Senior Design Reporting Guidelines and Required Elements For ENGR 4882/ENGR 4892

Presentations/Reports and Due Dates

Senior Design Teams will complete the following reports and a presentation during the academic year. Due dates for reports follow. Final Public Presentations will be scheduled late in the spring. A Poster Session for the Department of Engineering and Physics' Industrial Advisory Board will be scheduled during Finals Week.

1. Project Initiation Form — due on Friday of week ~3 of the fall semester
2. Project Proposal — due on Friday of week ~7 of the fall semester
3. Project Proposal Presentation — due on Tuesday of week ~7 of the fall semester
4. Final Design Report — due on Last Day of Class of the fall semester
5. Final Design Presentation — due on Final Exam time for Class of fall semester
6. Final Project Report — due on Friday of week ~13 of the spring semester
7. Final Public Presentation — on Tuesday of week ~13 of the spring semester
8. Poster Session — on Friday of Finals Week of the spring semester

A five point grade deduction will be assessed for each day late after the due date. No reports will be accepted after five days tardiness. If corrections to a report are needed, the time allotted for completing the corrections will be at the faculty advisor's discretion. No final grade will be issued to any team member unless and until all required reports have been accepted as complete by the faculty advisors and all required signatures are on the Project Approval Form.

Formatting, Writing, and Grammar

Reports should be prepared using a word processor (Microsoft Word or LaTeX are recommended). All pages should maintain a 1" margin top, right, and bottom and a 1.25" left margin to allow for hole punching if needed. For the main text use 12 point Times New Roman as the font, 1.5 line spacing, and print on one side of the paper only. You may use your judgement and creativity when placing pictures, diagrams, and drawings. Do not shrink drawings so much that the detail and labeling cannot be read. There should be no label text less than 8 points. You may wrap text around drawings – again, use your judgement and creativity. Drawing and pictures embedded in the text should have an identifying figure number and short description centered beneath the figure. Tables should likewise be numbered but the Table number and description should go above the table. Check, double-check, and triple-check your spelling and grammar. Grammatically incorrect papers will be returned for correction and points will be deducted for sloppy work and poor writing. **The Senior Design proposal and reports represent your ability to function as professional engineers after four years of training and they are to be presented in a professional manner and format.**

Team Work Sessions

All students in ENGR 4412/ENGR 4422 are expected to devote a minimum of six hours per week to the course for meetings and work sessions. Typically, advisors will ask students to attend in-class work sessions for 1-3 hours per week. Time has been allotted in your schedules for these meetings each Tuesday from 1:00-3:50 PM. At a minimum, your advisor is expected to meet with your team for one (1) hour every two weeks.

Project Proposal

The Project Proposal is used to present the team's project idea, background for the idea, and a plan for completing a detailed design. Project Proposals will be graded by the team's faculty advisor. However, the grade for the proposal will count as 25% of the final grade for the ENGR 4412 course. Faculty sponsors are asked to assign a numeric grade to each report with a suggested point value for sections as shown. The Project Proposal should have the following sections and contents.

Project Approval Form

A copy of this form MUST be attached to the top of the report with a paper clip. Do not staple it to the report. Find all SD forms at the course web site.

Letter of Transmittal (15 pts)

A letter of transmittal, written to the project advisor(s) should accompany each report. The letter should communicate the importance of the attached report (why it was written) and briefly state the most important conclusions and recommendations derived from the work. It should be very brief and businesslike; one or two paragraphs is often sufficient. It should be written in letter or memo format and signed by all team members. A team member signature indicates a substantive contribution by that person to the work and to the report.

Title Page (5 pts)

The title should state clearly the subject of the report. Avoid terms such as "investigation of", "analysis of", "effect of", etc. in your titles. The title should be very specific, not general.

Table of Contents (5 pts)

The left hand column should be used to itemize the divisions and subdivisions of the report with the corresponding page numbers noted on the right side of the page. It is helpful to the reader if the page listings are connected with dots to the main headings. To do this in MS Word, set up a right justified tab next to the right margin marker in the page ruler. After typing the heading on the left, hit the tab key, and type the page number. Then, pull down under the Format menu to Tabs... and you will find a choice of "leaders" including the "....." type to be used in the Table of Contents. Click the appropriate radio button and the dots will fill the tabbed space between the text and the page number. Subsequent headings will be formatted this way for you by Word (if you are lucky and have good karma).

Executive Summary (10 pts)

This section should contain a brief summary of the project idea and why the team wishes to pursue the project. For scientific papers this section would be the Abstract for the paper. For industrial design proposals and reports, it is more typically titled "Executive Summary." It is called this, in part, because it is meant to summarize the proposal or report findings in a brief and concise way for company executives. Upper level managers need to understand the basic elements of the proposal, but will otherwise not read the entire document. It is therefore imperative to create a strong case for pursuing the project in just a few sentences – usually in no more than ½ to 1 page.

Introduction (Background and Literature Search) (15 pts)

This section should explore the reasons for doing the project, possibly putting the project idea in historical context if needed. Has the problem been worked on previously? If yes, by whom? With what results? Are there previous experiments or designs reported in the literature? What did those experiments or designs lack that your proposal will correct? Are there other, relevant data or modeling results from the literature that should be cited and discussed? If the proposal concerns a new way to make an existing material, how does the current process work and how will your proposal improve on the process or on the product produced? Are there economic, environmental, or safety improvements to be made? If you are proposing to carry out a project that has been previously considered but rejected, were there political reasons at that time which no longer exist? Were there ethical reasons for the prior rejection that your proposal surmounts? Normally, at least two pages are required to do a reasonable job on a background discussion - more if diagrams or extensive literature citations are required.

Project Proposal (20 pts)

In this section, specifically address and detail exactly what your group proposes to design and/or build. Use a block diagram of your proposed device or system or process to help the reader visualize what you will design. Remember that you are *proposing to <u>do</u> a design*; there is no expectation that the design itself will be conveyed in this document. What types of design calculations will be needed and what other information will have to be gathered to complete a design? Show the path of the proposed project as a series of activities and indicate milestones. Milestones might comprise completion of activities involving gathering physical property data, completion of design calculations, or flow diagrams completion of computer analyses, completion of the selection of materials of construction, completion of mechanical design calculations, completion of dynamic calculations, completion of circuit simulations, and so on. Each of these items serves as a design deliverable. Indicate which team member will have the responsibility for ensuring completion of each activity. You should consider the use of one or more tables to summarize the proposed activities in addition to a discussion.

Project Timing (15 pts)

The report should convey a strong sense that the team has thoroughly discussed the working relationships between the project members who are carrying out the project. What are the technical skills needed to carry out the design and which team members have those skills? Will the same person lead the team throughout the project or will team members rotate into and out of this assignment?

Your report should include an agreed-to work schedule for the team, including times and locations, which takes into account the meeting requirements described above. How long will the design phase of the work take? How will project planning be carried out? Which software will be used to maintain a project schedule and which team member will be responsible for the schedule? Use a Gantt chart or other appropriate scheduling tool to detail the start and finish dates for each activity discussed in this section. Clearly indicate the dates when milestones will be met and design deliverables will be available. Clearly indicate the responsibilities of each team member toward meeting the project goals. If appropriate, consider carrying out a Critical Path Analysis.

Project Considerations (15 pts)

As appropriate to your proposal, address and discuss a minimum of five of the following considerations in **separate** subsections. The meanings of these phrases have been discussed in ENGR 4412 during the first few weeks of classes to help you understand the discussion being requested in these sections.

1. Engineering Standards
2. Economic Issues
3. Environmental Issues
4. Process Sustainability
5. Manufacturability
6. Ethical Considerations
7. Health and Safety Considerations
8. Social Implications
9. Political Issues

Design Report

The Design Report is used to convey the details of your design. It should contain copious design calculations, detailed drawings, construction schedules, and team member responsibilities. Design Reports will be graded by the faculty advisor. Input may be solicited from an external advisor at the faculty advisors discretion. Each team member's grade for ENGR 4412 will depend strongly on the grade assigned for the Design Report. Include (see Project Proposal)

Project Approval Form (MUST be attached)
Letter of Transmittal (10 pts)
Title Page (5 pts)
Table of Contents (5 pts)

Executive Summary (10 pts)

Briefly describe the purpose of the project and why it is being done. Summarize the main elements of the design and briefly describe the supporting documentation (design calculations etc.) attached. Briefly describe areas of uncertainty or concern in the design. Remember that the Executive Summary will be read by those who will not necessarily read the entire document but who nevertheless need to understand the reasons for the project and the main features of the design. For a Design Report, this section may be ½ – 1 page long.

Background (5 pts)

Write a brief background section referencing the Background in the Project Proposal as needed.

Design Objectives and Specifications (20 pts)

Detail the objectives of the design. What is the team accomplishing with the design? What important outcomes does this design enable? For example, does the design enable a new or better product to be produced? How so? Does the design enable measurements to be made that have not previously been available? How so? Does this design improve process safety or allow significant energy savings? How so? Detail any shortcomings of the design. Were there desired components omitted due to cost? If so, how was the design affected by the omission? Were design elements included or omitted which limit the most desirable operation or use of the design? Why so? What other tradeoffs in design elements were investigated and why were such elements included or rejected?

Detail the specifications of the design. Include process flow diagrams, circuit schematics and simulations, piping and instrumentation diagrams, mechanical (fabrication) drawings, flow rates, temperatures, pressures, and materials of construction as appropriate. In an Appendix, attach example calculations documenting the work done on critical design elements, results from computer simulations, and laboratory measurements and analyses. Supply statistical analysis of critical data and set limits on the design based on these analyses as appropriate. For example, if your design includes a chemical reactor, support your reactor choice and specifications with reaction engineering calculations. If your design includes a mechanical device, support your design with structural strength calculations etc. as appropriate. If your design includes and electronic device, provide circuit diagrams, computer simulations, printed circuit board layouts, and the like. Try to set upper and lower limits on the expected behavior of the design. For

experimental system designs, include calculations which support the design sensitivity of the instrument for the variables or quantities to be measured or controlled.

Cost Analysis (15 pts)

If you are designing an experimental system or mechanical or electrical device, include a cost analysis for the design by supplying a spreadsheet detailing all items needed. Include part numbers, vendor names, vendor contact information, quoted costs, and delivery times. Also, include quotations (not estimates) from fabricators for specialty work (machine shops, etc.). If your team is designing a mechanical or electrical device and this device is meant to be a commercial product, supply a manufacturing cost estimate including fixed capital, raw materials, and labor costs to produce and package the device. Supply a detailed estimate of the operating and overhead costs associated with marketing your device including the costs associated with marketing and advertising, liability insurance, employee benefits, etc. For process plant designs, indicate the production rate basis for the design. Include a preliminary fixed capital cost estimate (±15-20%), manufacturing cost estimate (±15-20%), and projected sales price for the product(s) for 15% and 25% ROI at the design production rate. Indicate in your report where you obtained the data used for your estimate.

Project Timing (15 pts)

Modify the Gantt chart completed for the Project Proposal to show actual completion dates for design milestones and discuss any reasons why the original, proposed timing was not achieved. If a Critical Path Analysis was done, discuss any adjustments to the original path and the reasons for those adjustments. Supply a new Gantt chart detailing the timing for completion of the project or fabrication of an experimental system or prototype device as appropriate for the design. For process plant designs, supply a new Gantt chart detailing the start and end dates for all remaining tasks needed to complete the design, the final detailed cost estimate, and a recommended construction schedule. Indicate the responsibilities that each team member will assume to ensure completion of the project.

Design Considerations (15 pts)

As appropriate to your design, address and discuss a minimum of five of the following considerations in separate subsections. If you are doing a process plant design, you are required to include detailed discussions of economic issues, environmental issues, and process safety as three of your considerations. This section will also count as 10% of your grade in ENGR 4412.

1. Engineering Standards
2. Economic Issues
3. Environmental Issues
4. Process Sustainability
5. Manufacturability
6. Ethical Considerations
7. Health and Safety Considerations
8. Social Implications
9. Political Issues

Design Presentations

All teams will submit a PowerPoint presentation for a Senior Design Symposium to be held late in the fall semester. The presentation will count 20% towards the final grade in ENGR 4412 and will be collectively graded by the Project Sponsors and the ENGR 4412 instructor.

Final Project Report

The Final Report should summarize the entire project and supply a detailed discussion of the results of the project. It should include, for example, data from any experiments carried out on an experimental system design, pictures and initial test results of a prototype that has been constructed, and final flow diagrams and simulations of a process plant that has been designed. As for the other reports, include

Project Approval Form (MUST be attached)
Letter of Transmittal (5 pts)
Title Page (5 pts)
Table of Contents (5 pts)
Executive Summary (10 pts)

Final Design and Fabrication (20 pts)

Include updated process flow diagrams, piping and instrumentation diagrams, mechanical drawings, circuit diagrams etc. as appropriate. These should be consistent with the completed project. Include a picture of the prototype if one has been constructed. Changes made to the original drawings and specifications should be indicated and discussed. Why were the changes made? Support the design changes with calculations as appropriate. Include the results of process simulations carried out using the final design if appropriate. Discuss areas where improvements to the design could be made. Discuss difficulties encountered while constructing the prototype if appropriate.

Cost Analysis (15 pts)

Supply a final cost analysis for the design. If your team designed an experimental system or mechanical or electrical device, include a spreadsheet detailing all items purchased. List and discuss deviations from the original design cost analysis. Include part numbers, vendor names, vendor contact information, actual versus costs, and actual versus estimated delivery times. Include actual costs from fabricators for specialty work (machine shops etc.). If your team designed a mechanical or electrical device and this device is meant to be a commercial product, indicate the manufacturing cost expected including fixed capital, raw materials, and labor costs to produce and package the device. Include final values for the operating and overhead costs associated with marketing your device including the costs associated with marketing and advertising, liability insurance, employee benefits etc. Indicate changes from the Design Report values (if any), and discuss why the values have been altered. If your team did a process plant design, indicate the production rate basis for the design. Include a detailed fixed capital cost (±5%), manufacturing cost (±5%), and expected sales price for the product(s) for 15% and 25% ROI at the design production rate. Indicate where you obtained the data for the cost estimates and discuss any changes in the cost estimates compared with those in the Design Report.

Project Timing (10 pts)

Update the Gantt Chart detailing the timing for construction of the project or fabrication of an experimental system or prototype device as appropriate for the design. List and describe changes made since completing the Design Report. If your team designed a mechanical or electrical device and this device is meant to be a commercial product, develop and include a schedule for commercialization, market entry, and initial marketing efforts. If your team developed an experimental system, develop and include a detailed experimental plan to test the

design. Include guidance on statistical analysis of the data to be obtained in order to set limits of error for the data to be taken using your system. If you are doing a process plant design, develop a construction schedule that would need to be followed if you were actually going to build the plant. Include delivery dates and installed data for key or critical pieces of equipment or subsystems (e.g., control system, water treatment system, etc.). Your schedule should end with a specified start-up date.

Design Considerations (20 pts)

As appropriate to your design, address and discuss a minimum of five of the following considerations in separate subsections. If you are doing a process plant design, you are required to include detailed discussions of economic issues, environmental issues, and process safety as three of your considerations.

1. Economic Issues
2. Environmental Issues
3. Process Sustainability
4. Manufacturability
5. Ethical Considerations
6. Health and Safety Considerations
7. Social Implications
8. Political Issues

Future Work (10 pts)

Provide guidance and suggestions for the design activities or engineering tasks required to carry the project forward. If a new engineering team were to start where your team finished, what should the new team do next? What significant changes or modifications should be considered. Point out and discuss new opportunities for your design. What derivative products might come from your project? What major issues, technical and otherwise, are unresolved? Discuss any barriers that exist to prevent pushing the design through the next phase. Include a new timeline. How long might it take for a new team to complete the next phase you suggest?

Final Project Presentations

All teams will submit a PowerPoint presentation for a Senior Design Symposium to be held late in the spring semester. A poster session will accompany the symposium. Symposium presenters will be chosen competitively and there will be one or more prizes for the best paper(s). The presentation or poster session will count 20% towards the final grade in ENGR 4422 and will be collectively graded by the Project Sponsors and the ENGR 4422 instructor.