PROJECT EPR400/EPR402 STUDY GUIDE

APPENDIX 4: REQUIREMENTS FOR THE FINAL REPORT

(version: 1 October 2018)

A. THE THREE SUBMISSION ITEMS OF THE FINAL REPORT

Note that the report consists of

- **Submission Item 1:** a printed submission (the main report), and
- **Submission Item 2:** a non-printed submission, submitted on electronic media (CD, DVD of flash disk) (the technical documentation section as well as other items described below).

Submission Item 3: Note as well that you need to submit an electronic copy of your final report online, in addition to Submission Items 1 and 2 above. Details will appear on the Project website.

Submission Item 1: Printed copies of the report

- **Submission.** Four printed, *numbered* copies of the main report must be submitted on the date (and by the deadline) indicated on the Project website. The final deadline and place of submission will be announced on the website. This will normally be exactly as indicated in the study guide.

- **Content.** The printed copy contains the main report only (Parts 1, 2, 3 and 4 described below). Part 4 is referred to as the *core section* of the main report. The required content of the main report is described in sections to follow.

- **Numbering of copies of copies.** Printed copies of the report are numbered from "copy 1 of 4" to "copy 4 of 4". These numbers must appear on the cover. See the example that will appear on the Project website.

- **Length of the main report.** Requirements and guidelines for the length of each section are given below, but the total length of the *core section* of main report (i.e. this is only Part 4 of the report, described below) should be between 50 (minimum) to 75 pages (maximum). For page count purposes, this core section *excludes* everything up to and including the Project Proposal (Part 3); the core section page count starts on page 1 of Part 4 of the report, but also excludes the References section and any appendices. Note that a report core of fewer than 50 pages is usually incomplete and will probably not be accepted. A report core of more than 75 pages is not allowed.

  Numbers given below give you a guideline of how long sections should typically be. These are not rules – e.g., the Results section is not required to be a minimum of 12 pages and a maximum of 15 pages. These are good guidelines, however. If you are significantly outside these guidelines, you are writing too little or too much. If you go over the guideline in one section, you will need to cut back in a different section to meet the page count restrictions.

- **Prescribed layout and content.** It is ***compulsory*** that the final report should contain the layout and content described below. See the example on the Project website as well.

- **Format: numbering.** Use the exact section and paragraph numbering scheme as below.

- **Format: sections.** Begin each *main* section on a new page.

- **Format: page numbers.** All sections up to and including "List of Abbreviations" should have Roman numeral page numbers (i, ii, iii, iv, etc.). Use normal numerals for page numbers from the Part 4 (main report) onwards. Page numbers appear at the bottom right of each page except the cover page of the report.

- **Format: header.** Each page of the report should have a header containing your initials and surname at the left margin, and the section name at the right margin. Please refer to the final report template for an example.

- **Format: other requirements.** Please see Part D of the present document for more detail on formatting requirements.

Submission Item 2: Non-printed material on electronic media

The complete documentation, including an electronic copy of (i) *the main printed report* and (ii) *the technical documentation section* (described below), must be included on a CD, DVD or flash drive[a] (referred to as electronic media).

Two copies of the submission on electronic medium must be submitted on the date indicated on the Project website (final deadline and place of submission will be announced on the website, which will be the same as the deadline of submission of the printed copies). The electronic medium should contain *all* of the following, organised into directories as indicated in square brackets.

- **The complete main report**. This is an electronic copy of the printed report, i.e. Parts 1, 2, 3 and 4 of the report. Kindly provide *both* a pdf and an editable word processor version (the latter typically being MS Word) of the document. [*directory on electronic medium: Main report*]

- **The complete technical documentation**. This section will be Part 5 of the final report, and is described in Appendix 5 of the Project study guide that appears on the Project website. [*directory on electronic medium: Part 5: Technical documentation*]

  Note on the length of the technical documentation: This may be of *any* reasonable length. See the description of the technical documentation below (where Part 5 of the

[a] Note: if preferred, you may also submit USB flash drives (FAT32 format). Place these in a sealed, CD-sized envelope with your details clearly indicated on the envelope (Surname, Initials, year, Project EPR400/402).

final report is discussed) and also see Appendix 5 of the Project study guide. The technical documentation should appear *only* on the electronic medium that accompanies the report, and *not* in the printed report.

- *All* the computer code and software models that you developed, including code developed for a PC platform (e.g., Visual Basic, Delphi, C, C++, C#, Python), simulations developed (e.g., in Matlab, C, Octave, Simulink, Python…), simulations in any specialist software package (e.g., SPICE, Comsol, NEC, FEKO, PSIM, electromagnetic simulators, network simulators, optical network simulators), code and models for FPGAs (e.g. VHDL code, other models in MaxPlus, Quartus, Mentor Graphics packages), DSPs or microprocessors (e.g., C or assembly code), circuit designs (e.g., Orcad, Pads, Eagle), microelectronics designs (e.g., Ledit). [*directory on electronic medium: Software*]

- Copies of all journal articles and other references of which you have obtained electronic copies (i.e. those cited in your reference list). [*directory on electronic medium: References*]

- Include datasheets of components that you used on the electronic medium. [*directory on electronic medium: Datasheets*]

- A photograph of the author of the report (i.e. yourself). [*directory on electronic medium: Author*]

- All datasets you created as part of your project (e.g., data used to train classifiers; data measured in listening experiments). Both the raw data and the final processed dataset should be included, as well as any code / scripts used to generate the final dataset from the raw data. [*directories on electronic medium: Datasets/raw, Datasets/final*]

- Photographs of the product that has been developed, both the prototype stages and the final version. The original images used in the main report and technical documentation section should also be included. In the case of a software-only product, screenshots of the final product should be included. [*directory on electronic medium: Project photos*]

Submission Item 3: Online electronic submission

As a third item for submission, you will need to upload an electronic copy in pdf format to the server that will be indicated on the Project website. This will be an electronic copy of the printed version of the report, i.e. Parts 1, 2, 3 and 4 of the report.

B. CONTENTS OF THE PRINTED REPORT

Important note
Take note before you start writing: absolutely no part of the report is intended for marketing. Specifically:

- Ensure what you write here is the truth. Do *not* guess at what may happen between the writing of the final report and the day of the oral exam.
- If some aspects of the project are incomplete, or if some specifications have not been met, you are obliged to say so.
- Do not attempt to foresee or falsify results. If what you write in your report is not truthful, the consequences may be severe.

There are *four main sections* in the printed final report, listed below.

- Part 1. The preamble, including a plagiarism declaration
- Part 2. A summary section, which is a complete, but brief summary of the work in journal article format
- Part 3. A problem identification section, containing the approved Project Proposal
- Part 4. The main report (i.e., the part referred to as the core of the report), that provides complete detail on the items mentioned in the summary section

The technical documentation section is part of the final report (i.e. Part 5), but is not printed, and appears only on the CD in its own separate directory. The required content of this section is described in detail in Appendix 5 of the study guide.

The headings in bold below (and within a margin to margin frame for the Part headings) are the headings exactly as they should appear in the final report. Use the correct font size, though (see the template). Formatting hint: the margin to margin frame is just a single-row, single-column table in Word.

Part 1. Preamble

This should commence on page (i) (Roman numerals) and is typically one page long.

This is the only section of the report written in the first person. No other section of the report may be written in the first person.

Commence with a one sentence description of the work, e.g. (text in `this font` is example text):

```
This report describes work that I have done in my final year project,
developing a low power communication system for long distance data
transmission.
```

Indicate in a next paragraph that the Project Proposal and technical documentation section is attached and summarise the contents of the latter. This is compulsory. Here is an example of the typical text (adapt as appropriate):

> This main report contains a copy of the approved Project Proposal (Part 3 of the report) and technical documentation (Part 4 of the report). The latter provides more detail on the software that was used in the experiments, including program listings, a user guide and circuit designs. This section appears on the CD or DVD that accompanies this printed report.

Next, specify whether this project builds upon a previous project or not. You have to indicate what was done by yourself and what was done by others. You *must* include a paragraph with this information. Here is an example:

> This project extends a previous project by Owens (2017), but my implementation is completely new. I borrowed some ideas from Owens, but only regarding the antenna design procedure and nothing else.

Your manuscript *must* be language edited (proofread, i.e. edited for grammar and spelling) by a *knowledgeable* person. The following text should be used to indicate that your manuscript has been language edited.

> The report will <u>not be accepted</u> without the signature of the language editor. Submission without his/her signature will ensure that the report retains a "not submitted" status.

> This document has been language edited by a knowledgeable person. By submitting this document in its present form, I declare that this is the written material that I wish to be examined on.
>
> My language editor was _____ mr. John Davies _____ (*example*).
>
> J. Davies — 31 October 2018
>
> _____ _____
> Language editor signature — Date

Finally, indicate whether the work that you present was your own work. Then certify the accuracy of the information on this page by signing at the bottom of the page.

> The report will <u>not be accepted</u> without your signature. Submission without your original signature *in all four copies* of the report will mean that the status of the report remains "not submitted".

The following text must appear in your report.

> I,_____ understand what plagiarism is and have carefully studied the plagiarism policy of the University. I hereby declare that all the work described in this report is my own, except where explicitly indicated otherwise. Although I may have discussed the design with my study leader, fellow students or consulted various books, articles or the internet, the design work is my own. I have mastered the design and I have made all the required calculations in my lab book (and/or they are reflected in this

report) to authenticate this. I am not presenting a complete solution of someone else.

Wherever I have used information from other sources, I have given credit by proper and complete referencing of the source material so that it can be clearly discerned what is my own work and what was quoted from other sources. I acknowledge that failure to comply with the instructions regarding referencing will be regarded as plagiarism. If there is any doubt about the authenticity of my work, I am willing to attend an oral ancillary examination/evaluation about the work.

I certify that the Project Proposal appearing as the Introduction section of the report is a verbatim copy of the approved Project Proposal.

J.R. Greenwood 1 November 2018

J.R. Greenwood Date

Table of Contents

The Table of Contents follows the declarations described above, and should commence on a new page (still using Roman numeral page numbers). This will typically be page ii. Page numbers of each section are given at the right margin. The Table of Contents should only list sections that follow, i.e. it should not list itself or anything else that is part of the Preamble.

List of Abbreviations

Start this section on a new page (still using Roman numeral page numbers). This will typically be page iii. Here you have to provide a list that defines all abbreviations used in the text, *including* more common abbreviations like SNR, rms, DC, AC, RAM, FPGA and GSM.

Remember that you also have to define each abbreviation at the first instance thereof in the text of the report.

You should also provide definitions of notation in this section. E.g., if you use x for scalars and $\boldsymbol{x}$ (bold print) for vectors, this is the correct place to define this.

Part 2. Summary

- After the Preamble, you should have a page (page number in Roman numerals) with just the heading: Part 2. Summary. The rest of the page will be blank. This may typically be page iv.
- The rest of the summary section then follows on the next page (e.g. page v).
- This section should be a clear, complete and concise summary of the work, focussing

on *what was done*, *what has been achieved* and *your findings*.

This brief section should not be an afterthought, but a well-structured summary of your main report. There will of necessity be repetition of items appearing in the main report. The objective of this section is to give the casual reader (somebody wanting to know what your project is about, but not wishing to read all 70 pages to find out) a quick overview of the work. The objective of the main report, on the other hand, is to give a complete and detailed description of all your work throughout the year.

For this summary section, use the four headings as given in the brief example below. While the example below is very brief, the length of the summary section will be around two pages. No references are included in this section.

Example

This report describes work carried out on the design of a voice communication system, with the objective of using very low power to achieve reliable wireless communication over long distances.

What has been done

A literature survey was completed on modern communication system design. The hardware and software for a low power communication system was then designed from first principles. At the core of the system is an existing DSP board, and all additional hardware were designed and implemented. A Matlab program was developed to simulate the system, as well as C code for the DSP, and assembly language code for a PIC processor that resides on the hardware that was designed. The system was implemented and several field tests were carried out. A voice communications channel was set up between the University and my home in Midrand. The main result is shown in the BER graph below.

(Note: Typically, one would add one or more figures here – these will probably be figures that also appear in section 4 of the report).

What has been achieved

Successful voice communications of good quality was achieved over a distance of more than 30 km. It was found that it is possible to achieve long distance communication with low power by employing an appropriate design. Figure 1 above shows that the bit error rate is dependend on communication distance.

Findings

An important discovery was that the carrier frequency plays a major role in determining the relationship between distance achieved and power used. One implication of this is that the carrier frequency and modulation scheme has to be designed carefully, while considering the tradeoff between BER and power.

Contribution

(Note: this subsection is where you need to indicate clearly to the reader what you did that was new.

(i) Specifically, you need to indicate what was new to you. E.g. which software did you master that was included in a previous module? (Matlab or Python

would typically not count as "new"). Which new theory did you have to master? Which new hardware did you use?

(ii) Indicate clearly what your own contributions were, and what the contributions of other people were. For example, give some insight into you interaction with your study leader – did you consult him/her regularly, and to which extent did you follow his/her *instructions* (e.g. "you have to use this particular processor") and his/her *guidance* (e.g. "you need to focus less on this aspect and read more on that aspect"). Indicate whether your study leader helped you directly or indirectly with aspects of the project, like finding errors in your code or hardware design. Explain how much you learned from your friends in class or perhaps engineers in industry. Explain which software modules were taken directly from elsewhere, which were modified from other code, and which you developed on your own.

The example text below shows what a particular student may have written here.

New software that had to be mastered to complete this project was Comsol. Comsol is a finite elemnet package, which is not something that undergraduate students would usually have any knowledge of, and that is not covered in any undergraduate module.

Specifically, the Comsol physics module was used. In order to use this, a thorough understanding of turbulent water flow had to be developed. Literature was consulted, and especially chapter 4 in the textbook by Nicholson (2012) was mastered. The mathematics used in Comsol largely reflects the underlying theory explained in this chapter of the textbook.

No new code was developed, but multiple simulations were developed in Comsol. From these, an entirely new implementation was developed without any inputs from the study leader. Once the hardware implementation was completed and several errors were discovered, the study leader provided much assistance to help with investigating the origin of these errors.

Code was mostly developed by the student, with a strong reliance on existing libraries. As the code was of large scope, some modules were taken directly from existing libraries, while other modules were coded from first principles. Friends in class initially helped with coding in R for statistical analyses, as this was complex and completely new to the student.

Part 3. Project identification: approved Project Proposal

Following the Summary section, you should have a page with just the heading: Part 3. Project definition: approved Project Proposal.

This heading is followed by this exact text:

```
This section contains the problem identification in the form of the
complete approved Project Proposal, unchanged from the final approved
version.
```

The rest of the page will be blank.

On the next page, insert a copy of your final, approved Project Proposal, including the references as they appear in the Project Proposal, but excluding the Project Proposal cover page. This will be a new printout of your approved Project Proposal, *without any alterations other than these*:

(i) Do not include the Project Proposal cover page.
(ii) Renumber the pages to have Roman numerals.
(iii) Update fonts and font size to be the same as the rest of the final report.
(iv) Correct any grammar errors that need to be corrected.
(v) Perform any formatting corrections that may be necessary.

Leave all other formatting as it was in the Project Proposal (e.g. frames/blocks around headings). Sections are not renumbered.

Important note: any alterations to the approved Project Proposal, other than formatting updates or corrections to grammar, may be construed as fraudulent behaviour.

If you submitted an Engineering Change Proposal, this section will contain the *approved* change proposal, i.e. the final approved version of the Project Proposal.

Part 4. Main report

Following Part 3, you should have a page (which will be the last page having a page number in Roman numerals) with just the heading: Part 4. Main report. The rest of the page will be blank. The Literature study section follows on the next page, and this will commence on page 1 of the main report. Use the following headings exactly as given here.

1. Literature study

Commence this section on a new page. In this section you have to provide a summary of information from the literature that was required to complete your project and that places your work into context.

Hint: Your task in this section is to show that you have acquired and evaluated the requisite knowledge, information and resources.

Literature sources to be consulted include journal articles from technical journals (e.g. IEEE, Springer, Elsevier or Wiley journals), technical information from good quality technical websites, books and standards documents.

Organise this section into (i) a description of the background and context (typically between five and eight pages), referring to the relevant literature, and (ii) a brief summary of how you applied this background (one to two pages). The former is a structured summary of what other people have done before you that supports your work, including (but not limited to) how others have solved similar or related problems. The latter summarises what has been learnt in the literature study and describes how you applied what you learnt from literature (and perhaps expanded what has been reported on before in the literature).

Notes on how to prepare a literature study appear on the Project website. Hint: One way to approach a literature study is to regard it as an argument. You want to show your reader, by referring to several examples (i.e. citing the relevant literature), what others have done and where shortcomings exist that you needed to address with your project.

A good literature study will *not* be an article-by-article summary of the material you read, but will merge the material into a unified view of the literature. To see what a good literature study looks like, look at the introduction section of (almost) any article published in an IEEE journal. Review articles (often appearing in the Proceedings of the IEEE) are usually particularly good examples of literature studies.

You should give at least six references to articles in technical journals (often IEEE journals, but may also include others), and perhaps further references to other material.

Remember that there should be a one-to-one correspondence between the citations in the text and the reference list. I.e., do not include an item in the reference list if it is not cited in your report.

You should use either IEEE-style or Harvard-style referencing format. Kindly check which format your study leader prefers. Harvard is described on the Project website, while a description of IEEE format may be found on the websites of IEEE journals. Whichever format you choose, be consistent in its use. The exact formatting is less important than using a consistent format throughout. E.g., you could use APA-format, which is very Harvard-like (author-date format), as long as you use this consistently.

2. Approach

Commence this section on a new page. In this section, you will be giving the reader an *overview* of how you approached the problem, instead of just jumping in with a disconnected series of paragraphs. This will act as an introduction to section 3 of your report, so that the reader will understand why you provide the details that appear in section 3.

> Hint: it is important to have a clear "storyline" in the report. One of the main things that examiners often miss in reports is why you are writing something.

Make sure that your report is not a disconnected series of paragraphs.

This section answers the question, HOW? In this section you need to tell the reader how you planned to achieve the objectives mentioned in Part 3 (the Project Proposal). I.e., describe the approach; the steps followed to solve the problem. Don't jump into the detail of the design or experiments yet, but explain at a conceptual level what you did to solve the problem.

You will need to focus on your concept design, the design alternatives and tradeoffs considered, and your eventual preferred solution. You will typically refer to your functional analysis to explain how different functional blocks were implemented and why. Explain how the functional design (as given in Part 3 that contains the Project Proposal) has been translated into a first concept design. For example, to implement a specific logic function, you may have used discrete logic, or FPGA technology, or a microprocessor. Explain conceptually what you did, and explain why. Give hardware block diagrams and/or software flow diagrams.

This section of the report may also include brief descriptions of design tools used where appropriate (e.g. software tools like SPICE, MaxPlus, Quartus, Comsol), and off-the-shelf hardware used (e.g. the specific DSP board used). It is proposed that you briefly describe the architecture of the product (where applicable), what you used it for, and why you decided to use these particular tools.

The approach section will typically be one to two pages long.

3. Design and implementation

Commence with a description of the approach followed (section 2.1 below).

►This is the main part of your report and should be detailed. Here you should give all the details about the theory, simulations that have been done, experiments that have been conducted, software and hardware that have been developed.

Hint: Document everything that you would like to claim credit for, but keep the maximum allowed number of pages in mind.

All of these should be appropriately organised into paragraphs. This part of the report may be divided into several sections if required (i.e. 3.1, 3.2 and so on). For example, you may use subheadings like theory, analysis, modelling, simulation, optimisation, hardware design, hardware implementation, software design, and software implementation. You can decide which subheadings would be appropriate. Make sure that there is a clear storyline or "golden thread" that ties everything you describe together.

All calculations must be included. Circuit descriptions and calculations of component values must accompany any circuit diagrams given. Circuit diagrams should include component values.

Make sure that all the work is properly motivated. Ensure that you do not give

disconnected descriptions of experiments, but describe why an experiment was done and how the experiment contributed to the solution of the problem. When explaining models and simulations, explain which parameters are important and why they are important. Explain any assumptions.

Students with software engineering projects, or any software part in the project, please see section E of this document for a description of specific items that should be included in your report. A summary goes into the final report, while the details should be included in the technical documentation section (see Record 30 in Appendix 5).

3.x Design summary

Important! Ensure that the summary table (described below) is included. This is a strict requirement.

The subsection number will depend on the number of subsections that you have defined within section 3. Replace "x" in the subsection number with the appropriate number, e.g. write 3.8 if you have seven earlier subsections within section 3.

Commence this section with a sentence that says something like "This section summarises the project tasks and how they were implemented (see table I)".

Then create a table with three columns, like the one below.

Task	Implementation	Task completion
Here you need to indicate the specific task, e.g. “design of a PCB for the main electronics”, or “Development of optimization routine” Each task should appear in a new row.	Here you need to summarise what you did to complete this particular task, e.g. “The PCB design was completed, using the PCBCAD package. This was done from first principles”, or “the PCB design was replaced with a veroboard design, completed from first principles”, or “optimization was completed in Matlab, but without the Optimization Toolbox. All code was developed from first principles”, or “optimization was completed in Matlab, but the Optimization Toolbox was used, and while some code was developed from first principles, numerical methods for optimization were taken off the shelf”.	Here you indicate whether the task has been completed, or not, by simply writing either “completed” or “incomplete”. Do not guess! This needs to be the truth at the time of submission of the report.

Table 1
Design summary.

Section 3 of the report will typically be around 35 - 40 pages long.

4. Results

Commence this section on a new page. This section is firstly a description of how you measured or confirmed that your system complies with the expected outcomes (user requirements and specifications as described in the Project Proposal for design projects).

Secondly, you should give your *actual measured results* in the sections that follow. *All* your results should be described in this section, *even those that you regard as unsuccessful*.

See the notes below on different ways to organise this section (under "Organisation of section 3 of the report" at the end of the description of this section of the report).

Commence with the section heading below.

4.1 Summary of results achieved

This section is extremely important! Ensure that the summary table (described below) is included. This is a strict requirement.

You should commence the Results section of your report with a summary table *(compulsory)* that compares the *intended* outcomes (including all product mission requirements, mission-critical specifications and deliverables as expanded on in the Project Proposal) with the *actual final outcomes* (how each mission requirement is reflected in the final product, the actual specifications of the final product [where appropriate, measured specifications], and how each promised deliverable reflects in the final product).

Ensure that what you indicate here is the truth, i.e. the *actual* measurements or outcomes, and not outcomes that you guessed. This is very important.

The table should have three columns.

- "Description of requirement or specification", where (i) all the product mission requirements, (ii) all the field conditions, (iii) all the mission-critical specifications, and (iv) all the deliverables are listed (i.e. those that were documented in the approved Project Proposal). *A text description, or a text description along with the specification is given in this first column*. This is the intended outcome, where values or descriptions are given of what you intended to achieve (as given in the Project Proposal);
- "Actual outcome", where measured values or outcomes are given;
- "Location in report", which is an indication of where exactly in the report the reader can read more about the particular result.

  The table will look like Table 2 below (this is the same example that also appears in the final report template).

Description of requirement or specification (intended outcome)	**Actual outcome**	**Location in report**

Mission requirements of the product		
The system should provide continuous AC power to a household	The system could provide continuous power during daytime hours when grid power failed.	Section 4.2.6
Motor speed should be controlled.	Stable feedback control of the motor speed was achieved.	Section 4.2.2
Fuel consumption must be kept to a minimum.	Fuel consumption was slightly higher than expected.	Section 4.2.7
Bit error rate (BER) should be low.	The measured BER was high.	Section 4.2.1
Delivered power should be adequate for the load.	The system could not deliver the required power into the load.	Section 4.2.3
Field conditions		
The system should supply power and actual environmental conditions (sunshine or rain; day or night)	The system was never tested under rainy conditions. The system could not supply power under any conditions other than bright sunlight.	Section 4.2.6
The system should use actual real-time data, corrupted by noise, arriving over a noisy wireless link.	The system could work error-free for at least one hour under these actual field conditions.	Section 4.2.1
Specifications		
BER should be below 1E-6.	The BER was measured as 10 bit errors in 1000 bits.	Section 4.2.1
The motor should reach 50 rpm.	46 rpm was measured.	Section 4.2.2
2 kW should be delivered to the load.	The system could deliver 800 Watts into the load before overheating.	Section 4.2.3
Deliverables		
DC-DC convertors had to be designed and implemented by the student.	The student completed the design and implementation.	Section 4.2.8
The inverter had to be designed and implemented by the student.	The student did not complete the inverter. The design was completed and simulated, but the implementation in hardware did not work correctly.	Section 4.2.8

Table 2
Summary of results achieved.

4.2 Qualification tests

This subsection must be detailed. You need to complete descriptions of how the design part of the project was verified and qualified. You need to show how compliance with *all* the mission-critical specifications (those that characterise your system as a whole) was verified.

Important! Document the qualification tests in order of importance, from most important to least important.

You will need to describe each test or experiment that you performed in a formal manner (as explained below), and in order of importance. In other words, the mission-critical specifications would be the most important to confirm in a test and should appear first.

The first qualification test described will be for your single most important specification. E.g., if you designed a path-finding robot, this specification will consider the ability of the robot to fulfil this task, and will not consider (e.g.) the power supply design.

Important! Ensure that your qualification tests primarily capture the operation of your system as a whole, rather that focussing on fine details or subsystems.

It sometimes happens that there are no qualification tests for the system as a whole. Please ensure that this does not happen.

This section will look like this (using the headings below).

4.2 Qualification tests

4.2.1 Qualification test 1: (title of test) (or perhaps "Implementation 1")
- 4.2.1a Qualification test
  - *Objectives of test/experiment*
  - *Equipment used*
  - *Experimental parameters and setup*
  - *Experimental protocol (experimental steps)*
- 4.2.1b Results and observations
  - *Measurements*
  - *Description of results*
  - *Statistical analysis (if appropriate)*

4.2.2 Qualification test 2: (title of test) (or "Implementation 2" if this was the case)
- 4.2.2a Qualification tests
  - *Objectives of each test/experiment*
  - *Equipment used*
  - *Experimental parameters and setup*
  - *Experimental protocol*
- 4.2.2b Results and observations
  - *Measurements*
  - *Description of results*
  - *Statistical analysis (if appropriate)*

The paragraph numbers will depend on the number of tests that you describe in

separate sections. If you have ten tests, paragraph numbers will run up to 4.2.10. Heading shown in italics will appear exactly like that in the report, i.e. without a heading number.

Under the heading "Equipment used", indicate in exact detail which equipment was used (e.g. a Tektronix TDS2000C osscilloscope). You should also include the design of any hardware and/or software that you specifically developed to qualify your design or perform your experiments in this subsection. The latter may be regarded as part of the tools that you required to solve the engineering problem, so if you need a dedicated section to describe these tools, create a new subsection that appear before the qualification tests. This will then be section 4.2, and the qualification tests will become section 4.3.

The subsections "Measurements" and "Description of results" are, respectively, where you need to *show* the results (typically in the form of tables or graphs) and *describe* them objectively. These section are intended to give an *objective* description of the outcomes of experiments that were intended to verify system functionality and specifications. Ensure that (in the latter subsection) you describe the results *objectively* without attaching your own interpretation to them or coming to conclusions from them - this you will do in the discussion section (Section 4 of the report). Here you need to describe that which any electrical/electronic/computer engineer looking at the measurements or graphs could also observe. I.e., these are simply *observations*.

Note the requirements in section F of this document (also Record 31 in Appendix 5) for all software parts of projects.

As a guideline, this section will be around 12 to 15 pages long, including figures.

5. Discussion

This section is extremely important! This is where the examiners will evaluate your ability to judge your own work, which is very important for an engineer.

Commence this section on a new page. In this section you will be giving your interpretation and evaluation of the results, and will then place your work into context. The idea is that you stand back and give your own opinion of what you have achieved. I.e., these are your *findings*. Findings are more than just observations. Here you need to stand back and place your results in context. For example, a discussion of the *implications* of your results would be appropriate.

Important note: ensure that this section is detailed enough and that you are completely honest – this is where the evaluators will judge whether you have been working and thinking like an engineer and whether you can take responsibility for your work. The readers of the report will evaluate your engineering judgement from what you say in these paragraphs.

This section should contain *at least* the following information, *which you may organise as appropriate*.

Hint: You are welcome to organise the discussion into the paragraphs indicated below, but this is not compulsory, and sometimes this section is improved if you use fewer paragraphs and integrate the aspects discussed. You may also include some of your own paragraph headings as appropriate.

5.1 Interpretation of results

What do the results mean? Are they very good, acceptable, or poor? What are the implications? It is important to be *honest* here. If the results are not what you hoped for or designed for, you as an (aspiring) engineer should be able to recognise that, and the exam panel will specifically evaluate this aspect.

I.e., it is very important to demonstrate that you can stand back and be critical of your own work.

Also, in this section you should indicate *why* you think the results turned out as they did and what you think the application and/or consequences of the results are. What is the cause or origin of a specific result? What is the effect? How were your measurements influenced by external factors? Why could you not meet a particular technical specification or answer a particular research question?

Expand the discussion on (design) considerations (briefly mentioned in the Approach section), the alternatives that you have considered and trade-offs. Evaluate (in hindsight) the choices that you have made and defend them (where appropriate). What worked well and what did not? You may address aspects like: specific implementation choices made (e.g., which part of the design was implemented in software and which in hardware) and the consequences; which techniques you chose (e.g., which design procedure, which method for deriving a model, which method for solving differential equations, which experimental protocol) and whether these were good choices; technical and economic feasibility and implementability.

5.2 Aspects to be improved (in the current design, when discussing design projects)

Are there any unsolved problems in the current design? Are there aspects of the design that you would improve on if you had more time, more funding, or could start the project from scratch?

Are there problems that you could not solve?

Hint: if you did not do everything that you promised in your Project Proposal, or if you did something in an entirely different fashion, explain this in this section. For example, it may be that the outcome of a specific experiment prompted you to perform designs or experiments that were not planned initially.

5.3 Strong points (of the current design, when discussing design projects)

What turned out well in the design or in the project? And why? E.g., because of the way it was designed, the system is especially robust (e.g. against noise, against hacking, against mechanical damage). With which parts of the results are you pleased, and why? In hindsight: were the implementation alternatives chosen appropriate?

5.4 Under which circumstances will the current system fail?

What are the design limitations? What are possible criticisms against the results? What will happen when a failure occurs, i.e. will the system fail gracefully or will it blow up? E.g., in a particular software design, if more than 10 users log on, the system will not be able to carry the load and everything will slow down (or the program will crash). Or, in a secure network, under which circumstances will a hacker be allowed access? Or, in a communication system design, under which circumstances will the communication link be lost? Thus, try to think of all the circumstances, whether inherent in your design or environmental, that will cause your system to fail.

Stand back and critically evaluate what you have achieved. Try to think of which aspects other engineers or researchers will criticise. Compare your results and interpretation thereof with findings reported in literature.

5.5 Design ergonomics

In this section, give a complete description of the ergonomics that you built into your design. This will include many aspects relating to the interaction of the user with the product. You may include a discussion of user-friendly graphical interfaces, layout of front panels, positioning of controls, accessibility of physical interfaces, packaging, ease of installation (relevant for both software and hardware), reliability of software and other relevant aspects of the design.

5.6 Health and safety aspects of the design

You must include a summary of the safety features of the design in this section. This includes aspects like electrical safety, provision for safety against burns (where hot surfaces appear in the product) and hearing protection (for a noisy product, e.g., an alarm). This particular section may be less relevant for strongly software-focussed projects, but a clearly motivated statement to the effect that the design does or does not create potential health or safety risks must still be included.

5.7 Social and legal impact and benefits of the design

In this section, you need to discuss all legal and social issues relating to your design. State clearly which legislation or regulations your product has to comply with, and describe how you incorporated these into your design. Also include comments on the possible social impact of your product. E.g. will it contribute towards solving problems like AIDS, poverty, crime or the supply of electricity, water and communications to rural communities? Will the product, if marketed, create job opportunities or save people money or time? Identify possible cultural issues relating to your design.

If your project required ethics clearance, this should be mentioned in this section, and you should mention the ethics clearance number assigned.

5.8 Environmental impact and benefits of the design

Finally, address environmental protection issues of your design under the heading provided above. State clearly how you designed your product so as to contribute to environmental protection. E.g., discuss aspects like: How could your product potentially pollute the environment? Does it create noise (which may include, e.g., acoustic noise)? Does it contribute to electromagnetic noise? What happens if your product reaches the end of its lifetime - can it be recycled? How have you solved these problems?

As a guideline, this section should be around four to six pages long.

6. Conclusion

Commence this section on a new page. In this final section you should present a brief summary of your most important results and findings. This is in fact a succinct summary of the previous three sections (Design and Implementation, Results, and Discussion) and will be an expansion of the Summary section of the report.

Hint: Remember to be very honest here about what you achieved, *and* what you did not achieve.

Also, include suggestions for future work here. The latter explains where you feel other engineers may expand or improve your work. You may also describe new design alternatives that you discovered, but could not attempt because of time or funding limitations.

You may write this section of the report in bullet list format.

Note that this section is written in the third person just like the rest of the report (with the single exception being the Summary section of the report). Conclusions must be technical and be applicable to your project and *not* to your personal experience. It is *not* acceptable to write (for example): "I found the project very rewarding".

The following headings are recommended for this section.

6.1 Summary of the work completed
6.2 Summary of the observations and findings
6.3 Suggestions for future work

This section *should be at least one page long* and *may not* be longer than three pages.

7. References

Commence this section on a new page. Your work does not exist in isolation. You should have consulted several sources to complete your project. You need to give at least six

references to articles in technical journals. In addition, you may also cite books or material found on the internet.

You may use either the Harvard referencing format as described in Appendix 6 of the study guide, or you may use the IEEE referencing format. Whichever you prefer (or your study leader prescribes), adhere consistently to the particular format. E.g., Bioengineering requires Harvard format, while Electromagnetism requires IEEE format. Please find out from your study leader.

Hint: No references may appear in the reference list that are not cited in the report.

Even if you are of opinion that nobody has ever done a similar project, there are either people who worked on similar projects, or you built upon someone else's work. Ask yourself the question, where did you learn how to approach this problem?

For example, say you designed a system including a high rate A/D converter that samples data from a plant and transmits this data via a wire link to a remote PC. You may wish to refer to books or articles on bit error rate, communications protocols, transmission lines, high frequency PC board design and sampling.

Finally, do not refer to your study leader as (e.g.) "prof. Smith" in your report. Use a proper reference to a book or journal article by him/her, or otherwise if you think it necessary to quote your study leader, quote him/her in the same fashion as you would quote other specialists (see Appendix 6 of the study guide). Do not give any other references to your study leader. This is your project that you have to defend alone.

Part 5. Technical documentation

In the printed report, simply use the following paragraph (or equivalent).

> This main report is supplemented with technical documentation. This provides more detail on the software that was used in the experiments, including program listings, a user guide and circuit designs. This section appears on the electronic medium (CD, DVD or flash disk) that accompanies this report.
>
> The electronic medium is organised as follows:
> (give the directories as they appear on the CD or DVD).

The rest of this section will then appear on the CD, DVD or flash disk only, in the directory *Part 5: Technical documentation.*

C. CONTENTS OF THE NON-PRINTED SUBMISSION

Note: please read section A ("The three submission items of the final report") carefully. That section explains all the items that need to be submitted on CD, DVD or flash disk. The present section explains only Part 5 of the final report that is one part of the non-printed submission.

Part 5. Technical Documentation

This section is compulsory and may be of any reasonable length. It should appear on the electronic medium that accompanies the report, in the directory *Part 5: Technical documentation.*

Printing of this section to bind into the final report should not be done. You may, however, decide to print *some* sub-sections of this section, but to include the rest on electronic medium only. A typical example will be where you wish to include parts of your software code in the printed report. You will then add these as Appendix 1, 2 and so on in the printed report.

Appendix 5 of the Project study guide provides detail on what is required in the Technical Documentation section of the report.

Note 1
The required content of the electronic medium that should accompany the report has been described in section A at the beginning of Appendix 4 (i.e. the document that you are reading now!) to the Project study guide.

Note 2
The technical documentation on the electronic medium *may not* contain the *only* version of information that should have appeared in the main report. The examiners will not have the CDs/DVDs/memory sticks available before the oral exams. An example of a typical mistake is that students do not include a complete circuit diagram in the main report, because it is available in the technical documentation.

Hint: The main report should be complete and should be able to stand on its own without the need to refer to the Technical Documentation section.

There will certainly be overlap between the main report and the technical documentation, but this should not be of concern. These two are seen as separate documents with different objectives:

- the main report documents your thought processes and the details of the design, to enable the examiners to evaluate your work and whether you acted as expected of an engineer;
- the technical documentation is used by your study leader or students that will follow in your steps and that would need to understand some of the deeper details of (e.g.) your software code, or that would need to repeat some of the work.

D. FORMAT OF THE MAIN REPORT

It is easy to follow the rules for proper formatting and it is expected that a final year engineering student should be able to do this accurately.

> Hint: Students that make mistakes here, will be penalised *heavily*.
>
> Remember that there are no revisions of your final report. The report that you submit is what you wish to be evaluated on.

If your report is not of acceptable standard regarding formatting, layout, grammar and language editing, you may be qualifying yourself for either examination refusal, or for a supplementary exam, or to fail the module.

The list below contains formatting rules.

Title page	Use the template on the Project website.
Language	The report should be in English.
Binding	*Only* glue binding (with soft cover) is allowed. No ring bound reports or hard bound reports will be accepted. Use a transparent plastic cover, so that the title page is readable through the cover.
Printing	Note that *laser quality printing* is required.
Fonts and font sizes	**Body text:** Use 12 point font size for the main text of the report. Use a serifed font like Times Roman, Baskerville, or Caledonia, and NOT a sans serif font like Arial or Helvetica. Do not mix fonts in your report, but use the same font and font size throughout. **Text on figures and tables:** use the same font size and font type consistently across all figures. The minimum font size allowed on figures is 8 point font. San serif fonts *are* allowed on figures (but are *not* allowed in the main text, see previous bullet). **Text on figure and table captions:** Figure and table caption are printed in **bold** text. Use the same font size and font type consistently across all figure and table captions. You are allowed to select a font size for captions from 10 point to 12 point font size. San serif fonts *are* allowed in figure and table captions (but are *not* allowed in the main text, see first bullet). **Text in headings:** Use the same font for heading than was used for body text. Font sizes for headings are given below. Headings may be printed in colour if preferred, as you long as you do this consistently across all headings at the same level of heading.
Justification of text	Use full justification for all text (body text, table and figure captions), except for headings. Headings are left-justified.
Spelling	Spelling errors are *completely unacceptable.* It is recommended that a knowledgeable person or language editing specialist proofread your manuscript. The name and signature of the language editor

	should appear on the summary page as in the example on the Project web page. Note that it is your responsibility to ensure the correctness of spelling and language. Your study leader will *not* proofread or edit your report.
Grammar	Similarly, poor language and grammar is *unacceptable.* See notes about spelling above.
Tense	Write your report in the past tense, unless not appropriate in a particular sentence. Assume that by the time people read the report, the project has been completed. E.g., instead of writing "the hardware that will be developed", you should write "the hardware that was developed". However, ensure that what you write makes sense: e.g., usually, specifications are given in the present tense.
Style	Write in formal style. You *may not* write in the first person (except in the Preamble). Do not write either in conversational style or in telegram style. Always use full sentences, unless you give a list. Even for lists, full sentences are preferred. For lists, use the format described on the Project web page. Do not give a chronological account of what you did. The report should be factual and not bound to you as a person or to a particular timeline. This is a technical report, not a personal narration of your experiences and ideas. Give the facts in a brief, clear and professional manner.
Software	No long program listings are allowed other than in the technical documentation section (Part 5 of the report). However, you may (and should) reproduce sections of code in the report to explain the implementation of a specific function. Handle these code snippets as if they were figures. These figures should normally be limited to one page maximum. If your complete code is just a few pages long, it may appear in the main report. Otherwise, it should appear in Part 5 only.
Footnotes	If you want to refer to a footnote in the text, put the number of the footnote directly to the right of a word as superscript, for example: "Here FDM[1] is used instead of TDM[2]". You must then give an explanation at the bottom of the same page. Draw a line across the page at the bottom of the page (typically from margin to margin) and place the footnote below this line. Number the footnote with the same superscript number against the left margin. Print the footnote in 8 point font size. Footnotes are numbered consecutively throughout the text.
Layout of the report	• Cover: transparent plastic. See the description under "binding".

	• Your name and the year should be printed on the spine (not back) of the report. Use 12 point font size. Print out and attach to the spine of the report using adhesive tape. Text should read downwards when the report is in an upright position and should start around 20 mm from the top of the spine. • See the Project website for a template for the title page and evaluation page. • The first page (cover) is a title page, containing the information indicated in the template on the Project website. • The title page should not have a page number. • The following font sizes are *suggested* for readability (if you prefer other font sizes, use them *consistently*): print the title, name of author, and name of study leader in 18 point font size. Print the rest of the text on the title page in 14 point letter size. Commence the text 70 mm from the top of the page. Centre the text. • The rest of the report then follows as described above under "B. Contents of the main report", commencing with the Preamble and ending with the Appendices. Section headings numbered 1 through 6 (Literature study through References), as well as the Summary, Table of contents, List of abbreviations and any appendices are all main headings and should typically be printed in 18 point font. Commence each of these sections that appear under a main heading on a new page. • Use at least one introductory sentence after a heading. *Never* commence a section with a figure.
Page layout	Use the template provided on the Project website as a *guideline*. Where there are differences between the guidelines below and the template, the latter takes priority. If you deviate from this slightly, ensure that your format is consistent. • Margins (guideline): 25 mm left, 25 mm right, 25 mm bottom, 25 mm top. • Line spacing: single • Part headings (i.e. for the four main parts of the report, i.e. Part1. Preamble through Part 4.): 24 point bold, lowercase. • Section headings (guideline): lowercase, 18 point bold font (these are 1. Literature study, …, 6. References) ; subheadings: 14 point bold uppercase; sub-subheadings 12 point bold and italic. For further depth of subheadings: lowercase, 12 point bold and italic. • Numbering of headings: Use the numbering scheme above. Subheadings: (e.g.) 1.1.; sub-subheadings: (e.g.) 1.1.2.; for further depth of subheadings: use (a), (b) and so on; for even further depth of subheadings: headings in bold and italics are

	suggested, but no numbering is used. • Left justify headings. • Underline section headings with a horizontal line from margin to margin. • Page numbering: lower right corner. • Print only on one side of the paper. • Leave one blank line between paragraphs and do not indent the first word of a paragraph.

Equations	• Number equations sequentially from 1, with the equation number in round brackets ( ), right-justified.
	• The easy way to do this is to create one-line, two column table. Use the first column for the equation and the second column for the equation number. Then simply remove all borders around and within the table. This is how Equation 1 below was created.
	• Leave one line open after an equation. If you feel that readability is improved, you may also leave an open line before an equation.
	• An equation should read like any other sentence regarding the punctuation. <u>All symbols must be defined</u>. Print symbols in italics. Centre the equation. Here is an example:
	`The equation for a straight line is`
	$y=mx+c$, (1)
	`where` m `is the slope and` c `the` y`-axis intersection.`
	x `is the independent variable.`
	• When the equation is at the end of a sentence, the equation ends with a full stop.
	• <u>All equations must be referred to in the text of your report</u>.
	• When referring to an equation in the text of the document, this is the way to do it:
	`As is shown in Equation 1, the influence of…`
	Thus, write `Equation 1` or `Eq. 1`, but not `equation (1)`.

Figures and tables	• Tables and figures may not flow from one to the next A4 page, and A4 sized figures are preferred to larger figures. • For A3 sized figures, fold the figure appropriately so that the orientation is the same as that of the rest of the text. • Don't, however, use larger figures than necessary. Preferably keep figures small, but typically not smaller 8 cm x 8 cm. • Figures and tables should be centered on the page. • All tables and figures should preferably have the same orientation as the rest of the text, or be placed with the bottom of the figure facing towards the outside edge of the page.

	• Under all circumstances, the caption should be upright. • Text in figures should be in the same language as the rest of the text. Fonts and font size were described earlier in this list. • Make sure all your figures are formatted similarly and that the font type and size is consistent throughout all figures. Do not copy figures from different sources that use different styles and fonts. • Where figures are scanned, make sure the resolution is as high as the rest of the text, and that text is clearly readable and not smaller than 8 point font. • Number tables and figures separately from number 1 (Figure 1, Figure 2, …, Table 1, Table 2, … . • *Do not use frames around figures*. • Captions appear *below* figures and *below* tables. Figures and tables should each have a short description printed in the caption. Figure should *not* have a caption or description at the top as well (e.g., as would appear in typical Excel-style figures). • Print the figure or table number as well as the caption in bold. Below is an *example* of a caption. **Figure 1.** **The figure shows data as measured for the protection circuitry. Note that the current limits at 10 A.** • If figures are copies from other sources, give credit to these. E.g., "This figure was taken from Conroy (2017)", or "this figure was modified from Mokoena (2016)". • Figures are there to illustrate concepts explained in the text. Therefore, all figures must be referred to in the text of your report.

E. CONTENTS OF THE DESIGN AND IMPLEMENTATION SECTION FOR SOFTWARE ENGINEERING PROJECTS or PROJECTS WITH A LARGE SOFTWARE COMPONENT

For projects with a strong software engineering focus, but also for all the software engineering parts of your project, please ensure that in addition to the requirements explained earlier regarding the contents of Section 3 (Design and implementation), the report should also include the following where appropriate – please check with your study leader.

3.2.1 Data design

This is a description of all data structures including internal, global, and temporary data structures.

Internal software data structure
Data structures that are passed among components of the software are described.

Global data structure
Data structures that are available to major portions of the architecture are described.

Temporary data structure
Files created for interim use are described.

Database description.
Database(s) created as part of the application is (are) described.

3.2.2 Architectural and component-level design

A description of the program architecture is presented.

Program structure
A detailed description of the program structure chosen for the application is presented.

Architecture diagram
A pictorial representation of the architecture is presented.

Alternatives
A discussion of other architectural styles considered is presented. Reasons for the selection of the style presented must be provided.

3.2.3 Description for component n

A detailed description of each software component contained within the architecture is presented. Section 3.2.3 is repeated for each of n components.

Description for component n
A processing narrative for component n is presented.

Component n interface description
A detailed description of the input and output interfaces for the component is presented.

Component n processing detail
A detailed algorithmic description for each component is presented.

Interface description
Algorithmic model (e.g., PDL)
Restrictions/limitations
Local data structures
Performance issues
Design constraints

3.2.4 Software interface description
The software's interface(s) to the outside world are described.

External machine interfaces
Interfaces to other machines (computers or devices) are described.

External system interfaces
Interfaces to other systems, products, or networks are described.

Human interface
An overview of any human interfaces designed for the software is presented.

3.2.5 User interface design
A description of the user interface design of the software is presented.

Description of the user interface
A detailed description of the user interface including screen images or prototype is presented.

Screen images
Representations of the interface from the user's point of view are provided.

Objects and actions
All screen objects and actions are identified.

Interface design rules
Conventions and standards used for designing/implementing the user interface are stated.

Components available
GUI components available for implementation are noted.

UIDS description
The user interface development system is described.

3.2.6 Restrictions, limitations, and constraints

Special design issues, which impact the design or implementation of the software, are noted here.

F. CONTENTS OF THE RESULTS AND DISCUSSION SECTION FOR SOFTWARE ENGINEERING PROJECTS

For projects with a strong software engineering focus, but also for all the software engineering parts of your project, apart from the requirements explained earlier regarding the contents of Section 4 (Qualification tests), the report may also include the following where appropriate (please check with your study leader).

4.2.1 Component test plans and procedures

Component test strategy overview

An overview of the testing strategy used for each component identified will be discussed here.

Component test procedure

This table is to be filled in for each component identified in section 3.2.3 (of this section of this Appendix).

Component n

Test case number	
Features to be tested	
Testing approach	
Pass/fail criteria	
Testing environment	

4.2.2 System test plans and procedures

System test strategy overview

An overview of the plan that has been used for system testing is described here.

Integration

Test cases are written when integration of components is performed. The following table is completed for each test case group e.g. platform independence group, information accuracy group.

Test case number	
Features to be tested	
Testing approach	
Pass/fail criteria	
Testing environment	

4.2.3 Acceptance test

Procedure by which the software product will be acceptance tested
Specific acceptance criteria
Scenario by which the software product will be installed

* * * * *