 105) can only be obtained on an Internal Requisition. Cash purchases from these places will not be reimbursed.

No reimbursements will be made if the above procedures are neglected. No exceptions!

VI. Grading

Grades are based on both individual and group performance. Descriptions for all written reports and a sample grade sheet for the oral presentations are provided in Appendices A through E. All assignments are expected to be of professional quality. Everyone has completed AME 341 and those standards should be followed.

Students will also be graded on their individual performance in the laboratory. To facilitate this, and provide guidance on each group's research, conferences with one or more instructors will be held at regular intervals. During these conferences, current work and problems are to be discussed and evaluated. The instructors should be notified immediately of any difficulties in the research, as delays will have an adverse effect on performance assessment. **It is essential that these projects are worked on continuously; waiting until the last few weeks will surely be detrimental to your grade.** Successful projects are the result of a sustained effort that begins on week one.

Part of the laboratory performance grade will also be adherence to safety guidelines. Each safety violation will result in a 3 point reduction in your lab performance grade. This is a serious penalty for a serious issue. There is no such thing as a “quick cut” or “quick job.” That is how you quickly loose an eye.

All students are required to attend the oral presentations during their registered lecture section. Attendance will be recorded and one absence will be permitted, use it wisely. A 10% penalty will be applied to your oral presentation score for each additional absence. Arriving late or leaving early counts as an absence.

Each group is required to keep a laboratory notebook as described in Section V. This is to be turned in with the final report at the end of the semester. This year we have put added emphasis on the maintenance of this laboratory notebook – incomplete and untidy entries will result in a 5% penalty, applied to your final grade. The notes, thoughts and sketches contained in the notebook should be informative and useful. Write in this as if you planned to give it to another group for the following year.

Each student must complete, or have already completed the mandatory lab safety training and workshop within the first two weeks of labs. **Lab work on your project will NOT be permitted until this training has been completed**. Failure to complete the training within the announced time frame will result in a 5% penalty on your final grade.

The complete grade distribution is detailed in Table 1. This distribution is subject to change. Also note that performance in this class is cumulative. It is difficult to write a high-quality Final Report if your project doesn't begin with a high-quality proposal.

Table 1. Final Grade Weight Distribution (%)

Literature Review & Proposal	10
Progress Reports	10
Oral Presentation	20
Lab Performance	20
Final Report	40
TOTAL	**100**

VII. Deliverables

INCLUDE YOUR GROUP #, DATE, TITLE AND NAMES OF THE AUTHORS ON ALL ASSIGNMENTS

Table 2: Schedule of Deliverables

Literature Review	January 9th, 10am, BHE 310
Project Proposal	January 20th, 12 pm, RRB 101
Progress Report 1	February 17th, 12 pm, RRB 101
Progress Report 2	March 10th, 12 pm, RRB 101
Progress Report 3	March 31st, 12 pm, RRB 101
Oral Presentations	Mid-April, TBD
Laboratory Notebook	**April 28th, 5 pm, RRB 101**
Final Report	**April 28th, 5 pm, RRB 101**

- **The first deliverable is the Literature Review**. This is due on the **FIRST DAY OF CLASS.** This document should be 3-4 pages in length and provide your team, your project idea and a summary of research which has lead you to your topic. More details are given in Appendix A.

- **The second deliverable is the Project Proposal.** At a minimum, the proposal should follow the guidelines provided in Appendix B. Only one document per project is required. Proposals are due on **Friday, January 20th at 12 pm in RRB 101.** Since major rewrites are sometimes required for project approval, early submission of the proposal is strongly encouraged. It is also recommended that you discuss any ideas and/or approaches with your instructors, TA's and lab staff before and during this process. Remember, work may not begin until the project has been approved.

- **A progress report is due every three weeks before 12 pm, starting Friday, February 17th.** Only one per project is required and the contents should follow the suggested guidelines presented in Appendix B. A total of three progress reports will be handed in throughout the semester. These will be graded on the amount of project progress achieved, as well as clarity in technical communication.

With every progress report, **each** group member is required to submit a **Group Evaluation Form** which can be found in Appendix E. Forms will be kept confidential and there will be separate drop boxes for group evaluation forms in RRB 101. These forms are intended to assess the involvement of each group member and the group dynamics of each team.

- **<u>Oral presentations will be given during the lecture sessions</u>** during Mid-April. The order of presentations will be determined by lottery. Presentations will be 20 minutes long, which includes time for questions. A sample grade sheet for the oral presentation can be found in Appendix E. On your presentation day, arrive at lecture 15 minutes prior to the start of class (*e.g.*, 10:45 am) and upload your file to the class computer.

- **<u>Each group is required to maintain a laboratory notebook and/or binder</u>.** The notebook should be a record of the design process. Raw data, calculations, construction and set-up drawings, uncertainty analysis, etc., should all be contained in this notebook. Highlight problems encountered and how they were solved. **The notebook should be kept neat and legible so that an individual assigned to take over the project at a later time can easily continue the project.** In the back of the notebook, a log of hours spent on the project for each group member should be detailed. With each entry, a brief description of what was done at particular times should be listed as well. Noting the hours logged will help to create a plan of corrective action if/when it appears that time or effort is running short. **This notebook is to be submitted with the final report and will be graded.**

- **<u>The Final Report is due Friday, April 28th by 5:00 pm in RRB 101</u>. Each project is required to submit *one* final report. Late reports will be penalized (-10% per day, including the weekend).** The *suggested* format for the final report can be found in Appendix C. All documents are to be typed, stapled or clipped, and a hard copy must be submitted. Do **<u>NOT</u>** email reports.

<u>INCLUDE YOUR GROUP #, DATE, TITLE AND NAMES OF THE AUTHORS ON EVERYTHING</u>

Appendix A: Literature Review

The literature review is a document that summarizes the state of current knowledge on your chosen project topic. The literature review should contain numerous *scholarly* references and present the tools you will use to formulate your project proposal. If successfully completed, having this document will facilitate constructive project discussions during the proposal writing process. In fact, this will likely end up being the majority of your proposal introduction.

Note this is due on the **FIRST DAY OF CLASS** so we can begin the semester immediately!

Suggested Format

- **Cover Page:** Includes group members, potential project title and a one paragraph abstract
- **Topic Summary** (1-2 pages): Discuss why this project is important. Why do we care about this topic? Include the state of current knowledge and what you propose to improve. You should also highlight anticipated design challenges and the technical knowledge that will be required to complete your project.
- **Literature Review** (2-3 pages): Summarize key resources you intend to use during your project. What knowledge was gained from each reference and how will it help formulate your proposal? Don't just write a list of papers and a sentence for each, condense your research into a *narrative*.
- **Reference List**: References should be *scholarly* (i.e. Journal articles, conference papers, books, etc. *NO INSTRUCTABLES!*) and sufficient to demonstrate a purposeful investigation of your topic. Don't stop with one or two good papers, look at what *they* referenced and take your investigation one step further. Present the references list in a professional format, i.e. AIAA.

Appendix B: Suggested Proposal Format

Section Title	No. of Pages
1. Introduction/Historical Background	1
2. Theory/Basic Equations	1-3
3. Experimental Setup/Procedure (including a sketch of the apparatus)	1-4
4. Cost Estimate	1
5. Timetable	1
6. Reference List	1

The objective of the proposal is to convince the reader that your project will provide useful information and can be successfully completed within the time, budget, and other given constraints. A proposal isn't meant to present sweeping, general knowledge. It is intended to be a concise document limited in scope to the specific project under development. **The proposal should be no more than 10 pages of typed double spaced text.**

Although short in length, the proposal must be thorough. The reader must be convinced that you have sufficiently researched your topic and that you have sufficient understanding to produce meaningful results. Reference previous and current work and give legitimate reasons for conducting the experiment. **Your goal must be explicitly stated.**

The proposal also must present a clear picture of how you are going to conduct your experiment. Calculations and results are required which enable an intelligent preliminary design. Additionally, it is highly important that the proposal contain an estimate of your expected results. Determine what you will need to both produce and capture *meaningful* data.

What facilities and equipment will you be using? How large will the model be? What are the important parameters? What kind of data will be taken? **You should have researched your topic in enough detail and performed some initial calculations to be able to answer these types of questions. Include a sketch of the proposed set-up along with calculations, graphs and figures that will help explain what you will do.**

The cost estimate must provide an accurate account for the ***total*** cost of your project. It should include all equipment, devices, materials, etc. that are required to perform and complete your experiment. This should be presented in a tabular format. A clear distinction must be made between the devices and materials that are currently available in the AME Lab and what needs to be purchased using your allocated AME 441 budget.

The timetable should be presented as a Gantt chart, highlighting the project milestones required for completion, the resources available, and the course deliverables due throughout the semester. The Gantt chart should contain large tasks which are broken down into additional sub-tasks. Tasks should also be assigned to individual group members. Ensure that this is readable so the proposed timeline can be accurately assessed.

Write your proposal in a manner which can be easily followed by a competent engineer even if they are not a specialist in your project's field. A good rule is to define any terms or concepts that you were not familiar with before you started your literature search. As a test, have one of your classmates (not a group mate) read your proposal to see if she/he understands, and can picture what you want to do!

Appendix C: Format for Tri-Weekly Progress Report

Progress reports should be written in third person past tense, as with all technical communications. The task of writing the progress report for the group should be distributed evenly between the group members. These reports will be graded partially on form but mostly on content and the amount of progress you have made in the lab. Note: preparing an oral presentation or writing the progress report is not lab progress. Ideally, progress reports should be no longer than five pages.

You will write three progress reports throughout the semester. **These are due by 12 pm in RRB 101 on the following Friday's: February 17th, March 10th and March 31st.**

Progress reports should include the following:

- **Cover Page:** Project Title, Group Members, Group Number, Date Range and one paragraph project abstract
- **Progress Update**: The main contents of the progress report. Specifically detail what was accomplished during the previous three weeks. Include calculations, descriptions of designed components, drawings etc. – any and all information helpful to assessing your progress. If you have acquired data, present results and discuss their meaning. This is what you've ***done*** and should be presented in a *professional*, third person past tense format.
- **Project Setbacks**: What issues or problems were encountered? Don't just list problems – you also need to present a path forward. Include what happened, plans for mitigation and the ultimate effect on your timeline. Note that machining, shipping and other delays do *not* count as project setbacks. These inevitabilities should have been considered in your project planning.
- **Future Work**: A concise explanation of the tasks to be performed during the upcoming progress period.
- **Updated Gantt Chart**
- **Peer Eval Forms**: *Each* group member is required to submit a confidential Group Evaluation form with each progress report. A separate submission box will be provided. The eval form is given in Appendix F.

Appendix D: Suggested Format for Final Report

Section Title	No. of Pages
Abstract (on title page)	1
Introduction	2-4
Experimental Technique	2-4
Results	3-6
Discussion	2-3
Conclusion	1
References	1
Appendices	No more than 5

Note: No more than 25 pages of typed double spaced text, including appendices. Look at long-format journal articles for the tone and style required of a professional project report.

Assume the reader knows nothing about your work! The final report should stand alone with no references to your proposal or progress reports. (You may of course reference other papers or books.) The introduction should state the goal/objective, give some historical background and/or the state of the art of the subject, and any theoretical derivations pertinent to the project.

The experimental technique section should give the important details of the set-up (**a schematic must be included**) as well as the procedure. Mention all the equipment used, type of data taken, how the data was processed, etc. When writing this section, keep in mind that you want to give the reader the impression that you were careful when you took your measurements and your data is reliable. Towards this end you can mention your estimates of uncertainty without going into excessive detail. (**Detailed uncertainty analysis could be placed into an Appendix and should definitely be in your lab notebook, but do not clutter the main body of your final report with lengthy uncertainty derivations.**) Also, do not go into a narration of all the trouble you went through to get to your final set-up!

Results and Discussion can be two separate sections or combined. It can even be subdivided into the different aspects of the investigation. The only requirement is that you present your results and then discuss them in a manner that can be easily followed. This is by far the most important part of your report and should be worded carefully so as to enhance the virtues of your work.

In the Conclusion, assess whether you have achieved your goal/reached your objective as stated in the Introduction. You may restate your important findings briefly. Also, you could suggest an alternate approach to solving the same problem or, talk about improvements to the work and applications.

Appendix E

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Oral Presentation Grade Sheet

Group # ____________ Date: ____________________

Title of Project: ____

Name(s) of Speakers: ____

Grade for each category is based on the scale shown below.

	Grade	**Comments**
1. **Organization and Delivery** (Was project clearly defined? Continuous thoughts? Speech easy to understand? Visual aids: timing, sufficient number of slides, neatness, clarity, etc.)	______ (35)	
2. **Technical Content** (Scientific merit appraised? Symbols and parameters defined? Technically sound arguments? Logical methods of experimentation and evaluation? Etc.)	______ (50)	
3. **Overall Performance** (Did presentation hold audience's attention? Questions answered, etc.)	______ (15)	
Total Score	______ **(100)**	

Appendix F

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<u>Group Evaluation Form</u>

Although all Progress Reports and the Final Report are turned in as a group, <u>each student</u> is required to submit the following Group Evaluation Form with each of these assignments. Turn this form in on the same day **in RRB 101**. There will be a separate, confidential drop box for the Group Evaluation Forms.

Use this form to evaluate the contributions made to your AME 441 Senior Project by **all members** of your group (**including yourself**) during the given period. In the table provided below, print the names of all group members and assign a score for each performance category. Rank each category on a scale of 0 to 4 (0 being the lowest; 4 being the highest); don't forget to rate *your* performance as well. You should provide specific comments for each team member in the space provided. The scoring guideline is as follows:

0 = Poor, would have been better without

1 = Below average, rarely met expectations

2 = Average, fulfilled expectations of the group

3 = Above average, occasionally exceeded expectations

4 = Outstanding! Often exceeded expectations

Group #	**Project Title:**				
Team Member NAME	**Cooperation**	**Dependability**	**Participation**	**Quality of Work**	**Interest and Enthusiasm**
your name					
	Comments:				
	Comments:				
	Comments:				
	Comments:				

Appendix G: Faculty List – ASTE Department

Name	Area of Interest	Office	Email
Prof. D. Erwin	Spacecraft propulsion, optics and optical instruments, kinetics of gases and plasmas	RRB 222	erwin@usc.edu
Prof. D. Barnhart	Spacecraft design, bus architecture, mission concepts and testing		barnhart@serc.usc.edu
Prof. S. Gimelshein	Research Associate Professor; Computational fluid dynamics and hypersonic aerodynamics, spacecraft propulsion, laminar separated flows, plume flows, plume interactions and surface contamination, physics of molecular energy transfer, chemical reactions in gas phase and on the surface, and upper atmosphere radiation processes	RRB 201	gimelsch@usc.edu
Prof. M. Gruntman	Spacecraft and space mission design, propulsion, space physics, space sensors and instrumentation, space plasmas.	RRB 224	mikeg@usc.edu
Prof. J. Kunc	Atomic and molecular interactions, transport of particles and radiation in non-equilibrium gases and plasmas, molecular dynamics, classical and statistical thermodynamics.	RRB 230	kunc@usc.edu
Prof. A. Madni	Complex system analysis and design; complexity management; socio-technical systems; modeling and simulation; model based engineering; engineered resilient systems; integration of humans with adaptable systems; STEM education simulations/games.	RRB 201	azad.madni@usc.edu
Prof. H. Schorr	Artificial intelligence, advanced computing systems, information technology		schorr@isi.edu
Prof. F. Settles	Engineering management, integrated management and design, quality management, manufacturing for biomedical/biotechnical applications	GER 2126C	settles@usc.edu
Prof. J. Wang	Electric propulsion, space environment and spacecraft interactions, particle simulation algorithms for gases and plasmas, microfluidics	RRB 216	josephjw@usc.edu

Appendix H: Faculty List – AME Department

Name	Area of Interest	Office	Email
Prof. I Bermejo-Moreno	Computational fluid mechanics, turbulent flows, fluid structure interaction, combustion, hypersonic propulsion, high performance computing	RRB 215	bermejom@usc.edu
Prof. C. Campbell	Two-phase flow, flow of granular material, heat transfer, slurry flows, fluidized beds, comminutron, particle fracture	OHE 400E	campbell@usc.edu
Prof. J. Domaradzki	Computational fluid mechanics, environmental and geophysical fluid mechanics, turbulence	RRB 215	jad@usc.edu
Prof. F. Egolfopoulos	Aerodynamic and Kinetic Processes in Flames, High-speed air-breathing propulsion, Microgravity Combustion, Mechanisms of Combustion-Generated Pollutants, Heterogeneous Reacting Flows, Conventional and Alternative Fuels, Detailed Modeling of Reacting Flows, Laser-Based Experimental Techniques	OHE 400B	egolfopo@usc.edu
Prof. H. Flashner	Dynamics and control of systems, control of structurally flexible systems, analysis of nonlinear systems, biomechanics	OHE 430E	hflashne@usc.edu
Prof. R. Ghanem	Risk assessment and mitigation, computational mechanics and computational stochastic mechanics, dynamics and identification, inverse problems and optimization under uncertainty, multiscale modeling; applications of these to problems in science and engineering	KAP 254	ghanem@usc.edu
Prof. S. K. Gupta	Computer Aided Design, Manufacturing Automation, and Robotics	OHE 430G	skgupta@usc.edu
Prof. Y. Jin	Collaborative engineering, design theory and methods, knowledge-based design and manufacturing systems, intelligent agents for engineering support	OHE 400D	yjin@usc.edu
Prof. E. Kanso	Dynamical systems, animal hydrodynamic propulsion	RRB 214	kanso@usc.edu
Prof. M. Luhar	Turbulence, Environmental Fluid Mechanics, Flow-Structure Interaction	OHE 400C	luhar@usc.edu
Prof. P. Newton	Nonlinear dynamical systems, fluid mechanics, vortex dynamics, probabilistic game theory, mathematical modeling of cancer metastasis	RRB 221	newton@usc.edu
Prof. M. Oussama Safadi	Structural Dynamics, finite element, stress analysis, fracture mechanics	OHE 430L	
Prof. N. Pérez-Arancibia	Mechatronics, robotics, feed-back control, signal processing, dynamics, applied optics, fabrication of microrobots, and biologically inspired engineering	OHE 430I	perezara@usc.edu
Prof. L. Redekopp	Theoretical fluid mechanics, nonlinear waves and stability, geophysical fluid dynamics	RRB 212	lg.redekopp@usc.edu
Prof. P. Ronney	Combustion, micro-scale power generation and propulsion, biophysics and biofilms, turbulence, internal combustion engines and control systems, low-gravity phenomena, radiative transfer	OHE 430J	ronney@usc.edu
Prof. S. Sadhal	Drops and bubbles in acoustic fields, thermo-capillary flows with drops in low gravity, heat conduction in composite solids	OHE 400G	sadhal@usc.edu
Prof. G. Shiflett	Kinematics and dynamics of mechanical systems, computer-aided design, optimal design techniques, micro-electromechanical systems	OHE 430F	shiflett@usc.edu
Prof. G. Spedding	Geophysical fluid dynamics, animal aero- and hydrodynamics, turbulence	OHE 430B	geoff@usc.edu
Prof. A. Uranga	Fluid mechanics, aerodynamics, computational fluid dynamics, aircraft design, airframe-propulsion system integration, boundary layer ingestion	RRB 218	auranga@usc.edu
Prof. B. Yang	Dynamics, vibration and control of mechanical systems, distributed-parameter systems, modeling and control of space structures, computational mechanics	OHE 400F	bingen@usc.edu