**Guidelines for Senior Design Technical Report**

The following is a template for the senior project. You may add more sections to this. Brief explanation for these items is given after the template. Please note that design and verifications are most important sections. This is a senior **design** project … so **please make sure that you provide detailed discussion on how your proposed design meets the project requirements, constraints and standards.**

**General guide**

*This is a general guide to writing your final year project report. Sections* ***can be modified*** *slightly in agreement with the supervisor of the project.*

Your report should be your ambassador to the committee who are about to evaluate you and hence should present an image of efficient, coherent, consistent team members who have worked hard to achieve a good product/software/design/research and know what they are doing.

Start with small sections (abstract and intro) and add detail in the following sections and then as you wrap up start to reduce the sections again.

Your report should be on A4 pages with page footers that have page numbers and any additional info you wish to include.

**Title/Cover page** should include (with ABSOLUTELY NO SPELLING MISTAKES!)

University Name

College

Department

List of Team Members including IDs and Majors

Date of submission

Report itself should include the following sections

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# Acknowledgments

It is better not to acknowledge everyone in the college

# Abstract

Please explain in half a page what you did, why and how beneficial it is including the tools you used

# Introduction

Start to introduce your project and team and tools, justify the process and the product and give simple examples of why it is important to do this project.

The introduction has two functions: to introduce the project and the report (what is coming in the following sections). After reading this section, the readers should know what the project is about, why you are doing it, whether they have the necessary background to read the rest of the report, and know how to find whatever they want in the rest of the report

## Background/literature survey

Any background information needed for this project is included here. If others have done similar work, please briefly describe their work.

# Requirement Analysis

## Functional Requirements

List all the major project functional requirements in a bullet format. List the sub-requirements/features under the major requirement

Example:

* R1: User should be able to login with his/her email\_id and password
  + R1.1: Support forgot password feature
  + R1.2: Support Remember Me feature

## Security Requirements

Please provide a list of security related concerns addressed by your application. This can include authentication, password hashing, authorization with different roles, data safety and security (like preventing SQL injection or other similar issues), non-repudiation, data integrity etc.

Some of the security aspects that can be covered in the project requirement, design and implementation include:

* User authentication based on password or fingerprint
* User authorization (different user roles)
* Password constraints (8-10 char long, must include capital letters, numbers etc.)
* Password hiding (in html form/UI, in database and also send hash password to the server)
* Use Prepared statement to prevent SQL injection
* Implement forgot password feature
* Use SSL if applicable for secure communication
* Etc.

Please review the following article for more details on security related requirements:

<https://www.pmi.org/learning/library/importance-of-security-requirements-elicitation-9634>

## Other Non-Functional Requirements and Constraints

Please provide non-functional requirements and constraints of the project. Non-functional requirement may include technical and non-technical constraints such as time, cost, reliability, manufacturability, processing speed, specific language / tool/ or device to use, power consumption, size, weight, ease of use, health and safety, sustainability, ethical, social impact etc.

**You should provide a list of project constraints in tabular format as shown below:**

**Project Constraints Table**

|  |  |  |
| --- | --- | --- |
| **Constraint Number** | **Constraint Type** | **Constraint Description** |
| C.1 | Technical Constraint (Reliability, Performance, Usability,  Supportability) | For example, for a line-following robot project:   * The robot shall be able to stop if it cannot detect line * The robot shall not make haphazard movement even if lines are not completely straight * The robot shall work even if the color of the line is bit different or bleak. * Etc.   For example, for a web-based project:   * System shall not fail even if user input is invalid * System shall handle internet outages properly * System shall not allow a user access to any other user information inadvertently * System shall process every user request within 30 seconds (with a max load of 100 concurrent users) * System shall work properly with hundreds of concurrent users |
| C.2 | Project Management Constraints | * The systems shall be completed within 3 months * Some team members would be trained for required background knowledge on Machine Learning * The project required components would be purchased in advance. |
| C.3 | Economic Constraints | * The total cost of the project will be below SAR 1000. |
| C.4 | Environmental Constraints | * The hardware system shall be able to work for at least one year within rainy weather or extremely hot weather conditions |
| C.5 | Social/Ethical Constraints |  |
| C.6 | Safety Constraints |  |
| C.7 | Manufacturability Constraints |  |

Following are some guidelines on how to complete the above Project Constraints Table.

The project constraints can be categorized as follows:

**Technical Constraints:** Any technical constraints such as customer/instructor enforced programming languages, development environment, processing (CPU), memory and other resource requirement enforced by the user. Also mention any timing constraints such as the algorithm should complete within 10 seconds per image etc. In general, the technical constraints can be categorized using FURPS model (<https://en.wikipedia.org/wiki/FURPS>). You can categorize the technical constraints under usability, reliability, performance, supportability categories etc.

**Project Management Constraints:** Time constraints in terms of project development. How much time is allocated for project work and when should each module be ready.

**Economic Constraints:** Cost and other economic constraints (if applicable)

**Environmental Constraints:** The impact of project on environment (if applicable)

**Social Constraints:** The impact of project on society or any privacy or related concerns. (if applicable)

**Safety Constraints:** Any safety related constraints. These can be safety measure to be taken to operate the project OR safety concerns due to use of the project. (if applicable)

**Manufacturability Constraints:** Any constraint on manufacturing such as product size or material etc. (if applicable)

Following are few concrete examples of non-technical constraints for your reference.

|  |  |
| --- | --- |
| **Example Constraints in Senior Design Project** | |
| **Economic** | Prices of current related or similar products on market and your cost and profit  Available budget  Potential impact to the local and national economy  Designs for public use need to consider high maintenance cost  Both over design and under design cost money |
| **Environmental** | Weather proofing of product (e.g. hot or rainy weather, sandstorms)  Vibration induced noise to workers and product users  Air pollution: use electric or hybrid engines  Water pollution: toxic waste into river  Landscape: plastic bags, computer cases  Global warming: temperature control of exhaust gas  Manufacturing waste collection and processing  Space debris  Control of energy saving devices |
| **Social, Political & Legality** | Designs in favor of certain people but against others  Products (e.g., computer games, marks on clothes) that profile negative sides of a specific race or gender  Products that are physically and/or mentally destructive for people |
| **Ethical** | Designs without considering safety and health of workers, consumers, and/or the public  Products implicitly using patent protected designs/concepts  Products use materials that have better appearance but are toxic  Under design for profit |
| **Health and Safety** | Safety of workers and consumers  Safety of the public  Noise causes hearing loss  Hazardous materials and environment for workers  Products require the use of radioactive materials  Products use materials that have better appearance but are toxic  Products for infants/children require special safety considerations  Design of a control system with acceptable stability margins where safety is of concern |
| **Manufacturability** | Ease of manufacturing and availability of the parts  Designs with an impossibly small manufacturing tolerance  Material weld ability if welding is the proposed assembly method.  Is the product’s surface paintable if it is designed to have an artificial color?  Availability of chosen material  Design of a control system which is physically realizable with manufacturing constraints such as amplifier saturation and bandwidth |
| **Sustainability** | Can the business survive?  A well-defined life span under the assumed normal operation conditions  Consideration of actual environmental factors (extreme working temperature, corrosive fluid, abrasive air, severe radiation in space, etc.) in design  All parts need to have a similar designed life span  Reliability and durability of the product’s supposed function |

## Risk Assessment

Please highlight any risks that can be encountered in the project. This includes technical risks (such as battery issues, short circuits, component availability, faulty or mismatch components, prevent data hacking, security vulnerabilities, sql injection etc.), or project management risks (such as time and cost constraints, team members’ coordination issues etc.) or external risks (such as pandemic or natural disasters etc.).

Please also explain briefly on how would you handle each risk in your project using the following table. The “Risk Mitigation” column can be completed during the project design and implementation phases. Following are some examples of how risks should be specified:

|  |  |  |
| --- | --- | --- |
| **Risk(s)** | **Potential Impact** | **Risk Mitigation** |
| An intruder can get unauthorized access to system | The system data will be compromised | * Provide stronger authentication (password difficulty level) * Provide fingerprint identification * Send OTP |
| Batteries will need to be replaced often | System maintenance cost will increase | * Provide more powerful batteries that can last * Use power consumption strategies to consume less power (e.g. system going into sleep mode etc) * Use solar charging |
| Camera might get damaged over longer duration in open air installation of the system | System maintenance cost will increase | * Camera lenses would be covered if unused for 30 minutes * Send notification to maintenance person if camera image is not good quality |

## Applicable standards

This subsection needs to be present in all reports. Students need to describe the engineering standards used during their projects (for instance, IEEE, ITU, NIST, COBIT, ISO, ANSI, ISA, ASTM standards).

What are Standards?

"*A prescribed set of rules, conditions, or requirements concerning definitions of terms; classification of components; specification of materials, performance, or operations; delineation of procedures; or measurement of quantity and quality in describing materials, products, systems , services or practices.*"

Why search standards?

Searching standards during design can help you to:

* Identify design constraints from best practices established by experts in the industry
* Comply with laws that specify design and testing criteria
* Reduce your product liability risk by not complying with best practices and/or laws
* Budget for certification testing that may be required or can improve your market position.

For example, there are well known standards for shoe sizes. This makes it possible for any new shoe manufacturer to produce shoes with standard sizes.  
<https://en.wikipedia.org/wiki/Shoe_size>

How to find standards?

Some good resources to find the standards are as follows:

Computer Science & Software Engineering: Standards  
<https://library.rose-hulman.edu/c.php?g=104543&p=888557>

Electrical and Computer Engineering (ECE) : Standards  
<https://researchguides.library.wisc.edu/c.php?g=177674&p=1170680>  
<https://cec.georgiasouthern.edu/ece/engineering-standards/>

Few examples of standards used in projects are as follows:

* The project uses ASCII (American Standard Code for Information Interchange) or Unicode (UTF-8) standard for character representation
* Unified Modeling Language (UML) standard used for software modelling
* Project entity relationship diagrams (ERDs) is based on data modeling notations defined by [IDEF1X](https://www.datanamic.com/dezign/idef1x.html) or Crow's Foot
* Project uses Structured Query Language (SQL) which is an ISO standard query language for Relational Database Management Systems (RDBMSs)
* Project hardware components use Ethernet standard used in LAN(IEEE 802.3)
* Project hardware components use Wireless standard used in WLAN(IEEE 802.11x)
* Project hardware components use router on stick in LAN (IEEE 802.11q)
* Project software uses on transport and application layer( ISO and TCP/IP model) for communication.
* Project components use communication medium such as USB, Firewire (IEEE 1394) etc.
* Project uses standards for signal compression (audio/video) like JPEG/MPEG are used for integration among different signal processors.
* AC power supply standards (110V or 220V) and frequency (50 Hz or 60Hz) are used for making component choices in the hardware projects
* IEEE standards for diodes and transistors are used for testing them prior to building the circuits in hardware-based projects
* Standard for OpAmp is DTL/TTL/CMOS which are used for making choice regarding the integration among various electronics components.
* ANSI, JIRA and ISO standards for robotics systems are used for constructing the robotic components in the hardware-based projects
* Resistors standards from EIA (Electrical Industries Association) such as the E-series are introduced
* SSI or MSI standard based ICs are used for making component choices in the hardware projects
* Another standard for ICs is CMOS and TTL which are introduced for making choice regarding the speed of logic circuit operations.

## Requirement Specification

Provide detailed analysis of each requirement and how you intend to address the requirement from an engineering perspective. This can include use cases, use case tables, use case diagrams, user stories, volere shell cards, prototyping end system sketches etc.

Example:

* R1: User should be able to login with his/her email\_id and password:

Specifications:

* User will be provided with an HTML page interface to enter his/her login details. The password must be 8 characters long. The email ID must be a valid PMU email address.
* The email\_id will be used for recovering password as well.
* After three unsuccessful attempts, the system should lock the account.
* The login button should not be enabled if the user has not entered a password yet.
* The user should not be allowed to enter a very large id or password (to protect against buffer overflow)
* Email\_id and password must be stored in some database. Password must be stored in encrypted format

## Project Plan

Describe the project plan with a week-by-week set of tasks from concept to implementation. Please provide details on which team members will be responsible for each task. You may show a table with all major project tasks and team members involved.

# Project Design

Project design may include software and/or hardware design. Create a subsection for each module of software and/or hardware design elements. This section describes major technical aspects of your project.

**Please make sure that you discuss on how your proposed design meets the project functional requirements, security requirements and constraints and standards listed in Requirements Analysis section.**

For software related projects include requirements, software design, flowchart, database diagrams, class diagrams, functionality and other diagrams to illustrate your algorithmic approach. You can also include screenshots or photos of the system at work. **Please elaborate in each design section on how the proposed design meets the security and other non-functional requirements of the project.**

For hardware related projects include hardware and software components. From hardware perspective describe all major hardware components, choice of components, major specifications, schematic designs, testing, etc. From software perspective, describe major modules, flow chart or other similar diagram to describe the software functionality.

For both software and hardware projects:

* Every diagram must also be explained in words.
* Please describe your design decisions, For example:
  + Why this particular hardware/software component was chosen out of other alternatives?
  + Why the components are interconnected in this particular manner?
  + Why a particular software library was chosen over other alternatives? What are its benefits?
  + Why this particular class or table was included? Why is it designed/organized in this particular way?
  + What considerations were taken in program to make it more efficient (in time and space)

## Conceptual Design

Any high level block diagram to illustrate project components and their interactions. Please discuss how the conceptual design addresses the security and other non-functional requirements of the project. This can include selecting appropriate software architectures, communication channel between modules etc.

## User Interface Design

This can include user interface screen shots. Please discuss how the user interface design addresses the security and other non-functional requirements of the project. This can include password hiding, remember password, forgot password, change password, captchas etc.

## Database Design (if applicable)

This can include ER Diagram or other database design aspect. Please discuss how the database design addresses the security and other non-functional requirements of the project. This can include use of encrypted password storage, managing roles in the database tables etc.

## Software Design

This can include flow chart, class diagram, sequence diagram etc. This can also include algorithm design and its explanation. Please discuss how the software design addresses the security and other non-functional requirements of the project. This can include authentication, authorization, hashing, encryption and role management related classes or modules.

## Algorithm Design (if applicable)

Please provide details of any algorithms developed to meet the project requirements. Please discuss how the algorithm design addresses the security and other non-functional requirements of the project.

## Hardware Design (if applicable)

The hardware design should include schematics diagrams. It can also include flow chart, sequence diagrams or timing diagrams. Please discuss how the hardware design addresses the security and other non-functional requirements of the project. This can include use of encrypted password storage, managing roles in the database tables, power consumption strategies, strategies used to meet design constraints (such as weight, size, networking and accessibility requirements).

## Design Constraints

**For each non-functional requirement or constraints specified in Section 2.3 (“Project Constraints Table”) please elaborate in the following table on how your project design meets these constraints.**

|  |  |  |
| --- | --- | --- |
| **Constraint Number** | **Constraint Description** | **How is the constraint handled in the project design** |
| C.1 | The robot shall be able to stop if it can not detect line | If the robot color sensor can not detect a color for 100 cm distance, the robot will come to stop. |
|  | The robot shall not make haphazard movement even if lines are not completely straight | The robot will only change direction if there is a change of readings on two sensors (not just based on one sensor) |
|  | System shall not fail even if user input is invalid | System checks for valid user input before processing the request. The user input should be a non-empty string with alphanumeric characters only. |
|  | The system should respond within 30 seconds for any user input | We are using appropriate hardware/software components to meet this requirement. The software will use multiple processes/threads to keep the system interactive. |
|  | … | … |
| C.2 | The systems shall be completed within 3 months | The project work was limited in scope to complete it within 3 months |
|  | … | … |
| C.3 | The total cost of the project will be below SAR 1000. | We are using free/open source software such as Java, NetBeans, IntelliJ Community etc. to reduce cost  We are using Raspberry Pi 3B microcontroller to reduce cost of custom developed boards  The prototype system has higher cost per unit, but under large scale production cost will be reduced by printed circuit boards |
|  | … | … |
| C.4 | The hardware system shall be able to work for at least one year within rainy weather or extremely hot weather conditions | … |
|  | … | … |
| C.5 | … |  |
|  |  |  |
| C.6 | .. |  |
|  |  |  |
| C.7 | .. |  |
|  |  |  |

# Implementation

For every software or hardware module implementation, there could be a corresponding subsection describing its development and testing (verification) phases.

Please elaborate on how the software or hardware implementation addresses the security and other non-functional requirements of the project by including code snippets to highlight it.

# Testing and Verification

Testing is very important to see whether the module meets its design specifications. Note that every software and hardware module needs to be tested/verified. You can perform unit testing, integration testing and system testing. Test results should be discussed to evaluate your project.

Please elaborate on how the functional, security and other non-functional requirements of the project were tested with different test cases.

# Conclusions and Future Work

You can talk about impact of your solution and problems/issues addressed by your solution. You can say we have been able to prove that our initial understanding was correct and our implementation is a good demo of this, although we recommend the following functionality be implemented in future versions of this system: 1….2…. 3…. Etc. Difficulties & Challenges

Do not forget to discuss the challenges you faced and hence list the limitations of your system, for example your system was planned to operate with Solar and Electric power but you only had enough time to implement electric power, state and explain why this limitation occurred, for example, we could not import solar panels with enough efficiency in time

## Life-long Learning

Please discuss how the project work provided you with an enhanced learning experience. What did you learn during the project work? Also discuss the impact of your computing solution on individuals, organizations or society in general.

# References

List here any references including web links you used

# Appendix

If you have many images or source code to add to the report, it is better to have those in appendices that are referenced in the report. Please don’t put all your code here.