Appendix I

Pronunciation of letters of the alphabet

English alphabet

a	/eɪ/	g	/dʒiː/	m	/em/	t	/tiː/
b	/biː/	h	/eɪtʃ/	n	/en/	u	/juː/
c	/siː/	i	/aɪ/	o	/əʊ/	v	/viː/
d	/diː/	j	/dʒeɪ/	p	/piː/	w	/'dʌbljuː/
e	/iː/	k	/keɪ/	q	/kjuː/	x	/eks/
f	/ef/	l	/el/	r	/ɑːʳ/	y	/waɪ/
				s	/es/	z	/zed/ AmE /ziː/

Greek alphabet

Letters		Name	Pron.	Letters		Name	Pron.
Capital	Small			Capital	Small		
Α	α	alpha	/'ælfə/	Ν	ν	nu	/njuː/
Β	β	beta	/'biːtə/	Ξ	ξ	xi	/ksaɪ/
Γ	γ	gamma	/'gæmə/	Ο	ο	omicron	/'əumɪkrən/
Δ	δ	delta	/'deltə/	Π	π	pi	/paɪ/
Ε	ε	epsilon	/'epsɪlən/	Ρ	ρ	rho	/rəʊ/
Ζ	ζ	zeta	/'ziːtə/	Σ	σ, ς	sigma	/'sɪgmə/
Η	η	eta	/'iːtə/	Τ	τ	tau	/taʊ/
Θ	θ	theta	/'θiːtə/	Υ	υ	upsilon	/'jʊpsɪlən/
Ι	ι	iota	/aɪ'əutə/	Φ	φ	phi	/faɪ/
Κ	κ	kappa	/'kæpə/	Χ	χ	chi	/kaɪ/
Λ	λ	lambda	/'læmdə/	Ψ	ψ	psi	/psaɪ/
Μ	μ	mu	/mjuː/	Ω	ω	omega	/'əumɪgə/

Appendix II

Pronunciation of some common mathematical expressions

Individual mathematicians often have their own way of pronouncing mathematical expressions and in many cases there is no generally accepted 'correct' pronunciation.

Distinctions made in writing are often not made explicit in speech; thus the sounds fx /'ef 'eks/ may be interpreted as any of: fx, f(x), f_x, FX, $\overline{FX}$. The difference is usually made clear by the context; it is only when confusion may occur, or where he wishes to emphasise the point, that the mathematician will use the longer forms: f multiplied by x, the function of x, f subscript x, line FX, vector FX.

Similarly, a mathematician is unlikely to make any distinction in speech (except sometimes a difference in intonation or length of pauses) between pairs such as the following:

$$x+(y+z) \quad \text{and} \quad (x+y)+z$$
$$\sqrt{ax}+b \quad \text{and} \quad \sqrt{(ax+b)}$$
$$a^n-1 \quad \text{and} \quad a^{n-1}$$

The most common pronunciations are given in the list below. In general, the *shortest* versions are preferred (unless greater precision is necessary).

$x+1$	x plus one
$x-1$	x minus one
$x\pm1$	x plus or minus one
xy	xy / x multiplied by y
$(x-y)(x+y)$	x minus y, x plus y
$\frac{x}{y}$	x over y
$x=5$	x equals 5 / x is equal to 5
$x\equiv y$	x is equivalent to y / x is identical with y
$x>y$	x is greater than y
$x\geq y$	x is greater than or equal to y
$x<y$	x is less than y
$0<x<1$	zero is less than x is less than 1
$0\leq x\leq1$	zero is less than or equal to x is less than or equal to 1
x^2	x squared
x^3	x cubed
x^4	x to the fourth / x to the power four
x^n	x to the n /x to the nth/ x to the power n
x^{-n}	x to the minus n / x to the power minus n
$\sqrt{x}$	root x / square root x / the square root of x
$\sqrt[3]{x}$	cube root x
$\sqrt[4]{x}$	fourth root x
$\sqrt[n]{x}$	nth root x /'enθ ruːt 'eks/
$(x+y)^2$	x plus y all squared
$\left(\frac{x}{y}\right)^2$	x over y all squared
$n!$	n factorial / factorial n
$x\%$	x per cent /'eks pə 'sent/
∞	infinity
$x\propto y$	x varies as y / x is (directly) proportional to y
$\dot{a}$	a dot /'eɪ dɒt/
$\ddot{a}$	a double dot /'eɪ 'dʌbl dɒt/
$f(x)$	fx /f of x/ the function of x
$f'(x)$	f dash x / the (first) derivative of f with respect to x
$f''(x)$	f double-dash x / the second derivative of f with respect to x

$f'''(x)$	f triple-dash x / f treble-dash x / the third derivative of f with respect to x
$f^{(4)}(x)$	f four x / the fourth derivative of f with respect to x
$\frac{\partial v}{\partial \theta}$	the partial derivative of v with respect to θ
$\frac{\partial^2 v}{\partial \theta^2}$	d two v by d theta squared / the second partial derivative of v with respect to θ
w.r.t.	with respect to
$\int_0^\infty$	the integral from zero to infinity
$\sum_{i=1}^{n}$	the sum from i equals one to n
$\lim_{\Delta x \to 0}$	the limit as delta x approaches zero
$\mathrm{Lt}_{\Delta x \to 0}$	the limit as delta x tends to zero
grad	gradient
div	divergence
$\log_e y$	log y to the base e / log to the base e of y / natural log (of) y
$l_n y$	log y to the base e / log to the base e of y / natural log (of) y
$\overline{OA}$ or $\overrightarrow{OA}$	OA / vector OA
$x \in A$	x belongs to A / x is a member of A / x is an element of A
$x \notin A$	x does not belong to A / x is not a member of A / x is not an element of A
$A \subset B$	A is contained in B / A is a proper subset of B
$A \subseteq B$	A is contained in B / A is a subset of B
$B \cap A$	B intersection A
$B \cup A$	B union A
cos x	/kɒs eks/
sin x	/saɪn eks/
tan x	/tæn eks/
sec x	/sek eks/
cosec x	/'kəusek eks/
sinh x	/ʃaɪn eks/ or /sɪntʃ eks/
cosh x	/kɒʃ eks/
tanh x	/θæn eks/ or /tæntʃ eks/
m_a	ma / m subscript a / m suffix a
$x_1 + x_2 + x_3 \ldots\ldots$	(usually) x one plus x two plus x three, etc.
$\lvert x \rvert$	mod x / modulus x

Appendix III

Units

S.I. Units

S.I. Units (S.I. = système international) have now been adopted by most countries of the world and should always be used. Points to note are:

a) There is no full stop after abbreviations (except, of course, at the end of a sentence).
   eg *10 cm long* NOT *10 cm. long*
b) The abbreviations do not change in the plural.
   eg *10 cm* *NOT* *10 cms*
   When written in full, however, the units *do* take the plural -s, (eg 10 centimetres) except when used as adjectives (eg a ten-centimetre line).
c) No unit is written with a capital letter, even when its abbreviation is written with a capital letter.
   eg *1 newton* NOT *1 Newton*
d) Note the preferred spellings:
   gramme rather than *gram*
   metre rather than *meter*
e) Numbers with more than three digits are separated into groups of three with *spaces*, not commas or full-stops.
   eg *one million* is written *1 000 000*
   NOT *1,000,000* and NOT *1.000.000*
f) Figures after the decimal point are separated in the same way.
   eg 2·732 981 326
g) The decimal point is written as a point and not as a comma.
   eg *3·141* NOT *3,141* (three point one four one)

The following are the more important S.I. units for mathematics:

Quantity	Unit	Pronunciation	Symbol
length	metre	/'miːtəʳ/	m
mass	kilogramme	/'kɪləgræm/	kg
time	second	/'sekənd/	s
temperature	kelvin*	/'kelvɪn/	K
plane angle	radian	/'reɪdɪən/	rad
solid angle	steradian	/ste'reɪdɪən/	sr
area	square metre	/ˌskweə 'miːtəʳ/	m^2
volume	cubic metre	/ˌkjuːbɪk 'miːtəʳ/	m^3
speed	metre per second	/'miːtə pə 'sekənd/	$m\,s^{-1}$
acceleration	metre per second per second	/'miːtə pə 'sekənd pə 'sekənd/	$m\,s^{-2}$
density	kilogramme per cubic metre	/'kɪləgræm pə ˌkjuːbɪk 'miːtə/	$kg\,m^{-3}$
force	newton**	/'njuːtən/	N
pressure	newton per square metre	/'njuːtən pə ˌskweə 'miːtə/	$N\,m^{-2}$
energy	joule	/dʒuːl/	J

Notes: *°C = °K − 273·15. The degree Celsius will continue to be widely used.
**one newton = one kilogramme metre per second per second ($1N = 1\,kg\,m\,s^{-2}$)

SYMBOLS AND NOTATION USED IN THIS BOOK

This notation is based on that indicated by the International Organisation for Standardisation.

N	the set of positive integers and zero, $\{0, 1, 2, 3, \ldots\}$
Z	the set of integers, $\{0, \pm 1, \pm 2, \pm 3, \ldots\}$
Z^+	the set of positive integers, $\{1, 2, 3, \ldots\}$
Q	the set of rational numbers
Q^+	the set of positive rational numbers, $\{x \mid x \in Q, \ x > 0\}$
$\mathcal{R}$	the set of real numbers
$\mathcal{R}^+$	the set of positive real numbers, $\{x \mid x \in \mathcal{R}, \ x > 0\}$
C	the set of complex numbers, $\{a + bi \mid a, b \in \mathcal{R}\}$
i	$\sqrt{-1}$
z	a complex number
z^*	the complex conjugate of z
$\|z\|$	the modulus of z
$\arg z$	the argument of z
$\mathrm{Re}\, z$	the real part of z
$\mathrm{Im}\, z$	the imaginary part of z
$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \ldots$
$n(A)$	the number of elements in the finite set A
$\{x \mid \ldots$ or $\{x : \ldots$	the set of all x such that
$\in$	is an element of
$\notin$	is not an element of
$\emptyset$	the empty (null) set
U	the universal set
$\cup$	union
$\cap$	intersection
A'	the complement of the set A
$a^{\frac{1}{n}}, \sqrt[n]{a}$	a to the power of $\frac{1}{n}$, nth root of a (if $a \geqslant 0$ then $\sqrt[n]{a} \geqslant 0$)
$a^{\frac{1}{2}}, \sqrt{a}$	a to the power $\frac{1}{2}$, square root of a (if $a \geqslant 0$ then $\sqrt{a} \geqslant 0$)
$\|x\|$	the modulus or absolute value of x, that is $\begin{cases} x \text{ for } x \geqslant 0 & x \in \mathcal{R} \\ -x \text{ for } x < 0 & x \in \mathcal{R} \end{cases}$
$\equiv$	identity or is equivalent to
$\approx$ or $\doteqdot$	is approximately equal to
$>$	is greater than
$\geq$ or $\geqslant$	is greater than or equal to
$<$	is less than
$\leq$ or $\leqslant$	is less than or equal to
$\ngtr$	is not greater than
$\nless$	is not less than
$[a, b]$	the closed interval $a \leqslant x \leqslant b$
$]a, b[$	the open interval $a < x < b$
u_n	the nth term of a sequence or series
d	the common difference of an arithmetic sequence
r	the common ratio of a geometric sequence
S_n	the sum of the first n terms of a sequence, $u_1 + u_2 + \ldots + u_n$
S_∞	the sum to infinity of a sequence, $u_1 + u_2 + \ldots$
$\sum_{i=1}^{n} u_i$	$u_1 + u_2 + \ldots + u_n$
$\binom{n}{r}$	$\frac{n!}{r!(n-r)!}$
$f : A \to B$	f is a function under which each element of set A has an image in set B
$f : x \mapsto y$	f is a function under which x is mapped to y
$f(x)$	the image of x under the function f
f^{-1}	the inverse function of the function f
$f \circ g$	the composite function of f and g
$\lim_{x \to a} f(x)$	the limit of $f(x)$ as x tends to a
$\frac{dy}{dx}$	the derivative of y with respect to x
$f'(x)$	the derivative of $f(x)$ with respect to x
$\frac{d^2y}{dx^2}$	the second derivative of y with respect to x
$f''(x)$	the second derivative of $f(x)$ with respect to x
$\frac{d^ny}{dx^n}$	the nth derivative of y with respect to x
$f^{(n)}(x)$	the nth deriviative of $f(x)$ with respect to x
$\int y\, dx$	the indefinite integral of y with respect to x
$\int_a^b y\, dx$	the definite integral of y with respect to x between the limits $x = a$ and $x = b$
e^x	exponential function of x
$\log_a x$	logarithm to the base a of x
$\ln x$	the natural logarithm of x, $\log_e x$

continued next page

Set operators

$\in$	in, membership	$a \in \{a, b, c\}$
$\cup$	union	$\{a, b, c\} \cup \{a, d\} = \{a, b, c, d\}$
	... over an index set	$\bigcup_{i \in \mathbb{N}} S_i = S_0 \cup S_1 \cup S_2 \cup \cdots$
$\cap$	intersection	$\{a, b, c\} \cap \{a, d\} = \{a\}$
	... over an index set	$\bigcap_{i \in \mathbb{N}} S_i = S_0 \cap S_1 \cap S_2 \cap \cdots$
$\setminus$	difference	$\{a, b, c\} \setminus \{a, d\} = \{b, c\}$
$\supset$	strict superset	$\mathbb{Z} \supset \mathbb{N}$
$\supseteq$	superset	$\mathbb{N} \supseteq \mathbb{N}$
$\subset$	strict subset	$\mathbb{N} \subset \mathbb{Z}$
$\subseteq$	subset	$\mathbb{N} \subseteq \mathbb{N}$
2^A	power set of A	if $A = \{a, b, c\}$, then $2^A = \{\emptyset, \{a\}, \{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, A\}$

String, grammar, and formal language notation

λ	empty string (at times, ϵ is used instead of λ)	$\lambda a = a$
$*$	Kleene star, zero or more occurrences	$a^* = \{\epsilon, a, aa, aaa, \ldots\}$
$+$	one or more occurrences	$a^+ = \{a, aa, aaa, \ldots\}$
$\lvert\ \rvert$	string length	$\lvert abc\rvert = 3$, $\lvert a^n\rvert = n$, $\lvert\epsilon\rvert = 0$
$A \to x$	A goes to x (grammar production)	
$A \Longrightarrow x$	A derives x	
$A \overset{*}{\Longrightarrow} x$	A derives x in some number of steps	
$A \underset{G}{\Longrightarrow} x$	A derives x according to G	
$A \underset{G}{\overset{*}{\Longrightarrow}} x$	A derives x according to G in some number of steps	
$(q, aa) \vdash (p, a)$	(q, aa) yields (p, a) in one step	
$(q, aa) \overset{*}{\vdash} (p, a)$	(q, aa) yields (p, a) in some number of steps	
$(q, aa) \underset{M}{\vdash} (p, a)$	(q, aa) yields (p, a) in one step according to M	
$(q, aa) \underset{M}{\overset{*}{\vdash}} (p, a)$	(q, aa) yields (p, a) in some number of steps according to M	
$M \searrow w$	the Turing machine M halts on string w	
$M \nearrow w$	the Turing machine does not M halt on string w	

And remember...

$0! = 1$
$\forall n \in \mathbb{Z}, \forall m \in \mathbb{N}, m > 0 \Rightarrow n = (n \text{ div } m)m + (n \bmod m)$
$\bigcup_{i \in \emptyset} S_i = \emptyset$
$\sum_{i \in \emptyset} n_i = 0$
$\prod_{i \in \emptyset} n_i = 1$

LaTeX source available at `http://www.cs.ucr.edu/~ciardo/teaching/Notation.tex`

A partial list of mathematical symbols and how to read them

Greek alphabet

A	α	alpha	B	β	beta	Γ	γ	gamma	Δ	δ	delta	E	ϵ, ε	epsilon
Z	ζ	zeta	H	η	eta	Θ	θ, ϑ	theta	I	ι	iota	K	κ	kappa
Λ	λ	lambda	M	μ	mu	N	ν	nu	Ξ	ξ	xi	O	o	omicron
Π	π, ϖ	pi	P	ρ, ϱ	rho	Σ	σ, ς	sigma	T	τ	tau	Υ	υ	upsilon
Φ	ϕ, φ	phi	X	χ	chi	Ψ	ψ	psi	Ω	ω	omega			

Important sets

$\emptyset$	empty set		
$\mathbb{N}$	natural numbers	$\{0, 1, 2, \ldots\}$	
$\mathbb{N}^+$	positive integer numbers	$\{1, 2, \ldots\}$	
$\mathbb{Z}$	integer numbers	$\{\ldots, -2, -1, 0, 1, 2, \ldots\}$	
$\mathbb{Q}$	rational numbers	$\{m/n : m \in \mathbb{Z}, n \in \mathbb{N}^+\}$	
$\mathbb{R}$	real numbers	$(-\infty, +\infty)$	
$\mathbb{R}^+$	positive real numbers	$(0, +\infty)$	
$\mathbb{C}$	complex numbers	$\{x + iy : x, y \in \mathbb{R}\}$	(i is the imaginary unit, $i^2 = -1$)

Logical operators

$\forall$	for all, universal quantifier	$\forall n \in \mathbb{N}, n \geq 0$
$\exists$	exists, there is, existential quantifier	$\exists n \in \mathbb{N}, n \geq 7$
$\exists!$	there is exactly one	$\exists! n \in \mathbb{N}, n < 1$
$\wedge$	and	$(3 > 2) \wedge (2 > 1)$
	... over an index set	$\bigwedge_{i \in \mathbb{N}} B_i = B_0 \wedge B_1 \wedge B_2 \wedge \cdots$
$\vee$	or	$(2 > 3) \vee (2 > 1)$
	... over an index set	$\bigvee_{i \in \mathbb{N}} B_i = B_0 \vee B_1 \vee B_2 \vee \cdots$
$\Rightarrow$	implication, if-then	$\forall a, b \in \mathbb{R}, (a = b) \Rightarrow (a \geq b)$
$\Longleftrightarrow$	biimplication, if-and-only-if	$\forall a, b \in \mathbb{R}, (a = b) \Longleftrightarrow (b = a)$
$\neg$	negation, not	$\neg(2 > 3)$
	alternative notations for negation	$\overline{(2 > 3)}$, $2 \not> 3$

Arithmetic operators

$\lvert\ \rvert$	absolute value	$\lvert -7 \rvert = \lvert 7 \rvert = 7$
$\sum$	summation	$\sum_{i \in \mathbb{N}^+} 2^{-i} = 1$
$\prod$	product	$\prod_{i=1}^{n} i = n!$
!	factorial	$7! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 = 5040$
$\binom{n}{m}$	n choose m, combinatorial number	$\binom{n}{m} = \frac{n!}{(n-m)!m!}$
mod	modulo, remainder	7 mod 3 = 1, -8 mod 5 = 2
div	integer quotient	7 div 3 = 2, -8 div 5 = -2