Microcontroller Based Vehicle Anti Collision Monitoring System

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A Thesis
Presented to the Faculty of the
Department of Electronics and Communications Engineering
Gokongwei College of Engineering
De La Salle University

————————

In Partial Fulfillment of the
Requirements for the Degree of
Bachelor of Science in Computer Engineering

————————

by

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COMENDADOR, Glenn Rommel P.
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GARCIA, Laureen Audrey R.
LERIT, Jose Mari Luis L.

May, 2016

De La Salle University

ORAL DEFENSE RECOMMENDATION SHEET

This thesis, entitled **Microcontroller Based Vehicle Anti Collision Monitoring System**, prepared and submitted by thesis group, Ariba, composed of:

CHAN, Zion Eric O.
COMENDADOR, Glenn Rommel P.
FALLAR, Mac Excel S.
GARCIA, Laureen Audrey R.
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in partial fulfillment of the requirements for the degree of **Bachelor of Science in Computer Engineering** (**BS-CPE**) has been examined and is recommended for acceptance and approval for **ORAL DEFENSE**.

Dr. Melvin Kong Cabatuan
Adviser

May 29, 2016

De La Salle University

THESIS APPROVAL SHEET

This thesis entitled **Microcontroller Based Vehicle Anti Collision Monitoring System**, prepared and submitted by:

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Dr. Melvin Kong Cabatuan
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Date: May 29, 2016

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ACKNOWLEDGMENT

Write this prior to hard binding if you have submitted all requirements and are told by your adviser that you have passed.

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ABSTRACT

Keep your abstract short by giving the gist/nutshell of your thesis.

Index Terms—Microcontrollers, Automobile.

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TABLE OF CONTENTS

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LIST OF FIGURES

LIST OF TABLES

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ABBREVIATIONS

NOTATION

Throughout this thesis, mathematical notations conform to ISO 80000-2 standard, e.g. variable names are printed in italics, the only exception being acronyms like e.g. SNR, which are printed in regular font. Constants are also set in regular font like j. Functions are also set in regular font, e.g. in $\sin(\cdot)$. Commonly used notations are t, f, $j = \sqrt{-1}$, n and $\exp(\cdot)$, which refer to the time variable, frequency variable, imaginary unit, nth variable, and exponential function, respectively.

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GLOSSARY

LISTINGS

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Chapter 1

INTRODUCTION

Contents

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1.1   Background of the Study

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1.2   Prior Studies

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1.3   Problem Statement

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1.4 Objectives

1.4.1 General Objective(s)

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1.4.2 Specific Objectives

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1.5 Significance of the Study

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1.6 Assumptions, Scope and Delimitations

Bulletize your scope in one group, and then bulletize the delimitations in another. Bulletize your assumptions as well.

1.7 Description and Methodology

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1.8 Overview

Provide here a brief summary and what the reader should expect from each succeeding chapter. Show how each chapter are connected with each other.

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Chapter 2

LITERATURE REVIEW

Contents

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Cite and summarize here relevant and significant literature (dissertations, theses, journals, patents, notable conference papers) to prove that no one has done your work yet.

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376 ## 2.1 Summary

Chapter 3

THEORETICAL CONSIDERATIONS

Contents

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3.1 Summary

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Fig. 3.1 A quadrilateral image example.

Chapter 4

DESIGN CONSIDERATIONS

Contents

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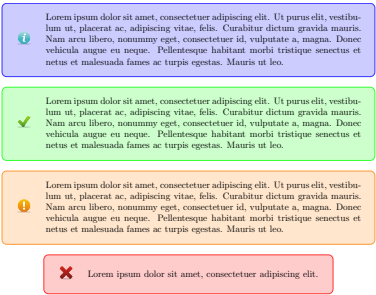
4.1   Summary

Chapter 5

METHODOLOGY

Contents

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5.1   Implementation

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5.2   Evaluation

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581 ## 5.3 Summary

Chapter 6

RESULTS AND DISCUSSION

Contents

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6.1 Summary

Chapter 7

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE DIRECTIVES

Contents

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7.1 Concluding Remarks

In this Thesis, . . .

7.2 Contributions

The interrelated contributions and supplements that have been developed in this Thesisare listed as follows.

- the ;

- the ;

- the ;

7.3 Recommendations

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7.4   Future Prospects

There are several prospect related in this research that may be extended for further studies. . . . So the suggested topics are listed in the following.

1. the . . . .

2. the . . . .

3. the . . . .

REFERENCES

[ISO, 2009] ISO (2009). 80000-2. *Quantities and units–Part 2: Mathematical signs and symbols to be used in the natural sciences and technology.*

[Oetiker et al., 2014] Oetiker, T., Partl, H., Hyna, I., and Schlegl, E. (2014). *The Not So Short Introduction to LaTeX 2ε Or LaTeX 2ε in 157 minutes.* n.a.

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Appendix A
ANSWERS TO QUESTIONS TO THIS THESIS

Contents

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A1   How important is the problem to practice?

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A2   How will you know if the solution/s that you will achieve would be better than existing ones?

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A2.1   How will you measure the improvement/s?

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A2.1.1   What is/are your basis/bases for the improvement/s?

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A2.1.2   Why did you choose that/those basis/bases?

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A2.1.3   How significant are your measure/s of the improvement/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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A3 What is the difference of the solution/s from existing ones?

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A3.1 How is it different from previous and existing ones?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A4 What are the assumptions made (that are behind for your proposed solution to work)?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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A4.1 Will your proposed solution/s be sensitive to these assumptions?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A4.2 Can your proposed solution/s be applied to more general cases when some of the assumptions are eliminated? If so, how?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A5 What is the necessity of your approach / proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris.

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Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A5.1   What will be the limits of applicability of your proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A5.2   What will be the message of the proposed solution to technical people? How about to non-technical managers and business men?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A6   How will you know if your proposed solution/s is/are correct?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla

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tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A6.1 Will your results warrant the level of mathematics used (i.e., will the end justify the means)?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A7 Is/are there an/_ alternative way/s to get to the same solution/s?

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A7.1 Can you come up with illustrating examples, or even better, counter examples to your proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor.

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934 Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla
935 tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue
936 a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris.
937 Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit
938 amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A7.2 Is there an approximation that can arrive at the essentially the same proposed solution/s more easily?

941 Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem.
942 Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec
943 ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus
944 placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor.
945 Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla
946 tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue
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948 Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit
949 amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A8 If you were the examiner of your proposal, how would you present the proposal in another way?

952 Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem.
953 Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec
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956 Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla
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959 Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit
960 amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A8.1 What are the weaknesses of your proposal?

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963 Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec
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966 Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla
967 tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue
968 a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris.
969 Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit
970 amet ipsum. Nunc quis urna dictum turpis accumsan semper.

971 # Appendix B
972 # USAGE EXAMPLES

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The user is expected to have a working knowledge of LaTeX. A good introduction is in [Oetiker et al., 2014]. Its latest version can be accessed at http://www.ctan.org/tex-archive/info/lshort.

B1 Equations

The following examples show how to typeset equations in LaTeX. This section also shows examples of the use of `\gls{ }` commands in conjunction with the items that are in the `notation.tex` file. **Please make sure that the entries in `notation.tex` are those that are referenced in the LaTeX document files used by this Thesis. Please comment out unused notations and be careful with the commas and brackets in** `notation.tex` .

In (B.1), the output signal $y\left(t\right)$ is the result of the convolution of the input signal $x\left(t\right)$ and the impulse response $h\left(t\right)$.

$$y\left(t\right) = h\left(t\right) * x\left(t\right) = \int_{-\infty}^{+\infty} h\left(t-\tau\right) x\left(\tau\right) \mathrm{d}\tau \tag{B.1}$$

Other example equations are as follows.

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix} \tag{B.2}$$

$$\frac{1}{2} < \left\lfloor \mathrm{mod}\left(\left\lfloor \frac{y}{17} \right\rfloor 2^{-17\lfloor x\rfloor - \mathrm{mod}(\lfloor y\rfloor,17)}, 2\right)\right\rfloor, \tag{B.3}$$

$$|\zeta(x)^3 \zeta(x+iy)^4 \zeta(x+2iy)| = \exp\sum_{n,p} \frac{3 + 4\cos(ny\log p) + \cos(2ny\log p)}{np^{nx}} \geq 1 \tag{B.4}$$

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986

The verbatim LaTeX code of Sec. B1 is in List. B.1.

Listing B.1: Sample LaTeX code for equations and notations usage

```
1  The following examples show how to typeset equations in \LaTeX.
2
3  In~\eqref{eq:conv}, the output signal \gls{not:output_sigt} is the
       result of the convolution of the input signal \gls{not:input_sigt}
       and the impulse response \gls{not:ir}.
4
5  \begin{eqnarray}
6      y\left( t \right) = h\left( t \right) * x\left( t \right)=\int_{-\
           infty}^{+\infty}h\left( t-\tau \right)x\left( \tau \right) \
           mathrm{d}\tau
7      \label{eq:conv}
8  \end{eqnarray}
9
10 Other example equations are as follows.
11
12 \begin{eqnarray}
13     \left[ \dfrac{ V_{1} }{ I_{1} } \right] =
14     \begin{bmatrix}
15         A & B \\
16         C & D
17     \end{bmatrix}
18     \left[ \dfrac{ V_{2} }{ I_{2} } \right]
19     \label{eq:ABCD}
20 \end{eqnarray}
21
22 \begin{eqnarray}
23 {1\over 2} < \left\lfloor \mathrm{mod}\left(\left\lfloor {y \over 17} \
       right\rfloor 2^{-17 \lfloor x \rfloor - \mathrm{mod}(\lfloor y\
       rfloor, 17)},2\right)\right\rfloor,
24 \end{eqnarray}
25
26 \begin{eqnarray}
27 | \zeta(x)^3\zeta(x+iy)^4\zeta(x+2iy) | =
28 \exp\sum_{n,p}\frac{3+4\cos(ny\log p) +\cos (2ny\log p)}{np^{nx}}\ge 1
29 \end{eqnarray}
```

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B2 Notations

In order to use the standardized notation, the user is highly suggested to see the ISO 80000-2 standard [ISO, 2009]. The following were taken from `isomath-test.tex`.

Math alphabets

If there are other symbols in place of Greek letters in a math alphabet, it uses T1 or OT1 font encoding instead of OML.

mathnormal	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, °, !, v, w, 0, 1, 9$
mathrm	$\text{A, B}, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, °, !, \text{v}, \text{w}, 0, 1, 9$
mathbf	$\mathbf{A, B}, \boldsymbol{\Gamma}, \boldsymbol{\Delta}, \boldsymbol{\Theta}, \boldsymbol{\Lambda}, \boldsymbol{\Xi}, \boldsymbol{\Pi}, \boldsymbol{\Sigma}, \boldsymbol{\Phi}, \boldsymbol{\Psi}, \boldsymbol{\Omega}, \mathbf{ff}, \mathbf{fi}, \mathbf{ß}, °, !, \mathbf{v}, \mathbf{w}, \mathbf{0, 1, 9}$
mathsf	$\text{A, B}, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff, fi, ß}, °, !, \text{v, w}, 0, 1, 9$
mathtt	$\text{A, B}, \Gamma, \Delta, \theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \uparrow, \downarrow, \text{ß}, °, !, \text{v, w}, 0, 1, 9$

New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-italic.

mathbfit	$\boldsymbol{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9}$
mathsfit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathsfbfit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$

Do the math alphabets match?
$$ax\alpha\omega \boldsymbol{ax\alpha\omega} ax\alpha\omega \quad \textsf{TCΘΓ} \textsf{TCΘΓ} TCΘΓ$$

Vector symbols

Alphabetic symbols for vectors are boldface italic, $\boldsymbol{\lambda} = \boldsymbol{e}_1 \cdot \boldsymbol{a}$, while numeric ones (e.g. the zero vector) are bold upright, $\boldsymbol{a} + \mathbf{0} = \boldsymbol{a}$.

Matrix symbols

Symbols for matrices are boldface italic, too:[1] $\boldsymbol{\Lambda} = \boldsymbol{E} \cdot \boldsymbol{A}$.

---

[1]However, matrix symbols are usually capital letters whereas vectors are small ones. Exceptions are physical quantities like the force vector $\boldsymbol{F}$ or the electrical field $\boldsymbol{E}$.

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Tensor symbols

1001

1002 Symbols for tensors are sans-serif bold italic,

$$\boldsymbol{\alpha} = \boldsymbol{e} \cdot \boldsymbol{a} \quad \Longleftrightarrow \quad \alpha_{ijl} = e_{ijk} \cdot a_{kl}.$$

1003 The permittivity tensor describes the coupling of electric field and displacement:

$$\boldsymbol{D} = \epsilon_0 \boldsymbol{\epsilon}_\mathrm{r} \boldsymbol{E}$$

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Bold math version

1004

1005 The "bold" math version is selected with the commands `\boldmath` or `\mathversion{bold}`

mathnormal	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, \degree, !, v, w, 0, 1, 9$
mathrm	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, \degree, !, v, w, 0, 1, 9$
mathbf	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, \degree, !, v, w, 0, 1, 9$
mathsf	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \text{ff}, \text{fi}, \text{ß}, \degree, !, v, w, 0, 1, 9$
mathtt	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \uparrow, \downarrow, \text{ß}, \degree, !, v, w, 0, 1, 9$

1006 New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-italic.

mathbfit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathsfit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathsfbfit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$

1007 Do the math alphabets match?
1008 $a x \alpha \omega a x \alpha \omega a x \alpha \omega \quad T C \Theta \Gamma T C \Theta \Gamma T C \Theta \Gamma$

Vector symbols

1010 Alphabetic symbols for vectors are boldface italic, $\boldsymbol{\lambda} = \boldsymbol{e_1} \cdot \boldsymbol{a}$, while numeric ones (e.g.
1011 the zero vector) are bold upright, $\boldsymbol{a} + \mathbf{0} = \boldsymbol{a}$.

Matrix symbols

1013 Symbols for matrices are boldface italic, too:[2] $\boldsymbol{\Lambda} = \boldsymbol{E} \cdot \boldsymbol{A}.$

Tensor symbols

1015 Symbols for tensors are sans-serif bold italic,

$$\boldsymbol{\alpha} = \boldsymbol{e} \cdot \boldsymbol{a} \quad \Longleftrightarrow \quad \alpha_{ijl} = e_{ijk} \cdot a_{kl}.$$

1016 The permittivity tensor describes the coupling of electric field and displacement:

$$\boldsymbol{D} = \epsilon_0 \epsilon_{\mathrm{r}} \boldsymbol{E}$$

1017

---

[2]However, matrix symbols are usually capital letters whereas vectors are small ones. Exceptions are physical quantities like the force vector $\boldsymbol{F}$ or the electrical field $\boldsymbol{E}$.

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The verbatim LaTeX code of Sec. B2 is in List. B.2.

Listing B.2: Sample LaTeX code for notations usage

```
1  % A teststring with Latin and Greek letters::
2  \newcommand{\teststring}{%
3  % capital Latin letters
4  % A,B,C,
5  A,B,
6  % capital Greek letters
7  %\Gamma,\Delta,\Theta,\Lambda,\Xi,\Pi,\Sigma,\Upsilon,\Phi,\Psi,
8  \Gamma,\Delta,\Theta,\Lambda,\Xi,\Pi,\Sigma,\Phi,\Psi,\Omega,
9  % small Greek letters
10 \alpha,\beta,\pi,\nu,\omega,
11 % small Latin letters:
12 % compare \nu, \omega, v, and w
13 v,w,
14 % digits
15 0,1,9
16 }
17
18
19 \subsection*{Math alphabets}
20
21 If there are other symbols in place of Greek letters in a math
22 alphabet, it uses T1 or OT1 font encoding instead of OML.
23
24 \begin{eqnarray*}
25 \mbox{mathnormal} &  & \teststring \\
26 \mbox{mathit} &  & \mathit{\teststring}\\
27 \mbox{mathrm} &  & \mathrm{\teststring}\\
28 \mbox{mathbf} &  & \mathbf{\teststring}\\
29 \mbox{mathsf} &  & \mathsf{\teststring}\\
30 \mbox{mathtt} &  & \mathtt{\teststring}
31 \end{eqnarray*}
32  New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-
       italic.
33 \begin{eqnarray*}
34 \mbox{mathbfit}    &  & \mathbfit{\teststring}\\
35 \mbox{mathsfit}    &  & \mathsfit{\teststring}\\
36 \mbox{mathsfbfit} &  & \mathsfbfit{\teststring}
37 \end{eqnarray*}
38 %
39 Do the math alphabets match?
40
41 $
42 \mathnormal  {a x \alpha \omega}
43 \mathbfit    {a x \alpha \omega}
44 \mathsfbfit{a x \alpha \omega}
45 \quad
46 \mathsfbfit{T C \Theta \Gamma}
47 \mathbfit    {T C \Theta \Gamma}
48 \mathnormal  {T C \Theta \Gamma}
49 $
50
51 \subsection*{Vector symbols}
52
```

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```
1073    53   Alphabetic symbols for vectors are boldface italic,
1074    54   $\vec{\lambda}=\vec{e}_{1}\cdot\vec{a}$,
1075    55   while numeric ones (e.g. the zero vector) are bold upright,
1076    56   $\vec{a} + \vec{0} = \vec{a}$.
1077    57
1078    58   \subsection*{Matrix symbols}
1079    59
1080    60   Symbols for matrices are boldface italic, too:%
1081    61   \footnote{However, matrix symbols are usually capital letters whereas
1082         vectors
1083    62   are small ones. Exceptions are physical quantities like the force
1084    63   vector $\vec{F}$ or the electrical field $\vec{E}$.%
1085    64   }
1086    65   $\matrixsym{\Lambda}=\matrixsym{E}\cdot\matrixsym{A}.$
1087    66
1088    67
1089    68   \subsection*{Tensor symbols}
1090    69
1091    70   Symbols for tensors are sans-serif bold italic,
1092    71
1093    72   \[
1094    73       \tensorsym{\alpha}  =  \tensorsym{e}\cdot\tensorsym{a}
1095    74       \quad \Longleftrightarrow \quad
1096    75       \alpha_{ijl}  =  e_{ijk}\cdot a_{kl}.
1097    76   \]
1098    77
1099    78
1100    79   The permittivity tensor describes the coupling of electric field and
1101    80   displacement: \[
1102    81   \vec{D}=\epsilon_{0}\tensorsym{\epsilon}_{\mathrm{r}}\vec{E}\]
1103    82
1104    83
1105    84
1106    85   \newpage
1107    86   \subsection*{Bold math version}
1108    87
1109    88   The ``bold'' math version is selected with the commands
1110    89   \verb+\boldmath+ or \verb+\mathversion{bold}+
1111    90
1112    91   {\boldmath
1113    92       \begin{eqnarray*}
1114    93       \mbox{mathnormal} &  & \teststring \\
1115    94       \mbox{mathit} &  & \mathit{\teststring}\\
1116    95       \mbox{mathrm} &  & \mathrm{\teststring}\\
1117    96       \mbox{mathbf} &  & \mathbf{\teststring}\\
1118    97       \mbox{mathsf} &  & \mathsf{\teststring}\\
1119    98       \mbox{mathtt} &  & \mathtt{\teststring}
1120    99       \end{eqnarray*}
1121    100       New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-
1122            italic.
1123    101       \begin{eqnarray*}
1124    102       \mbox{mathbfit}    &  & \mathbfit{\teststring}\\
1125    103       \mbox{mathsfit}    &  & \mathsfit{\teststring}\\
1126    104       \mbox{mathsfbfit} &  & \mathsfbfit{\teststring}
1127    105       \end{eqnarray*}
1128    106       %
1129    107       Do the math alphabets match?
```

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```
1130  108
1131  109      $
1132  110      \mathnormal  {a x \alpha \omega}
1133  111      \mathbfit    {a x \alpha \omega}
1134  112      \mathsfbfit{a x \alpha \omega}
1135  113      \quad
1136  114      \mathsfbfit{T C \Theta \Gamma}
1137  115      \mathbfit    {T C \Theta \Gamma}
1138  116      \mathnormal  {T C \Theta \Gamma}
1139  117      $
1140  118
1141  119      \subsection*{Vector symbols}
1142  120
1143  121      Alphabetic symbols for vectors are boldface italic,
1144  122      $\vec{\lambda}=\vec{e}_{1}\cdot\vec{a}$,
1145  123      while numeric ones (e.g. the zero vector) are bold upright,
1146  124      $\vec{a} + \vec{0} = \vec{a}$.
1147  125
1148  126
1149  127
1150  128
1151  129      \subsection*{Matrix symbols}
1152  130
1153  131      Symbols for matrices are boldface italic, too:%
1154  132      \footnote{However, matrix symbols are usually capital letters whereas
1155           vectors
1156  133      are small ones. Exceptions are physical quantities like the force
1157  134      vector $\vec{F}$ or the electrical field $\vec{E}$.%
1158  135      }
1159  136      $\matrixsym{\Lambda}=\matrixsym{E}\cdot\matrixsym{A}.$
1160  137
1161  138
1162  139      \subsection*{Tensor symbols}
1163  140
1164  141      Symbols for tensors are sans-serif bold italic,
1165  142
1166  143      \[
1167  144          \tensorsym{\alpha}  =  \tensorsym{e}\cdot\tensorsym{a}
1168  145          \quad \Longleftrightarrow \quad
1169  146          \alpha_{ijl}  =  e_{ijk}\cdot a_{kl}.
1170  147      \]
1171  148
1172  149      The permittivity tensor describes the coupling of electric field and
1173  150      displacement: \[
1174  151      \vec{D}=\epsilon_{0}\tensorsym{\epsilon}_{\mathrm{r}}\vec{E}\]
1175  152  }
1176
```

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B3   Abbreviation

This section shows examples of the use of LaTeXcommands in conjunction with the items that are in the `abbreviation.tex` and in the `glossary.tex` files. Please see List. B.3. **To lessen the LaTeX compilation time, it is suggested that you use** `\acr{ }` **only for the first occurrence of the word to be abbreviated.**

Again please see List. B.3. Here is an example of first use: alternating current (ac). Next use: ac. Full: alternating current (ac). Here's an acronym referenced using `\acr` : hyper-text markup language (html). And here it is again: html. If you are used to the `glossaries` package, note the difference in using `\gls` : hyper-text markup language (html). And again (no difference): hyper-text markup language (html). Here are some more entries:

- extensible markup language (xml) and cascading style sheet (css).

- Next use: xml and css.

- Full form: extensible markup language (xml) and cascading style sheet (css).

- Reset again.

- Start with a capital. Hyper-text markup language (html).

- Next: Html. Full: Hyper-text markup language (html).

- Prefer capitals? Extensible markup language (XML). Next: XML. Full: extensible markup language (XML).

- Prefer small-caps? Cascading style sheet (CSS). Next: CSS. Full: cascading style sheet (CSS).

- Resetting all acronyms.

- Here are the acronyms again:

- Hyper-text markup language (HTML), extensible markup language (XML) and cascading style sheet (CSS).

- Next use: HTML, XML and CSS.

- Full form: Hyper-text markup language (HTML), extensible markup language (XML) and cascading style sheet (CSS).

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1206   • Provide your own link text: style sheet.

1207   The verbatim LaTeX code of Sec. B3 is in List. B.3.

Listing B.3: Sample LaTeX code for abbreviations usage

```
 1  Again please see List.~\ref{lst:abbrv}. Here is an example of first use:
        \acr{ac}. Next use: \acr{ac}. Full: \gls{ac}.  Here's an acronym
        referenced using \verb| \acr |: \acr{html}.  And here it is again: \
        acr{html}. If you are used to the \texttt{glossaries} package, note
        the difference in using \verb| \gls |: \gls{html}. And again (no
        difference): \gls{html}. Here are some more entries:
 2
 3  \begin{itemize}
 4
 5      \item \acr{xml} and \acr{css}.
 6
 7      \item Next use: \acr{xml} and \acr{css}.
 8
 9      \item Full form: \gls{xml} and \gls{css}.
10
11      \item Reset again. \glsresetall{abbreviation}
12
13      \item Start with a capital. \Acr{html}.
14
15      \item Next: \Acr{html}. Full: \Gls{html}.
16
17      \item Prefer capitals? \renewcommand{\acronymfont}[1]{\
            MakeTextUppercase{#1}} \Acr{xml}. Next: \acr{xml}. Full: \gls{xml
            }.
18
19      \item Prefer small-caps? \renewcommand{\acronymfont}[1]{\textsc{#1}}
            \Acr{css}. Next: \acr{css}. Full: \gls{css}.
20
21      \item Resetting all acronyms.\glsresetall{abbreviation}
22
23      \item Here are the acronyms again:
24
25      \item \Acr{html}, \acr{xml} and \acr{css}.
26
27      \item Next use: \Acr{html}, \acr{xml} and \acr{css}.
28
29      \item Full form: \Gls{html}, \gls{xml} and \gls{css}.
30
31      \item Provide your own link text: \glslink{[textbf]css}{style}
32
33  \end{itemize}
```

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B4 Glossary

This section shows examples of the use of `\gls{ }` commands in conjunction with the items that are in the `glossary.tex` and `notation.tex` files. Note that entries in `notation.tex` are prefixed with " `not:` " label (see List. B.4).

Please make sure that the entries in `notation.tex` are those that are referenced in the LaTeX document files used by this Thesis. Please comment out unused notations and be careful with the commas and brackets in `notation.tex` .

- Matrices are usually denoted by a bold capital letter, such as $\boldsymbol{A}$. The matrix's (i, j)th element is usually denoted a_{ij}. Matrix $\mathbf{I}$ is the identity matrix.

- A set, denoted as $\mathcal{S}$, is a collection of objects.

- The universal set, denoted as $\mathcal{U}$, is the set of everything.

- The empty set, denoted as $\emptyset$, contains no elements.

- The cardinality of a set, denoted as $|\mathcal{S}|$, is the number of elements in the set.

The verbatim LaTeX code for the part of Sec. B4 is in List. B.4.

Listing B.4: Sample LaTeX code for glossary and notations usage

```
1  \begin{itemize}
2
3    \item \Glspl{matrix} are usually denoted by a bold capital letter,
         such as $\mathbfit{A}$. The \gls{matrix}'s $(i,j)$th element is
         usually denoted $a_{ij}$. \Gls{matrix} $\mathbf{I}$ is the
         identity \gls{matrix}.
4
5    \item A set, denoted as \gls{not:set}, is a collection of objects.
6
7    \item The universal set,  denoted as \gls{not:universalSet}, is the
         set of everything.
8
9    \item The empty set, denoted as \gls{not:emptySet}, contains no
         elements.
10
11   \item The cardinality of a set, denoted as \gls{not:cardinality}, is
         the number of elements in the set.
12
13  \end{enumerate}
```

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B5   Figure

This section shows several ways of placing figures. PDFLATEX compatible files are PDF, PNG, and JPG. Please see the `figure` subdirectory.
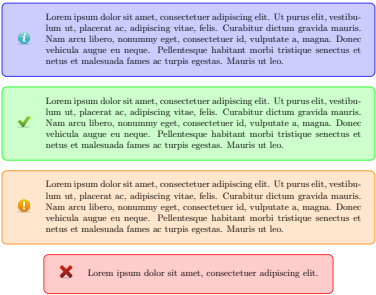
Fig. B.1   A quadrilateral image example.

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1225   Fig. B.1 is a gray box enclosed by a dark border. List. B.5 shows the corresponding
1226 LaTeX code.

Listing B.5: Sample LaTeX code for a single figure

```
1  \begin{figure}[!htbp]
2      \centering
3          \includegraphics[width=0.5\textwidth]{example}
4      \caption{A quadrilateral image example.}
5      \label{fig:example}
6  \end{figure}
7  \cleardoublepage
8
9  Fig.~\ref{fig:example} is a gray box enclosed by a dark border. List.~\
       ref{lst:onefig} shows the corresponding \LaTeX \ code.
10 \end{figure}
```

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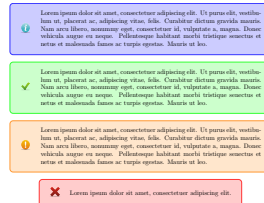
(a) A sub-figure in the top row.
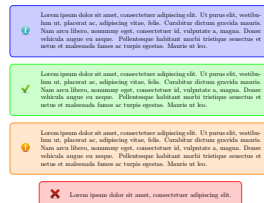
(b) A sub-figure in the middle row.

(c) A sub-figure in the bottom row.

De La Salle University
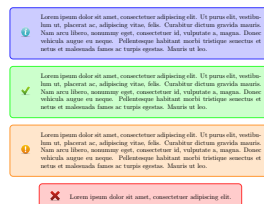
Listing B.6: Sample LaTeX code for three figures on top of each other

```
1   \begin{figure}[!htbp]
2   \centering
3   \subbottom[A sub-figure in the top row.]{
4   \includegraphics[width=0.35\textwidth]{example}
5   \label{fig:top}
6   }
7   \vfill
8   \subbottom[A sub-figure in the middle row.]{
9   \includegraphics[width=0.35\textwidth]{example}
10  \label{fig:mid}
11  }
12  \vfill
13  \subbottom[A sub-figure in the bottom row.]{
14  \includegraphics[width=0.35\textwidth]{example}
15  \label{fig:botm}
16  }
17  \caption{Figures on top of each other}
18  \label{fig:tmb}
19  \end{figure}
```

De La Salle University
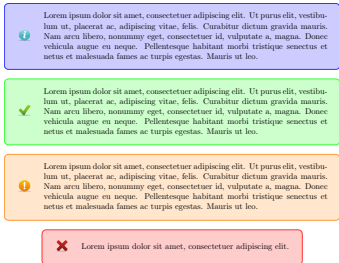
(a) A sub-figure in the upper-left corner.

(b) A sub-figure in the upper-right corner.
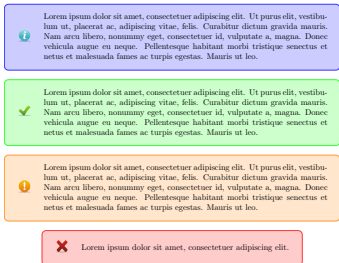
(c) A sub-figure in the lower-left corner.

(d) A sub-figure in the lower-right corner

Fig. B.3   Four figures in each corner. See List. B.7 for the corresponding LaTeX code.

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Listing B.7: Sample LaTeX code for the four figures

```
1  \begin{figure}[!htbp]
2  \centering
3  \subbottom[A sub-figure in the upper-left corner.]{
4  \includegraphics[width=0.45\textwidth]{example}
5  \label{fig:upprleft}
6  }
7  \hfill
8  \subbottom[A sub-figure in the upper-right corner.]{
9  \includegraphics[width=0.45\textwidth]{example}
10 \label{fig:uppright}
11 }
12 \vfill
13 \subbottom[A sub-figure in the lower-left corner.]{
14 \includegraphics[width=0.45\textwidth]{example}
15 \label{fig:lowerleft}
16 }
17 \hfill
18 \subbottom[A sub-figure in the lower-right corner]{
19 \includegraphics[width=0.45\textwidth]{example}
20 \label{fig:lowright}
21 }
22 \caption{Four figures in each corner. See List.~\ref{lst:fourfigs} for
       the corresponding \LaTeX \ code.}
23 \label{fig:fourfig}
24 \end{figure}
```

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B6 Table

1227

1228 This section shows an example of placing a table (a long one). Table B.1 are the triples.

TABLE B.1   FEASIBLE TRIPLES FOR HIGHLY VARIABLE GRID

Time (s)	Triple chosen	Other feasible triples
0	(1, 11, 13725)	(1, 12, 10980), (1, 13, 8235), (2, 2, 0), (3, 1, 0)
2745	(1, 12, 10980)	(1, 13, 8235), (2, 2, 0), (2, 3, 0), (3, 1, 0)
5490	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
8235	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
10980	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
13725	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
16470	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
19215	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
21960	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
24705	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
27450	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
30195	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
32940	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
35685	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
38430	(1, 13, 10980)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
41175	(1, 12, 13725)	(1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
43920	(1, 13, 10980)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
46665	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
49410	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
52155	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
54900	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
57645	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
60390	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
63135	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
65880	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
68625	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
71370	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
74115	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
76860	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
79605	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
82350	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
85095	(1, 12, 13725)	(1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
87840	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
90585	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
93330	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
96075	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
98820	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
101565	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
104310	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
107055	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
109800	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
112545	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
115290	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
118035	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
120780	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
123525	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)

Continued on next page

59

De La Salle University

Continued from previous page

Time (s)	Triple chosen	Other feasible triples
126270	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
129015	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
131760	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
134505	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
137250	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
139995	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
142740	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
145485	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
148230	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
150975	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
153720	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
156465	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
159210	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
161955	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
164700	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)

1229

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List. B.8 shows the corresponding LATEX code.

Listing B.8: Sample LATEX code for making typical table environment

```
1   \begin{center}
2   {\scriptsize
3   \begin{tabularx}{\textwidth}{p{0.1\textwidth}|p{0.2\textwidth}|p{0.5\
        textwidth}}
4   \caption{Feasible triples for highly variable grid} \label{tab:triple_
        grid} \\
5   \hline
6   \hline
7   \textbf{Time (s)} &
8   \textbf{Triple chosen} &
9   \textbf{Other feasible triples} \\
10  \hline
11  \endfirsthead
12  \multicolumn{3}{c}%
13  {\textit{Continued from previous page}} \\
14  \hline
15  \hline
16  \textbf{Time (s)} &
17  \textbf{Triple chosen} &
18  \textbf{Other feasible triples} \\
19  \hline
20  \endhead
21  \hline
22  \multicolumn{3}{r}{\textit{Continued on next page}} \\
23  \endfoot
24  \hline
25  \endlastfoot
26  \hline
27
28  0 & (1, 11, 13725) & (1, 12, 10980), (1, 13, 8235), (2, 2, 0), (3, 1, 0)
         \\
29  2745 & (1, 12, 10980) & (1, 13, 8235), (2, 2, 0), (2, 3, 0), (3, 1, 0)
         \\
30  5490 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
31  8235 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
32  10980 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
33  13725 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
34  16470 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
35  19215 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
36  21960 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
37  24705 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
38  27450 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
         0) \\
39  30195 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
40  32940 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
41  35685 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
42  38430 & (1, 13, 10980) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
```

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```
1285   43   41175 & (1, 12, 13725) & (1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1,
1286            0) \\
1287   44   43920 & (1, 13, 10980) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1288   45   46665 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1289   46   49410 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1290   47   52155 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
1291            0) \\
1292   48   54900 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1293   49   57645 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1294   50   60390 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1295   51   63135 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1296   52   65880 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1297   53   68625 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1298   54   71370 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1299   55   74115 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1300   56   76860 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1301   57   79605 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1302   58   82350 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1303   59   85095 & (1, 12, 13725) & (1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1,
1304            0) \\
1305   60   87840 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1306   61   90585 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1307   62   93330 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1308   63   96075 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1309   64   98820 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1310   65   101565 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1311   66   104310 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1312   67   107055 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1313   68   109800 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1314   69   112545 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1315            1, 0) \\
1316   70   115290 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1317   71   118035 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1318   72   120780 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1319   73   123525 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1320   74   126270 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1321            1, 0) \\
1322   75   129015 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1323   76   131760 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1324   77   134505 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1325   78   137250 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1326   79   139995 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1327   80   142740 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1328   81   145485 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1329            1, 0) \\
1330   82   148230 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1331   83   150975 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1332   84   153720 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1333   85   156465 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1334   86   159210 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1335   87   161955 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1336   88   164700 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1337   89   \end{tabularx}
1338   90   }
1339   91   \end{center}
1340
```

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B7 Algorithm or Pseudocode Listing

Table B.2 shows an example pseudocode. Note that if the pseudocode exceeds one page, it
can mean that its implementation is not modular. List. B.9 shows the corresponding LaTeX
code.

TABLE B.2   CALCULATION OF $y = x^n$

Input(s):		
n	:	nth power; $n \in \mathbb{Z}^+$
x	:	base value; $x \in \mathbb{R}^+$
Output(s):		
y	:	result; $y \in \mathbb{R}^+$

Require: $n \geq 0 \vee x \neq 0$
Ensure: $y = x^n$
1: $y \Leftarrow 1$
2: **if** $n < 0$ **then**
3:      $X \Leftarrow 1/x$
4:      $N \Leftarrow -n$
5: **else**
6:      $X \Leftarrow x$
7:      $N \Leftarrow n$
8: **end if**
9: **while** $N \neq 0$ **do**
10:      **if** N is even **then**
11:          $X \Leftarrow X \times X$
12:          $N \Leftarrow N/2$
13:      **else** $\{N$ is odd$\}$
14:          $y \Leftarrow y \times X$
15:          $N \Leftarrow N - 1$
16:      **end if**
17: **end while**

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Listing B.9: Sample LATEX code for algorithm or pseudocode listing usage

```
1   \begin{table}[!htbp]
2       \caption{Calculation of $y = x^n$}
3       \label{tab:calcxn}
4       {\footnotesize
5       \begin{tabular}{lll}
6       \hline
7       \hline
8       {\bfseries Input(s):} & & \\
9       $n$ & : & $n$th power; $n \in \mathbb{Z}^{+}$ \\
10      $x$ & : & base value; $x \in \mathbb{R}^{+}$ \\
11      \hline
12      {\bfseries Output(s):} & & \\
13      $y$ & : & result; $y \in \mathbb{R}^{+}$  \\
14      \hline
15      \hline
16      \\
17      \end{tabular}
18      }
19      \begin{algorithmic}[1]
20      {\footnotesize
21          \REQUIRE $n \geq 0 \vee x \neq 0$
22          \ENSURE $y = x^n$
23          \STATE $y \Leftarrow 1$
24          \IF{$n < 0$}
25              \STATE $X \Leftarrow 1 / x$
26              \STATE $N \Leftarrow -n$
27          \ELSE
28              \STATE $X \Leftarrow x$
29              \STATE $N \Leftarrow n$
30          \ENDIF
31          \WHILE{$N \neq 0$}
32              \IF{$N$ is even}
33                  \STATE $X \Leftarrow X \times X$
34                  \STATE $N \Leftarrow N / 2$
35              \ELSE[$N$ is odd]
36                  \STATE $y \Leftarrow y \times X$
37                  \STATE $N \Leftarrow N - 1$
38              \ENDIF
39          \ENDWHILE
40      }
41      \end{algorithmic}
42  \end{table}
```

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1345

B8 Program/Code Listing

1346
1347

List. B.10 is a program listing of a C code for computing Fibonacci numbers by calling the actual code. Please see the `code` subdirectory.

Listing B.10: Computing Fibonacci numbers in C (./code/fibo.c)

```
1   /* fibo.c -- It prints out the first N Fibonacci
2    *           numbers.
3    */
4
5   #include <stdio.h>
6
7   int main(void) {
8       int n;        /* Number of fibonacci numbers we will print */
9       int i;        /* Index of fibonacci number to be printed next */
10      int current;  /* Value of the (i)th fibonacci number */
11      int next;     /* Value of the (i+1)th fibonacci number */
12      int twoaway;  /* Value of the (i+2)th fibonacci number */
13
14      printf("How many Fibonacci numbers do you want to compute? ");
15      scanf("%d", &n);
16      if (n<=0)
17          printf("The number should be positive.\n");
18      else {
19          printf("\n\n\tI \t Fibonacci(I) \n\t====================\n");
20          next = current = 1;
21          for (i=1; i<=n; i++) {
22      printf("\t%d \t   %d\n", i, current);
23      twoaway = current+next;
24      current = next;
25      next    = twoaway;
26          }
27      }
28  }
29
30  /* The output from a run of this program was:
31
32  How many Fibonacci numbers do you want to compute? 9
33
34      I   Fibonacci(I)
35      ====================
36      1       1
37      2       1
38      3       2
39      4       3
40      5       5
41      6       8
42      7       13
43      8       21
44      9       34
45
46  */
```

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1348   List. B.11 shows the corresponding LaTeX code.

Listing B.11: Sample LaTeX code for program listing

```
1  List.~\ref{lst:fib_c} is a program listing of a C code for computing
      Fibonacci numbers by calling the actual code. Please see the \verb|
      code | subdirectory.
```

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B9   Referencing

Referencing chapters: This appendix is in Appendix B, which is about examples in using various LaTeX commands.

Referencing sections: This section is Sec. B9, which shows how to refer to the locations of various labels that have been placed in the LaTeX files. List. B.12 shows the corresponding LaTeX code.

Listing B.12: Sample LaTeX code for referencing sections

```
Referencing sections: This section is Sec.~\ref{sec:ref}, which shows
    how to refer to the locations of various labels that have been
    placed in the \LaTeX \ files. List.~\ref{lst:refsec} shows the
    corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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B9.1 A subsection

Referencing subsections: This section is Sec. B9.1, which shows how to refer to a subsection. List. B.13 shows the corresponding LaTeX code.

Listing B.13: Sample LaTeX code for referencing subsections

```
Referencing subsections: This section is Sec.~\ref{sec:subsec}, which
    shows how to refer to a subsection. List.~\ref{lst:refsub} shows the
    corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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B9.1.1 A sub-subsection

Referencing sub-subsections: This section is Sec. B9.1.1, which shows how to refer to a sub-subsection. List. B.14 shows the corresponding LaTeX code.

Listing B.14: Sample LaTeX code for referencing sub-subsections

```
1  Referencing sub-subsections: This section is Sec.~\ref{sec:subsubsec},
        which shows how to refer to a sub-subsection. List.~\ref{lst:
        refsubsub} shows the corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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B10 Index

For key words or topics that are expected (or the user would like) to appear in the Index, use `index{key}`, where `key` is an example keyword to appear in the Index. For example, Fredholm integral and Fourier operator of the following paragraph are in the Index.

If we make a very large matrix with complex exponentials in the rows (i.e., cosine real parts and sine imaginary parts), and increase the resolution without bound, we approach the kernel of the Fredholm integral equation of the 2nd kind, namely the Fourier operator that defines the continuous Fourier transform.

List. B.15 is a program listing of the above-mentioned paragraph.

Listing B.15: Sample LATEX code for Index usage

```
1  If we make a very large matrix with complex exponentials in the rows (i.
      e., cosine real parts and sine imaginary parts), and increase the
      resolution without bound, we approach the kernel of the \index{
      Fredholm integral} Fredholm integral equation of the 2nd kind,
      namely the \index{Fourier} Fourier operator that defines the
      continuous Fourier transform.
```

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B11   Adding Relevant PDF Pages (e.g. Standards, Datasheets, Specification Sheets, Application Notes, etc.)

Selected PDF pages can be added (see List. B.16), but note that the options must be tweaked. See the manual of `pdfpages` for other options.

Listing B.16: Sample LaTeX code for including PDF pages

```
1  \includepdf[pages={8-10},%
2  offset=3.5mm -10mm,%
3  scale=0.73,%
4  frame]
5  {./reference/Xilinx2015-UltraScaleArchitectureOverview.pdf}
```

Virtex UltraScale FPGA Feature Summary

Table 6: **Virtex UltraScale FPGA Feature Summary**

	VU065	VU080	VU095	VU125	VU160	VU190	VU440
Logic Cells	626,640	780,000	940,800	1,253,280	1,621,200	1,879,920	4,432,680
CLB Flip-Flops	716,160	891,424	1,075,200	1,432,320	1,852,800	2,148,480	5,065,920
CLB LUTs	358,080	445,712	537,600	716,160	926,400	1,074,240	2,532,960
Maximum Distributed RAM (Mb)	4.8	3.9	4.8	9.7	12.7	14.5	28.7
Block RAM/FIFO w/ECC (36Kb each)	1,260	1,421	1,728	2,520	3,276	3,780	2,520
Total Block RAM (Mb)	44.3	50.0	60.8	88.6	115.2	132.9	88.6
CMT (1 MMCM, 2 PLLs)	10	16	16	20	30	30	30
I/O DLLs	40	64	64	80	120	120	120
Fractional PLLs	5	8	8	10	15	15	0
Maximum HP I/Os[1]	468	780	780	780	650	650	1,404
Maximum HR I/Os[2]	52	52	52	104	52	52	52
DSP Slices	600	672	768	1,200	1,560	1,800	2,880
System Monitor	1	1	1	2	3	3	3
PCIe Gen3 x8	2	4	4	4	5	6	6
150G Interlaken	3	6	6	6	8	9	0
100G Ethernet	3	4	4	6	9	9	3
GTH 16.3Gb/s Transceivers	20	32	32	40	52	60	48
GTY 30.5Gb/s Transceivers	20	32	32	40	52	60	0

Notes:
1. HP = High-performance I/O with support for I/O voltage from 1.0V to 1.8V.
2. HR = High-range I/O with support for I/O voltage from 1.2V to 3.3V.

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Virtex UltraScale Device-Package Combinations and Maximum I/Os

Table 7: **Virtex UltraScale Device-Package Combinations and Maximum I/Os**

Package[1][2][3]	Package Dimensions (mm)	VU065 HR, HP GTH, GTY	VU080 HR, HP GTH, GTY	VU095 HR, HP GTH, GTY	VU125 HR, HP GTH, GTY	VU160 HR, HP GTH, GTY	VU190 HR, HP GTH, GTY	VU440 HR, HP GTH, GTY
FFVC1517	40x40	52, 468 20, 20	52, 468 20, 20	52, 468 20, 20				
FFVD1517	40x40		52, 286 32, 32	52, 286 32, 32				
FLVD1517	40x40				52, 286 40, 32			
FFVB1760	42.5x42.5		52, 650 32, 16	52, 650 32, 16				
FLVB1760	42.5x42.5				52, 650 36, 16			
FFVA2104	47.5x47.5		52, 780 28, 24	52, 780 28, 24				
FLVA2104	47.5x47.5				52, 780 28, 24			
FFVB2104	47.5x47.5		52, 650 32, 32	52, 650 32, 32				
FLVB2104	47.5x47.5				52, 650 40, 36			
FLGB2104	47.5x47.5					52, 650 40, 36	52, 650 40, 36	
FFVC2104	47.5x47.5			52, 364 32, 32				
FLVC2104	47.5x47.5				52, 364 40, 40			
FLGC2104	47.5x47.5					52, 364 52, 52	52, 364 52, 52	
FLGB2377	50x50							52, 1248 36, 0
FLGA2577	52.5x52.5						0, 448 60, 60	
FLGA2892	55x55							52, 1404 48, 0

Notes:

1. Go to Ordering Information for package designation details.
2. All packages have 1.0mm ball pitch.
3. Packages with the same last letter and number sequence, e.g., A2104, are footprint compatible with all other UltraScale architecture-based devices with the same sequence. The footprint compatible devices within this family are outlined. See the UltraScale Architecture Product Selection Guide for details on inter-family migration.

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UltraScale Architecture and Product Overview

Virtex UltraScale+ FPGA Feature Summary

Table 8: **Virtex UltraScale+ FPGA Feature Summary**

	VU3P	VU5P	VU7P	VU9P	VU11P	VU13P
Logic Cells	689,640	1,051,010	1,379,280	2,068,920	2,147,040	2,862,720
CLB Flip-Flops	788,160	1,201,154	1,576,320	2,364,480	2,453,760	3,271,680
CLB LUTs	394,080	600,577	788,160	1,182,240	1,226,880	1,635,840
Max. Distributed RAM (Mb)	12.0	18.3	24.1	36.1	34.8	46.4
Block RAM/FIFO w/ECC (36Kb each)	720	1,024	1,440	2,160	2,016	2,688
Block RAM (Mb)	25.3	36.0	50.6	75.9	70.9	94.5
UltraRAM Blocks	320	470	640	960	1,152	1,536
UltraRAM (Mb)	90.0	132.2	180.0	270.0	324.0	432.0
CMTs (1 MMCM and 2 PLLs)	10	20	20	30	12	16
Max. HP I/O[1]	520	832	832	832	624	832
DSP Slices	2,280	3,474	4,560	6,840	8,928	11,904
System Monitor	1	2	2	3	3	4
GTY Transceivers 32.75Gb/s	40	80	80	120	96	128
PCIe Gen3 x16 and Gen4 x8	2	4	4	6	3	4
150G Interlaken	3	4	6	9	9	12
100G Ethernet w/RS-FEC	3	4	6	9	6	8

Notes:
1. HP = High-performance I/O with support for I/O voltage from 1.0V to 1.8V.

Virtex UltraScale+ Device-Package Combinations and Maximum I/Os

Table 9: **Virtex UltraScale+ Device-Package Combinations and Maximum I/Os**

Package [1][2][3]	Package Dimensions (mm)	VU3P HP, GTY	VU5P HP, GTY	VU7P HP, GTY	VU9P HP, GTY	VU11P HP, GTY	VU13P HP, GTY
FFVC1517	40x40	520, 40					
FLVF1924	45x45					624, 64	
FLVA2104	47.5x47.5		832, 52	832, 52	832, 52		
FHVA2104	52.5x52.5[4]						832, 52
FLVB2104	47.5x47.5		702, 76	702, 76	702, 76	624, 76	
FHVB2104	52.5x52.5[4]						702, 76
FLVC2104	47.5x47.5		416, 80	416, 80	416, 104	416, 96	
FHVC2104	52.5x52.5[4]						416, 104
FLVA2577	52.5x52.5				448, 120	448, 96	448, 128

Notes:
1. Go to Ordering Information for package designation details.
2. All packages have 1.0mm ball pitch.
3. Packages with the same last letter and number sequence, e.g., A2104, are footprint compatible with all other UltraScale devices with the same sequence. The footprint compatible devices within this family are outlined.
4. These 52.5x52.5mm overhang packages have the same PCB ball footprint as the corresponding 47.5x47.5mm packages (i.e., the same last letter and number sequence) and are footprint compatible.

Appendix C
PUBLICATION LIST AND AWARD

Journal

1. …

2. …

Conference

1. …

2. …

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1413 **Others**

1414   1. . . .

1415   2. . . .

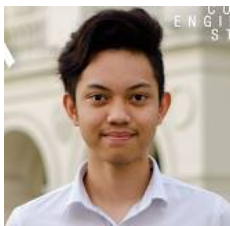1416 **Award**

1417   1. . . .

1418   2. . . .

Appendix D
VITA

Zion Eric O. Chan is currently taking up his B.Sc. Computer Engineering studies and is in his 3rd academic year. He has made various projects consisting of software and hardware and the combination of both such as a line following robot and a sensor robot during his stay in the university. He is interested in the software side of the Computer Engineering program rather than the hardware side.

Glenn Rommel Comendador is currently taking up his B.Sc. Computer Engineering studies and is in his 3rd academic year. He has also completed several projects such as the Batbot, the FM Radio, and the Line Following Robot. He is currently studying Data Communications, Digital Systems Design, Computer Systems Architecture and Microprocessor Systems in De La Salle University. He is more interested in the hardware side of the Computer Engineering Program since he loves to build and design electronics rather than programming.

Mac Excel Fallar is currently taking up his B.Sc. Computer Engineering studies and is in his 3rd academic year. He has completed multiple projects, mostly hardware and software offered in his course, during his stay in the University. He is proficient in Programming with the languages, C#, C++, and Java. Created a cloud

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database application for android mobile phones called Tap President, and helped create A line following robot, and a sensor robot.

Laureen Audrey R. Garcia is currently taking up her B.Sc. Computer Engineering studies and is in her 3rd academic year. She has completed various software and hardware related courses such as Switching Devices, Signal Processing, Advanced Electronics, and Principles of Communication. Her interest in engineering is more inclined to the study of Embedded and Real-Time Systems and Computer Hardware Architecture.

He is currently taking up his B.Sc. Computer Engineering studies at the De la Salle University Manila and is now a 3rd year student. He has developed different skills and acquired knowledge in the field of computer engineering. He already completed some of his software and hardware courses which enabled him to create an android application, a line following mobot and a distance sensor mobot. His research interests focuses more on the hardware side, embedded system, microcontroller, microprocessor and computer system architecture.

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INDEX