SANTA CLARA UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Date: September 18, 2025

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Student Name 1
Student Name 2

ENTITLED

Project Title - TEMPLATE FOR CSEN SENIOR DESIGN THESIS

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREES OF

BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING
BACHELOR OF SCIENCE IN WEB DESIGN AND ENGINEERING

_____
Thesis Advisor

_____
Department Chair

Project Title - TEMPLATE FOR CSEN SENIOR DESIGN THESIS

by

Student Name 1
Student Name 2

Submitted in partial fulfillment of the requirements
for the degrees of
Bachelor of Science in Computer Science and Engineering
Bachelor of Science in Web Design and Engineering
School of Engineering
Santa Clara University

Santa Clara, California
September 18, 2025

Project Title - TEMPLATE FOR CSEN SENIOR DESIGN THESIS

Student Name 1
Student Name 2

Department of Computer Science and Engineering
Santa Clara University
September 18, 2025

ABSTRACT

A good abstract is a concise summary (1–2 paragraphs) of the entire project: introduction, problem statement, work accomplished, results, conclusions, and recommendations. When you write the abstract, imagine that the reader will not read anything else but that you must get your major point across immediately. This requires the efficiency of words and phrases. An abstract is written to stand alone, without jargon or references to figures and tables in the report body.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Table of Contents

List of Figures

Overall, have at least 20 figures at the end of the senior design project.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 1

Introduction

The introduction should be approximately 1–3 pages in length, and should contain the following information:

Problem statement: Make a concise statement of the problem, ideally in a few sentences but not more than a paragraph. For example, try to complete this statement: "The sponsor desires that... (insert goals of the project) ... subject to the following criteria:... (insert numbered list)." These goals and criteria help define the scope of work and deliverables.

Background or Related Work: Describe who else has worked on this problem or similar problems (you should do most of your citations here). For applied projects, provide information on other existing programs which will use your program. Objectives: The objectives are a battle plan for the project. They are a breakdown of steps or accomplishments that must be completed to achieve the project goals.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

1.1 Problem Statement

Re-use the content from your problem statement.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

1.2 Background or Related Work

State who else has worked on this problem or similar problems (you should do most of your citations here). For applied projects, provide information on other existing programs which will use your program.

Describe what systems already exist and why they are inadequate.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

1.3 Objectives

The objectives are a battle plan for the project. They are a breakdown of steps or accomplishments that must be completed to achieve the project goals.

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1.4 Our approach

Describe the team's approach for developing a system at a high level. Why will your work result in a system that is different / better than existing solutions?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 2

User Research - example middle chapter

2.1 Methods

Describe what methods you have used to identify user needs. This can include methods such as storyboards and interviews and surveys with target users. Describe how you analyze the data you collect. Include an example.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

2.2 Stakeholder needs

Who are the stakeholders for this system? Provide a short description of what you know (so far) about each of the stakeholders and their needs. Highlight cases where their needs may differ. Personas could be appropriate here. Describe whose needs your system will prioritize. It is ok to state that a potential stakeholder is out of scope for the project. For example, a virtual tour of the SCU campus might target prospective students, but choose *not* optimize for their parents (who are also potential stakeholders/viewers, but have different needs).

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

2.3 User stories

For each stakeholder that you choose to prioritize, describe one or more user stories that your system will support, e.g., "As a prospective student, I want to find a social group at SCU so that I have friends to hang out with."

Based on our user research and the priority stakeholders, we formulate the following user stories to guide system design. Each story captures a specific goal from a stakeholder's perspective and informs both feature planning and testing.

Prospective Students

- **As a prospective student,** I want to take a virtual tour of SCU's dorms, **so that** I can compare housing options before visiting campus.
- **As a prospective student,** I want to preview clubs and student groups, **so that** I can plan how to get involved socially.

Parents of Prospective Students

- **As a parent,** I want to access safety and health information during the tour, **so that** I feel confident in my child's well-being on campus.
- **As a parent,** I want to know about academic support services, **so that** I can trust the school's ability to help my child succeed.

Admissions Officers

- **As an admissions officer,** I want to update featured content on the tour, **so that** we can highlight new programs each quarter.
- **As an admissions officer,** I want to track which parts of the tour are most visited, **so that** I can refine our outreach strategy.

Student Tour Guides

- **As a student ambassador,** I want to record guided walkthroughs of campus spots, **so that** I can offer a personal touch remotely.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 3

Design and Rationale - example middle chapter

3.1 Design

Describe the design of the system at a high level. The system should support the use cases described in the previous chapter.

—C4 system context and container diagrams go in this section. See: https://c4model.com/ (C4 Model Website)

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

3.2 Use Case Overview

Brief explanation of how use cases were derived from user stories.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

3.3 Use Case Descriptions

Use Case 1: EXAMPLE Explore Campus Virtually

Actor: Prospective Student **Preconditions:** User is on the landing page.
Main Flow:

1. User selects "Start Virtual Tour".
2. System displays a map of campus buildings.
3. User clicks on a building icon.
4. System opens a 3D or 360° tour of that building.

Alternate Flow: If media fails to load, fallback images are shown. **Postconditions:** User has explored one or more buildings virtually.

Figure 3.1: Use Case 1: EXAMPLE Explore Campus Virtually

Use Case 2: EXAMPLE View Campus Safety Information

Actor: Parent of Prospective Student **Preconditions:** User is on the main information page.
Main Flow:

1. User navigates to the "Safety Info" section.
2. System displays emergency contacts and safety resources.

Postconditions: User is informed about campus safety services.

Figure 3.2: Use Case 2: EXAMPLE View Campus Safety Information

3.4 Use Case Diagram(s)

Include at least one UML use case diagram that includes an overview and relationship of your text use cases. (You can use the tikz-uml package to draw a Unified Modeling Language models or you use an UML editor of your choice and upload the pictures here.)

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

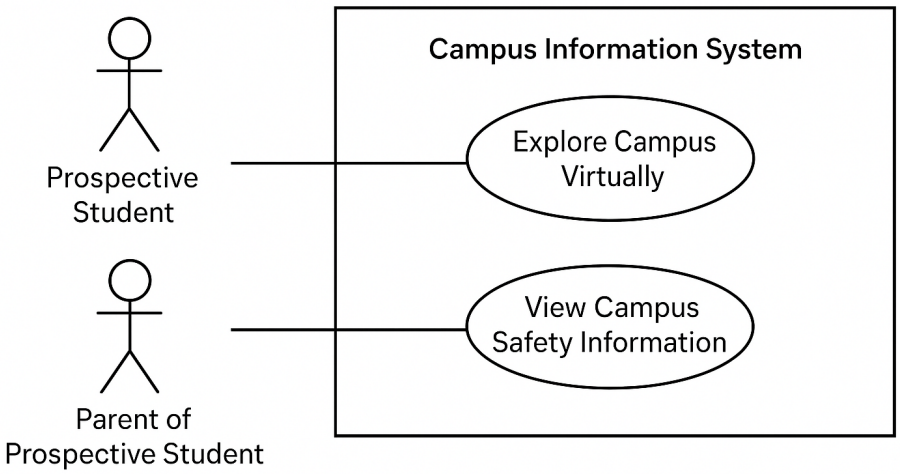

Figure 3.3: EXAMPLE UML Use Case Diagram: Campus Information System

3.5 Class Diagram

Include at least one UML Class Diagram that includes an overview over your system.

(You can use the tikz-uml package to draw a Unified Modeling Language models or you use an UML editor of your choice and upload the pictures here.)

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

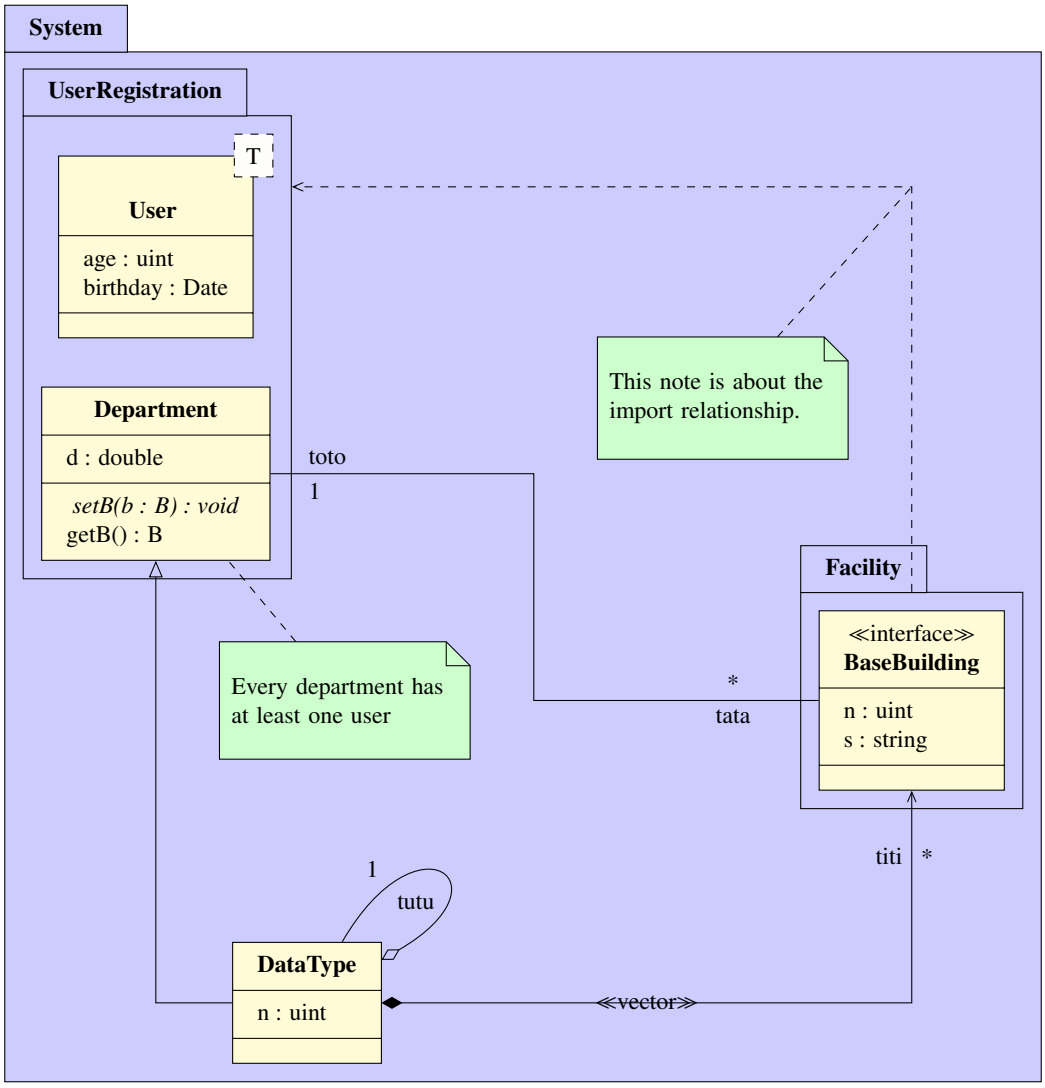

Figure 3.4: EXAMPLE Class Diagram: System

3.6 Sequence Diagram

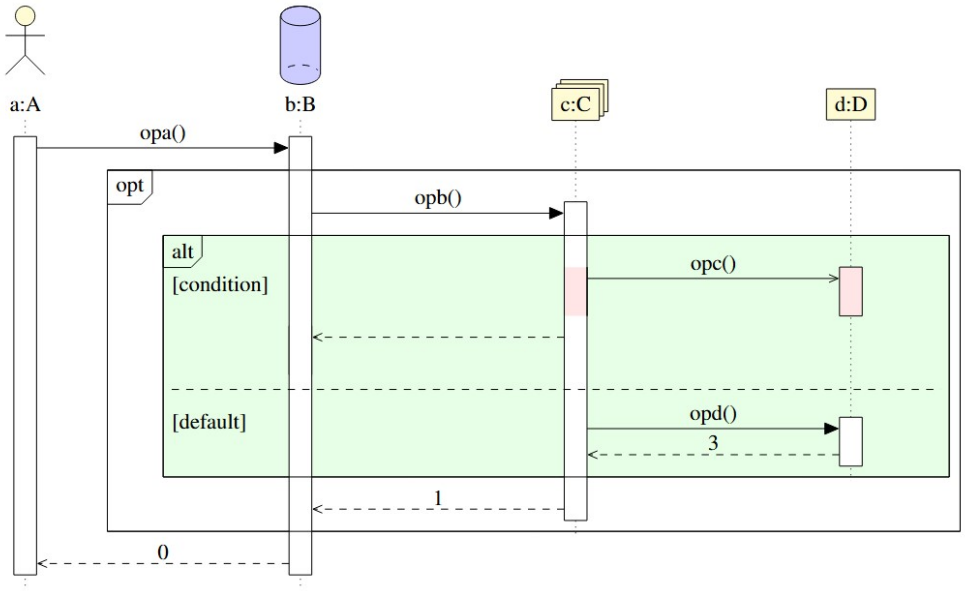

Figure 3.5: EXAMPLE Sequence Diagram: Security Hand Shake

3.7 State Diagram

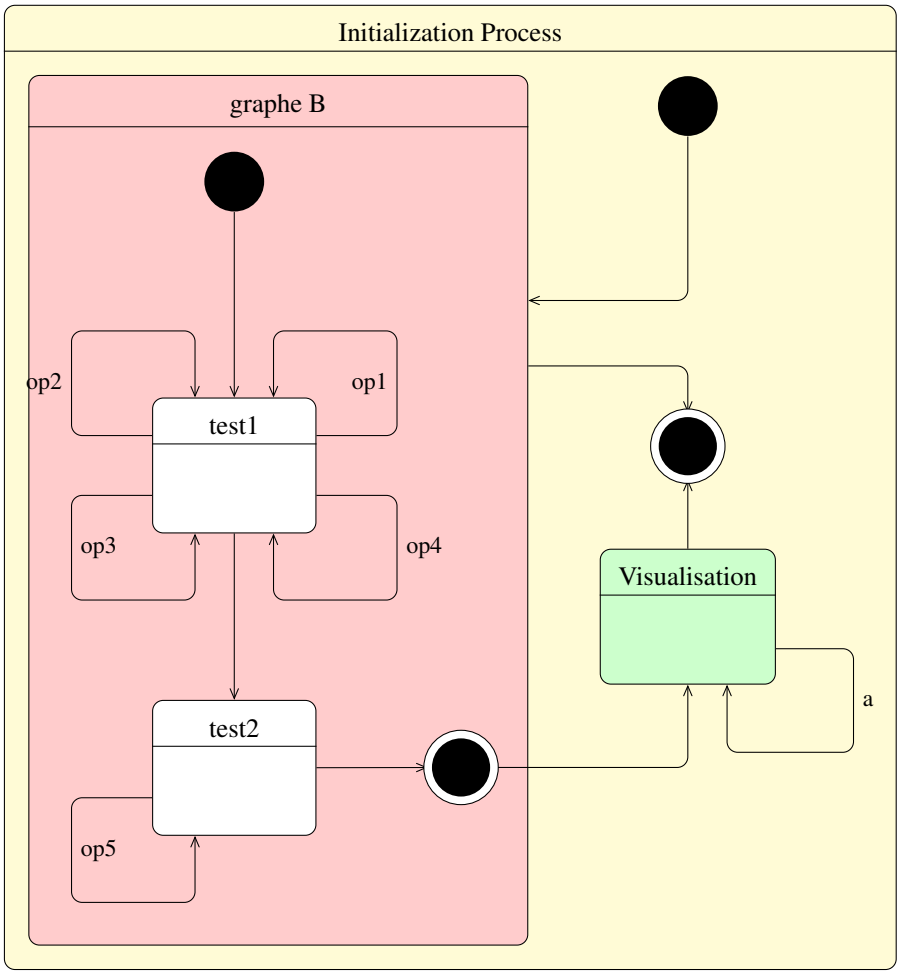

Figure 3.6: EXAMPLE State Diagram: Initialization Process

3.8 Component Diagram

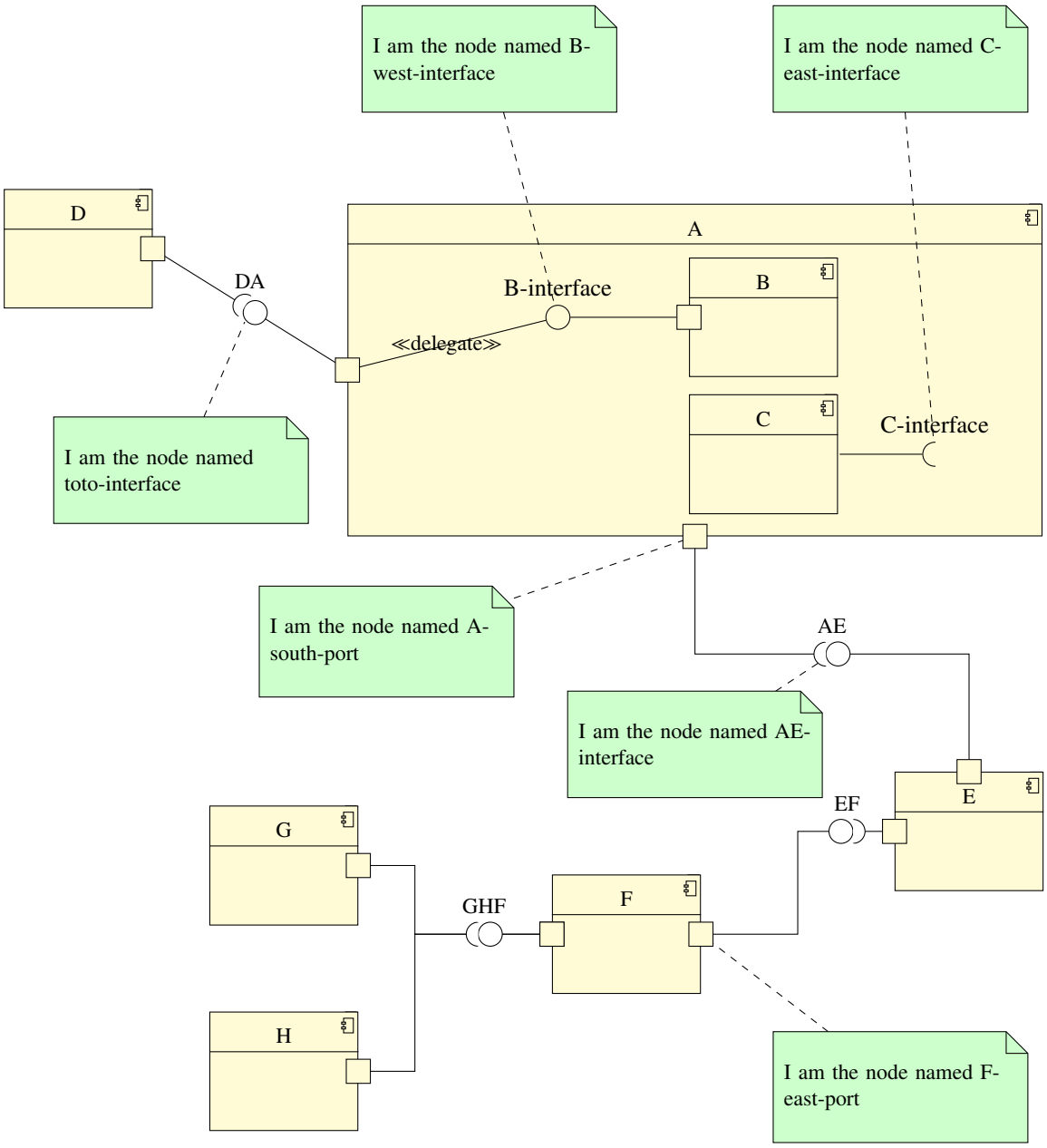

Figure 3.7: EXAMPLE Component Diagram: Major Components

3.9 Functional requirements

Generally expressed in the form: "system must do <requirement>." These are similar to use cases (i.e, "the user can do XYZ"), but written from the perspective of the system. For example: "The landing page must introduce several different virtual tours and let the user choose one."

See https://en.wikipedia.org/wiki/Functional_requirement

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

3.10 Non-functional requirements

Generally expressed in the form: "system shall be <requirement>." These are also known as quality requirements. For example: "The virtual tour shall be fast-to-load. That is, the tour itself and any embedded media in it should load quickly enough that it is not a major annoyance for our target users."

See https://en.wikipedia.org/wiki/Non-functional_requirement

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

3.11 Rationale

Describe why the system is designed this way. What alternatives did you consider, and why is design a good choice.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 4

Technologies - example middle chapter

4.1 System Components

Describe the technologies you will use to build the system.

Don’t forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 5

System Evaluation - example middle chapter

Describe how you will evaluate the system you create. In particular, you need to have a plan for how to evaluate your functional and non-functional design requirements. And how you do unit and integration testing.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

5.1 Internal Testing

How will test the system with internal users? That is, how will you and the team evaluate it yourself? This is also called `https://en.wikipedia.org/wiki/Eating_your_own_dog_food`.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

5.2 External Testing

How will test the system with external users? That is how you will get user feedback on your system. This can include methods such as usability testing, user interviews, and analyzing log data from the product/service. How will you incorporate this user feedback into subsequent iterations of your system?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

5.3 Unit Testing

Unit Testing:

Unit testing verifies small, isolated parts of a program (such as functions or classes) to ensure they work as intended. It helps catch bugs early, simplifies debugging, and improves software reliability. In our capstone project, unit testing gives us confidence that core features function correctly and remain stable as the system evolves.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

5.4 Integration Test(s)

Integration Test:

Integration testing checks how different modules or components of a system work together. It ensures that interactions between parts are correct, reliable, and consistent with the overall design. For our capstone project, integration testing helps verify that individually tested features combine into a cohesive and functioning system.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 6

Implementation Plan - example middle chapter

6.1 Timeline

Introduce the planned timeline for the work.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

6.2 Agile software development

Repeat that we are using agile software development methods–the final system design will change in response to user feedback. Describe how in each two-week sprint, we work towards on one or more of the user stories. In the sprints, these are broken down into tasks that are assigned to specific team members. Show an example of what such tasks look like.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

6.3 Project Risks

Briefly discuss any risks to the project and how you will mitigate them.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 7

Constraints and Standards

7.1 Constraints

Constraints are factors that limit your development process. They could be material such as money or hardware, or non-material such as time or customer satisfaction. Constraints include budget, customer satisfaction, quality, requirements, risk, time, ease of use, reliability, maintenance costs, etc.

Generally, a trade-off exists between time, cost, and scope (features and functionality) and should be discussed. Resources constraints include equipment, materials, software, facilities, and people. In addition, there are legal and ethical constraints to be considered when developing any project.

For example, will your project be maintained after deployment? Did the use of third-party software or hardware affect the design or your project? Did legal requirements such as HIPAA limit the scope of your project? Did the licensing of any components used affect your final project?

HAVE AT LEAST 5 CONSTRAINTS!

REFERENCE AT LEAST ONE CONSTRAINTS YOU MENTION HERE!

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

7.2 Standards

Standards are specifications or requirements, practices, guides, test methods, etc., covering various materials, products, systems or services. Standards are minimally accepted professional practices and qualities that must be observed. Common examples of standards in computer science and engineering include IEEE standards for electrical engineering and networking, and ISO standards for programming languages and design methodologies.

For example, IEEE provides standards for Ethernet (IEEE 802.3), wireless communications (IEEE 802.11), Bluetooth (IEEE 802.15), Verilog (IEEE 1364), as well as public-key cryptography (IEEE P1363). ISO provides standards for C++ (ISO 14882), UML (ISO 19501), QR codes (ISO 18004), ECMAScript (i.e., JavaScript) (ISO 16262), and software testing (ISO 29119-1), among others.

For example, did you choose specific standards for interoperability or to minimize power consumption? Did you use standard languages and libraries to help ensure maximum portability? Did your user interface conform to industry design standards for the devices used? Did you use any accessibility libraries or tools to make your project more inclusive?

HAVE AT LEAST 5 STANDARDS!

YOU NEED TO REFERENCE EVERY STANDARD YOU MENTION HERE!

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 8

Societal Issues

If you do not think an issue, such as ethics for example, has any relation to your project, you can say so, but you should justify this.

SELECT AT LEAST FIVE OF THESE ISSUES TO ADDRESS IN AT LEAST ONE PARAGRAPH EACH

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.1 Ethical

Ethical conduct is what one ought to do in working with others. It is the right thing to do, the moral action. It is not surprising that virtually all of our professional societies and groups, in all professions, have codes of ethical conduct. Professions realize that there are good and bad ways of working with others, and we need to make the distinction. Sometimes it can be difficult to know what is the right thing to do. What ethical questions were or could be raised about your project?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.2 Social

Engineering is done within a social context, within a community of other people. Sometimes that community is defined very narrowly, sometimes very broadly. A focus on social issues allows us to consider the impact of our work on society. If we develop this product, or implement this system, what will be the effect? All of our human developments, in engineering and elsewhere, have unanticipated consequences, some good, some bad. We have an obligation to reflect on these consequences as well as we are able.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.3 Political

Many of our projects are very political in nature, requiring us to take into consideration the will of the general public, usually through elected representatives. Engineers who work on public projects need to understand the political processes that make such work possible. What is the potential impact of your project or this type of project on society?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.4 Economic

Economic considerations in engineering concern the costs of the various steps in the project. Such costs are usually dependent on the engineering decisions that are made during the design phase. Alternative approaches may offer cost options. We also need to consider the cost of money. How do we pay for the cost of a product development? If we must borrow significant amounts of money how do we account for the cost of the loan in the pricing of the product? What economic considerations arose in your project?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.5 Health and Safety

We develop our products for the use of the public. Hence we must consider health and safety issues related to our product. How safe does a product have to be? Are there laws that determine this? Are there related ethical issues? What health effects are relevant? What health and safety issues arose in your project?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.6 Manufacturability

Manufacturability issues are of great importance. Can the product be built? Is there an easier way to build this product than first imagined? What development time issues arise? What are the cost issues? Could your project be manufactured? What problems might arise?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.7 Sustainability

Sustainability means two things in engineering; one is a narrow sense, one broad sense. In the former sense sustainability refers to the degree to which a product that is developed can continue to be viable and useful for a reasonable amount of time. A product that fails soon after it is built and cannot be repaired or updated or modified to fit new needs is not a sustainable product. In the broader sense a community or region or a world, perhaps, that uses its resources effectively so that it can sustain its life for a long time is said to be sustainable. We say that such a community has a sustainable economy. Engineering can help develop sustainable economies. What sustainability issues arise?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.8 Environmental Impact

All of our products and systems have some environmental impact, in the uses of valuable resources, or in the production of pollution, or in other changes in our surroundings. The engineer is obliged to consider such impacts, and to point them out where they arise, or are a threat. What are the environmental issues related to your product?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.9 Usability

Usability refers to what is sometimes called "user-friendliness." Is the device straightforward, easily learned and easily used by the end user. Is your product usable?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.10 Lifelong learning

Lifelong learning is a necessary part of all professions. You wouldn't want to have a doctor who did not know the latest procedures and medications to protect your life. And you wouldn't want an engineer who didn't know the analysis tools that had been developed since graduation, or the cost-effective materials that had just come along. We just have to keep up. Learning never stops. Did this project help prepare you for the time when you will have to learn on your own, or did it inspire you to study new material?

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

8.11 Compassion

One definition for compassion is an awareness of and sympathy for the suffering of another. Compassion means to recognize the suffering of another. But let's look at a broader definition. Let's define compassion as "the awareness of and sympathy for the suffering of another, and the desire to relieve that suffering." What does that have to do with engineering? Simple! One of the things that engineers can choose to do in life is to look for and try to relieve suffering where they find it. Perhaps it means replacing an ancient water supply system that is leading to disease in some tiny village, or designing a communication system to protect seniors with illnesses, or designing prosthetic devices for crippled children. Even if we do not decide to make the relieving of suffering the focus of our life's work, it is still critically important to our fullness as a human being that we feel compassion for the suffering. It is a part of the education that we hope you acquired at Santa Clara.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 9

Conclusion

State what you learned from your work. In this section:

- Summarize what you did. This can be viewed as the evidence.
- State what you learned (the actual conclusions that you are drawing), and relate them to the project objectives.
- List the advantages and disadvantages of your work. In what ways is your solution deficient or lacking? You are not divulging a weakness in your work when you state problems that still remain.
- State directions for future work and list any open problems.
- **Do not use bullet points!**

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 10

Acknowledgments

Acknowledge the contributions of the sponsor, university staff, other students, faculty, and other persons who were of assistance.

This section is OPTIONAL.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Chapter 11

References

You must include a list of references that you cite to support facts that are not common knowledge or expert opinions that you include in your report. In general, it is better not to use a bibliography of sources consulted for general background knowledge; instead, make a habit of citing the sources that you actually use. The format of the citations (which appear within the body of your report), and the format of the list of references (which appears near the end of the report, just before the appendices) should follow the guidelines described by the library.

You need to replace these ones:

Example citation 1 EXAMPLE: Ahmed et al. [1974]

Example citation 2 EXAMPLE: Soh et al. [2017]

HAVE AT LEAST 20 REFERENCES!

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.

Bibliography

N. EXAMPLE: Ahmed, T. Natarajan, and K.R. Rao. Discrete Cosine Transform. *IEEE Transactions on Computers*, C-23(1):90–93, 1974. doi: 10.1109/T-C.1974.223784.

Jae Woong EXAMPLE: Soh, Hyun-Seung Lee, and Nam Ik Cho. An image compression algorithm based on the Karhunen-Loève transform. In *Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC)*, pages 1436–1439, 2017. doi: 10.1109/APSIPA.2017.8282257.

Chapter 12

Appendices

Include:

- Important source code listings (listing 50 pages of source code is not really helpful), as a rule of thumb make it around 5 to 10 pages of source code listings, not more.
- Logic diagrams
- Parts lists
- Parts layout
- Data tables
- Background calculations
- And other information needed for completeness, but would bog down the discussion in the body of the report.

Don't forget to delete this explanatory red text/block introduction, and replace it with your text in black.