SUMMARY

Professional Engineers require good communications skills in order to successfully present their ideas in a clear, concise manner. The aim of this writing guide is to provide Mechanical Engineering students with the fundamentals of good written communication, in terms of technical reports and logbooks. It provides the general structure of a good report, as well as style and format suggestions to help students produce professional reports. This guide includes information about planning out a report, specific style and format requirements, the essential components of a report, formatting of figures and tables, as well as examples showing good and bad techniques. In addition to the suggestions for writing good technical reports, a section is included for creating good logbook entries, as keeping a good logbook will make the report writing process easier. Finally, checklists which summarize the information presented in the writing guide are provided in an appendix, to be used as quick reference guides. By using the information provided in this writing guide, all students should be able to produce well written technical reports.
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1.0 INTRODUCTION

The ability to communicate well is essential for all Professional Engineers. Whether communicating with colleagues, supervisors or clients, success relies on being able to communicate ideas in a clear, concise manner. The purpose of this writing guide is to provide students with a foundation on which to build their written communication skills. All undergraduate students must use this guide when writing reports for Mechanical Engineering classes.

Professional Engineers are often required to write documents such as project proposals, progress or status reports, assessment or feasibility studies, incident or accident reports, research papers and design specifications. This writing guide cannot cover the essential parts of each type of written communication. Instead, it provides the general structure of a good report, which can be fine-tuned to meet the specific needs of the situation. It also addresses many style issues that are intended to help students produce professional reports. MacLennan (2009), Blicq and Moretto (2004), Rubens (2001) and Porush (1995) provide further guidance for scientific and technical writing.

2.0 ACADEMIC HONESTY

Academic honesty and ethical behaviour are very important aspects of all activities at the University of Saskatchewan. Students are expected to behave with integrity in all aspects of their studies. In addition, Professional Engineers are bound by a code of ethics mandated by their professional engineering association. The Association of Professional Engineers and Geoscientists of Saskatchewan Code of Ethics (APEGS 2011, 10) states that engineers “shall conduct themselves in an honourable and ethical manner, upholding the values of truth, honesty and trustworthiness, and shall safeguard human life and welfare and the environment.”

To uphold this obligation, students are expected to write their own reports, cite all resources used in the creation of their reports and present the information in an honest manner. For group work where individual reports are required, such as in lab classes, students may discuss their ideas together, but each must write their report in their own words. When information for a report has been obtained from another source, that source must be cited in the body of the report and listed...
in the reference section, as described later in this document. Finally, any information presented, such as data recorded in a lab, must be presented honestly. It is acceptable to process data, such as calculating averages or converting units, but it is not acceptable to alter the data to better match data collected by other groups or theoretical expressions. This can also apply to photographs which should not be altered to erroneously highlight or hide characteristics. Any cases of suspected academic misconduct will be dealt with as per the University’s policies.

3.0 REPORT WRITING STYLE

An effective technical report is clear, concise and easy to understand. Everything in the report should aid in the understanding of the main purpose of the report. Things such as poor grammar, spelling mistakes and inconsistencies in the report divert the reader’s attention and make the report difficult to understand. To avoid common mistakes and inconsistencies, all technical reports submitted for Mechanical Engineering classes should adhere to the following style and format guidelines.

3.1 Planning

Before beginning to write a report, a quick outline should be made to collect and organize the information that will be needed in the report. Start with the main purpose and conclusions of the work and then include any information that is needed to help explain how the conclusions were reached. Technical reports do not need to follow a chronological order; rather, start with an introduction of the concept and build up to the conclusions the reader should take away from the report.

Another factor to think about before beginning to write a report is who the audience will be. Consideration of the audience is an important factor, as it helps to determine the level of detail to include in the report. Potential readers might be professors, fellow students, employers, supervisors, colleagues, clients or lay people. It is important to understand who the document is being written for and what level of technical expertise they have. For undergraduate classes, the appropriate audience is usually fellow engineering students who have taken the same classes and are familiar with the general theory. For a design report, the audience would typically be the client who proposed the project. The client is usually very familiar with the project and therefore
more specific details can be included and are often necessary to explain the complete analysis of the design.

Finally, before beginning to write a report, thought should be given to the verb tense and viewpoint that the report will be written from. Verb tense should be chosen appropriately for the information being presented. Describing measurements that were taken or calculations that have been completed should be done in the past tense (e.g. The wind speed was 22 m/s.). Describing the current state of a situation is done in the present tense (e.g. The field is west of the farmhouse.). Describing future actions is done in the future tense (e.g. Next year, the pressure drop will be measured again to see if fouling has occurred.). Technical reports should be written using a formal writing tone. To write in a formal tone, do not use first-person or second-person pronouns, avoid contractions and slang expressions, and write in full, complete sentences. Careful consideration of these factors before beginning to write will help to ensure a clear, consistent report.

3.2 Style and Format

As mentioned previously, consistency in the style and format of a report make it easier for the reader to focus on the content of the report. It is also important to have good flow from one section of the report to the next. Using headings along with introductory and concluding statements in each section of the report contribute to good flow and style.

Headings and/or sub-headings at the beginning of each section highlight the main ideas presented in each section. For longer reports, such as design project reports, chapters may also be appropriate. Headings and chapter titles should be as descriptive as possible. Chapters always start on a new page, whereas headings and sub-headings continue on the same page as the previous section. Chapters always have numbers; headings and sub-headings can be numbered, but do not require it. If headings and sub-headings are used too frequently, however, they can take away from the flow of the report. Each concept requires a heading, rather than each paragraph.

Each section should have an introductory statement and a concluding statement. A heading should never be followed directly by a sub-heading. There should be an opening paragraph
introducing the main concept that will be presented in that section. Also, each section should end with a concluding statement that summarizes the main points of the section. To aid in the flow of the report, this statement should also lead into the topic of the next section.

All reports for Mechanical Engineering classes must follow these formatting rules:

- Times New Roman size 12, left-aligned font,
- 1.5 line spacing,
- one inch margins on all sides,
- page numbers at the bottom centre of the page,
- no page number on the title page,
- lower case Roman numerals (i, ii, etc.) for the front material (summary, table of contents, list of figures, list of tables, nomenclature), and
- Arabic numerals for the remainder of the report, beginning with the introduction on page one and continuing through the end of the appendices.

For longer reports where chapters are used, the appendices are sometimes numbered with the appendix letter in addition to the number (A-1, A-2, etc.). By following these style and format suggestions, the reader will be able to easily navigate through the report and focus his or her attention on the content of the report. The content, or components, of a report will be discussed in the next section.

4.0 COMPONENTS OF A REPORT

The intent of a technical report is to convey a particular message to the reader. As discussed previously, there are a variety of reasons to write a technical report. As such, there is no set formula for what should be included in a report. Each report must be tailored to meet the specific needs of the report. For example, if the purpose is to look at several samples and compare them, the report will have few results, but likely have lots of pictures and detailed discussions. If the purpose is to calculate the efficiency of a piece of equipment, the report will likely have lots of data, with more graphs and tables and possibly shorter discussions. This section describes the basic components that should be included in every report, but the amount of detail required in each section is left up to the writer.
4.1 Title Page

The title page should contain a short but descriptive title that covers the major intent of the report. It should include the name(s) of the author(s), any other personnel that were involved (i.e.: group members) and the date the report was submitted. For lab reports, it should also include the date the lab was performed. For course work, the number and title of the class must also be included (e.g. ME 318.3 Mechanical Engineering Laboratory I).

4.2 Summary

The summary is one of the most important parts of any report. It gives an overview of what the report contains and allows the reader to quickly ascertain its important results or conclusions. Consider a senior executive who has many reports cross his or her desk and does not have time to read them all. By reading the summary, he or she should be able to determine everything he or she needs to know. The summary can also be the most difficult part to write. A good summary touches on all aspects of the report: the purpose, scope, methods, results, discussions and conclusions. It should contain specific details, including values, but be brief and concise. It should also follow good report writing style, with an introductory sentence at the beginning and a concluding sentence at the end. The summary must be a self-contained document and should not refer to any other part of the report. It should not include tables, figures, equations or references. In order to accurately summarize the whole report, the summary should always be written last.

4.3 Table of Contents

A table of contents must be included, beginning on the page after the summary. If the reader does not have time to read the whole report, the table of contents helps him or her to skim the report and find exactly the information he or she wants. The table of contents should include all major headings and sub-headings, up to a maximum of three levels of headings, and the page number on which that section begins. Major headings should be left-aligned and page numbers right-aligned. Sub-headings should be indented to highlight the different levels.

If the report contains figures and/or tables there must also be a list of figures and/or a list of tables, following the table of contents, each on their own page. These should follow the same
format as the table of contents, with the figure or table name left-aligned and the page number right-aligned. Both the list of figures and the list of tables are included in the table of contents.

In some cases, for longer reports, reports with a significant number of variables or when the audience has a non-technical background, a nomenclature or glossary is included. A nomenclature is a list of all symbols and acronyms used in the report, along with their definition and units. It should not include values, unless the symbol is a constant whose value does not change. A glossary is a list of technical words and their definitions. Remember that the purpose of a nomenclature or glossary is to help the reader better understand the document, so they should be clear and concise. Items in a nomenclature or glossary should be listed in alphabetical order. These items would follow the list of tables and also be included in the table of contents.

4.4 Introduction

The introduction prepares the reader for the rest of the report. It should contain all the information needed to understand the content that will be presented. There are three main components of a good introduction: the purpose of the work (objectives), the scope of the work (including constraints and/or limitations) and the necessary background information.

The purpose should be a clear, realistic definition of the problem. For a lab report, it might be enough to simply state the main objective of the lab. The purpose might be to measure a quantity, such as temperature or pressure, or to demonstrate a technique, such as how to mount a strain gauge. For a design report, there might be several objectives that the design must meet, usually set out by the client. Having a clear purpose statement will make it easier to write the conclusions at the end of report.

Objectives should be stated in technical terms and not as educational goals. For example, if students are measuring the performance characteristics of a pump an appropriate objective is “To determine the head versus flow characteristics of a Wilgers PX-2000 pump” and not “To learn about the flow characteristics of a centrifugal pump”.

The scope covers the specific focus of the report. It is not possible to consider every aspect of every problem. The scope might include the number of samples that were tested, the range of temperatures that were considered, limitations of time, etc. For design projects, the client usually
gives a set of constraints that the project must meet. These might include cost limitations, availability of materials, etc. Using bullet points to highlight each constraint helps the reader to understand the full scope of the work.

The background information gives more details to the purpose and scope. This might include the motivation for doing the work, a literature review of how other people have studied this problem and what constraints they considered, as well as how the work presented is different from other published work. For lab reports, a literature review is not required but there should be enough information to place the lab in context of actual industrial practice.

4.5 Body

The main body will make up most of the report. This is where the details of the theory, analysis, data, results, observations and discussions will be presented. The organization of the report body requires judgement and is influenced by the main purpose of the report. For most lab reports, the body will include a section on theory, a description of the experimental investigation, results of the experiments, calculations and discussions of the results. In some cases separate results and discussion sections are appropriate, but in most cases it is better to have one section with results and discussion presented simultaneously.

Theory

The purpose of the theory section is to give the reader the necessary background information required to understand what will be presented in the results and discussion section. At this point it is crucial to remember who the selected audience is and consider what technical knowledge it has. Ideally, the theory should be very brief. Theory that is already well established (e.g. conduction through a wall) does not need to be explained in detail. A better method is to highlight the theory and then reference other sources such as lab manuals or textbooks. Well-known equations do not need to be derived here. If a derivation is necessary, it should be placed in an appendix. Some things that should be included are assumptions and limitations of the theory, so the reader can follow the analysis that will be presented later.
Experimental Investigation
The description of the experimental investigation should include enough detail to allow someone to repeat the experiment for him or herself. This should include a brief description of the apparatus, instruments and procedure. Often a sketch or photograph of the apparatus is included to help with the description. If specific instruments are used, include the manufacturer and model number. If the experiment involves several pieces of equipment and instruments, a wiring diagram showing how they are connected should be included. The procedure is often best written in bullet form, however, if the procedure is well documented elsewhere, such as in the lab manual or in the instrument manual, it does not need to be copied in its entirety. A reference to the source material and notes on any deviations from the procedure are sufficient. If a detailed procedure is required, it may be better placed in an appendix.

Results and/or Discussion
In this section, the results are presented, often using tables and figures to emphasize key results. Tables are good for comparing sets of data, whereas figures are good for highlighting trends in data or relationships between variables. It is easiest for the reader to follow the presentation of results if a discussion is included with the results. Typically there is a written paragraph or two, followed by a figure or table showing the results discussed in the previous paragraphs, and then another paragraph discussing the next results, followed by the next figure or table. The significance of each table or figure should be discussed, along with any irregular or unexpected results. A strong discussion does not merely repeat information that the reader can already see by looking at a figure or table (e.g. “The temperature of sample A was 5°C higher than sample B.”). Instead, the discussion should try to explain the results (e.g. “The temperature of sample A was higher than sample B due to the reduced heat loss to the surroundings at that location.”). At the end of this section there should be a paragraph summarizing all of the main results presented.

With every experiment performed, there is some degree of uncertainty in the results. Wherever possible, experimental values should be presented with their uncertainty limits (e.g. “The temperature of sample A was 10.1°C ± 0.1°C.”). In some labs it is not feasible to calculate the actual value of uncertainty, due to lack of information about instruments, complex equations or time limitations. In all cases, a discussion of the possible sources of uncertainty should be
included with the discussion of results. If a detailed uncertainty analysis is possible, it should be done in an appendix, with only the value of uncertainty presented in the body of the report.

When presenting numerical results, an appropriate number of significant figures, or decimal places should be used. For measurements or results that are calculated from measurements, the uncertainty of the measurement determines the appropriate number of decimal places. For example, if the uncertainty of a temperature measurement has one decimal place (± 0.1°C) then the result can only have one decimal place (10.1°C). If you are unsure what the uncertainty is, a good practice is to use the same number of decimals as the display on the instrument used to take the measurement. For calculations where multiple variables are used, the variable with the least number of decimal places should be used as the guide. For course assignments, reports, design projects, etc., the appropriate number of significant figures will depend on the type of variables that go into the calculations, and how these numbers were obtained. Typically, in engineering problems, three to five significant figures is considered an appropriate range. However, students are encouraged to ask the professor of the course what their expectations are.

Typically, the term ‘results’ is associated with numbers, i.e., data collected during an experiment. This may not be the case for all reports. Results might be pictures of different specimens that need to be compared to each other. It might be the code for a computer program, or a wiring diagram. This is why the well-defined purpose statement discussed earlier is so important. It will help to direct the flow of the results presented.

While the details presented here focus more on lab reports, similar details are required for a design report. For a design report however, the body of the report will typically be several chapters in length and include a great deal more detail than is necessary for a lab report.

4.6 Conclusions

The conclusions should briefly restate the major discoveries or ideas presented in the report. It should be linked directly to the purpose statement or objectives of the experiment. The conclusions must be based solely on material already presented in the report, they should not include any new information. In some cases the conclusions will be values (e.g. “The effectiveness of the energy exchanger was 73%”.) while in others they may be comparisons (e.g.
“The deformation in sample one was greater than the deformation in sample two”). In some reports, concluding comments are more appropriate than conclusions.

4.7 References

Any resource material that is used to write a report must be referenced in the report. This includes a lab manual, textbooks, journal articles, technical reports, websites or other material. The preferred reference style for engineering reports is the author-date system, as outlined in the Chicago Manual of Style (2017).

Every reference must be cited in the text, either in the main body of the report or an appendix. The citation includes the surname of the author(s) and the year of publication. There are two methods of citation: either the author’s name appears as part of the sentence, with the year in parentheses, or both the author’s name and the year appear in parentheses. For example:

MacLennan (2009) outlines the key steps to writing a good report...

or

There are several key steps to writing a good report (MacLennan 2009) that ...

If a publication has two authors, the surnames of both authors should be listed along with the year (e.g. William and Moore 2017). When a publication has more than two authors, the surname of the first author is listed, followed by et al. and the year of publication. If the work has no specific author, such as the lab manual, cite the corporation or organization in place of the author (e.g. Department of Mechanical Engineering 2018). In some cases it may be appropriate to list the page that the information was found on with the citation (e.g. MacLennan 2009, 31). This would only be done if referring to one specific item from the source. If the reference is a general summary of the whole article, then this would not be included.

All material that is cited in the report must be included in a reference list, which begins on a new page following the conclusions. References are arranged alphabetically, by the lead author’s last name. The publication year always follows the author’s name. Typeset this list so that references are easy to locate. A hanging indent with single spacing within a reference and 1.5 spacing between references works well. For clarity, spell out the entire journal name rather than using abbreviations. There are many examples of possible references; a few are listed here to
demonstrate the technique. When writing the references section, the Chicago Manual of Style (2017) should be consulted for details.

**Journal Article:**
Author’s name(s). Year. “Article Title.” *Journal Title* Volume(Issue): page numbers.


**Book:**
Author’s name(s). Year. *Book Title*. Location of publication: Publisher.


**Book (Organization instead of author):**
Organization (abbreviation if appropriate). Year. Title. If a Standard include the standard number here. Location of publication: Publisher.


**Website:**
It is never sufficient to provide only a URL for a website. The full details of the publication must also be recorded. This helps the reader to determine the nature and authentication of the source information. In addition, it is possible that a company will change or shut down their website. The reference for a website should include the date the website is accessed to give an idea how old the information is. In some cases a publication date will not be available on the website. In this case, the publication date should be listed as ‘no date’ (n.d.).


4.8 Appendices

The body of a report should contain only the information that is necessary for the reader to understand the conclusions that are made. Any additional information should be included in appendices. This might include a more detailed development of the theory, a description of a computer program with a printout of the code, tables of measurements, sample calculations, an uncertainty analysis, specifications of equipment or instruments, technical drawings or detailed procedures. However, it is possible to put too much information into appendices rather than the body of the report. The reader should not need to consult an appendix on first reading of the report in order to understand the main purpose and conclusions of the report.

Each appendix should have a descriptive title, an introductory paragraph and a concluding or summary statement. Information should not be put into an appendix without some explanation as to why it is included. Each appendix should be a self-contained document and must be referred to in the main body of the report. Appendices are labeled in the order that they are referred to in the report, typically starting with A, B, etc.

5.0 VISUALS

Technical reports contain a lot of detailed, often complex, information. Often the material can be explained more easily with the aid of visuals, in the form of graphs, sketches, photographs and tables. Visuals should not be used to decorate the report, but to help present the material in a straightforward manner. Although visuals are great tools to help the reader understand the material, if they are not properly formatted, they can cause confusion or frustration for the reader. The following section details how to make good visual aids.

Each figure and table must be referred to in the body of the report and must be located after the paragraph where it is first referred to. These elements should be referred to specifically by their number and not by their relative location in the document (e.g. “Figure 2 presents the apparatus…” rather than “The figure below presents the apparatus…”). Titles should be detailed enough for a reader to have a very good idea of what he or she is looking at, even if he or she has not read the surrounding text. For example, “Figure 1: Apparatus” is a bad title while “Figure 1: Apparatus used to measure the effectiveness of a cross flow heat exchanger” is a good title.
Visuals which contain data from other sources must have a proper citation to the source in the figure title or on the figure itself.

5.1 Figures

Figures include visuals such as graphs, sketches, drawings and photographs. For figures, the title is placed below the figure, with no separation between the figure and the title. Figures and their titles should be centred in the middle of the page and must on the same page. One line should be left above and below the figure to separate it from the main text.

Graphs

Graphs are useful for plotting experimental data or theoretical correlations as they show the trend that the data follow and relationships between variables. There are several software packages that can be used to create graphs, however, the default settings are usually not appropriate for a technical report. The following points should be considered when making graphs:

- label both axes with the variable name and units,
- use the same font style and size as the main text on all parts of the graph,
- do not include a title at the top of the graph,
- do not include a box around the graph,
- choose appropriate maximum and minimum bounds for the axes,
- represent experimental data with points, theoretical correlations with curves and
- use a legend when more than one set of data is shown on the same graph.

To demonstrate some of these points, an example of a bad graph is shown in Figure 1. The graph shows the temperature of the hot water flow and the cold water flow through a parallel-flow heat exchanger. This is not at all clear from the graph. The graph is missing labels on the axes and has a title at the top, which is incorrect. It is impossible to tell what the dots represent. It presents the data that were measured, but does not add any insight and is more confusing than helpful.
Figure 1: An example of a bad graph made using the default settings in a software program.

Conversely, Figure 2 shows an example of a good graph that was made by adjusting the settings and adding axes titles and a legend. From this graph it is clear that the temperature of the hot water decreases as it moves through the heat exchanger, while the temperature of the cold water increases. The relationship between temperature and position in the heat exchanger is not linear. It is easier to follow the description of the graph and understand its importance than was the case for Figure 1. In addition, the two data sets have different shapes, so the information in the graph will still be easy to understand if it is printed in black and white.

Figure 2: An example of a good graph made by adjusting the settings and adding labels.
**Sketches/Drawings/Photographs**

A piece of equipment or experimental set-up is easier to describe using an image. Whether the image is hand-drawn or a photograph depends on the complexity of the information being presented. Photographs are often effective for site description, an overview of equipment or a large set-up, but can be distracting if not taken properly. Hand- or computer-drawn sketches are better to show specific details and can be as simple or as complex as needed. Computers do not need to be included as part of the apparatus. Some specific items to consider for all sketches or photographs include:

- the photographs are high resolution,
- crop images to remove any unnecessary background,
- adjust the contrast and brightness to improve images,
- ensure that the images will be clear if printed in black and white,
- label all important parts using arrows or lines and
- include important dimensions and units.

Figure 3 is an example of a photograph that contains excess information. It is hard to tell which equipment was used in the experiment and there is no representation of the scale of the apparatus. In addition, while the picture looks good in color, it would not print well in black and white. Finally, there are no annotations pointing out the important parts of the apparatus.

**Figure 3:** An example of a bad photograph, showing too much background detail.
The same apparatus is shown in Figure 4, but the photograph has been cropped to only show the equipment used in the experiment. The brightness and contrast have been altered to make the picture clearer. Finally, annotations have been added to point out the important pieces of equipment used in the experiment.

Figure 4: An example of a good photograph, showing appropriate detail.

Figure 5 shows a simple sketch of the same apparatus. The sketch has a lot less detail, but shows exactly which equipment was used in the experiment. In addition, the important parts have been labeled and dimensions are shown to give an idea of the scale. The sketch was hand-drawn and then scanned and the image was darkened to make the pencil marks easier to see. While a photograph is easier to take, often a sketch is simpler to explain as it contains only the necessary parts. It is easier to annotate as the arrows stand out easily on the black and white drawing, whereas they are often lost in the color of a photograph.
Tables

Tables are useful tools for comparing data sets and summarizing lots of information. As with figures, tables must be labelled with a number and a descriptive title, but the title should be located above the table. Tables and their titles can be either left-justified or centred on the page. Tables should be designed to fit on one page. If it is necessary to continue a table on a second page, the title and column headings should be repeated on each page. In this case, it may be more appropriate to place the table in an appendix. Some specific items to consider for tables are:

- left-align or centre words in each column,
- align the decimal points in each column of numbers,
- use the same number of significant figures (ideally three) in each column,
- label each column, including units in parentheses and
- use borders to separate columns; borders separating rows are optional.

The data shown in Figure 1 and Figure 2 are presented in Table 1, to demonstrate a good table. The information in the table is easy to read, which makes comparing the temperature of the hot water flow to the cold water flow at each position easy.
Table 1: Temperatures of the hot and cold water flows in a parallel flow heat exchanger.

<table>
<thead>
<tr>
<th>Position from inlet (m)</th>
<th>Hot water flow</th>
<th>Cold water flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>55.6</td>
<td>14.8</td>
</tr>
<tr>
<td>0.870</td>
<td>47.9</td>
<td>22.2</td>
</tr>
<tr>
<td>1.73</td>
<td>43.7</td>
<td>26.5</td>
</tr>
<tr>
<td>2.59</td>
<td>38.6</td>
<td>29.0</td>
</tr>
<tr>
<td>3.45</td>
<td>38.2</td>
<td>30.8</td>
</tr>
</tbody>
</table>

5.2 Equations

As mentioned in the section on theory, it is advisable to present a simplified version of the theory in the report and refer the reader to other documentation for more details. Only necessary equations are included in the main body. Equations appear on a separate line, either left-aligned or centered, and are numbered sequentially, with the number in parenthesis and right-aligned on the same line. All terms in an equation, and their units, must be defined the first time they are used. The definition may be in a sentence after the equation or if there are several terms, in a list. Equations are written as part of a sentence and should be punctuated accordingly. There should be sufficient description between each equation so that the reader understands the information being presented. A sequence of equations with no connecting text is unlikely to be helpful.

Equations may be entered directly in the software used to write the report or may be neatly hand-written and scanned into the report. An example of a short equation is Newton’s second law of motion, which states

$$\vec{F} = m\vec{a}$$  \hspace{1cm} (1)

where $\vec{F}$ is the force on a particle [N], $m$ is its mass [kg] and $\vec{a}$ is the acceleration of the particle [m/s²]. An example of a longer equation is the total head loss $h_{IT}$ between the entrance and the exit of a pipe network, which is defined by the steady-flow energy equation in the following form:
\[ \frac{P}{\rho g} + \frac{V_1^2}{2g} + z_1 - \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 = h_{It} \]  

(2)

where

- \( P \) is the pressure [Pa],
- \( \rho \) is the density [kg/m³],
- \( V \) is the velocity [m/s],
- \( z \) is elevation above some arbitrary datum [m] and
- \( g \) is acceleration due to gravity [m/s²].

The International Organization for Standardization (ISO 2009) requires that when typesetting mathematics:

- variables are always italicized (e.g. \( P, T, F, \beta, \phi \)),
- Units are never italicized (e.g. m/s, kPa),
- Descriptive subscripts/superscripts are typeset in Roman typeface (e.g. \( T_{out} \)),
- Subscripts/superscripts that are themselves variables are italicized (e.g. \( C_P \)),
- Numbers are never italicized (e.g. \( T = 7°C \), not \( T = 7^oC \)),
- A space is inserted between a number and its units (e.g. 150 mm), with the exception of degrees Celsius (e.g. 7°C) and percentage symbols (e.g. 10%),
- Typed equations should include separation between different terms, by including a space on either side of the operator (e.g. \( x + y = 15 \), not \( x+y=15 \)), and
- Multiplication symbols should not be included in equations (e.g. \( y = 5x \), not \( y = 5*x \)).

The report writing suggestions and requirements presented in Sections 3, 4 and 5 are summarized in a checklist in Appendix A. The checklist is intended to provide students with a quick reference to check before submitting reports, to ensure all the criteria covered in this writing guide have been met. The final section of this writing guide will cover logbooks, which are not used in all classes, but are essential tools in lab and design classes and for practicing Professional Engineers.
6.0 LOGBOOKS

A logbook is a useful tool for keeping notes during meetings with clients and supervisors, recording preliminary data, observations and discussions and making sketches of equipment. Professional Engineers keep logbooks to record important details of their research or projects. For undergraduate students, a logbook is a great tool for collecting raw data that can be used to write a formal report. Logbook entries should be made during each lab, as well as during all meetings for design projects. The logbook is a place where active thinking is recorded. It should be recorded ‘in the moment,’ as work is being done. Keeping a good logbook will make writing reports much easier.

The logbooks of Professional Engineers are frequently entered as evidence in a court of law, for example, in cases of patent or design rights. As such, logbooks must meet certain standards. These standards include:

- use a bound, hardcover book so that pages cannot easily be removed,
- date each page,
- number each page,
- list all personnel involved in meetings or projects,
- include locations as appropriate,
- write neatly and legibly,
- neatly cross out errors, do not erase or use correction fluid,
- affix any external pages (glue, tape, staple) and
- cross out blank pages or areas with large amounts of white space.

In addition to these obligations, each class that uses a logbook may have additional requirements. The logbook should be a complete record of all relevant information pertaining to the work that was performed. This includes a statement of purpose, notes and questions, answers to questions, background material, sketches, figures, tables, procedural steps, observations, uncertainty, discussions, conclusions, lists of constraints and recommendations for future work. Appendix A includes a checklist which students can refer to when writing in their logbooks, to ensure all relevant information is included. This will set up a good foundation to begin writing the technical report.
7.0 REFERENCES


APPENDIX A – CHECKLISTS

It is essential for Professional Engineers to communicate well, in order to successfully present their ideas to supervisors, colleagues and clients. This appendix presents a summary of the suggestions and requirements presented in the Mechanical Engineering Writing Guide, for writing good technical reports and logbook entries. The summaries are presented as checklists, which students should review to ensure they have met all of the requirements before submitting their reports or logbooks.

TECHNICAL REPORT CHECKLIST

Style and Format

- Formal tone and appropriate verb tenses
- Descriptive headings and sub-headings as appropriate
- Introductory and concluding statements are included in each section
- Times New Roman size 12 font, 1.5 line spacing, left-aligned text
- One inch margins on all sides
- Page numbers (Roman numerals for front material, Arabic numerals for rest)

Components

- Title page – title, author’s name, submission date
- Summary – touches briefly on all sections of the report
- Table of contents, list of figures, list of tables, nomenclature, glossary as needed
- Introduction:
  - Well defined technical objectives/purpose
  - Scope of the report
  - Background material – motivation, literature review, context of the work
- Theory:
  - Highlights important information, refers to other sources for details
  - Assumptions and limitations of the theory
- Experimental Investigation:
  - Brief description of equipment, a sketch or photograph and wiring diagram if needed
  - Procedure (references to manual as appropriate)
Results – presented in tables or figures
Discussion – results are explained in detail, highlighting their significance
Uncertainty analysis – possible sources are discussed, values presented when possible
Conclusions – restate the major discoveries or ideas, links to objectives/purpose
References:
- Cited in the text of the report, included in the reference section
- Author/date format (Chicago Manual of Style 2017)
Appendices:
- Referred to in the text of the report
- Self-contained documents with introductions and conclusions

Visuals
- Figures and tables are referred to in the text of the report, by number, before they appear
- Figures have detailed titles located below the figure, above for tables
- Visuals are compatible with black and white printing
- Graphs:
  - Labels on the axes, same font as main text, including units
  - Experimental data represented by data points, analytical expressions by curves
- Sketches/drawings/photographs:
  - Edited to be clear and useful
  - Properly annotated to highlight important features
  - Dimensions are included
- Tables:
  - Columns with words are left- or centre-aligned; numbers are aligned to the decimal
  - Numbers are presented to three significant figures
  - Columns are labeled, including units in parenthesis
- Equations:
  - Appear on a separate line, numbered sequentially
  - Variables are defined the first time they are used, including units
  - Mathematics (variables, numbers, units) are typeset to ISO (2009) standards
LOGBOOK CHECKLIST

Format
- Bound, hardcover book
- Date of meeting or lab
- Page numbers
- Group members/personnel present
- Location of meeting or lab
- Writing is neat and legible
- Errors are crossed out, not erased
- External pages are affixed with tape or glue
- Blank spaces or pages are crossed out

Components
- Statement of purpose
- Notes, questions and answers
- Background material, scope, constraints
- Sketches of equipment/apparatus, specimens, etc.
- Procedure
- Observations
- Results – including figures and tables as appropriate
- Discussion of results
- Uncertainty – values or possible sources, as appropriate
- Conclusions
- Recommendations for future work

The checklists presented in this appendix highlight the requirements for technical reports and logbooks for all Mechanical Engineering classes. For more details on each requirement, refer to the appropriate section of the main body of the Mechanical Engineering Writing Guide.