# FINAL YEAR GRADUATION PROJECT HANDBOOK

Computer Engineering Department
College of Computer and Information Systems
Umm Al-Qura University
Makkah, Saudi Arabia

# Table of Contents

# Graduation Project (GP) Procedures

## 1. Introduction

### 1.1 Terminology Used:

a) **Project Team (PT)**
A group of 2 to 4 students working together on the graduation project is called Project Team or PT.

b) **Capstone Project Committee (CPC)**
A committee (Capstone Project Committee) formed by the chairman of the department, which is in charge of all Graduation Projects (GPs) and ensures that the prescribed procedures are properly implemented for all projects. CPC's main duty is to ensure that the following requirements in each GP proposal are satisfied:

- It is a Design problem that has several possible solutions and realistic constraints.
- Project objectives are well defined and clearly stated without ambiguity.
- The project objectives are achievable within two semesters.
- The project can give the students opportunity to demonstrate the required student outcomes (SOs).
- The project is based on the courses and is not a research project.
- The project selected should not have been done in past years.

c) **Main Project Advisor (MPA)**
A faculty member, who coordinates a Graduation Project (GP), advises the project team and is responsible for reporting the assessment data.

d) **Supporting Advisor (SA)**
A Supporting advisor is optional. The supporting advisor may be a person from within the faculty or outside, and is assigned the job of advising the students on specialized aspects of the project.

### 1.2 GP Duration:

The duration of the graduation project is three semesters.
- Orientation Semester (Sem-0)
- First Semester (Sem-1)
- Second Semester (Sem-2)

The detailed description of the tasks for each semester are given later in this document.

### 1.3 Objectives of GP

The GP provides an opportunity for students to apply concepts, rules, methods and techniques learned in their undergraduate education toward a realistic computer engineering project. The main objectives of the graduation project are:

1. To make the students understand and practice the basic concepts of engineering design for multidisciplinary computer engineering project.
2. To expose the students to group learning and teamwork by working on a multidisciplinary project.
3. To improve the oral and written communication skills of the students
4. To make students capable of integrated project planning, scheduling, and cost analysis for computer engineering project.
5. To let the students demonstrate their abilities in all Student Outcomes (SOs) as prescribed by the department.

These objectives of the GP are attained by attaining the prescribed Course Learning Outcomes (CLOs) of the Graduation Project given in the next section.

## 2. Graduation Project CLOs and SOs

### 2.1 CLOs of Graduation Project

The Course Learning Outcomes (CLOs) of GP are pre-specified by the curriculum committee of the department. They are periodically reviewed and the recommendations of the faculty are considered in improving them. The prescribed CLOs are listed in Table 1. These CLOs are the focus of teaching for the faculty and the focus of learning for the students in going through the GP. All these CLOs are oriented towards attaining the SOs specified by the department that the students must attain at the time of graduation.

| CLO ID | CLO |
|--------|-----|
| 1 | An ability to formulate engineering problems |
| 2 | An ability to develop an objective tree, based on the needs and literature review |
| 3 | An ability to specify/define engineering requirements and constraints |
| 4 | An ability to design a system with defined/specified specifications and constraints |
| 5 | An ability to discuss various design alternatives and select the best option |
| 6 | An ability to perform design verification |
| 7 | An ability to develop team process guidelines |
| 8 | An Ability to run/execute the project effectively |
| 9 | An Ability to incorporate ethics in the engineering design process |
| 10 | An ability to communicate effectively through report, presentation and poster |

Table 1: Graduation Project CLOs

## 2.2  SOs of Graduation Project

The Student Outcomes (SO's) are specified by the department, and students must attain those SO's at the time of graduation. The prescribed SOs are listed in Table 2.

| SO ID | SO |
|-------|----|
| 1 | An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics |
| 2 | An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors |
| 3 | An ability to communicate effectively with a range of audiences |
| 4 | An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts |
| 5 | An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives |
| 6 | An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions |
| 7 | An ability to acquire and apply new knowledge as needed, using appropriate learning strategies |

Table 2: Graduation Project SOs

## 2.3  CLO-SO Map of the Graduation Project

The CLO-SO map is prescribed by the curriculum committee. For a GP all the SOs are significant. The students must demonstrate their abilities in all the 7 SOs. The below table (Table 3) shows the Student Outcomes – Mapped to Course Learning Outcomes.

| CLOs | SO-1 | SO-2 | SO-3 | SO-4 | SO-5 | SO-6 | SO-7 |
|------|------|------|------|------|------|------|------|
| CLO-1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLO-2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| CLO-3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLO-4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CLO-5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| CLO-6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CLO-7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CLO-8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CLO-9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CLO-10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

Table 3: Graduation Project CLO-SO map

## 3. Orientation Semester (SEM-0)

### 3.1 Orientation Semester Events

1. Starting from the 2nd week, CPC will provide an electronic link, which asks students for the following:
   a. The list of group members (if ready)
   b. Proposed idea (if ready)
   c. Request to join a group (if alone or couldn't find a group)
2. Week-4: CPC head will send an email requesting submission of project ideas from department faculty members.
3. Week-5: CPC will announce project ideas through notice boards and department web page.
4. Orientation lecture (TBA) will be conducted to introduce students, who will take graduation project course, to procedures, available ideas to work on, and techniques for achieving a goal.
5. Week-6: Students will select a project idea, form a team, and fill the official course registration form and Graduation Project Team form (Form A).
6. Week-7: Students who failed to complete the above task will be contacted by the Semester Zero Coordinator, encouraging them to start: forming the groups, finding a topic and an advisor no later than the 8th week of the academic semester preceding GP Sem-1.

### 3.2 Orientation Semester Tasks

Students must accomplish the following tasks in Sem-0:

1. Choose an idea
2. Form a team
3. Fill the official course registration form and Graduation Project Team form (Form A).
4. Attend the orientation lecture

## 4. First Semester (SEM-1)

### 4.1 First Semester Tasks

Students must accomplish the following fundamental tasks in Sem-1:

1. Registering the subject of the graduation project (GP1) with the academic advisor or the department's head (The registration form is available at: https://uqu.edu.sa/cis_ce/App/Forms/Show/936).
2. Attending a weekly meeting with the supervisor and reporting the achieved progress.
3. Keeping a register of important events, analyses, designs, data of the laboratory tests (if any), telephone conversations, minutes of meetings, and the results.
4. Coordinating with the supervisor to identify the general requirements of the project (also known as custom requirements).

5. Formulation of research problem which includes but is not limited to the following:

- The student's understanding of the problem (Need Statement)
- The project's goals (Objectives)
- A review of the basic knowledge and the principles relevant to the problem (Background and Related Work)
- Identification of the data and information required to solve the problem (Objective tree of the project to illustrate what the proposed system will do)

6. Development of Requirement Specifications. It should include all the relevant:

- Requirements (such as functional, performance, energy, cost, permits etc.)
- Constraints
- Standards

7. Project teams should develop clear and detailed guidelines that govern their processes (also known as Team Process Guidelines). It must include how the decision will be taken and how the conflicts will be resolved. (Task-2 and 3 are included here)

8. Students must develop a project plan, showing the work breakdown structure, Gantt Chart, and/or network diagram. Furthermore, students must develop a tabulated list of costs for the equipment, materials, and human resources necessary to carry out the project. The estimated cost in the beginning of the project should be compared to the actual cost at the end of the project.

9. In order to incorporate ethics in the design process, students must show that they have followed good design practices to make the product safe. It includes but not limited to:
    a. The identification of to safety and health factors
    b. Understanding of related work to minimize the conflicts over IP ownership.
    c. Development of requirement specifications to minimize the communication gap between marketing and engineering functions of an organization
    d. Identifying and applying safety standards as much as possible. Performing the design space exploration to understand the effects of various choices on health and safety.
    e. Highlighting all of the possible ways that a system can fail.
    f. Identifying the ways in which the developed system in the project can fail by misuse or operator error. Here, the ethics is to provide manuals for operation and safety labels whenever possible.
    g. Conduction of design reviews at various stages of the project. Here, the ethics lies in the fact that students seek and accept the honest criticism while acknowledge and correct the errors accordingly.
    h. Verification of engineering requirements during testing at the end of the project when the pressure to complete the project is huge. Here, the ethics is to ensure that the engineering requirements have been verified. If there is a conflict between the requirement and verification results, mention explicitly and provide the reasons.

10. Report writing and presentations (oral)

## 4.2 First Semester Deliverables

**Week 4**: Each project team must submit their proposal (abstract/idea) by the end of this week.

**Week 6**: The proposal will be examined and approved by CPC by the end of the 6th week. Once the proposal is approved, students can start directly on their projects. All finalized proposals (ideas) will be published on the website.

**Week 7**: The proposals that are not approved by CPC will have to be revised and submitted by the end of this week.

**Week 13**: Project team should give a PowerPoint oral progress report presentation. The project advisory team must attend this presentation. The project team is required to submit a written progress report summarizing the work completed at this time. The students need to list the tasks required to complete the project in the second semester.

## 4.3 Assessment of First Semester Tasks:

The assessment will be based on the abilities demonstrated by the students in the tasks listed in Table 4. The examiners will grade these tasks out of 100. CLO-SO will calculate the grades based on the relative weight of each task as given in Column 3 of Table 4. Each student will be rewarded for his contribution in these tasks. The examiner will use forms to evaluate each project.

| Task ID | Brief Task Description* | Weight | CLO |
|---|---|---|---|
| 1 | Registering the subject of GP | - | - |
| 2 | Attending a weekly meeting with the supervisor and reporting the achieved progress. | 1 | CLO 7 |
| 3 | Register important events, analyses, designs, telephone conversations, minutes of meetings, and the results. | 1 | CLO 7 |
| 4 | Coordinating with the supervisor to identify the general requirements of the GP | - | - |
| 5 | Formulation of research problems like objectives of GP, background and related work | 30 | CLO 1 |
| | | 10 | CLO 2 |
| 6 | Development of requirement specifications like constraints and standards. | 20 | CLO-3 |
| 7 | Team Process Guidelines | 3 | CLO 7 |
| 8 | Project plan | 5 | CLO 8 |
| 9 | Design process and practices to make the product safe | 5 | CLO 9 |
| 10 | Final GP Report | 15 | CLO 10 |
| | Presentation (Oral) | 10 | |
| **Total Marks** | | **100** | |

\* Detailed task description can be found in section 4.1

Table 4: GP Semester-1 Assessment Items

## 5. <u>Second Semester (SEM-2)</u>

### 5.1 <u>Second Semester Tasks</u>

1. System Design and Implementation (Chapter 3 of the project report). It should include three main parts:
   a. Structure of the system in terms of Level0, Level1 and Level 2 diagrams
   b. Behavior of the system in terms of either state diagrams, flow charts or data flow diagrams, depending upon the nature of the project.
   c. Discussion on various design alternatives by providing justification for a particular selection

2. System Verification (Testing) (Chapter 4 of the project report). It should describe that how the students have tested their system. It consists of two parts
   a. Testing of functionality of individual modules (identified in chapter 3). It is also known as unit level testing
   b. System level testing (performed after the integration of individual modules)
   c. Discussion to prove that all the engineering requirements (identified in chapter 3) have been achieved.

3. Project teams should develop clear and detailed guidelines that govern their processes (also known as Team Process Guidelines). It must include that how the decision will be taken and how the conflicts will be resolved.

4. Students must develop a project plan, showing the work breakdown structure, Gantt Chart, and/or network diagram. Furthermore, students must develop a tabulated list of costs for the equipment, materials, and human resources necessary to carry out the project. The estimated cost in the beginning of the project should be compared to the actual cost at the end of the project.

5. In order to incorporate ethics in the design process, students must show that they have followed good design practices to make the product safe. It includes but not limited to:
   a. The identification of to safety and health factors
   b. Understanding of related work to minimize the conflicts over IP ownership.
   c. Development of requirement specifications to minimize the communication gap between marketing and engineering functions of an organization
   d. Identifying and applying safety standards as much as possible. Performing the design space exploration to understand the effects of various choices on health and safety.
   e. Highlighting all of the possible ways that a system can fail.
      Identifying the ways in which the developed system in the project can fail by misuse or operator error. Here, the ethics is to provide manuals for operation and safety labels whenever possible.
   f. Conduction of design reviews at various stages of the project. Here, the ethics lies in the fact that students seek and accept the honest criticism while acknowledge and correct the errors accordingly.
      Verification of engineering requirements during testing at the end of the project when the pressure to complete the project is huge. Here, the ethics is to ensure that the engineering requirements have been verified. If there is a conflict between the requirement and verification results, mention explicitly and provide the reasons.

6. Report writing and presentations (oral as well as poster)

## 5.2 Second Semester Deliverables

**Week 12**: Students must submit the Final GP report and hardware/software to CPC for approval and final exam scheduling. Before scheduling, CPC will forward the final report and promised proposal to prospective examination to check the project is according to the proposal.

Once CPC approves the submitted materials, CPC sets a date/time for the final exam session and sends it to the department chairman for approval.

**Week 14**: Once the department chairman approves the date/time, the final report along with the date/time of exam are to be emailed to the exam committee members. Each examiner should reply confirmation upon receipt of the email and final report ASAP.

Also, in Week 14, the students must participate and display their project on a poster in the project exhibition session organized by CPC.

**Week 15**: Final presentation and examination session is to be held in this week.

The student or MPA should send a reminder e-mail regarding the exam session to the exam committee members the day before the exam.

Students should bring a hard copy of the final GP report to the exam.

If a student failed to appear in the examination session, he will receive F (fail) as a grade in the course.

**Week 17**: Final GP report after considering the examiners' comments/modifications must be submitted to CPC associated with a CD/USB that contains all project files such as, Final GP report in word and pdf format, presentation in PPT and pdf format, program scripts files, and results/multimedia or any other material the project report has. If a student failed to submit the Final GP report with CD/USB by the announced deadline, his grade will not be entered into the system until he does so.

## 5.3 Assessment of Second Semester Tasks

| Task ID | Brief Task Description* | Weight | CLO |
|---------|------------------------|--------|-----|
| 1 | System Design | 30 | CLO 4, CLO 5 |
| | Implementation | 10 | |
| 2 | System Verification (Testing) | 20 | CLO 6 |
| 3 | Team Process Guidelines | 5 | CLO 7 |
| 4 | Project plan | 5 | CLO 8 |
| 5 | Design process and practices to make the product safe | 5 | CLO 9 |
| 6 | Final GP Report | 10 | CLO 10 |
| | Oral | 10 | |
| | Poster Presentation | 5 | |
| | Total Marks | 100 | |

\* Detailed task description can be found in section 5.1

Table 5: GP Semester-2 Assessment Items

## 6. Graduation Project Final Report Format

Student's GP report must be according to the prescribed format which is available in Appendix A. Three copies of the graduation project report will be required from students to be submitted to the department.

## 7. Guidelines for Poster Presentation

The following guidelines outline the major sections of the poster presentation and provide a brief synopsis of the content that should be presented within each section. Each section of the poster should not have more than 5 points.

**Sections of the Poster:** The major sections of the poster should include: Title, Abstract, Introduction, Methods, Results (if any), and Discussion. Listed below are the suggested content guidelines for each section.

**Title:** The title of the poster should include the title of the student's GP as well as his name and the name of the department.

**Abstract:** The abstract is a short informative and descriptive summary of your GP. The abstract should be descriptive and as such should identify the statement of purpose and scope of the GP. In addition, the abstract should also be informative and summarize the entire GP, giving the reader an overview of the methods, findings, and conclusions of your study. The abstract must, however, be short in length and should not exceed 1 to 2 paragraphs. In total, the abstract should not exceed 400 words. The abstract should be followed by a list of 3 to 5 key words that would be used to describe and index the GP.

**Introduction:**

1. Introduction should include clear statements about the question or problem which to be tackled in the GP.
2. Provide theoretical grounding for the GP.
3. Introduction must end with a clear purpose of the GP.

**Method:**

1. This section should explain procedures and methods that you completed within your study.
2. Be sure to describe your processes, procedures and, any method, protocols that were followed within the scope of your GP.
3. Students are encouraged to use block diagrams, algorithms, flow charts or any other visual aids to express their GP.

**Results (if any):** The results section is where you will describe the main findings from your GP. You are encouraged to use tables, charts, and figures to illustrate your results. Be sure to include the findings from all your analysis of data.
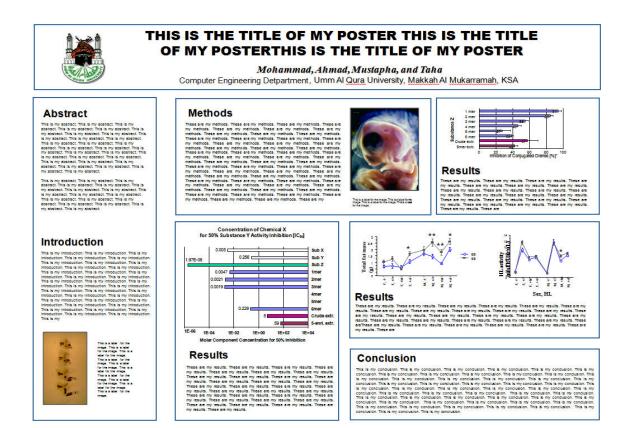
**Conclusion:**

In this section students need to provide detailed outcomes of the project.

**Design Tips for Poster Presentation:**

1. Most students use Microsoft PowerPoint to design posters. Be sure to begin by setting the page size to your final poster size. More sophisticated programs such as Adobe InDesign, Illustrator, or Photoshop are other design options that can be used.

2. Use large text (text should be at least 18-24 pt; headings 30-60 pt; title > 72 pt)

3. Do not use more than 2-3 font styles in total

4. Use fonts that are easy to read (such as Time New Roman, Garamond, and Arial)

5. Avoid jagged edges: left-justify text within text boxes or fully justify blocks of text

6. Avoid too much text

7. Choose colors carefully and pay attention to contrast. If in doubt, dark print on light background is best. Remember - some colorblind people cannot distinguish between red and green

8. Organize and align your content with columns, sections, headings, and blocks of text

9. White space is important to increase visual appeal and readability (this is the "empty" space between sections, columns, headings, blocks of text, and graphics)

10. Selectively incorporate charts, graphs, photographs, key quotations from primary sources, maps and other graphics that support the theme of your poster

11. Avoid fuzzy images; make sure all graphics are high-resolution (at least 300ppi) and easily visible

12. Include the University logo in your poster

13. Edit the poster carefully for typographic or grammatical mistakes and image quality before the final print-out (use the print-preview function)

## 7.1: <u>Project Poster Sample</u>

The students prepare a Poster of size 22.5'' x 34.5''which are placed on an open display and are reviewed by the Supervisory Committee.

# FORMS

**Graduation Project Team Form - Orientation Semester (Form A)**

Orientation Semester/Year: ………………….

Title of the Project (Tentative):

(Main Project Advisor):

**Students Information:**

| S/N | Name | University ID | GPA |
|---|---|---|---|
| A | | | |
| B | | | |
| C | | | |
| D | | | |
| E | | | |

Name of the Main Project Adviser (MPA)                    Signature and date

**Graduation Project Weekly Meetings Attendance Sheet (Form B)**

Project Title:

Project Adviser:                                         Semester/year:

Student's Name:                                         Student's ID:

| Week# | Tasks for Next Week | Tasks Accomplished | Advisor Signature, Date |
|-------|---------------------|--------------------|--------------------------|
|       |                     |                    |                          |
|       |                     |                    |                          |
|       |                     |                    |                          |
|       |                     |                    |                          |
|       |                     |                    |                          |

# Appendix A

# FINAL YEAR GRADUATION PROJECT
# Template

Computer Engineering Department
College of Computer and Information Systems
Umm Al-Qura University
Makkah, Saudi Arabia

### *Title Page*

The title page should include the title of the report along with the name(s) of the department and university for which the report is written, month & year of submission and the project number. Each project will be assigned a Project number for future reference. Also included on the title page should be the name(s) of the author(s) of the report. Title Page is followed by a blank page. A sample title page is shown below.

Umm Al-Qura University
Collage of Computer and Information Systems
Computer Engineering Department

# Graduation Project Report

*BSc Project*
*CE Department*
*Project ID: UQU-CE–XX-XXX* <span style="color:red">*(XX-XXX, Please request the number from CPC by sending email to ce_cpc@uqu.edu.sa)*</span>

# Centered Title Times Font Size 26 Bold

## Centered Subtitle Times Font Size 16 Bold

## Centered Author(s) TimesFontSize18Bold (Name & ID)

Department of Computer Engineering

Faculty of Computer and Information Systems

Umm Al-Qura University, KSA

## Contact Information

Below is a sample contact information page. It follows the blank page (after the title page) and contains information about the author(s), external supervisor (if any), internal supervisor and the examiner.

*This project report is submitted to the Department of Computer Engineering at Umm Al-Qura University in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Engineering.*

**Author(s):**
*Firstname Lastname, (ID)*
*Address: If applicable*
*E-mail: If applicable, a long-term e-mail (not your student e-mail)*

**University supervisor(s):**
*Firstname Lastname*
*Department name*

**Co-supervisor**(*if applicable*)**:**
*Firstname Lastname*
*Company/Organization full name*
*Address:*
*Phone: International standard, e.g. use +*

*Department of Computer Engineering*                *Internet: http://uqu.edu.sa*
*Faculty of Computer and Information Systems*        *Phone: +966 12 527 0000 Ext. 6710*
*Umm Al Qura University*                             *Fax : +966 12 528 1376*
*Kingdom of Saudi Arabia*

*Intellectual Property Right Declaration*

Below is a sample for intellectual property right declaration page. It follows the contact information page.

# Intellectual Property Right Declaration

*This is to declare that the work under the supervision of _____ having title " _____ " carried out in partial fulfillment of the requirements of Bachelor of Science in _____ , is the sole property of the Umm Al Qura University and the respective supervisor and is protected under the intellectual property right laws and conventions. It can only be considered/ used for purposes like extension for further enhancement, product development, adoption for commercial/organizational usage, etc., with the permission of the University and respective supervisor.*

*This above statement applies to all students and faculty members.*

*Date: _____*

*Author(s):*

*Name: Firstname Lastname          Signature: _____*

*Name: Firstname Lastname          Signature: _____*

*Name: Firstname Lastname          Signature: _____*

*Supervisor(s):*

*Name: Firstname Lastname Signature: _____*

*Anti-Plagiarism Declaration*
Below is a sample for Anti-plagiarism declaration, it follows the intellectual property right declaration page.

# Anti-Plagiarism Declaration

This is to declare that the above publication produced under the supervision of_____having title "_____" is the sole contribution of the author(s) and no part hereof has been reproduced illegally (cut and paste) which can be considered as Plagiarism. All referenced parts have been used to argue the idea and have been cited properly. I/We will be responsible and liable for any consequence if violation of this declaration is proven.

Date:                                                                                        _____

**Author(s):**

Name: Firstname Lastname Signature: _____

Name: Firstname Lastname Signature: _____

Name: Firstname Lastname Signature: _____

*Acknowledgement*

Below is a sample for Acknowledgement page, it follows the Anti-Plagiarism Declaration page.

# ACKNOWLEDGMENTS

*This work is dedicated to my dear parents, the most loving in this world.*

## *Abstract*

Below is a sample for Abstract page. It follows the Acknowledgement page.

# ABSTRACT

[Abstract text]

**Keywords**: 3-4 keywords, maximum 2 of these from the title, which starts one line below the Abstract.

## *Table of Contents*

Below is a sample for Contents page. It follows the Abstract page.

## TABLE OF CONTENTS

[Table of contents]

*GP Report Chapters*

From here onwards this document should be organized into different chapters specific to each project. Rest of the section outlines chapters to be included and the recommended contents of each chapter.

## Chapter 1 INTRODUCTION

1.1 Purpose of the Project
  1.2 Purpose of this Document
  1.3 Overview of this Document
  1.4 Existing System
        1.4.1 Existing system description
        1.4.2 Problems in the existing system

## Chapter 2 SYSTEM ANALYSIS

2.1 Data Analysis
        2.1.1 Data flow diagrams
        2.1.2 System requirements
                2.1.2.1 Clients, customer and users
                2.1.2.2 Functional and data requirements
                2.1.2.3 Non-functional requirements
                        2.1.2.3.1 Look and feel requirements
                        2.1.2.3.2 Usability requirements
                        2.1.2.3.3 Security requirements
                        2.1.2.3.4 Performance requirement
                        2.1.2.3.5 Portability requirements
        2.1.3 Proposed Solutions
        2.1.4 Alternative Solutions

## Chapter 3 DESIGN CONSIDERATIONS

3.1 Design Constraints
        3.1.1 Hardware and software environment
        3.1.2 End user characteristics
3.2 Architectural Strategies
        3.2.1 Algorithm to be used
        3.2.2 Reuse of existing software components
        3.2.3 Project management strategies
        3.2.4 Development method
        3.2.5 Future enhancements/plans

## Chapter 4 SYSTEM DESIGN

## Chapter 5 IMPLEMENTATION AND VALIDATION

## Appendix A CODE

## Appendix References