

```

\def\T{{\rm\kern.45em
  \vrule width.02em
    height1.47ex depth 0ex
  \kern-.47em T}}
\def\U{{\rm\kern.30em
  \vrule width.02em
    height1.47ex depth-.05ex
  \kern-.32em U}}
\def\V{{\rm\kern.27em
  \vrule width.02em
    height1.47ex depth-.8ex
  \kern-.29em V}}
\def\W{{\rm\kern.25em
  \vrule width.02em
    height1.47ex depth-.9ex
  \kern.34em
  \vrule width.02em
    height1.47ex depth-.9ex
  \kern-.63em W}}
\def\X{{\rm\kern.30em
  \vrule width.02em
    height1.47ex depth-1ex
  \kern.12em
  \vrule width.02em
    height0.4ex depth 0ex
  \kern-.46em X}}
\def\Y{{\rm\kern.25em
  \vrule width.02em
    height1.0ex depth 0ex
  \kern-.27em Y}}
\def\Z{{\rm\kern.26em
  \vrule width.02em
    height0.5ex depth 0ex
  \kern.04em
  \vrule width.02em
    height1.47ex depth-1ex
  \kern-.34em Z}}

% Some dimensions will require
% adjustments at large magnifications.

% Test print
\nopagenumbers
\tabskip=0pt plus1fil
\halign to18.75pc{&\setbox0=\hbox{#}%
  \hfil\copy0\copy0\box0\hfil\cr\cr
\A&\B&\C&\D&\E\cr\cr
\F&\G&\H&\I&\J\cr\cr
\K&\L&\M&\N&\O\cr\cr
\P&\Q&\R&\S&\T\cr\cr
\U&\V&\W&\X&\Y\cr\cr
& &\Z\cr\cr}

```

Using Greek Fonts with T_EX

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In this document I hope to show that typesetting Greek in T_EX using the gr family of fonts can be as easy as typesetting English text, and leads to equally good results. This is meant to be a tutorial, not an exhaustive discussion; some T_EXnical remarks that should be useful after the reader has acquired some familiarity with the fonts are printed in fine print.

The Alphabet

In order to typeset Greek text, you need to go into "Greek mode." This is achieved by typing `\begingreek` anywhere in your document; Greek mode will remain in effect until you type a matching `\endgreek`. While in Greek mode, the letters 'a' to 'z' and 'A' to 'Z' come out as Greek letters, according to the following code:

```

α β γ δ ε ζ η θ ι κ λ μ ν ξ ο π ρ σ τ υ φ χ ψ ω
a b g d e z h j i k l m n x o p r s t u f q y w

```

There is no digamma yet. The same character 's' will print as 'σ' or 'ς', depending on its position in a word.

The system does this by accessing a ligature of 's' with any other letter that follows it. If, for some reason, you want to print an initial/medial sigma by itself (as in the table above), or at the end of a word, you should type 'c'.

Try to typeset some simple text now. Create a file containing the following lines:

```

\input greekmacros % where \begingreek and
%                % other commands are defined
This is English text.
\begingreek
This is Greek text.
\endgreek

```

When you T_EX this file, you get the following gibberish:

This is English text. Της ις Γρεεκ τεξτ.

If you say `\greekdelims` near the top of your file, the character \$ can be used in place of both `\begingreek` and `\endgreek`. The control sequence `\math` takes on the former meaning of \$.

Editor's note: Thanks to Doug Henderson for METAFONTING the typesetter fonts from Silvio Levy's .MF source files. Doug was also responsible for the typesetter renditions of the APL fonts in TUGboat 8#3.

Accents and Breathings

To get an acute, grave or circumflex accent over a vowel, type ', ' or ~, respectively, before the vowel. To get a rough or smooth breathing, type < or > before the vowel (or rho) and any accent that it may have. To get an iota subscript, type | *after* the vowel. A diaeresis is represented by ", and if accompanied by an accent it can come before or after the accent.

For example, >en >arq~h| >~hn <o l'ogos gives ἐν ἀρχῇ ἦν ὁ λόγος. Neat, ain't it?

Accents and breathings, too, are typeset by means of ligatures: a vowel with a breathing, an accent and iota subscript, for example, is realized as a four-character ligature. The only exception is when a breathing is followed by a grave accent, in which case the breathing + accent combination is typeset as a \TeX \accent over the vowel. This means that words containing such combinations cannot be hyphenated in (standard) \TeX ; but this is not a problem because, with the exception of very rare cases of crasis, all such words are monosyllables.

Punctuation

Here's the table of correspondences for punctuation:

.	,	:	!	;	'	")
.	,	;	!	?	'	(())

The last three entries represent the apostrophe and quotations marks. The other available non-letters are the ten digits, parentheses, brackets, hyphen, em- and en-dashes, slash, percent sign, asterisk, plus and equal signs. All of these are accessible in the same way as under plain \TeX . In a future release there will be tick marks for numbers ($\alpha' = 1$, $\alpha = 1000$).

Hyphenation

A hyphenation table for both modern and ancient Greek is currently being debugged. For now one can use plain \TeX with its (English) hyphenation table, which gives the right results about 90% of the time (amazing, isn't it?). Be sure to proofread your text carefully, unless you've turned hyphenation off.

In standard \TeX , only one hyphenation dictionary can be used in a job. Thus, even with a Greek hyphenation table, a file that combines Greek and English text is likely to be incorrectly hyphenated. Michael Ferguson's extension to \TeX handles multiple hyphenation tables, and hyphenates words containing \accents (cf. the previous fine print paragraph).

Interaction with other macros

While in Greek mode you can do just about everything that you can outside: go into math mode, create boxes, alignments, and so on. The file `greekmacros.tex` sets things up so that in Greek mode the control sequences `\tt` and `\bf` switch to a typewriter and a bold Greek font, respectively: thus `{\tt s''>agap~w}` gives $\sigma' \acute{\alpha} \gamma \alpha \pi \tilde{\omega}$. (Try it.) On the other hand, there are no "italic" or slanted Greek fonts, so `\it` and `\sl` will give you the same fonts as outside Greek mode. The various constructions under $\mathcal{A}\mathcal{M}\mathcal{S}$ - \TeX and $\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ for increasing or decreasing point sizes don't work yet; they will in a future release.

The characters that form diacritics (<, >, ', ~, " and |) are treated differently depending on whether or not you're in Greek mode. More exactly, under plain \TeX these characters (with the exception of ~) have a `\catcode` of 12: they print as themselves, and they cannot appear in control words. But in Greek mode ', ~, " and | are "letters", that is, they have a `\catcode` of 11, while < and > are active, with a `\catcode` of 13. This may be important even for beginners because it means that ', for example, can be taken as part of a control word. Thus the sequence

```
\begingreek
\line{\wm'ega\hfil'alfa}
\endgreek
```

will cause an error message about an undefined control sequence `\hfil'alfa`, instead of printing

$\omega\acute{\mu}\acute{\epsilon}\gamma\alpha$ $\acute{\alpha}\lambda\phi\alpha$

as you might expect. (I hope classicists will forgive this use of the modern Greek one-accent system.) The solution, of course, is to remember to add a blank after the `\hfil`.

A more subtle problem arises when you use Greek text in macro arguments, if the arguments are scanned while you're outside Greek mode. This is because \TeX assigns `\catcodes` to tokens as it first reads them, so when the argument is plugged into the body of the macro the characters above have the wrong `\catcode`. If the legendary Jonathan Horatio Quick were to write

```
\def\hellenize#1{\begingreek #1\endgreek}
\hellenize{d'uo >'h tre~is,}
```

he would be unpleasantly surprised by the following output:

$\delta\acute{\upsilon}\tilde{\omega} \tilde{\eta} \tau\omicron\epsilon \iota\varsigma,$

which can be explained as follows: the ~, which should be a letter, is seen as an active character, and expands to a blank as in plain \TeX ; while the breathing, which should be active, is not, and in particular it doesn't do the right thing when next to the grave accent. Solutions to this problem require a bit of wizardry, and will not be discussed here; see, for example, Reinhard Wonneberger's article in the October, 1986 issue of *TUGboat*, especially pages 179-180.

Test of grreg10 on March 1, 1988 at 1352

Τῆ στιγμῇ τούτῃ νιώθω πόσο βαρὺ 'ναί τὸ μυστήριον τῆς
 ἑομολόγησιν. Ὡς τώρα, κανεὶς δὲν ξέρει πῶς πέρασα τὰ
 δυὸ χρόνια μου στὸ "Ἄγιον Ὄρος. Οἱ φίλοι μου θαρροῦν
 πῶς πῆγα νὰ δῶ βυζαντινὰ κονίσματα ἢ ἀπὸ μυστικοπάθεια
 νὰ ζήσω μιὰ περασμένη ἐποχὴ. Καὶ τώρα, νά, ντρέπομαι νὰ
 μιλήσω.

Πῶς νὰ τὸ πῶ; Θυμοῦμαι ἕνα ἀνοιξιὰτικο δειλινό, ποὺ
 κατέβαινα τὸν Ταύγετο, μιὰ ξαφνικὴ θύελλα μὲ κύκλωσε
 κοντὰ στοὺς Πενταυλοὺς. Τόσο φοβερὸς ἀνεμοσίφουνας,
 ποὺ ἔπεσα καταγῆς γιὰ νὰ μὴν γκρεμιστῶ. Οἱ ἀστραπὲς
 μ' ἔξωσαν ὀλοῦθε κι ἔκλεισα τὰ μάτια μὴν τυφλωθῶ,
 καὶ κατάχαμα, πίστομα, περίμενα. Ὅλο τὸ πανύψηλο
 βουνὸ ἔτρεμε, καὶ δυὸ ἔλατα δίπλα μου τσακίστηκαν ἀπ'
 τῆ μέση καὶ βρόντηξαν χάμου. Ἐνιωθα τὸ θειάφι τοῦ
 κεραυνοῦ στὸν ἀέρα, καὶ ξαφνικὰ ξέσπασε ἡ μπόρα, ἔπε-
 σεν ὁ ἀνεμος, καὶ χοντρές, θερμὲς στάλες βροχῆ χτύπη-
 σαν τὰ δεντρά καὶ τὸ χῶμα. Τὸ θυμάρι, ἡ θρούμπα, τὸ
 φασκόμηλο, τὸ φλισκούνη, χτυπημένα ἀπ' τὸ νερό, τίναξαν
 τίς μυρωδιὰς τους κι ὅλη ἡ γῆς μύρισε.

(From Kazantzakis' "Symposium")

'Ἄλλ' ἀκούσονται, ἐάνπερ εὖ δοκῆς λέγειν. τόδε δέ σου
 ἐνενόησα ἅμα λέγοντος, καὶ πρὸς ἑμαυτὸν σκοπῶ· εἰ ὅτι
 μάλιστά με Εὐθύφρων διδάξειεν, ὡς οἱ θεοὶ ἅπαντες τὸν
 τοιοῦτον θάνατον ἡγοῦνται ἄδικον εἶναι, τί μᾶλλον ἐγὼ
 μεμάθηκα παρ' Εὐθύφρονος, τί ποτ' ἐστὶν τὸ ὄσιόν τε καὶ
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 εἶη ἄν· ἀλλὰ γὰρ οὐ τούτῳ ἐφάνη ἄρτι ὠρισμένα τὸ ὄ-
 σιον καὶ μὴ· τὸ γὰρ θεομισὲς ὄν καὶ θεοφιλὲς ἐφάνη. ὥστε
 τούτου μὲν ἀφήμι σε, ὦ Εὐθύφρον· εἰ βούλει, πάντες αὐτὸ
 ἡγείσθων θεοὶ ἄδικον καὶ πάντες μισούντων. ἀλλ' ἄρα
 τοῦτο νῦν ἐπανορθώμεθα ἐν τῷ λόγῳ, ὡς δὲ μὲν ἂν πάντες
 οἱ θεοὶ μισῶσιν, ἀνόσιόν ἐστίν, δὲ δ' ἂν φιλῶσιν, ὄσιον· δ
 δ' ἂν οἱ μὲν φιλῶσιν, οἱ δὲ μισῶσιν, οὐδέτερα ἢ ἀμφοτέρω;
 ἄρ' οὕτω βούλει ἡμῖν ὠρίσθαι νῦν περὶ τοῦ ὄσιου καὶ τοῦ
 ἀνοσίου;

(From Plato's "Euthyphro")

Test of grrreg10 on February 6, 1988 at 1647

Τὴ στιγμή τούτη νιώθω πόσο βαρὺ 'ναι τὸ μυστήριο τῆς
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Πῶς νὰ τὸ πῶ; Θυμοῦμαι ἕνα ἀνοιξιὰτικο δειλινό, ποὺ
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καὶ κατάχαμα, πίστομα, περίμενα. "Ὅλο τὸ πανύψηλο
βουνὸ ἔτρεμε, καὶ δὺ ἔλατα δίπλα μου τσακίστηκαν ἀπ'
τῆ μέση καὶ βρόντηξαν χάμου. Ἐνιωθα τὸ θειάφι τοῦ
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ἀνοσίου;

(From Plato's "Euthyphro")

These text samples were set on a Xerox 4500; thanks to Tom Reid for
the METAFONT processing.

Test of grreg10 on March 1, 1988 at 1352

Page 2

	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	-	σα	σβ	σ'	σδ	σε	σφ	σγ	"0x
'01x	ση	σι	σθ	σκ	σλ	σμ	σν	σο	
'02x	σπ	σχ	σρ	σσ	στ	συ		σω	"1x
'03x	σξ	σψ	σζ		'	,	~	-	
'04x	"	!	-	-	~	%		'	"2x
'05x	()	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	.	'	=	'	;	
'10x	~	A	B	^	Δ	E	Φ	Γ	"4x
'11x	H	I	Θ	K	Λ	M	N	O	
'12x	Π	X	P	Σ	T	Υ	σ	Ω	"5x
'13x	Ξ	Ψ	Z	[~]	~	~	
'14x	`	α	β	σ	δ	ε	φ	γ	"6x
'15x	η	ι	θ	κ	λ	μ	ν	ο	
'16x	π	χ	ρ	ς	τ	υ		ω	"7x
'17x	ξ	ψ	ζ	"	.	"	-	—	
'20x	ά	ά	ά	σά	ά	ά	ά	σά	"8x
'21x	ά	ά	ά	σά	ά	ά	ά	σά	
'22x	ā	ā	ā	σā	ā	ā	ā	σā	"9x
'23x	ή	ή	ή	σή	ή	ή	ή	σή	
'24x	ή	ή	ή	σή	ή	ή	ή	σή	"Ax
'25x	ή	ή	ή	σή	ή	ή	ή	σή	
'26x	ώ	ώ	ώ	σώ	ώ	ώ	ώ	σώ	"Bx
'27x	ώ	ώ	ώ	σώ	ώ	ώ	ώ	σώ	
'30x	ῶ	ῶ	ῶ	σῶ	ῶ	ῶ	ῶ	σῶ	"Cx
'31x	ι	ι	ι	σι	ι	ι	ι	σι	
'32x	ι	ι	ι	σι	ι	ι	ι	σι	"Dx
'33x	ι	ι	ι	σι	ι	ι	ι	σι	
'34x	ε	ε	ε	σε	ε	ε	ε	σε	"Ex
'35x	ε	ε	ε	σε	ε	ε	ε	σε	
'36x	ι	ι	ι	ι	ι	ι	ι	ι	"Fx
'37x	φ	η	φ	ρ	ρ	σ	σ	σ	
	"B	"9	"A	"B	"C	"D	"E	"F	