EDITING MATHEMATICS

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A. The Language of Math

When editing technical publications it is important to remember that the mathematics often carries as much if not more meaning than the body of text itself. Therefore, it is critical that the grammar of an equation be taken into account when editing.

Most equations should read like a sentence. They should contain a noun and a verb and often contain adjectives, prepositional phrases, conjunctions, and conditions. Equations also contain punctuation. When math occurs along with text it shares the grammatical characteristics of the text. A displayed expression may be a main or subordinate clause, an expression in apposition, a direct object, an item in a list, or the object of a preposition. **Use a comma at the end of introductory sentences after: i.e., e.g., "Hence" or "That is." Use a colon after words such as "following" or "as follows."** There should be no punctuation after forms of the verb to be, or between a verb and its object or a preposition and its object. IEEE style dictates that the only punctuation used at the end of an equation is a period. There is, however, other punctuation permitted in the equation itself and between an equation and its condition. This interior punctuation contains mathematical meaning and must not be changed.

Some examples of interior punctuation are as follows.

Mathematical Ellipses:

$$I = 1, 2, 3, \ldots, n$$

NOTE: *Only three dots* are used and they are enclosed by commas and are on the baseline.

Matrix:

$$C_{\text{Eopt}} = \begin{bmatrix} -4.65\,E^{+0} & -1.07\,E^{-1} & -1.42\,E^{-1} & -9.50\,E^{-4} & 2.52\,E^{+1} & 3.36\,E^{+0} \\ 1.97\,E^{+0} & 1.44\,E^{-1} & 8.80\,E^{+0} & 5.88\,E^{-2} & 2.14\,E^{+1} & 1.46\,E^{+0} \\ -1.62\,E^{+0} & -1.10\,E^{-1} & 1.01\,E^{+1} & 6.27\,E^{-2} & -1.92\,E^{+1} & -1.37\,E^{+0} \end{bmatrix} \quad (1)$$

NOTE: There is a centered operator, equation number, and period.

Parenthetic Statement:

$$v(t) = u\,(t), \qquad t = 1, 2, \ldots, m.$$

$$\Phi_z = \begin{cases} \dfrac{L}{S_{\text{coil}}} \displaystyle\int_{R_3}^{R_4} \int_{\theta_1^z - \frac{\alpha}{2}}^{\theta_1^z - \frac{\alpha}{2} + \beta} A_s^z \mathrm{r} \mathrm{d}\mathrm{r} \mathrm{d}\theta, & \text{for } J_1^z \\ \dfrac{L}{S_{\text{coil}}} \displaystyle\int_{R_3}^{R_4} \int_{\theta_1^z + \frac{\alpha}{2} - \beta}^{\theta_1^z + \frac{\alpha}{2}} A_s^z \mathrm{r} \mathrm{d}\mathrm{r} \mathrm{d}\theta, & \text{for } J_2^z. \end{cases} \quad (77)$$

NOTE: There is a 2em space after the comma and before the condition $t = 1, 2, \ldots, m$. Multiple conditions should be separated with a semicolon, with a comma at the end of the equation, a 2em space, and the condition aligned on the operator.

B. In-Line Equations and Expressions

An inline equation is an equation within text or part of a paragraph. It is not displayed.

Rule 1: Equations appearing in text should be broken after a verb or an operator, meaning, if at all possible, the verb or operator should remain on the top line of text.

Rule 2: Fractions should not appear stacked in line. $\dfrac{(xy + 6\alpha)}{xy}$ should be written as $(xy + 6\alpha)/(xy)$.

Rule 3: Collective signs should not appear with limits to top and bottom, but to the side instead.

$\displaystyle\sum_{i=0}^{i=\infty}$ should be written as $\sum_{i=0}^{i=\infty}$.

Rule 4: Use Roman function exp instead of *e* followed by a lengthy superscript. $e^{(zx^2+y)(\alpha-2yx)+zx}$ should be written as exp[$(zx^2 + y)$ (α – 2yx) + zx].

Rule 5 (optional): Avoid square roots (radical signs) having long bars. $\sqrt{(x+\alpha)}$ should be rewritten as $(x + \alpha)^{½}$.

C. Break/Alignment Rules

Rule 1: Break equations at verbs and align on same when possible for a displayed equation.

$$\begin{aligned} A &= (5\alpha + x) + (10y + \beta)^2 \\ &\geq (5x - \alpha + y + x^2) \\ &\equiv B^2 \end{aligned}$$

Rule 2: In equations with one verb, break at operators and align to the right of verb.

$$\begin{aligned} A &= (5\alpha + x) \\ &\quad + (10y + \beta)^2 \\ &\quad - (5x - \alpha + y + x^2) \end{aligned}$$

Rule 3: Separate all equations with 1) an em quad if they fit on one line or 2) stack and align on verb.

$$x = (-b + 4ac) \quad y = (a - 2bc)$$

$$z = (-c + 3ab)$$

*Rule 4:*An equation that will fit conveniently on two lines without further breaks should be broken at the verb and aligned flush left/flush right over the column width.

$$\begin{aligned} 2xy \\ = \frac{(-c+3ab)+(a-bc)^2-(b-2c)}{(4ac+3bc)-(2c+3ab)} \end{aligned}$$

Rule 5: When breaking an equation within fences, break at an operator and align inside the left-hand fence.

$$\begin{aligned} x = &\left[\left(\frac{-c+3ab}{-bc}\right)-(b-2\alpha)\right. \\ &\left.+\left(\frac{4ac+3bc}{ac}\right)-(2c+3ab)\right] \end{aligned}$$

NOTE: Pairs of fences should match in size and be proportional to the math within.

Rule 6: A period is placed at the end of a fraction, case equation, or closed delimiters, shown as

$$\begin{aligned} &2xy \\ &= \frac{(-c+3ab)+(a-bc)^2-(b-2c)}{(4ac+3bc)-(2c+3ab)} \\ x = &\left[\left(\frac{-c+3ab}{-bc}\right)-(b-2\alpha)\right. \\ &\left.+\left(\frac{4ac+3bc}{ac}\right)-(2c+3ab)\right]. \end{aligned}$$

NOTE: Pairs of fences should match in size and be proportional to the math within.

D. Exceptions and Oddities

Right to Left Equations: Equations in which the verb appears in the right half of the statement are broken before an operator and aligned to the left of the verb.

$$5\alpha + x + 10y + \beta^2 + z = x$$

Solidus as Operator: Break after a solidus and align the next line to the right of the verb.

$$A = [(2z - 5\alpha + x)\,(xy + 6\alpha)] \,/\, [(xy + 6\alpha)]$$

Implied Product: When a set of fences is followed directly by another set of fences, the equation may be broken between them, provided a multiplication sign (×, ·) is inserted. Alignment is to the right of the verb as for other operators.

$$x = (-b + 4ac)\,(a - 2bc) \times (-c + 3ab)$$

Integrals and Differentials: If an equation containing an integral must be broken before the differential expression (see Glossary on p. 5) break at an operator and align to the right of the integral. It is preferential not to break this type of equation until a differential occurs, then break after the differential expression.

Preferential

$$x = \int_1^0 \frac{1}{2} + \left(\frac{n-1}{n}\right) - dy\,A_0 + \left(2x - 3zy\right)$$

If necessary

$$x = \int_1^0 \frac{1}{2}\left(\frac{n-1}{n}\right) - dyA_0 + \left(2x - 3zy\right)$$

E. Headings for Theorems, Proofs, and Postulates

Some articles do not conform to an outline style for theorems and proofs that is easily transformed into the normal heading sequence. The preferred style is to set the head giving the theorem number as a tertiary heading (no Arabic numeral preceding) and the proof head as a quaternary head. This rule also applies to Lemmas, Hypotheses, Propositions, Definitions, Conditions, etc.

F. Numbered Display Equations

Consecutive Numbering: Equations within an article are numbered consecutively from the beginning of the article to the end. There are some Transactions in which an author's own numbering system such as numbering by section, e.g., (1.1), (1.2.1), (A1), is permitted.

Appendix Equations: Continued consecutive numbering of equations is best in the Appendix, but if an author starts equation numbering over with (A1), (A2), etc., for Appendix equations, it is permissible to leave the copy as is.

Hyphens and Periods: Hyphens and periods are usually removed from equation numbers, i.e., (1a) rather than (1-a) and (2a) rather than (2.a). This should be done consistently throughout the article.

G. Reminders

Algorithms: Algorithms should not be edited. Keep title, formatting, punctuation, and placement as provided by the author. When positioning is unclear, an algorithm may be placed in-line within text or at the end of a paragraph if an introductory sentence or phrase precedes it (e.g., “as shown in the following”; “in the process below”; or “as follows in Algorithm 1”). Otherwise, float an algorithm to the top of the page when it is cited by only its number or title.

Angle Brackets: Angle brackets are not the same as greater than and less than signs.

Vectors: Vectors are usually made boldface (if distinguished by the author).

Thin Spaces and Roman Functions and Differentials: Thin spaces occur on either side of both functions and differentials.

Incorrect $\sin t_t = \log \mu r$

Correct $\sin\, t_t = \log\, \mu r$

Incorrect $x = \int_0^x dx A_0 + \partial z \beta$

Correct $x = \int_0^x dx\, A_0 + \partial z \beta$

However, a thin space is not necessary when functions and differentials are preceded or followed by verbs or an operator.

H. Short Reference List of Italics, Roman, and Small Capitals

Italics	Roman	Small Caps
RC	p-n	A.M., P.M.
RL	p-i-n	NOR
I-V	p^{+}-n-p^{++}	OR
LC	and variations thereof	ORing
S/N	(do not forget the hyphen)	ORed
f/22	SNR	AND
	O ring	NAND
	T junction	ADD
	Y-connected circuit	DIFFER
	class-A amplifier	EXTRACT
	2N5090 transistor	XOR
	e.g.,	EXCLUSIVE OR
	i.e.,	DIMENSION
	viz.,	GO TO
	Fortran IV	DO
	Algol 60	READ
	Cobol	WRITE
	Atlas Autocode	PRINT
	PL/1	CONTINUE
	BAL	PAUSE
	cf.,	FORMAT
	Tr	END
	Ke	ON
	Im	OFF
	et al.	IGFET
	in situ	IMPATT
	inter alia	TRAPATT
	in toto	ONE
	in vivo	ZERO
	in vitro	BARITT
	a priori	
	a posteriori	

I. Functions and Operators Always Set in Roman Font

ad	(adjoint)
arg	(argument)
cos	(cosine)
cosh	(hyperbolic cosine)
cot	(cotangent; do not use ctg)
coth	(hyperbolic cotangent)
csc	(cosecant; do not use cosec)
csch	(hyperbolic cosecant)
curl	(curl)
det	(determinant)
diag	(diagonal)
dim	(dimension)
div	(divergence)
exp	(exponential)
hom	(homology)
Im	(Imaginary)
inf	(inferior)
ker	(kernel)
lim	(limit)
liminf	(limit inferior)
limsup	(limit superior)
ln	(natural logarithm)
log	(logarithm)
lub	(least upper bound)
max	(maximum)
min	(minimum)
mod	(modulus)
Pr	(Probability)
Re	(real)
sec	(secant)
sin	(sin)
sinh	(hyberbolic sine)
tan	(tangent)
tanh	(hyperbolic tangent)
tr	(trace)
Tr	(transpose)
wr	(wreath)

J. Glossary

Base line: The imaginary line connecting the bottoms of capital letters.

Collective signs: Term used to describe a certain group of mathematical symbols including sums,products, unions, and integrals.

Differential: Identifiable as being *d* or delta (Δ, δ) combinations.

Em quad: Unit of linear measurement equal to the point size of the type font being used.

En quad: Half an em quad.

Fences: Any one of several signs of aggregation such as parens ( ), brackets [ ], or angle brackets $\langle\ \rangle$, having the following hierarchy when nested ({[( )]}).

Indices: Subscripts and superscripts which are inferior and superior, respectively, to the symbols on the base line. There are two classes of indices: first order and second order. In the term x^a_b, *a* and *b* are first-order indices. Subscripts and superscripts to the first-order indices are referred to as second-order indices. For example, in the expression $x^{b^c}_{a^d_e}$, *c, d,* and *e* are second-order indices. *Note:* Plural of an index is indices in math

Matrix: A rectangular array of mathematical terms written between fences.

Operator: A mathematical symbol that indicates an operation to be performed, e.g., +, –, /, ×.

Roman functions: Functions and operators typically set in Roman font.

Solidus: A slanted line used between the parts of a fraction such as 3/4. Also known as “shill”ed.

Stacked fraction: A fraction in which the numerator is set above a rule and the denominator is set below, in contrast to a fraction set with a solidus. Also known as “built up.”

Thick space: Not usually used but approximately one-third of an em space.

Thin space: Approximately one-fifth of an em space. Used around Roman functions.

Verb: A mathematical symbol indicating a relationship, e.g., =, ⩾, ⩽, >, <, etc.

$\approx$(\approx), usually to indicate approximation between numbers, like $\pi \approx 3.14$.

$\simeq$(\simeq), usually to indicate asymptotic equivalence between functions, like $f(n) \simeq 3n^2$. So writing $\pi \simeq 3.14$ would be wrong, despite being widely used.

$\sim$(\sim), usually to indicate proportionality between functions, the same $f(n)$ of the line above will be $f(n) \sim n^2$.

$\cong$(\cong), usually to indicate congruence between figures, like $\Delta ABC \cong A'B'C'$.

K. The Greek Alphabet

Name	Uppercase	Lowercase
Alpha	Α	α
Beta	Β	β
Gamma	Γ	γ
Delta	Δ	δ
Epsilon	Ε	ε
Zeta	Ζ	ζ
Eta	Η	η
Theta	Θ	θ
Iota	Ι	ι
Kappa	Κ	κ
Lambda	Λ	λ
Mu	Μ	μ
Nu	Ν	ν
Xi	Ξ	ξ
Omicron	Ο	ο
Pi	Π	π
Rho	Ρ	ρ
Sigma	Σ	σ
Tau	Τ	τ
Upsilon	Υ	υ
Phi	Φ	φ
Chi	Χ	χ
Psi	Ψ	ψ
Omega	Ω	ω

L. Common Mathematical Function Name Abbreviations and Symbols (use Roman for these symbols)

l	Script ell, used to distinguish ell from one; set as italic ell.
exp (x)	Exponential function of x; = e^x.
e	Base of natural logarithms.
ln x	Natural logarithm of x.
$\log_2 x$	Logarithm, base 2, of x.
log x $\log_{10} x$	Common logarithm of x.
Δx	Finite increase of x.
δx	Variation of x.
dx	Total differential of x.
∂x	Partial differential of x.
$f(x)$	Function of x.
lim $f(x)$	Limit of $f(x)$.
$\lim_{x \to a} f(x)$	Limit of $f(x)$ as x approaches a.
l.i.m. $f(x)$	Limit in the mean.
min $f(x)$	Minimum of $f(x)$.
$\max_i f(x)$	Maximum of $f(x)$ over i.
inf	Infimum over x (greatest lower bound).
$\sup_x$	Supremum over x (least x upper bound).
Pr (a)	Probability of a (do not use Prob., P_r).
Re z	Real part of z; sometimes appears as Re z (use Re).
Im z	Imaginary part of z.
arg z	Argument of z.
det	Determinant.
diag	Diagonal.
int	Integer value.
cov	Covariance.
var	Variance.
sgn x	Signum function of x.
sinc x	(sin x)/x.
sn cn dn an	(Sinus) Jacobian elliptical functions.
grad ϕ	Gradient of ϕ; $\nabla \phi$.

div V	Divergence of V; $\nabla \cdot V$.
curl V Rot V	$\nabla \times V$.
tr	Trace.
Tr	Transpose
$\|\Lambda\|$	Absolute value of A.
$\widetilde{\Lambda}$, Λ^T	Transpose of matrix A.
A*	Complex conjugate of A.
$A_\dagger$	Hermitian conjugate of A.
Si (z)	sine integral Si (z) $= S_0^z \frac{\sin t}{t}\, dt$.
Ci (x)	cosine integral Ci (z) = γ + ln z
Cin (z)	cosine integral Cin (z) = – Ci (z) + ln z + γ.
Shi (z)	Hyperbolic sine integral [also Shi (z)].
Chi (z)	Hyperbolic cosine integral.
Ei (z)	Exponential integral.
li (z)	Logarithmic integral.
Ai (z)	Airy integral.
erf z	Error function.
erfc z	1 – erf z.

Trigonometric Functions	
sin	sine
cos	cosine
tan	tangent (not tg)
cot	cotangent (not ctn or ctg)
sec	secant
csc	cosecant (not cosec)
arcsin, $\sin^{-1}$ arccos, $\cos^{-1}$ arctan, $\tan^{-1}$ arccot, $\cot^{-1}$ arcsec, $\sec^{-1}$ arccsc, $\csc^{-1}$	Inverse trigonometric functions (angle whose sine (etc.) is)

Hyperbolic Functions	
sinh	
cosh	
tanh	
coth	
csch	

ver A	versine A; 1 – cos A.
covers A	coversine A; 1 – sin A.
havers A	haversine A; 1/2 vers A.
exsec A	exsecant A; sec A – 1.
$p!$	p factorial; $1 \cdot 2 \cdot 3 \cdot \cdots p$.
gaf	Gaussian distribution function.
gafc	1 – gaf.
′	Prime.
″	Double prime.
‴	Triple prime.
⁗	Quadruple prime.
′	Inferior prime.
″	Inferior double prime.
‴	Inferior triple prime.
`	Reversed prime.
°	Degree.
∵	Because or since.
∴	Therefore.
:	Sign of proportion.
::	Sign of proportion.
:–:	Geometric proportion.
[	Full-face bracket.
]	Full-face bracket.
(	Full-face parenthesis.
)	Full-face parenthesis.
{	Brace.
}	Brace.
〈	Angular bracket.
〉	Angular bracket.
⌈	Broken bracket.
⌉	Broken bracket.
⟦	Open bracket.
⟧	Open bracket.
◊	Between.
∞	Infinity.
∝	Varies as, proportional to.
.	Decimal point.
.	Scalar product.
!	Factorial sign.
|	1) Modulus (used thus $\|x\|$). 2) Joint denial (math logic, thus: $p \mid q$). 3) Divides (number theory, thus: 3 | 6).

$\parallel$	Parallel to.
/	Divided by (solidus).
$\sqrt{}$	Square root.
$\sqrt[3]{}$	Cube root.
$\sqrt[4]{}$	Fourth root.
$\sqrt[n]{}$	*n*th root.
+	Plus.
−	Minus.
±	Plus or minus.
∓	Minus or plus.
⊗	Plethysm operator (group theory).
∔	Direct sum (group theory).
×	Multiply.
÷	Divide.
=	1) Equal to. 2) Logical identity.
≠	Is not equal to.
≈	1) Approximately equal to. 2) Asymptotic to. 3) Equal to in the mean.
≃	1) Similar to. 2) Geometrically equivalent, congruent to. 3) Equal or nearly equal to.
≎	Geometrically equivalent to.
≃	Equivalent to.
≒	Approximately equal to or equal to.
≒	Approximately equal to.
≏	Approximately equal to.
≃	Approximately equal to.
≄	Not asymptotic to.
~	1) Difference between. 2) Is equivalent to. 3) Asymptotic to. 4) Similar to. 5) On the order of. 6) The complement of. 7) Is not, negation sign (math. logic).
≁	1) Is not equivalent to. 2) Is not asymptotic to. 3) Is not similar to. 4) Is not the complement of.
≳	Greater than or equivalent to.
≲	Less than or equivalent to.

⋗	1) Has a higher rank or order. 2) Contains.
⊀	1) Does not have a lower rank or order than. 2) Is not contained in.
⩽	Is contained in or equal to.
<	Smaller than, less than.
>	Greater than.
≮	Not less than.
≯	Not greater than.
≪	Much less than.
≫	Much greater than.
≶	Greater than or less than.
≷	Less than or greater than.
≦	Less than or equal to.
≦	Less than or equal to.
≧	Greater than or equal to.
≥	Greater than or equal to.
⋛	Less than, equal to, or greater than.
≷	Greater than, equal to, or less than.
≦	Less than, greater than, or equal to.
≱	Not greater than or equal to.
≐	1) Approaches the limit. 2) Approaches in value to.
=	Equals.
⊂̇	1) Is implied by. 2) Contained as proper subclass within.
⊃	1) Implies. 2) Contains as proper subclass.
⊆	1) Contained as subclass within. 2) Is identical to.
⊇	1) Contains as subclass. 2) Is identical to, contains, or is contained in.
⊄	Is not contained in.
⊅	Does not contain.
⊈	1) Is not contained as subclass within. 2) Is not identical to.
⊉	1) Does not contain as subclass. 2) Is not identical to.
∩	Product or intersection, or meet of two classes (math. logic) or sets (algebra). Colloquially called “cap.”
∪	Sum or union or join of two classes (math. logic) or sets (algebra). Colloquially called “cup.”

⊢	What follows is true, assertion sign (math. logic).
∀	For all.
∋	Such that.
∃	There exists.
∈	Is an element of.
∉	Is not an element of.
∈̄	Is not an element of.
≡	1) Is congruent to. 2) Definitional identity (math. logic). 3) Is identical to. 4) Is equivalent to (math logic).
≢	1) Is not congruent to. 2) Is not identical to.
∤	Does not divide.
→	1) Approaches or tends to the limit. 2) Implies (math logic). 3) References of a relation, math. logic, used thus $\vec{R}$.
↦	Does not tend to.
←	Relata of a relation $\vec{R}$.
↑	Tends up to the limit.
↓	Tends down to the limit.
⇔	Implies and is implied by; if and only if.
⇉	Converges to.
⇐	Is implied by.
↔	1) Mutually implies. 2) One-to-one correspondence with. 3) Corresponds reciprocally. 4) Asymptotically equivalent to.
↷	Clockwise.
↶	Anticlockwise.
ˆ	1) Vector product. 2) Product of two sets (math. logic). 3) Symmetric difference of two sets (math. logic).
≙	Estimates or is estimated by.
≚	Equiangular (geometry).
≍	Is projective with or projective correspondence.
≍	Perspective correspondence.
∫	Integral sign.
∮	Contour integral.
ف	1) D'Alembertian operator. 2) Mean operator (finite differences).

Γ	Gamma function.
∂	Partial differentiation sign.
Δ	Increment or forward finite-difference operator.
∇	Nabla or del or backward finite-difference operator.
ϑ	Theta function.
$\prod$	Product sign.
Σ	Summation sign.
$\aleph$	Aleph. The number of finite integers is $0\aleph$ and transfinite cardinal numbers $1,2,3\aleph$....
$\wp$	Weierstrass elliptic function.
&	Conjunction of statements (math. logic).
$\vee$	1) Disjunction of statements (math. logic). 2) Sum of two sets (math. logic).
0	Of order [used thus: O(x)].
o	Of lower order than [used thus: o(*x*)].
f	Function of [used thus: *f*(*x*)].