BIOE 194, 195 and 196 - Senior Design Project

Final Design Thesis (FDT) Guideline for Biomolecular Track Research

This recommended structure for your report is based on the recommended structure for the final thesis document that you will submit at the end of the academic year. This guideline is recommended for the theses in the field of biomolecular engineering. Please note, this guideline does not intend to replace School of Engineering general formatting guidelines. Instead, it is ONLY a guideline that is IN ADDITION to School of Engineering general formatting guidelines. For general formatting guidelines, use format at: http://scu.edu/engineering/srdesign/student.cfm

General Comments -Reports must be neatly word processed, carefully proofread for correct spelling and grammar, and edited for continuity and style consistency between different authors.

Formatting Comments - Follow the following guidelines:

1. There should not be large sections of white space in the body of the thesis. Move text or resize figures accordingly. You may have blank space at the end of a chapter given that the next chapter will begin at the top of the next page.

2. Figures must be numbered with captions below the figure, with font size of 10.

3. Table must be numbered with captions above the table, with font size of 10.

4. All references must be properly cited and listed in a bibliography. This is critical - you MUST have fully documented citations, and all cited work MUST be properly credited. A free online software "Mendeley" is recommended for your bibliography organization from the beginning. Please go to www.mendeley.com for software download and setup instruction.

5. Respect the copyrights. In short, if you didn't create it, it is not yours. Students need to obtain owner's written permission to use it. That includes images, cartoons, figures, tables, data and sentences that you can usually download from internet and copy from textbooks. Please plan ahead for those signatures.

Common report organization - This shows a typical final thesis outline, although actual contents and organization may vary by project. Consult with your advisor and/or the instructor if you would like to get feedback on an alternate report structure.

Although the format may vary, underlined topics are required for all theses. For the FDT, students are required to include, at a minimum, the sections that are highlighted.

1. **Signature page** - use format at: http://scu.edu/engineering/srdesign/student.cfm

2. **Title page** - use format at: http://scu.edu/engineering/srdesign/student.cfm

3. **Abstract** - this is a well-crafted and highly concise summary of the report. It should be no more than 1 page. A good abstract motivates the issue, states the goals of the project and the work accomplished, summarizes the results, and notes the impacts and/or conclusions. Ironically, it's better to write the abstract AFTER you have finish the rest of the thesis, in other words, this is the last piece of your thesis writing.

Refer to the following example, and specifically note the structure of the abstract in terms of content: http://scu.edu/engineering/srdesign/student.cfm

4. **Acknowledgments** - You MUST properly acknowledge financial support and in-kind contributions of sponsors, donors, mentors, etc. Sponsors may have very specific wording that must be included in such reports, so check on this with your advisor. You may also use this section to thank friends and family for their assistance and support.

5. **Table of contents** – use format at: http://scu.edu/engineering/srdesign/student.cfm

6. **List of Figures** – use format at: http://scu.edu/engineering/srdesign/student.cfm

7. **List of Tables** – use format at: http://scu.edu/engineering/srdesign/student.cfm

8. **List of abbreviations** - including those for the chemicals, biologicals, instruments and technical terminology.

9. **Introduction and Significance** (What and Why)

This section is the most time-consuming part to write. You can skip to work on next section if you feel stuck but always remember to come back to finish it off.

In this section, you need to tell the readers what you want to do and why you do it. These two topics need to be explained in details. Then you want to outline how you are going to do it. The general order for this part could be:

* Background/motivation of subject matter. This is big picture rationale. It can be your vision of a "big thing", for example, cancer therapy, organ replacement, etc. No details needed here, it will be one paragraph, but your vision should be scientifically reasonable.

* Review of field/literature. This part needs the details and the review of previous literatures must be comprehensive. The literatures should be related to your "big thing". If there are many literatures (usually the case), you need to group them and categorize into paragraphs. Respect the copyrights and comprehensively cite references in bibliography.

* Critics of the current literatures and technologies. Nothing is perfect, you need to think

hard to analyze the literatures and identify the shortcomings of the reported theories and technologies. But all the critics should be based on scientific principles, not something you "thought", "guessed". After that, you can point out the key constraints to overcome these drawbacks. No "leap of faith" is allowed here.

* Statement of project goal, objectives and expected results. Here you can tell the readers exactly how to overcome these shortcomings and make things better in one or two sentences. That's your project goal. You can start with "Herein,". Next, you want to outline the milestone steps in order to reach your project goal. The relationship among those steps can be serial or parallel. For each step or milestone, you can spend maximum 3 sentences to describe. No details are needed here. Leave them to the following chapters. Last, you can describe briefly the expected results. These are the hypothetical results, you really don't want to get into details.

* A back-up plan. A back-up plan is needed. What about your design does not work out as you expected, what is your rescue plan? Ideally this backup plan should be conservative, the protocols and experiments should be well-established.

* Significance. You want to tell the readers what are the benefits and potential impacts if this project works and obtained the results above. Think big! Imagination is allowed here. for example, the field, well-beings, health, life of human kind, etc.

* Team and management.

* Budget for the entire project. discuss main issues, refer to appendix for spreadsheet.

* Timeline for the entire project. discuss main issues, refer to appendix for Gantt chart.

10. **Chapters of project**. Each step or milestone described above makes its own chapter. From now on, everything needs to be explained or described in details. Every piece of data you show must be true, original and repeatable. These chapters make up the main body of the thesis.

The organization of each chapter could be:

1. Introduction - This is very similar to the “introduction” part of the whole thesis, except being more focused on one milestone step you are going to describe in this chapter. "What" is this milestone or step you are going to do in this chapter, and its relationship and position in terms of the whole project ("why"). Next, you want to review the existing research and technologies regarding the milestone step in current chapter. This time, the review is more focused and detailed.

2. Details of key constraints - you could start with the critics of the existing technologies and continue with analysis and identification of the key constraints for this

sub-project.

3. Detailed design description, novel approaches/solutions to problems - description has to be in depth and logic. Do not make a hypothesis on top of another hypothesis. Use photos, sketches, CAD drawings, layouts, flowcharts, etc. if necessary. High level descriptions and summaries blended with narrative, detailed documentation in appendices. Do not use technical jargons, for example, PCR should be written in "polymerase chain reaction".

4. Detailed supporting analyses - brief description of approach to, and results of, major analyses and/or prototyping results.

5. Expected results - Detailed subsystem test/verification procedures/data specifically showing whether requirements are met or not.

6. A back-up plan

7. Materials and Methods - List all the chemicals, biologicals, instruments you used for your experiments, including their brand, company, model number. If mammalian cells, also includes the batch number of production. Describe every protocol you used in detail, the bottom line is that the readers can reproduce your experiment without asking you. Since this part is black and white, you can start to write this part as soon as you finish a particular experiment.

8. Results - This part you present the experimental results obtained from your own research. All the data, figures and tables should DIRECTLY result from your own experiments. Do not show any figures and tables from other publications. If it is cartoon illustration, you need to make your own. This part is also black and white, you just need to explain how you obtain those results (protocols, methods, data collection and organization etc), what each figure, curves and table means. No hypothesis in this part, just plain statement of the facts.

9. Discussion - In this part, you can discuss your results.

11. **Summary and Conclusion**. This is the final chapter of the main body of the thesis. It typically starts with a summary of the project. In this Summary section, you should restate your project objective and the milestone steps you did, discuss results (overall evaluation of the design, experimental results etc.). A table may help here.

Next, you move to integrate all the milestone steps and verify if your whole project design works or not. At the end of all the discussion, you need to write a clear statement if your project design works or not.

This chapter also typically has a Future Work section in which you provide a well-

thought out list of suggested improvements and areas for future exploration. The chapter often concludes with a Lessons Learned section in which you reflect on the project as an educational experience, discuss what your challenges were, consider what you did well and what you realize you should improve, and identify nuggets of wisdom to pass on to future students.

12. **Engineering Standards and Realistic Constraints** - discuss how the following considerations impact your design: economic, environmental, sustainability, manufacturability, ethical, health & safety, social, and political. At least five of these factors must be discussed in sufficient detail to show understanding of the issues and relevance to the project. Refer to the SCU Engineering Handbook for guidance and background on these issues. For FDT, include 5 topics of your choosing with one paragraph describing the importance and relevance of each topic. Note that this is not just a creative writing assignment. Most projects have very real standards and constraints that are relevant. Either you face them directly as you do your project, or perhaps they would be an issue if your product were to ever really be put into production/use.

13. **Bibliography**. Students MUST cite references properly and completely. Recommend to use free online software “Mendeley”.

14. **Appendices**. Appendices hold the detailed information that isn’t appropriate for the body of your narrative design report. That said, you should realize that the body of your report should still include some detail, but it is a selected set of detail. So, the body should include key figures, summary tables of specifications and results, high-level drawings (like configuration sketches, functional and component diagrams, data flow diagrams, etc.), specific test and simulation plots showing behavior and results, and perhaps particularly interesting detail (mechanical drawing, electronic schematic, pseudo-code, etc.) of critical components. In general, all the negative and non-critically positive results that you mentioned but didn’t fully described in the body go to appendix.