PURDUE
UNIVERSITY

School of Electrical and Computer Engineering

Thesis Format

A Style and Notation Guide for the
Preparation of Graduate Theses

July 2003

PURPOSE OF THIS GUIDE

As a graduate student, you should realize that your accepted thesis is a published document, and Purdue University is the publisher. A copy of your thesis will be archived in the Purdue library and another will be recorded by University Microfilm International who will also enter the abstract into a database. As such, your thesis must comply with certain formatting specifications in order to be processed through this system.

The preparation of an acceptable manuscript for publication must also conform to some set of rules and guidelines, usually specific to an individual's field of study. Adherence to such a set of guidelines is a necessary prerequisite to the typical review or analysis that leads to publication or public display. Following such a set of guidelines in the preparation of a thesis document, therefore, is an important learning experience that helps prepare the graduate student to participate more fully in professional activities. A thesis may be your first encounter with such prescriptive (and occasionally restrictive) rules. It is important to learn at the outset of one's career that consistency, accuracy, and adherence to the rules is a requirement for any publishable manuscript or other intellectual product that will be on public display.

Purdue's graduate faculty has authorized the Theses and Publication Committee to develop style and appearance requirements for all theses submitted to the University as part of the requirements for an advanced degree. These requirements are set forth in the "Graduate School Manual for the Preparation of Graduate Theses" which is available in the ECE graduate office. You will find a degree of flexibility in the format specifications for a thesis because academic disciplines have different stylistic requirements and formatting conventions. Thus, having one set of format requirements is impractical. Instead, each home department or discipline has the responsibility for providing many of the details of the appearance and format of your thesis.

The purpose of this guide is to provide the specifications for a thesis prepared through the School of Electrical and Computer Engineering, which were derived from the IEEE Transactions Guide for Authors. These specifications were adopted by the ECE Graduate Committee at its meetings on 3/30/94 and 9/16/94. The Thesis Format Advisor for ECE is responsible for inspecting your thesis to assure that it conforms with the specifications. You should consult the information on "Thesis Preparation and Distribution" available from the ECE Graduate Office for the name of the Thesis Format Advisor and further details on the approval process, including applicable deadlines. If there is any dispute over these specifications between you, your Major Professor, and the ECE Thesis Format Advisor, the matter will be referred to the ECE Graduate Coordinator for a final decision.

format: *the shape, size, and general makeup of a publication*

Processing of your thesis by the University will define several aspects of the format The following is a list of items the University will check on the deposit copy...

1. Paper size, weight, and rag content. (8 1/2 x 11, white, 20 lb, 100% rag)
2. Typeface* consistency and minimum point size (10 pt minimum)
3. Line spacing (4 lines/inch = 1 1/2 space = 18 pt vertical space)
4. Margins (Left - 1.5 in, Right - 1.0 in, Top - 1.0 in, Bottom - 1.25 in)
5. Page numbering (all pages numbered consecutively and in a consistent position)
6. Title page elements and layout
7. Abstract elements, structure and length

Detailed information about these specifications are provided in the "Manual for the Preparation of Graduate Theses" available in the ECE graduate office.

* A typeface is a set of all the type styles with the same name, e.g. Times is a typeface which includes Times Regular, Times Italic, and Times Bold.
A set of all the characters in a particular type style is called a font, e.g. Times Bold

style: *the custom or plan followed in spelling, capitalization, punctuation, and typographic arrangement and display*

The individual schools can define the following...

1. The position and convention of page numbers.
2 The typeface, font, and point size to be used in the body text.
3. The font, point size, positioning, numbering and referencing of equations.
4. Units and abbreviations
5. The convention for numbering, capitalizing, emboldening, and positioning chapter headings, sections and subsections.
6. The convention for paragraph indentation under various conditions.
7. The layout and numbering of figures and tables and their captions.
8. The convention for footnotes and other notes.
9. The notation convention for references
10. The layout of the table of contents and list of figures.

Specifications and examples of these items for a thesis prepared in Electrical and Computer Engineering are shown in the pages that follow.

1. The position and convention of page numbers.

Typeface:	Times
Font:	Times Regular
Point Size:	12

Page numbers should be right justified above the body of the text with the top of the characters one half inch from the top edge of the page.

All pages except the title page must be numbered, including text, references, and appendices.

Note that cover pages for sections, including those for the bibliography, references, vita, and appendices should not be numbered. They are centered on a page by themselves and should be neither numbered or counted.

The preliminary pages are numbers consecutively in lower case Roman numerals. The title page is considered page i, but the numeral should not appear on that page.

Example:

ii

Pages in the text should be numbered consecutively in Arabic numerals in the font Times Regular.

Example:

42

2. The typeface, font, and point size to be used in the body text.

Typeface:	Times
Font:	Times Regular
Point Size:	12

Example:

This is Times Regular body text in point size 12. This is more Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is more Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12. This is Times Regular body text in point size 12.

Note:

You should avoid excessive use of emphasis in your thesis, however you may use *Times Italic*, **Times Bold**, and underlining in body text for emphasis as appropriate.

3. The font, point size, positioning, numbering and referencing of equations.

Typeface:	Times
Text font:	Times Italic 12 point
Number font:	Times Regular 12 point
Positioning:	Centered
Numbering:	Sequential by chapter and number, right justified
Referencing:	In text, citation of equations should be enclosed in parentheses (1.1)

Example:

$$X^{jmo} = \prod_{n=0}^{n-1} e^{2}(\square) \tag{1.1}$$

Notes:

• All equations need not be numbered. This is at the discretion of the author and their advisors.

• It is important to distinguish clearly between the following terms.

a) Capital and lowercase letters when used as symbols.

b) Zero and the letter "O"

c) The lowercase letter "l," the numeral one, and the prime sign.

d) The letter "k" and kappa, "u" and mu, "v" and nu, "n" and eta.

• Avoid ambiguities in equations and fractions in text through careful use of parentheses, brackets, solidi (slants), etc. The convention order of brackets is {[( )]}.

• Separate numbers of more than four digits into groups of three on either side of the decimal point, separated by a space. If the magnitude of a number is less than one, the decimal sign should be preceded by a zero.

Examples:

12 531 7465 9.2163 0.102 834

• Use the multi dot rather than the multi × when multiplying by powers of ten in equations or text.

Example:

$$5.4 \bullet 10^{-4}$$

4. Units and Abbreviations

The International System of Units (SI units) should be used in the thesis. Refer to units listed in Appendix I of this guide for information on preferred usage of units, conversion factors, etc.

Unit symbols should be used with measured quantities, i.e. 1mm, but unit names are used in text without quantities, i.e. "a few millimeters."

If quantities must be expressed in English units, the SI equivalents should be given also in parentheses, i.e., a distance of 4.7 in (12 cm).

Most acronyms and abbreviations should be defined the first time they are used in text. A list of acronyms and abbreviations, including a list of those that need not be defined, is given in Appendix II of this guide.

5. The convention for numbering, capitalizing, emboldening, and positioning chapter headings, sections and subsections.

1. CHAPTER TITLES SHOULD BE CENTERED TIMES BOLD 14 POINT

Notes:

- Chapter Titles should begin 2 inches from the top edge of the sheet of paper.
- The numbering for chapters should be in Arabic numerals
- Text in the chapter titles should be in upper case.

1.1 Secondary Headings Should be Flush Left 12 Point Bold

Notes:

- The numbering for sections should be in Arabic numerals
- The first letter in each word of the secondary heading should be capitalized.

1.1.1 Third level headings should be flush left 12 point bold

Notes:

- The numbering for sections should be in Arabic numerals
- Only the first letter of the first word of the third level heading should be capitalized.

6. The convention for paragraph indentation under various conditions.

All paragraphs throughout the thesis should be indented at the beginning of the paragraph by a consistent amount. All paragraphs should be indented at the beginning of the paragraph by a consistent amount throughout the thesis. All paragraphs should be indented at the beginning of the paragraph by a consistent amount. All paragraphs should be indented at the beginning of the paragraph by a consistent amount.

All paragraphs should be indented at the beginning of the paragraph by a consistent amount. All paragraphs should be indented at the beginning of the paragraph by a consistent amount throughout the thesis. All paragraphs throughout the thesis should be indented at the beginning of the paragraph by a consistent amount. All paragraphs should be indented at the beginning of the paragraph by a consistent amount.

7. The layout and numbering of figures and tables and their captions.

Figures should be centered between the left and right margin with their captions centered below the figure in point size 12 Times Regular single spaced. Figures should be consecutively numbered per chapter. In the caption, the word Figure should be abbreviated as "Fig.".

Example:

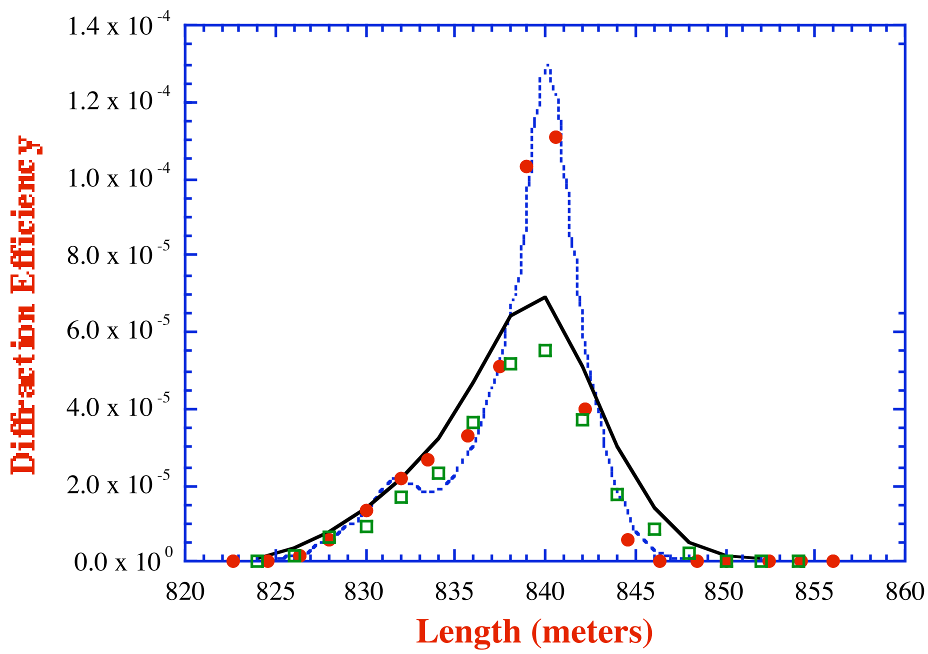

Fig. 1.1. The text for a figure should be point size 12 Times Regular single spaced, with all lines in the caption centered.

Note:
Line drawings in India ink on drafting film or paper are acceptable, as are high quality computer generated illustrations. Dot matrix graphs and printouts are not acceptable.

Tables should be centered between the left and right margin with their captions centered above the table. Tables should be consecutively numbered per chapter. The word Table should be spelled out (not abbreviated) on a line by itself with the table number, and the text of the caption should be centered in point size 12 Times Regular single spaced.

Example:

Table 1.1
The caption should come before the table.

	A	B	C
1.1	2.2	3.3	4.5
X	Z	Z	□

8. The convention for footnotes and other notes

Footnotes[1] should be left justified in point size 10 Times Regular at the bottom of the page they appear on. They should be consecutively numbered and indicated in the text by a superscripted Arabic numeral. They may be single spaced.

Other notes should be handled as indicated in the Purdue Format in Chapter Six of the Graduate Thesis Manual.

[1] Footnotes should be left justified in point size 10 Times Regular at the bottom of the page they appear on. They should be consecutively numbered and indicated in the text by superscripted Arabic numerals.

9. The notation convention for references

Typeface:	Times
Fonts:	Times Regular and Times Italic
Point Size:	12
Line Spacing:	Single spaced Use a blank line between references.

A numbered list of references must be provided a the end of the thesis, before any appendices. The list should be numbered in the order of citation in the text, not in alphabetical order. List only one reference per reference number.

Each reference number should be enclosed in square brackets. In text, citation of references may be given simply as "in [1]..."; rather than "in reference [1]...". Similarly, it is not necessary to mention the author of a reference unless the it is relevant to the text.

Be careful to use accepted abbreviations for names of journals. Avoid abbreviating names of conferences. Use the same abbreviation for a given item throughout the reference list.

Footnotes or other words and phrases that are not part of the reference format do not belong on the reference list.

Sample correct formats for various types of references are on the page that follows.

Books:

[1] O.T. Zimmerman and I. Lavine, *Conversion Factors and Tables*. Dover, NH: Industrial Research Service, 1961.

[2] G. O. Young, “Synthetic structure of industrial plastics,” in *Plastics,* vol. 3, *Polymers of Hexadromicon,* J. Peters, Ed. 2nd ed. New York: McGraw-Hill, 1964, p.15-64.

Periodicals:

[3] M. A. McHenry and D.C. Chang,“Coupled-mode theory of two non-paralleldielectric waveguides,” *IEEE Trans. Microwave Theory Tech.,* vol. MTT-32, pp. 1469-1475, Nov. 1984.

Articles from published conference proceedings:

[4] M. A. Nichols, H .J. Siegel, H .G. Dietz, R. W. Quong, and W. G. Nation, “Minimizing memory requirements for partitionable SIMD/SPMD machines,” in *1990 International Conference on Parallel Processing,* Vol. I, Aug. 1990, pp. 84-91.

Papers presented at conferences (unpublished):

[5] D. Ebehard and E. Voges, “Digital single sideband detection for interferometric sensors,” presented at 2nd Int. Conf. Optical Fiber Sensors, Stuttgart, F.R.G. 1984.

Technical Reports:

[6] E. E. Reber, R. L. Mitchell, and C. J. Carter, “Oxygen absorption in the earth's atmosphere,” Aerospace Corp., Los Angeles, CA, Tech. Rep. TR-0200 (4230-46)-3, Nov. 1968.

Theses:

[7] W. G. Nation, *The Network Interface Unit: An Enhancement to the PASM Parallel Processing System,* Master's Thesis, School of Electrical Engineering, Purdue University, 1986.

10. The layout of the table of contents and list of figures

All preliminary material...

- Title page
- Dedication page *(optional)*
- Acknowledgment page *(optional)*
- Preface *(optional)*
- Table of Contents
- List of Tables
- List of Figures
- List of Symbols, Abbreviations, Nomenclature, or Glossary *(optional)*
- Abstract

...should follow the Purdue Format outlined in Chapter Six of the Graduate Theses Manual.

FINAL NOTE:

- Other issues of format and style not covered in this document should also follow the conventions outlined in chapter six of the Graduate Theses Manual.

APPENDIX I
TABLE OF UNITS AND QUANTITY SYMBOLS

NOTE: Asterisks (*) indicate SI units, preferred multiples of SI units, or other units acceptable for use with SI.

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*ampere	A	amp, a	SI unit of electric current, magnetic (scalar) potential, magnetomotive force.	I U F
ampere-hour	Ah, A · h	amp-hr	Quantity of electricity. 1 Ah = $3.6 \cdot 10^3$ C.	
*ampere-turn	A	At	SI unit of magnetomotive force.	F
*ampere per meter	A/m		SI unit of linear current density, magnetic field strength (note: interpret as ampere turns per meter).	A H
*ampere per square meter	A/m^2		SI unit of current density.	J
*ampere meter squared	$A \cdot m^2$		SI unit of magnetic (area) moment.	m
angstrom	Å	A°, A	Wavelength. Use not recommended. 1 Å = 10^{-10} m.	
atmosphere, standard	atm		Pressure. Use not recommended. 1 atm = 14.7 lb/in^2 = $1.013 \cdot 10^5$ Pa.	
atmosphere, technical	at		Use not recommended. 1 at = 1 kgf/cm^2.	
*atomic mass unit (unified)	u		Atomic mass. The (unified) atomic mass unit is defined as one twelfth of the mass of an atom of the ^{12}C nuclide. Use of the old atomic mass (amu), defined by reference to oxygen, is not recommended.	
*atto	a		SI prefix for 10^{-18}.	
*attoampere	aA		See: ampere.	
*attofarad	aF		See: farad.	
bar	bar	b, barye	Pressure. 1 bar = 10^5 Pa. Use of the bar is strongly discouraged except for limited use in meteorology.	
barn	b		Nuclear capture cross section. In temporary use with SI. 1 b = 10^{-28} m^2.	
barrel	bbl		Volume. 1 bbl = 42 gal_{US} = $1.5899 \cdot 10^{-1}$ m^3.	
barrel per day	bbl/d		Standard barrel used for petroleum, etc. A different standard barrel is used for fruits, vegetables, and dry commodities.	
baud	Bd	baud (w/ prefix)	In telecommunications, a unit of signaling speed equal to one element per second. The signaling speed in bauds is equal to the reciprocal of the signal element length in seconds.	$1/\tau$
bel	B	b	Ratio of power. Rarely used. 1 B = 10 dB. See decibel and Appendix B of ANSI-IEEE Std 260-1978 for further guidance concerning notation.	
*becquerel	Bq		SI unit of activity of a radionuclide.	
billion electronvolts	GeV	bev, BeV	Energy of accelerated particles. The name *gigaelectronvolt* is preferred for this unit.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
bit	b	bit	In information theory, the bit is a unit of information content equal to the information content of a message, the *a priori* probability of which is one half. In computer science, the bit is a unit of storage capacity. The capacity, in bits, of a storage device is the logarithm to the base two of the number of possible states of the device.	
bit per second	b/s	bit/s, bits/s, bps, bit/sec		
British thermal unit	Btu		Heat, energy. Use of the joule (SI) is preferred. Conversion factors vary with usage. Consult ANSI/IEEE Std 268-1982.	
byte	byte		A group of bits or adjacent binary digits that a computer processes as a unit.	
calorie (International Table calorie)	cal_{IT}		Heat. Use not recommended. 1 cal_{IT} = $4.1868 \cdot 10^3$ J.	
calorie (thermochemical calorie)	cal		Heat. Use not recommended. 1 cal = $4.1840 \cdot 10^3$ J.	
*candela	cd		SI unit of luminous intensity.	I
candela per square foot	cd/ft^2		Luminance. Use of the SI unit cd/m^2 is preferred.	L
candela per square inch	cd/in^2		Luminance. Use of the SI unit cd/m^2 is preferred. 1 $cd/in^2 = 1.55 \cdot 10^3$ cd/m^2.	
*candela per square meter	cd/m^2	nit	SI unit of luminance.	L
candle	cd		The unit of luminous intensity has been given the name *candela*. Use of the name *candle* for this unit is not recommended.	
*centi	c (prefix)		SI prefix for 10^{-2}.	
*centimeter	cm		Length. (Preferred SI unit multiple.)	
*circular mil	cmil		Area (cross section of wire). 1 cmil = $(\pi/4) \cdot 10^{-6}$ $in^2 = 5.067 \cdot 10^{-10}$ m^2.	
*coulomb	C	c	SI unit of electric charge, quantity of electricity, electric flux. 1 C = 1 A·s.	Q, Ψ
*coulomb per meter	C/m		Linear density of charge (SI).	λ
*coulomb meter	C · m		SI unit of electric dipole moment.	p
*coulomb per square meter	C/m^2		SI unit of electrical flux density.	D
*coulomb per cubic meter	C/m^3		SI unit of volume density of charge.	ϱ
*cubic centimeter	cm^3	cc	Volume. (Preferred SI unit multiple.)	
cubic foot	ft^3		Volume. 1 ft^3 = $2.832 \cdot 10^{-2}$ m^3.	
cubic foot per minute	ft^3/min	cfm	Flow rate. 1 ft^3/min = $4.719 \cdot 10^{-4}$ m^3/s.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
cubic foot per second	ft^3/s		Flow rate. 1 $ft^3/s = 2.832 \cdot 10^{-2}\ m^3/s$.	
cubic inch	in^3		Volume. Section modulus. 1 $in^3 = 1.639 \cdot 10^{-5}\ m^3$.	
*cubic meter	m^3		SI unit of volume.	
*cubic meter per second	m^3/s		SI unit of flow rate.	
cubic yard	yd^3		1 $yd^3 = 0.7646\ m^3$.	
curie	Ci	C	A unit of activity of radionuclide. Use of the SI unit, the becquerel, is preferred. 1 Ci = $3.7 \cdot 10^{10}$ Bq.	
cycle per second	Hz	c/s, cps, c/sec, cycle	Frequency. See: hertz. The name *hertz* is internationally accepted for this unit; the symbol Hz is used instead of c/s.	
day	d		1 day = 24 h = 86 400 s.	
deci	d (prefix)		SI prefix for 10^{-1}.	
decibel	dB	db, DB	Noise intensity, gain, power. See Appendix A of ANSI/IEEE Std 260-1978 for further guidance concerning notation.	
decibel referred to 1 mW	dB (1 mW)	dBm	See Appendix A of ANSI/IEEE Std 260-1978 for further guidance concerning notation.	
degree	...°	deg	Plane angle.	
degree Celsius	°C	degree centigrade	SI unit of Celsius temperature. The degree Celsius is a special name for the kelvin, for use in expressing Celsius temperatures or temperature intervals. $T_K = t_{°C} + 273.15$.	t
degree Fahrenheit	°F		Temperature. $T_K = (t_{°F} + 459.67)/1.8$. $t_{°C} = (t_{°F} - 32)/1.8$.	
degree Kelvin			See: kelvin.	
degree Rankine	°R		Use discouraged. $T_K = T_{°R}/1.8$.	
deka	da (prefix)		SI prefix for 10.	
dyne	dyn	dyne	Force. Use not recommended. 1 dyn $= 10^{-5}$ N.	F
*electronvolt	eV	ev	Energy (nuclear physics). 1 eV = $1.602 \cdot 10^{-19}$ J.	
erg	erg		Work, energy. Use not recommended. 1 erg $= 10^{-7}$ J.	
exa	E (prefix)		SI prefix for 10^{18}.	
*farad	F	f, fd	SI unit of capacitance. 1 F = 1 C/V.	C
*farad per meter	F/m		SI unit of capacitivity, permittivity.	ϵ

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*farad, reciprocal	F^{-1}	daraf	Unit of elastance (SI).	S
*femto	f (prefix)		SI prefix for 10^{-15}.	
foot	ft		Length. 1 ft = 0.3048 m.	
foot per minute	ft/min	fpm	Velocity. 1 ft/min = $5.080 \cdot 10^{-3}$ m/s.	
foot per second	ft/s	fps, ft/sec	Velocity. 1 ft/s = 0.3048 m/s.	
foot-pound	ft · lb		A unit of work equal to the work done by a force of one pound acting through a distance of one foot in the direction of the force.	
foot pound-force	ft · lbf		Use joules. 1 ft · lbf = 1.356 J.	
foot poundal (OBSOLETE)	ft · pdl		An absolute unit of work equal to the work done by a force of one poundal acting through a distance of one foot in the direction of the force. Note: No longer used. 1 ft · pdl = $4.214 \cdot 10^{-2}$ J.	
footcandle	fc		Illumination. 1 fc = 1 lm/ft^2. The name *lumen per square foot* is also used for this unit. Use of the SI unit of illuminance, the lux (lumen per square meter), is preferred. 1 fc = 10.764 lx.	
footlambert	fL		Brightness (luminance). 1 fL = $(1/\pi)$ cd/ft^2. One lumen per square foot leaves a surface whose luminance is one footlambert in all directions within a hemisphere. Use of the SI unit, the candela per square meter, is preferred. 1 fL = 3.426 cd/m^2.	
gee	g	G	Acceleration of gravity. Standard acceleration of free fall. Use m/s^2. 1 g = 9.807 m/s^2.	
gal	Gal		Use strongly discouraged. The gal is used only for the quantity g. 1 Gal = 1 cm/s^2 = 10^{-2} m/s^2.	
gallon	gal		Volume. Use not recommended. 1 gal_{US} = 231 in^3 = 3.7854 L. 1 gal_{UK} = 4.5461 L.	
gauss	G		Electromagnetic CGS unit of magnetic flux density. Use not recommended. Use tesla. 1 G = 10^{-4} T.	B
*giga	G (prefix)	kM	SI prefix for 10^9.	
*gigabit	Gb		See: bit.	
gigacycle per second	GHz	kMC, Gc/s	Frequency. See: hertz, gigahertz.	f, ν
*gigaelectronvolt	GeV	bev, BeV	Energy. See: electronvolt.	
*gigahertz	GHz	kMHz, KMC, Gc/s	Frequency. (Preferred SI unit multiple.)	f, ν

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
gilbert	Gb		Electromagnetic CGS unit of magnetomotive force. Use not recommended. 1 Gb = 0.7958 A.	
*gram	g	gm	Mass. (Preferred SI unit multiple.) 1 g = 10^{-3} kg.	m
*gray	Gy		SI unit of absorbed dose in the field of radiation dosimetry.	
*hecto	h		SI prefix for 10^2.	
*henry (pl. henrys)	H	Hy, hy	SI unit of inductance: (self) inductance, permeance. 1 H = 1 Wb/A.	 L P, P_m
*henry, reciprocal	H^{-1}		Reciprocal inductance (SI). Reluctance (SI).	Γ R, R_m
*henry per meter	H/m		SI unit of (magnetic) permeability, absolute permeability.	μ
*hertz	Hz	cps, c/s, cycle	SI unit of frequency, bandwidth.	f, ν B
horsepower	hp		Power, rate of work. The horsepower is an anachronism in science and technology. Use of the SI unit of power, the watt, is preferred. Conversion factors vary with usage: 1 hp (electric) = $7.46 \cdot 10^2$ W. 1 hp (metric) = $7.35 \cdot 10^2$ W. 1 hp (U.K.) = $7.45 \cdot 10^2$ W.	
*hour	h	hr	Time. 1 h = $3.6 \cdot 10^3$ s.	
inch	in	in.	Length. 1 in = $2.54 \cdot 10^{-2}$ m.	
inch per second	in/s	ips	Velocity. 1 in/s = $2.54 \cdot 10^{-2}$ m/s.	
*joule	J		SI unit of energy, work, quantity of heat.	E, W W Q
*joule per degree Celsius	J/°C		SI unit of heat capacity, thermal capacitance.	C_θ
*joule per kelvin	J/K		SI unit of entropy.	S
kelvin	K		SI unit of temperature. Previous to 1967 called *degree kelvin*. Note no symbol ° appears with K. $t_{°C} = T_K - 273.15$.	
*kilo	k (prefix)		SI prefix for 10^3.	
*kilobit	kb		See: bit.	
*kilobyte	kilobyte		See: byte.	
kilocycle per second	kHz	kc/s, kc	Frequency. Use kilohertz. See: hertz.	
kilomegacycle per second	GHz	KMC, kMc/s	Frequency. Use gigahertz. See: hertz.	
kilogauss	kG		Use not recommended. See: gauss.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*kilogram	kg		SI unit of mass.	
kilogram-force	kgf		Use not recommended. Kilogram is SI unit of mass, newton is SI unit of force. 1 kgf = 9.807 N.	
*kilohertz	kHz		Frequency. (Preferred SI unit multiple.)	
*kilohm	kΩ		Resistance. (Preferred SI unit multiple.)	R
*kilojoule	kJ		See: joule.	
*kilometer	km		Length. (Preferred SI unit multiple.)	
*kilometer per hour	km/h		Velocity.	
*kilotesla	kT		See: tesla.	
*kilovar	kvar		Reactive power. (Preferred SI unit multiple.)	Q
*kilovolt	kV		(Preferred SI unit multiple.) See: volt.	
*kilovoltampere	kVA	KVA, kva	Apparent power. (Preferred SI unit multiple.)	
*kilowatt	kW		(Preferred SI unit multiple.) See: watt.	
kilowatthour	kWh		Temporarily in use with SI as a measure of of electric energy. Widely used, but should eventually be replaced by the megajoule. 1 kWh = 3.6 MJ.	
knot	kn		1 kn = 1 nmi/h = 0.514 m/s. Use not generally recommended.	
lambert	L		CGS unit of luminance. Use not recommended. 1 L = $(1/\pi) \cdot 10^4$ cd/m^2 = 3.183 $\cdot 10^3$ cd/m^2. One lumen per square centimeter leaves a surface whose luminance is one lambert in all directions within a hemisphere.	L
*liter	L	l	Volume. 1 L = 10^{-3} m^3. The letter l has been adopted for *liter* by the CGPM, and it is recommended in a number of international standards. In 1978 the CIPM accepted L as an alternative symbol. Because of frequent confusion with the numeral 1, the letter l is no longer recommended for U.S. use. (Script ℓ also not recommended.)	V, v
liter per second	L/s		Flow rate.	
*lumen	lm		SI unit of luminous flux. 1 lm = 1 cd·sr.	Φ
lumen per square foot	lm/ft^2		Unit of illuminance and also a unit of luminous exitance. Use of the SI unit, lumen per square meter is preferred. 1 lm/ft^2 = 10.764 lm/m^2.	
*lumen per square meter	lm/m^2		SI unit of luminous exitance.	M
*lumen per watt	lm/W		SI unit of spectral luminous efficacy, total luminous efficacy.	$K(\lambda)$ K, K_t

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*lumen second	lm · s		SI unit of quantity of light.	Q
*lux	lx		SI unit of illuminance. 1 lx = 1 lm/m^2.	E
maxwell	Mx		CGS electromagnetic unit of magnetic flux. Use not recommended. 1 Mx = 10^{-8} Wb.	
*mega	M (prefix)		SI prefix for 10^6.	
*megabyte	megabyte		See: byte.	
*megaelectronvolt	MeV		See: electronvolt.	
*megahertz	MHz		Frequency. (Preferred SI unit multiple.) See: hertz.	
*megohm	MΩ	M	(Preferred SI unit multiple.) See: ohm.	
*megavolt	MV		(Preferred SI unit multiple.) See: volt.	
*megawatt	MW		(Preferred SI unit multiple.) See: watt.	
*meter	m		SI unit of length, breadth, height, thickness, radius, diameter, length of path, wavelength.	l b h d, δ r d s λ
*meter, reciprocal	m^{-1}	/m	Wavenumber (SI).	σ (also, $\tilde{\nu}$ in spectroscopy only.)
*square meter	m^2		SI unit of area.	A
*cubic meter	m^3		SI unit of volume.	V, v
*meter per second	m/s		SI unit of velocity.	v
*meter per second squared	m/s^2		SI unit of acceleration.	a, g
*meter to the fourth power	m^4		Second (axial) moment of area (SI). Second (polar) moment of area (SI).	I, I_a J, I_p
*(ion) per cubic meter	m^{-3}	ion/m^3	Ion (number) density (SI).	n^+; n^-
*square meter per volt second	m^2/V · s		Mobility (of a charge carrier in a medium) (SI).	μ
*(electron) per cubic meter second	$m^{-3} \cdot s^{-1}$		Rate of production of electrons per unit volume (SI).	q
*cubic meter per second	m^3/s		Recombination coefficient (SI).	α
metric ton	t		Use not recommended. 1 t = 1000 kg.	
mho	mho	Ω^{-1}	Formerly used as the name of the siemens (S). Still in use in the U.S.	
*micro	μ (prefix)		SI prefix for 10^{-6}.	
micromicro	p (prefix)	μμ	Prefix for 10^{-12}. Do not use. Use pico.	
*microampere	μA		Electric current. See: ampere.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*microfarad	μF		Capacitance. (Preferred SI unit multiple.)	
*microgram	μg		See: gram.	
*microhenry	μH		Self inductance. (Preferred SI unit multiple.)	
microinch	μin		1 μin = $2.54 \cdot 10^{-8}$ m.	
*microliter	μL		See: liter.	
*micrometer	μm	μ	Length. (Preferred SI unit multiple.) 1 μm = 10^{-6} m.	
micron	μm	μ	Use not recommended. Micron = micrometer. Use micrometer. Change μ to μm.	
*microsecond	μs		Time. (Preferred SI unit multiple.)	
*microsiemens	μS		Conductance. (Preferred SI unit multiple.)	
*microwatt	μW		Power. (Preferred SI unit multiple.)	
mil	mil		1 mil = 0.001 in = $2.54 \cdot 10^{-5}$ m.	
mile (nautical)	nmi		1 nmi = $1.852 \cdot 10^{3}$ m.	
mile (statute)	mi (statute)		1 mi = 5280 ft = $1.609 \cdot 10^{3}$ m.	
mile per hour	mi/h	mph	Although use of mph as an abbreviation is common, it should not be used as a unit symbol. 1 mi/h = 0.447 m/s = 1.609 km/h.	
*milli	m (prefix)		SI prefix for 10^{-3}.	
*milliampere	mA		See: ampere.	
millibar	mbar		Use of the bar is strongly discouraged, except for limited use in meteorology. 1 mbar = 100 Pa.	
*milligram	mg		Mass. (Preferred SI unit multiple.)	
*millihenry	mH		Self inductance. (Preferred SI unit multiple.)	
*milliliter	mL		See: liter.	
*millimeter	mm		Length. (Preferred SI unit multiple.)	
millimicron	nm		Use of the name millimicron is not recommended. Use nanometer.	
*millipascal second	mPa · s		Dynamic viscosity. (Preferred SI unit multiple.)	
*millisecond	ms		Time. (Preferred SI unit multiple.)	
*millivolt	mV		(Preferred SI unit multiple.) See: volt.	
*milliwatt	mW		Power. (Preferred SI unit multiple.)	
*minute (plane angle)	...'		Used to measure plane angles in surveys, plans, electrical calculations. Radians are used to measure plane angles in scientific and engineering calculations.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*minute (time)	min		Time. Used to measure work time and in statistics. Note: In engineering measurements and calculations, minutes should be used in time derivative functions only when "second" related quantities (such as "millisecond, microsecond") become impractical. Time may also be designated by means of superscripts as in the following example: $9^h 46^m 30^s$.	
*mole	mol		SI unit of amount of a substance.	
month	mo			
*nano	n (prefix)		SI prefix for 10^{-9}.	
*nanoampere	nA		See: ampere.	
*nanofarad	nF		See: farad.	
*nanometer	nm		Length. (Preferred SI unit multiple.)	
*nanosecond	ns		Time. (Preferred SI unit multiple.)	
*nanowatt	nW		Power. (Preferred SI unit multiple.)	
nat	nat		Natural logarithmic equivalent of the bit.	
nautical mile	nmi		Distance, range. 1 nmi = 1852 m.	
*neper	Np		Natural logarithm of two amounts of power (SI). 1 Np = 8.686 dB.	
*neper per second	Np/s		Damping coefficient (SI).	δ
*neper per meter	Np/m		Attenuation coefficient (SI).	α
*newton	N		SI unit of force. $1\ N = 1\ kg \cdot m/s^2$.	F
*newton meter	N · m		Moment of force (SI). Torque (SI).	M T
*newton per square meter	N/m^2		SI unit of pressure or stress. See: pascal. Young's modulus. Modulus of elasticity. Shear modulus. Bulk modulus.	p, σ, τ E E G K
nit			Luminance. The name *nit* is sometimes given to the SI unit of luminance, the candela per square meter. Use of the *nit* is permitted as a name in text but not as a unit symbol. $1\ nit = 1\ cd/m^2$.	L
oersted	Oe	oe	Electromagnetic CGS unit of magnetic field strength. Use not recommended. 1 Oe = 79.57 A/m.	
*ohm	Ω		SI unit of resistance, impedance, reactance. 1 Ω = 1 V/A.	R Z X

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*ohm meter	Ω · m		SI unit of resistivity.	ϱ
ounce (avoirdupois)	oz		1 oz = 2.835 · 10^{-2} kg.	
*pascal	Pa		SI unit of pressure or stress. 1 Pa = 1 N/m^2.	
*pascal second	Pa · s		SI unit of dynamic viscosity.	
percent	%			
*peta	P (prefix)		SI prefix for 10^{15}.	
*pico	p (prefix)		SI prefix for 10^{-12}.	
*picoampere	pA		See: ampere.	
*picofarad	pF		Capacitance. (Preferred SI unit multiple.)	
*picosecond	ps		Time. (Preferred SI unit multiple.)	
*picowatt	pW		Power. See: watt.	
pint	pt		1 pt (U.K.) = 0.5683 L. 1 pt (U.S. dry) = 0.5506 L. 1 pt (U.S. liquid) = 0.4732 L.	
pound (avoirdupois)	lb		1 lb (av) = 0.4536 kg.	
pound per cubic foot	lb/ft^3		1 lb/ft^3 = 16.018 kg/m^3.	
pound-force	lbf		1 lbf = 4.448 N.	
pound-force foot	lbf · ft		1 lbf·ft = 1.356 N·m.	
pound-force per square foot	lbf/ft^2		1 lbf/ft^2 = 47.88 Pa.	
pound-force per square inch	lbf/in^2	psi	Although use of the abbreviation psi is common, it should not be used as a unit symbol. 1 lbf/in^2 = 6.895 · 10^3 Pa.	
quart	qt		1 qt (U.K.) = 1.1365 L. 1 qt (U.S. dry) = 1.1012 L. 1 qt (U.S. liquid) = 0.9464 L.	
rad	rd		Unit of absorbed dose in the field of radiation dosimetry. Use of the SI unit, the gray, is preferred. 1 rd = 0.01 Gy.	
*radian	rad		SI unit of plane angle.	
*radian per second	rad/s		SI unit of angular frequency, angular velocity.	ω
*radian per second squared	rad/s^2		SI unit of angular acceleration.	α
rem	rem		Unit of dose equivalent in the field of radiation dosimetry. Use of the SI unit, the sievert, is preferred. 1 rem = 0.01 Sv.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
revolution per minute	r/min	rpm	Speed of rotation. Although the use of rpm as an abbreviation is common, it should not be used as a unit symbol.	
revolution per second	r/s	rps	Speed of rotation.	
roentgen	R	r	A unit of exposure in the field of radiation dosimetry. $1\ R = 2.58 \cdot 10^{-4}$ C/kg.	
*second (plane angle)	...″		$1'' = 4.848 \cdot 10^{-6}$ rad.	
*second (time)	s	sec	SI unit of time, period.	*t* *T*
*second, reciprocal	s^{-1}	/s, /sec	Complex (angular) frequency oscillation constant (SI).	*p*
*siemens	S		SI unit of conductance. $1\ S = 1\ \Omega^{-1}$. The name mho has been used for this unit in the U.S.	
*sievert	Sv		SI unit of dose equivalent in the field of radiation dosimetry.	
slug	slug		FPS system unit of mass. Use not recommended. 1 slug = 14.59 kg.	
square foot	ft^2		Area. $1\ ft^2 = 0.0929\ m^2$.	
square inch	in^2		Area. $1\ in^2 = 6.452 \cdot 10^{-4}\ m^2$.	
*square meter	m^2		SI unit of area.	
*square meter per second	m^2/s		Si unit of kinematic viscosity.	
*square millimeter per second	mm^2/s		Kinematic viscosity. (Preferred SI unit multiple.)	
square yard	yd^2		Area. $1\ yd^2 = 0.8361\ m^2$.	
*steradian	sr	sterad	SI unit of solid angle.	
*tera	T (prefix)	t	SI prefix for 10^{12}.	
*tesla	T		SI unit of magnetic flux density (magnetic induction). $1\ T = 1\ N/(A \cdot m) = 1\ Wb/m^2$.	*B*
therm	thm		1 thm = 100 000 Btu. 1 thm (EEC) = $1.0551 \cdot 10^8$ J. 1 thm (U.S.) = $1.0548 \cdot 10^8$ J.	
ton (short)	ton		1 ton = 2000 lb = 907.2 kg.	
ton, metric	t		1 t = 1000 kg. Use of this name in the U.S. is not recommended.	
torr	torr	Torr	1 torr = 1/760 = $1.333 \cdot 10^2$ Pa. Use not recommended.	
*(unified) atomic mass unit	u		See: atomic mass unit, unified.	

UNIT	UNIT SYMBOL	SOMETIMES OCCURS AS: (DO NOT USE)	APPLICATIONS AND NOTES	QUANTITY SYMBOL (FOR USE AS VARIABLES, ETC.)
*var	var	VA reactive	SI unit of reactive power.	Q
*volt	V	v	SI unit of voltage, electromotive force. 1 V = 1 W/A.	V, E
*voltampere	VA	va	SI unit of apparent power.	S
*volt per meter	V/m		SI unit of electric field strength.	E
*watt	W	w	SI unit of power. 1 W = 1 J/s.	P
*watt per meter kelvin	W/(m · K)		SI unit of thermal conductivity.	λ
*watt per steradian	W/sr		SI unit of radiant intensity.	I
*watt per steradian square meter	W/sr · m^2		SI unit of radiance.	L
watthour	Wh		1 Wh = 3600 J.	
*watt per square meter	W/m^2		Poynting vector (SI).	S
*weber	Wb		SI unit of magnetic flux, magnetic flux linkage. 1 Wb = 1 V·s.	Φ, Λ
*weber per meter	Wb/m		SI unit of magnetic vector potential.	A
weight percent	wt%		Concentration.	
yard	yd		1 yd = 0.9144 m.	
year	a		In the English language, generally yr. 1 yr (365 days) = $3.1536 \cdot 10^7$ s.	

APPENDIX II: SOME COMMON ACRONYMS AND ABBREVIATIONS

Asterisks (*) indicate terms which must be defined the first time they are used in text. Other terms listed here may be used without definition.

ac	alternating current
A-D, A/D	analog-to-digital
AF	audio frequency*
AFC	automatic frequency control*
AGC	automatic gain control*
AM	amplitude modulation
APD	avalanche photodiode
AR	antireflection*
ASK	amplitude shift keying
av	average (subscript)*
avg	average (function)
BER	bit error rate*
BPSK	binary phase shift keying
BWO	backward-wave oscillator*
c.c.	complex conjugate (in equations)
CIM	computer integrated manufacturing *
CMOS	complementary metal-oxide-semiconductor
CPM	continuous phase modulation*
CPFSK	continuous phase frequency-shift keying
CPSK	continuous phase shift keying
CPU	central processing unit*
CRT	cathode-ray tube
CT	current transformer*
CV	capacitance-voltage
CW	continuous wave; clockwise *
dc	direct current
DC	directional coupler
DF	direction finder*, degree of freedom*
DFT	discrete Fourier transform*
DMA	direct memory access*
DPCM	differential pulse code modulation*
DPSK	differential phase shift keying*
EDP	electronic data processing
EHF	extremely high frequency*
ELF	extremely low frequency*
EMC	electromagnetic compatibility*
EMF	electromotive force*
EMI	electromagnetic interference*
ems	expected value of mean square
FDM	frequency division multiplexing*
FET	field-effect transistor
FFT	fast Fourier transform*
FM	frequency modulation
FSK	frequency-shift keying*
FWHM	full width at half maximum*
HF	high frequency
HV	high voltage
IC	impedance compensation*; integrated circuit
ID	inside diameter, induced draft*, interdigital*
IDP	integrated data processing*
IF	intermediate frequency
IGFET	insulated gate field-effect transistor
IM	intermediate modulation
IMPATT	impact ionization avalanche transit time (diode)
I/O, I-O	input-output
IR	infrared
IR	current-resistance
JFET	junction field-effect transistor
LC	inductance-capacitance
LED	light emitting diode
LF	low frequency
LHS	left-hand side*
LMS	least mean square
LO	local oscillator*
LP	linear programming*
LPE	liquid phase epitaxy*
LR	inductance-resistance
MESFET	metal-semiconductor field-effect transistor
MF	medium frequency*
MFSK	minimum frequency-shift keying
MHD	magnetohydrodynamics
MIS	metal-insulator-semiconductor
MMF	magnetomotive force
MOS	metal-oxide-semiconductor
MOST	metal-oxide-semiconductor transistor
MOSFET	metal-oxide-semiconductor field-effect transistor
NA	numerical aperture*
NIR	near infrared response*
NMR	nuclear magnetic resonance*
NRZ	nonreturn to zero*
OD	outside diameter
OEIC	optoelectronic integrated circuit*
PAM	pulse-amplitude modulation*
PCM	pulse-code modulation*
PDM	pulse-duration modulation*
PF	power factor*
PLL	phase-locked loop*
PM	phase modulation*
p-i-n,	
p-n-p	(diode)
pp, p-p	peak to peak *
PPM	pulse-position modulation*
PRF	pulse-repetition frequency*
PRR	pulse-repetition rate*
PSK	phase-shift keying*
PTM	pulse-time modulation*
p.u.	per unit*
Q	quality factor; figure of merit
QPSK	quantenary phase shift keying
R&D	research and development*
RAM	random access memory*
RC	resistance-capacitance
RF	radio frequency
RFI	radio frequency interference*
RHS	right-hand side*
RIN	relative intensity noise*
RL	resistance-inductance
rms	root mean square
ROM	read-only memory
SAW	surface acoustic wave*
SHF	super high frequency*
SI	International System of Units
S/N, SNR	signal-to-noise ratio
SSB	single sideband*
SW	short wave*
SWR	standing-wave ratio*
TDM	time division modulation*, time division multiplexing*
TE	transverse electric
TEM	transverse electromagnetic
TFT	thin-film transistor*
TM	transverse magnetic
TVI	television interference*
TWA	traveling-wave amplifier*
UHF	ultrahigh frequency
UV	ultraviolet
VCO	voltage controlled oscillator*
VHF	very high frequency*
V-I	voltage-current
VLF	very low frequency*
VLSI	very large scale integration*
WDM	wavelength division multiplexing*

Special Notes

- Please pay careful attention to the length of your abstract. The *Graduate School Manual for the Preparation of Theses* states that the second paragraph of the abstract (the summary of the dissertation research) can be no longer than 350 words. This requirement is monitored by University Microfilms and is based upon the constraints of the microfiche format in which they store the dissertation.

  To assess whether your abstract meets these requirements, they do *not* count the actual number of words in the research summary. Instead, they determine an average wordlength (including a trailing space) by scanning a portion of your summary, and then divide the total number of characters in your summary by your average wordlength to obtain an approximate number of words. This number must be less than or equal to 350.

  Since you will not know what part of the abstract is scanned to compute average wordlength, the requirement is a bit fuzzy. However, as a guideline, it is recommended that you assume an average of 6 characters per word (including the trailing space). Thus your summary paragraph must not exceed 2100 characters in length. Another rule of thumb is that the abstract should not be longer than 1.5 pages when formatted according to the thesis manual.