User's Guide to AMSFonts Version 2.1

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Standard distributions of TEX ordinarily come with all the fonts specified in `PLAIN.TEX`, and they may also come with a number of additional fonts intended for use with LATEX. Additional fonts designed for use in mathematics and defined in $\mathcal{AMS}$-TEX are not always included among such font collections. For this reason, the American Mathematical Society has compiled a collection, known as AMSFonts, which contains fonts of symbols and several alphabets corresponding to symbols and alphabets used in AMS publications, including the MathSci online database.

> **Warning:** The fonts in this collection are suitable for use with $\mathcal{AMS}$-TEX Version 2.0+ and $\mathcal{AMS}$-LATEX Version 1.0+, but are not compatible with earlier versions of $\mathcal{AMS}$-TEX. If you are using an older version of $\mathcal{AMS}$-TEX and are intending to use fonts from this Version 2.1 collection, you should obtain a new version of $\mathcal{AMS}$-TEX. Similarly, earlier versions of this collection are not compatible with $\mathcal{AMS}$-TEX Version 2.0+.

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Contents of the AMSFonts collection

The AMSFonts collection contains the following fonts, in the sizes indicated:

- The Euler family, all but EUEX in 5, 6, 7, 8, 9, and 10 point:
  - Fraktur (German), medium-weight and bold (EUFM and EUFB)
  - "Roman" cursive, medium-weight and bold (EURM and EURB)
  - Script, medium-weight and bold (EUSM and EUSB)
  - Euler-compatible extension font (EUEX), in 7, 8, 9, and 10 point
- Additional sizes of some Computer Modern math fonts (the 10-point fonts are included in standard TEX distributions):
  - bold math italic (CMMIB), in 5, 6, 7, 8, and 9 point
  - bold math symbols (CMBSY), in 5, 6, 7, 8, and 9 point
  - math extension font (CMEX), in 7, 8, and 9 point (the 10-point font is included in standard TEX distributions)

- Extra math symbols, in 5, 6, 7, 8, 9, and 10 point:
  - first series, medium-weight (MSAM)
  - second series, including Blackboard Bold, medium-weight (MSBM)
- Cyrillic, developed at the University of Washington
  - lightface (WNCYR), in 5, 6, 7, 8, 9, and 10 point
  - bold (WNCYB), in 5, 6, 7, 8, 9, and 10 point
  - italic (WNCYI), in 5, 6, 7, 8, 9, and 10 point
  - caps and small caps (WNCYSC), in 10 point
  - sans serif (WNCYSS), in 8, 9, and 10 point
- Computer Modern caps and small caps (CMCSC), in 8 and 9 point (the 10-point font is included in standard TEX distributions)
- The "dummy font," used in $\mathcal{AMS}$-TEX for syntax checking, exists only as metrics (`DUMMY.TFM`)
- Other files needed to use these fonts:
  - `AMSSYM.TEX`, a file defining the symbols in fonts MSAM and MSBM
  - `AMSSYM.DEF`, a file that loads the fonts MSAM, MSBM and EUFM and defines some control sequences required by `AMSSYM.TEX`
  - `CYRACC.DEF`, a file containing definitions needed for proper access to characters in the cyrillic fonts
- Other useful files:
  - `USERDOC.TEX`, the source file for this User's Guide
  - `USERDOC.CYR`, the source file for the table showing cyrillic input conventions, input by `USERDOC.TEX`
  - `USERDOC.FNT`, the source file for the tables of the principal 10-point fonts in the AMSFonts collection, input by `USERDOC.TEX`; this file may also be TEXed by itself
  - `USERDOC.DEF`, the macros used to format this User's Guide
  - `USERDOC.INS`, the source file for the appendixes to this User's Guide, input by `USERDOC.TEX`; this file may also be TEXed by itself

Each font at a particular size is provided in seven standard TEX magnifications, magsteps 0 through 5, including magstephalf. The AMSFonts package for the IBM PC and compatibles includes all magnifications. For use with *Textures* on the Macintosh, the Standard AMSfonts package includes only magsteps 0 and 1; the Extended AMSFonts package includes all seven magnifications. All instances of every font have been newly generated for this release of the AMSFonts collection.

The philosophy under which the Euler fonts were implemented was different from that used for Computer Modern, and the result is a lower degree of "meta-ness". For that reason, the appearance of these fonts is not very good at small sizes when output on low-resolution devices, in particular on screens. Even so, the fonts are included in AMSFonts in all the sizes and magnifications offered, on the assumption that the printed output will be prepared on a device of higher resolution (at least 300dpi) where this effect will not be noticeable.

Figure 1 shows the layouts for the 10-point fonts listed above. Where both medium-weight and bold versions are listed, only the medium-weight layout is shown. The bold fonts have the same layout as the corresponding medium-weight versions.

FIGURE 1A. Layouts of the AMSFonts — Euler

Note: The charts shown in this figure were set with the 10-point versions of the indicated fonts, then photographically reduced.

Charts to appear here:
Euler: EUFM10, EURM10, EUSM10, EUEX10

FIGURE 1B. Layouts of the AMSFonts—
Computer Modern bold math; extra symbols

Charts to appear here:

Symbols: MSAM10, MSBM10

Computer Modern bold math: CMMIB10, CMBSY10

FIGURE 1C. Layouts of the AMSFonts—
Computer Modern math extension; caps/small caps; cyrillic

Charts to appear here:

Math extension: CMEX10

Caps/small caps: CMCSC10

Cyrillic: WNCYR10, WNCYI10

Font naming conventions

Developers of fonts for use with TEX, at least those using METAFONT, generally try to make the names distinctive, so that a user will know the origin of the font by the font name. For most of the fonts in the AMSFonts collection, the first two letters identify the font source, as follows:

- "CM": These fonts are based directly on the specifications for Knuth's Computer Modern fonts, as described in Volume E of *Computers & Typesetting* [DEK86E].
- "EU": These are members of the Euler family, described below.
- "MS": These fonts of math symbols were developed by or under the direction of the AMS staff.
- "WN": These cyrillic fonts were developed at or under the direction of the University of Washington Humanities and Arts Computing Center, and are distributed with their permission.

DUMMY is a special case; it was developed as part of the Stanford University TEX Project, and follows no particular naming convention.

For information on CM fonts other than those specifically named here, and on other fonts in general, the TEX Users Group (TUG) is the best source. For TUG's address, see the section **For further information**.

History of these fonts

When the AMS began using TEX to produce its publications, the available complement of symbols was found to be inadequate. Several alphabets used extensively as symbols were not available either. While development of the symbols could be undertaken by in-house personnel, using the existing TEX symbol font as a model, the creation of new Fraktur and script alphabets required the assistance of someone with experience in font design.

Euler

With Donald Knuth's assistance and encouragement, Hermann Zapf, one of the premier font designers of this century, was commissioned to create designs for Fraktur and script, and for a somewhat experimental, upright cursive alphabet that would represent a mathematician's handwriting on a blackboard and that could be used in place of italic. The designs that resulted were named Euler, in honor of Leonhard Euler, a prominent mathematician of the eighteenth century. Zapf's designs were rendered in METAFONT code by graduate students at Stanford, working under Knuth's direction; the process by which the METAFONT fonts were implemented is described in a report by David Siegel [DRS85]. The Euler fonts were designed to be used as symbols; they are not intended for setting running text.

The Fraktur face of the Euler family has been used by the AMS for several years in its production. However, no extensive test or use had been made of the script or cursive until Knuth decided that they should be used in a textbook, *Concrete Mathematics*, written by him and two co-authors [GKP88]. During

the course of preparing that book, a number of errors, particularly in spacing parameters affecting the placement of sub- and superscripts, were discovered. All these errors have been corrected in the new medium-weight versions of the Euler fonts (almost no boldface symbols were used in *Concrete Mathematics*). Knuth also noticed that the style of some symbols in the Computer Modern extension font, in particular the integral sign, was too slanted to be attractive with Euler, and consequently he prepared a new (partial) extension font for use with Euler. Knuth has described his experience with the Euler fonts in a *TUGboat* article [DEK89]. In the article he also identifies the macros he used and where they can be obtained.

Additional Computer Modern fonts for use in math

Only the 10-point size of the Computer Modern bold math italic (which includes Greek), symbol, and math extension fonts are included in standard distributions of TEX. Since these symbols are often needed in mathematics, other sizes have been constructed, using the principles demonstrated in Knuth's *Computer Modern Typefaces* [DEK86E], and included in the AMSFonts collection.

Symbols

Two fonts of "extra" symbols are included in the AMSFonts collection. These are named MSAM and MSBM, and have been newly implemented in "new" METAFONT (MF84); they replace earlier fonts (named MSXM and MSYM) that were defined in old METAFONT (MF79). These fonts contain symbols needed in the publishing program of the AMS, including the MathSci online database, and include the uppercase letters of an alphabet known as Blackboard Bold ($\mathbb{A}, \ldots, \mathbb{Z}$).

Cyrillic

Titles of books reviewed in *Mathematical Reviews* are traditionally rendered in their original language. For books published in Russian or other Slavic languages, this frequently requires use of the cyrillic alphabet. A cyrillic font was developed at AMS using METAFONT79 with the AM fonts as a model. This font was organized in a manner suitable for use with the transliteration scheme adopted by *MR* in 1980, and contained only those letters which appear in current mathematical literature. In particular, this meant that the letters dropped from the Russian alphabet after the Revolution of 1917, and some letters used in non-Slavic languages now rendered in cyrillic (such as Azerbaijani, from which no mathematical literature is currently reviewed in *MR*) were absent.

In 1988, the Humanities and Arts Computing Center of the University of Washington undertook a font development project for support of scholars in Slavic languages. The fonts developed through this project include several different font layouts. One layout is based on that of the original AMS cyrillic augmented with 'й' (cyrillic short 'i'), 'ё' (umlauted 'e'), and several pre-Revolutionary letters. The fonts with the AMS layout are included in the AMSFonts collection with the

permission of the University of Washington developers. For information on cyrillic fonts with other layouts, see the section **For further information**.

The cyrillic fonts are based on Computer Modern letter shapes. Type styles include ordinary upright, bold (based on CM bold extended), caps and small caps, italic, and upright sans serif. The principal text fonts (upright, italic and boldface) are present in sizes from 5 through 10 point; sans serif is in sizes 8, 9 and 10 point; caps and small caps are in 10 point only.

Caps/small caps

The font CMCSC10 is referenced in `PLAIN.TEX` and should be included in all standard TEX distributions. However, Knuth did not generate this font in any other sizes. The AMSFonts collection includes 8 and 9-point sizes, generated according to the same principles as other CM fonts of these sizes.

Dummy font

This is a pseudo-font, which exists only as a set of metrics. Mainframe TEX distributions contain this font in "property list" (`.PL`) format, a human-readable file that contains everything in the corresponding `.TFM` file. (Transformation between `.PL` and `.TFM` formats can be accomplished by the programs `PLtoTF` and `TFtoPL`; for convenience, the AMSFonts collection includes the file `DUMMY.TFM`.) Specifically, the dummy font contains no ligature or kerning information, and all dimensions and parameter values are set to zero.

The dummy font is used in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX to implement "syntax checking." (Syntax checking is activated by the `\printoptions` command as described in *The Joy of TEX* [MDS86].) In this mode, the dummy font replaces all the usual "printing" fonts, so that TEX never accumulates any text to be set, and never tries to write out a page, but in the process of reading the input file, checks all control sequences for syntactic correctness. In this mode, an input file will be processed perhaps 30 percent faster than if it were actually being set. However, some errors and conditions are not detected during a syntax check; in particular, overfull boxes will not be detected until setting actually occurs.

How to use AMSFonts 2.1 with $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX 2.0+

In *The Joy of TEX*, Michael Spivak describes various fonts that are used in mathematics in addition to the fonts provided with the standard distributions of TEX. Two references in particular are of interest with respect to AMSFonts: the section **Fonts in math mode** in Chapter 20, and Appendix F, **Further fonts**. The first describes the use of letters from alphabets, including Fraktur, and the second, mostly nonalphabetic symbols.

> **Warning:** This information is effective as of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX version 2.0+, August 1991 and the 2nd edition of *The Joy of TEX* [MDS90]. The handling of non-`PLAIN` fonts in earlier versions is different from what is described here. If you have an earlier version of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, it is highly recommended that you obtain $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX Version 2.0+, which is available from AMS and most TEX distributors.

Instructions for using the fonts of the AMSFonts collection with $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX are also given in the *User's Guide to $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX Version 2.1* [AMS91] and in Appendix F of editions of *The Joy of TEX* [MDS90] dated 1990 or later.

Additional fonts to be used with $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX should be specified at the top of the document input file, in what is known as the "preamble." The arrangement of commands at the top of an input file is the following:

```
\input amstex
⟨preamble commands⟩
\documentstyle{...}
```

$\mathcal{A}\mathcal{M}\mathcal{S}$-TEX provides a simple method for accessing most of the fonts in the AMSFonts collection. The two extra symbol fonts and Euler Fraktur are loaded automatically by the preprint style (`AMSPPT.STY`). If you are using $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, but not the preprint style, the method used to load these fonts and define the associated symbol names depends on how many symbols will be needed. If a lot of the symbols will be needed, or you aren't worried about memory space and just want to do what is easiest, all three fonts will be loaded and the symbol names defined if you type the command `\UseAMSsymbols` in the preamble. This will load the file `AMSSYM.TEX`, in which all the symbol names (more than 200 of them) are defined. If only a few symbols from these fonts are needed, the commands `\loadmsam`, `\loadmsbm`, and `\loadeufm` will load the medium-weight versions of the two extra symbol fonts and Euler Fraktur respectively. The command `\newsymbol` can then be used to define just those symbols that are needed; its use is described below, in the section **Installing and using the extra symbols**.

> **Warning:** Additional fonts from the AMSFonts collection can be accessed easily in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX. However, users should be aware that TEX limits the number of math mode font families to 16, of which 11 are predefined in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX. Only those additional families should be activated that will actually be used in a document, to avoid exceeding the limit.

Two sizes of fonts, suitable for body text and for passages requiring smaller type (e.g. abstracts and footnotes), are incorporated in the preprint style `AMSPPT.STY`. These are accessed through the control sequences `\tenpoint` and `\eightpoint`, which are ordinarily referred to only by higher-level commands that identify the kind of text being input (e.g. `\title`, `\abstract`, `\footnote`). Most fonts in the AMSFonts collection have `\load...` instructions defined in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX and will be accessed properly for use with the preprint style when the `\load` instructions are included in the preamble of the document input. If you are not using the preprint style, you can use the font definitions in `AMSPPT.STY` as a model.

> **Warning:** Editions of *Joy* prior to 1990 describe an obsolete method of accessing these fonts. The directions given in Appendix F of these older editions are superseded by the `\load...` instructions cited here for Euler, bold math italic, and symbol fonts.

Euler

The Euler fonts are defined only in math mode, in sizes appropriate for text and two orders of sub- and superscripts. They can be activated by invoking the proper `\load` instructions before the `\documentstyle` command, in the preamble of a paper in which the fonts are to be used. (The medium-weight Fraktur font is activated automatically by the preprint style.) The Euler fonts can be activated by the following commands:

`\loadeufm`	Euler Fraktur medium (automatic with the preprint style)
`\loadeufb`	Euler Fraktur bold
`\loadeurm`	Euler cursive medium
`\loadeurb`	Euler cursive bold
`\loadeusm`	Euler script medium
`\loadeusb`	Euler script bold

After the EUFM font has been loaded, the medium-weight Fraktur letters can be produced by typing `\frak` followed by the desired letter. For example, `$\frak g \frak A$` yields $\mathfrak{g}\mathfrak{A}$. $\mathcal{AMS}$-TEX 2.1 also defines `\eufm`, `\eufb`, `\eurm`, `\eurb`, `\eusm` and `\eusb`

Computer Modern bold math italic and symbols

The Computer Modern bold math italic (CMMIB) and bold math symbol (CMBSY) fonts can both be loaded by the command `\loadbold`; there are no predefined commands to load them separately. `\loadbold` must be invoked in the preamble of the document input file.

A rather elaborate mechanism has been defined in $\mathcal{AMS}$-TEX to simplify access to bold letters and symbols, in math mode only. Three control sequences are available, each of which affects a particular class of characters:

`\bold`	for a single letter or numeral
`\boldkey`	for other symbols that appear on the keyboard
`\boldsymbol`	for a symbol specified by a single control sequence

These facilities are described in more detail in the *User's Guide to $\mathcal{AMS}$-TEX Version 2.1* [AMS91] and editions of *Joy* published in 1990 or later [MDS90].

Computer Modern math extension font

Smaller sizes of the math extension font are appropriate for use in text smaller than ten-point and in sub- and superscripts. They are provided automatically for these environments in the preprint style. If you are not using the preprint style, you can use the font definitions in either `AMSPPT.STY` or Appendix E of *The TEXbook* [DEK86A] as a model.

Extra symbols

The medium-weight versions of the two extra symbol fonts are available automatically, including all the symbol names, if you are using the preprint style or if you have specified `\input amssym`. If you wish to load these fonts separately, use the appropriate control sequence `\loadmsam` or `\loadmsbm` in the preamble of your document. If you load the fonts separately, a few symbols will be defined when one of the fonts is loaded, but most must be defined using the `\newsymbol` command before they can be used. See the section **Installing and using the extra symbols** for information on both the symbol names and on using `\newsymbol` to define them.

Cyrillic

Cyrillic is not referred to in the $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX files as distributed. The cyrillic fonts included in AMSFonts are intended for use mainly in text, not as symbols in math. Detailed instructions for loading and using cyrillic appear below in the section **Installing and using cyrillic**.

Caps/small caps

Caps/small caps are loaded automatically by the $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX preprint style for use in ten-point and eight-point text. If you are not using the preprint style, you can use the font definitions in either `AMSPPT.STY` or Appendix E of *The TEXbook* [DEK86A] as a model.

Dummy font

No special action is needed to use the dummy font with $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX. It is already built into the syntax checking procedure.

How to use AMSFonts 2.1 without $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX

For the most part, it is assumed that anyone using AMSFonts without $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX has some experience with TEX macros or has a friendly relationship with a TEXnician. Since all applications seem to refer to fonts in different ways, no assumptions are made about how any "average" user is going to use these fonts. However, some general guidelines may be helpful.

Two models for defining fonts should be accessible to most users:

- Appendix E of *The TEXbook* contains size-specific font definitions for `\tenpoint`, `\ninepoint` and `\eightpoint` that permit size-switching, including support of mathematics.
- `AMSPPT.STY`, the file of macros supporting the $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX preprint style, contains similar font definitions, `\tenpoint` and `\eightpoint`.

Extensive size-switching font facilities are also present in LATEX, but these cannot easily be copied for uses outside of LATEX.

Before attempting to load all available fonts into every TEX job, determine (if you can) how many fonts can be accommodated by the implementation of TEX you are using. It is generally a good idea to load seldom-used fonts selectively.

Euler

The following commands will load the medium-weight Euler Fraktur font, and can be used as a model for accessing the other Euler fonts.

```
\font\teneufm=eufm10
\font\seveneufm=eufm7
\font\fiveeufm=eufm5
\newfam\eufmfam
\textfont\eufmfam=\teneufm
\scriptfont\eufmfam=\seveneufm
\scriptscriptfont\eufmfam=\fiveeufm
\def\eufm#1{{\fam\eufmfam\relax#1}}
```

Individual letters in the Euler fonts are accessible by the ordinary letters on your keyboard, once the font has been loaded and named by a control sequence equivalent to `\eufm`.

The medium-weight Fraktur font, EUFM, can also be loaded by `\input amssym.def`; this loads the two extra symbol fonts as well.

Computer Modern bold math italic and symbols

The CMMIB and CMBSY fonts can be loaded and made accessible to math in ten-point environments by the following code:

```
\font\tencmmib=cmmib10  \skewchar\tencmmib='177
\font\sevencmmib=cmmib7 \skewchar\sevencmmib='177
\font\fivecmmib=cmmib5  \skewchar\fivecmmib='177
\newfam\cmmibfam
\textfont\cmmibfam=\tencmmib \scriptfont\cmmibfam=\sevencmmib
 \scriptscriptfont\cmmibfam=\fivecmmib

\font\tencmbsy=cmbsy10  \skewchar\tencmbsy='60
\font\sevencmbsy=cmbsy7 \skewchar\sevencmbsy='60
\font\fivecmbsy=cmbsy5  \skewchar\fivecmbsy='60
\newfam\cmbsyfam
\textfont\cmbsyfam=\tencmbsy \scriptfont\cmbsyfam=\sevencmbsy
 \scriptscriptfont\cmbsyfam=\fivecmbsy
```

The TEX primitive `\mathchar` must be used to access individual characters from a font in math mode. `\mathchar`, like the `\char` primitive, requires that you know the position in the font of the character you are accessing. However, `\mathchar` also requires that you specify the "class" and the family of the math character being accessed. See Chapter 17 of *The TEXbook* for more details on the use of `\mathchar`, as well as `\mathchardef`, which will allow you to define your own macro names for individual characters in these fonts.

Note: The file `AMSSYM.DEF` contains a convenient macro, `\hexnumber@`, to determine the family number of the font being accessed through `\mathchar`. For example, the `\mathchar` statement to properly access the bold alpha in the CMMIB font would be:

```
\mathchar"0\hexnumber@\cmmibfam0B
```

Computer Modern math extension font

The 10-point CMEX font is loaded by `PLAIN.TEX`. To install the 7-point size appropriate for sub- and superscripts in a ten-point math environment, include the following code in your file:

```
\font\sevenex=cmex7
\scriptfont3=\sevenex \scriptscriptfont3=\sevenex
```

To use other sizes implies the use of switchable-size fonts, which may be implemented according to the models cited at the beginning of this section.

Extra symbols

Detailed instructions for accessing the MSAM and MSBM fonts are given in the section **Installing and using the extra symbols**.

Cyrillic

See the section **Installing and using cyrillic** for instructions.

Caps/small caps

The 10-point CMCSC font is loaded by `PLAIN.TEX`. To use the smaller versions implies the use of switchable-size fonts, which may be implemented according to the models cited at the beginning of this section.

Dummy font

The dummy font was designed to be used for syntax checking. The general technique is described in Appendix D of *The TEXbook*, p. 401. This has been implemented in the file `AMSTEX.TEX`, which can be used as a model.

Installing and using cyrillic

The cyrillic fonts in the AMSFonts collection have been designed so that input using the transliteration conventions of *Mathematical Reviews* will be converted directly to cyrillic text. The following cyrillic fonts are included:

WNCYR (upright), in sizes 5, 6, 7, 8, 9, and 10 point

WNCYB (bold), in the same range of sizes as WNCYR

WNCYI (italic), in the same range of sizes as WNCYR

WNCYSC (caps and small caps), in size 10 point

WNCYSS (upright sans serif), in sizes 8, 9, and 10 point

The file `CYRACC.DEF`, which is included in the AMSFonts collection, must be input to any document using the cyrillic fonts as defined with the AMS layout. Since the cyrillic alphabet contains more letters than the roman alphabet, some cyrillic letters are accessed by combinations of roman letters, accented letters, or control sequences. `CYRACC.DEF` contains the definitions of these accents and control sequences. If this file is not input, some cyrillic letters will be inaccessible.

Making cyrillic available to a document

If you are not using $\mathcal{AMS}$-TEX, include the following instructions near the top of the document input file to make the 10-point cyrillic font available for use in text (see below for cyrillic in math):

```
\input cyracc.def
\font\tencyr=wncyr10
\def\cyr{\tencyr\cyracc}
```

If you require cyrillic text in more than one size, you must take a different approach in defining `\cyr`. An appropriate model appears in Appendix E of *The TEXbook* [DEK86A], pages 414–15. The definition of `\cyr` should be incorporated into size-specific macros such as `\tenpoint` and `\eightpoint` similarly to what is done there for `\bf`. Don't forget to include the command `\cyracc` in the definition.

If you are using $\mathcal{AMS}$-TEX and the preprint style, the following instructions should be included in the preamble of your document input file to make cyrillic available in 10-point and 8-point text:

```
\input cyracc.def
\catcode`\@=11
\font@\tencyr=wncyr10
\font@\eightcyr=wncyr8
\catcode`\@=13
\addto\tenpoint{\def\cyr{\tencyr\cyracc}}
\addto\eightpoint{\def\cyr{\eightcyr\cyracc}}
```

(The `\font@` command not only loads the fonts, but also makes them behave properly during syntax checking.) If you are not using the preprint style, you can use the font definitions in either `AMSPPT.STY` or *The TEXbook* Appendix E as a model.

The macro definitions in `CYRACC.DEF` govern the behavior of cyrillic-specific control sequences, including accents, in cyrillic and noncyrillic text. Definitions governing noncyrillic text are activated as soon as `CYRACC.DEF` is `\input`. This will permit text input according to the scheme shown in Figure 2 to be typeset in transliterated form, according to the *MR* conventions. To produce actual cyrillic text, enclose the cyrillic input in a group that begins with the instruction `\cyr` *inside* the group, as

```
...{\cyr ...} ...
```

Enclosing in braces both the `\cyr` and the text to be set in cyrillic type, in the same way that an italic phrase would be indicated in a roman text, is particularly important for two reasons. First, like `\it`, `\cyr` must be explicitly terminated to return to roman text. And second, unlike `\it`, the special cyrillic control sequences invoked by `\cyracc` are interpreted differently by TEX depending on whether they are in a cyrillic or a noncyrillic environment. The "cyrillic" interpretation is not turned off simply by invoking `\rm`. Failure to follow this practice will yield gibberish.

Cyrillic input

The table in Figure 2 follows the alphabetical order of the table published in the 1983 MR author index. The three paired columns contain: (1) Cyrillic; (2) Input; (3) Transliteration.

The letters in the Cyrillic columns will appear in the typeset output when the corresponding codes from the Input columns are used in the `{\cyr ...}` context described above. The roman letters in the Transliteration columns will appear in the output when the corresponding codes from the Input columns are used in a noncyrillic environment, i.e., have not been preceded by `\cyr`.

Several points should be noted here.

- Input codes for uppercase cyrillic which consist of more than one letter, e.g. `Zh` ↦ Ж, can also be input in all caps, e.g. `ZH` ↦ Ж, if the context is entirely in caps.
- Particular care is necessary when the letter t ↦ т is followed by s ↦ с. The control sequence `\cydot` ("cyrillic dot") is provided as a separator to keep those letters distinct: `t\cydot s` (t·s) ↦ тс. Otherwise, they will be combined as ts ↦ ц.

  The t·s pair appears, for example, in the word `sovet\cydot ski\u\i` (sovet·skiĭ) ↦ советский and is not uncommon in the suffix of reflexive verbs, e.g. `nakhodyat\cydot sya` (nakhodyat·sya) ↦ находятся.
- Because there is not a one-to-one correspondence between cyrillic and roman letters, some cyrillic letters have been placed in locations where a roman letter does not have a cyrillic counterpart. A user who is aware of this fact may be able to detect input keying that does not conform to the recommendations shown in Figure 2, and correct it more easily than otherwise. The following nonstandard assignments have been made:

  `c` ↦ ц; `h` ↦ х; `q` ↦ ч; `w` ↦ щ; `x` ↦ ш.
- Some very strange effects can occur in cyrillic text hyphenated by the default English hyphenation rules; in particular, a cyrillic letter input as a group of letters can be decomposed. (Most multiple-letter input groups are converted to a single cyrillic letter by way of TEX's ligaturing mechanism.) For example, `shch` ↦ щ might, in especially unlucky circumstances, be decomposed as с-хч, ш-ч or 7-х. In other words, if there is any chance that cyrillic text might fall into a position where hyphenation could occur, the results should be checked very carefully, and discretionary hyphens used as appropriate.

FIGURE 2. Input conventions for AMS cyrillic

Cyrillic		Input		Translit.		Cyrillic		Input		Translit.	
А	а	A	a	A	a	Р	р	R	r	R	r
Б	б	B	b	B	b	С	с	S	s	S	s
В	в	V	v	V	v	Т	т	T	t	T	t
Г	г	G	g	G	g	Ћ	ћ	\'C	\'c	Ć	ć
Д	д	D	d	D	d	Ќ	ќ	\'K	\'k	Ќ	ќ
Ђ	ђ	Dj	dj	Dj	dj	У	у	U	u	U	u
Ѓ	ѓ	\'G	\'g	Ǵ	ǵ	Ў	ў	\u U	\u u	Ŭ	ŭ
Е	е	E	e	E	e	Ф	ф	F	f	F	f
Ё	ё	\"E	\"e	Ë	ë	Х	х	Kh	kh	Kh	kh
Є	є	\=E	\=e	Ē	ē	Ц	ц	Ts	ts	Ts	ts
Ж	ж	Zh	zh	Zh	zh	Ч	ч	Ch	ch	Ch	ch
З	з	Z	z	Z	z	Џ	џ	\Dzh	\dzh	Dzh·	dzh·
И	и	I	i	I	i	Ш	ш	Sh	sh	Sh	sh
І	і	\=I	\=\i	Ī	ī	Щ	щ	Shch	shch	Shch	shch
Ї	ї	\"I	\"\i	Ï	ï	Ъ	ъ	\Cdprime	\cdprime	″	″
Ј	ј	J	j	J	j	Ы	ы	Y	y	Y	y
Й	й	\u I	\u\i	Ǐ	ǐ	Ь	ь	\Cprime	\cprime	′	′
К	к	K	k	K	k	Э	э	\`E	\`e	È	è
Л	л	L	l	L	l	Ю	ю	Yu	yu	Yu	yu
Љ	љ	Lj	lj	Lj	lj	Я	я	Ya	ya	Ya	ya
М	м	M	m	M	m	S	s	\Dz	\dz	Dz	dz
Н	н	N	n	N	n	№		N0		N0	
Њ	њ	Nj	nj	Nj	nj	«		<		¡	
О	о	O	o	O	o	»		>		¿	
П	п	P	p	P	p			\cydot		·	

- Hyphenation patterns do not exist for the AMS cyrillic font when the input conventions shown here are used. Furthermore, it is probably impracticable to attempt to develop such rules, since the rules to recognize control sequences and complicated ligatures, both used extensively by the AMS cyrillic input conventions, are not easily specified to TEX's hyphenation mechanism. Another approach to hyphenation, requiring some changes to the cyrillic `.TFM` files, has been described by Dimitri Vulis in a *TUGboat* article [DLV89].

Cyrillic in math

Although the cyrillic fonts are intended for use as text, the need occasionally arises to use one or two letters in math; for example, Ш may be used to represent the Shafarevich group. When cyrillic must also be made available to math mode, the following instructions (which will support the use of cyrillic in both text and math)

should replace the definition of \cyr shown previously (which will work only for text):

```
\newfam\cyrfam
\font\tencyr=wncyr10
\font\sevencyr=wncyr7
\font\fivecyr=wncyr5
\def\cyr{\fam\cyrfam\tencyr\cyracc}
\textfont\cyrfam=\tencyr \scriptfont\cyrfam=\sevencyr
  \scriptscriptfont\cyrfam=\fivecyr
```

If only the 10-point cyrillic font has been accessed, the references to \sevencyr and \fivecyr can be changed to \tencyr to save memory. When using $\mathcal{AMS}$-TEX and the preprint style, use \font@ instead of \font, remembering to change the \catcode of the @ appropriately, and embed the font family specifications in \addto\tenpoint, as shown above.

If other base text sizes are used besides ten point, the suggestions given above under **Making cyrillic available** apply here as well.

Installing and using the extra symbols

Most users of the extra symbol fonts will probably want to make them accessible to their TEX jobs with the least possible fuss. For $\mathcal{AMS}$-TEX users, these fonts are available automatically with the preprint style, and other methods of loading them for use with $\mathcal{AMS}$-TEX are described above.

If you are not using $\mathcal{AMS}$-TEX, the easiest method of loading these fonts and defining the control sequences for accessing the symbols is to place the commands

```
\input amssym.def
\input amssym
```

at the top of your input file. This will load the fonts MSAM, MSBM, and EUFM in sizes 10, 7, and 5 point, suitable for use in ordinary ten-point math environments, and define the names of all the symbols in these fonts. However, this assigns more than 200 control sequence names, so if you are limited for space, an alternative method may be preferred.

If you type just \input amssym.def, the fonts will be loaded, but only the names of the few special symbols listed below will be defined.

First there are four symbols that are normally used outside of math mode:

✓	\checkmark	®	\circledR
✠	\maltese	¥	\yen

These symbols, like ¶, §, †, and ‡, can also be used in math mode, and will change sizes correctly in subscripts and superscripts.

Next are four symbols that are "delimiters" (although there are no larger versions obtainable with \left and \right), so they must be used in math mode:

⌜	\ulcorner	⌝	\urcorner
⌞	\llcorner	⌟	\lrcorner

Finally, two dashed arrows are constructed from symbols in this family (note that one of them has two names; it can be accessed by either one):

⇢ `\dashrightarrow`, `\dasharrow` ⇠ `\dashleftarrow`

The Blackboard Bold letters $\mathbb{A}, \ldots, \mathbb{Z}$ can be accessed by typing (in math mode) `\Bbb A`,...,`\Bbb Z`.

Wider versions of the PLAIN.TEX `\widehat` and `\widetilde` are now available.

Letters in the EUFM font can be accessed (in math mode) by typing, for example, `\frak A \frak g` to get $\mathfrak{Ag}$. For the other Euler fonts, see the "Euler" subsections under **How to use AMSFonts 2.1 with $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX 2.0+** and **How to use AMSFonts 2.1 without $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX**.

The `\newsymbol` command

All other symbols of the MSAM and MSBM fonts must be named by control sequences so that they can be used (in math mode only) when the fonts are loaded. If you are very short on space for control sequence names, and need only a few of these symbols, you can omit the loading of AMSSYM.TEX and instead assign only the names you will need by using the command `\newsymbol` for each symbol you need, to create a control sequence that will properly produce that symbol. The control sequence can be either the "standard" name, as listed below, or one of your own choosing.

The list of symbols below shows for each symbol the symbol itself, a four-character "ID," and the "standard" name of the symbol. (The first character of the ID identifies the font family in which a symbol resides. Symbols from the MSAM family have `1` as the first character; symbols from the MSBM family have `2` as the first character.) For example, the symbol $\nleqslant$ appears as

$\nleqslant$ `230A \nleqslant`

To produce a control sequence with this name, the instruction

```
\newsymbol\nleqslant 230A
```

appears in the file AMSSYM.TEX. This same instruction can be typed by a user who is not using the $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX preprint style and has chosen not to load all the symbols, and thereafter the control sequence `\nleqslant` will produce the symbol $\nleqslant$ (in math mode), and will act properly as a "binary relation."

A few symbols in these fonts replace symbols defined in PLAIN.TEX by combinations of symbols available in the Computer Modern fonts. These are `\angle` ($\angle$) and `\hbar` ($\hbar$) from the group "Miscellaneous symbols," and `\rightleftharpoons` ($\rightleftharpoons$) from the group "Arrows" below. The new symbols will change sizes correctly in subscripts and superscripts, provided that you are using appropriate redefinitions. In order to use `\newsymbol` to replace an existing definition, the name must first be "undefined." Here are the lines you must put in your file if you are not using the $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX preprint style or `\input amssym` (which perform the redefinition automatically):

```
\undefine\angle
```

```
\newsymbol\angle 105C
\undefine\hbar
\newsymbol\hbar 207E
\undefine\rightleftharpoons
\newsymbol\rightleftharpoons 130A
```

These symbols are flagged in the tables below with a "(U)," as a reminder that they must be undefined.

Note in the tables that some symbols are shown with two names; in such a case, either one can be used to access the symbol.

- **Lowercase Greek letters**

F	207A	\digamma	$\varkappa$	207B	\varkappa

- **Hebrew letters**

ב	2069	\beth	ג	206A	\gimel
ד	206B	\daleth			

- **Miscellaneous symbols**

$\hbar$	207E	\hbar (U)	‵	1038	\backprime
$\hbar$	207D	\hslash	∅	203F	\varnothing
△	134D	\vartriangle	▲	104E	\blacktriangle
▽	104F	\triangledown	▼	1048	\blacktriangledown
□	1003	\square	■	1004	\blacksquare
◊	1006	\lozenge	⧫	1007	\blacklozenge
Ⓢ	1073	\circledS	★	1046	\bigstar
∠	105C	\angle (U)	◁	105E	\sphericalangle
∡	105D	\measuredangle			
∄	2040	\nexists	∁	107B	\complement
℧	2066	\mho	ð	2067	\eth
ⅎ	2060	\Finv	⁄	231E	\diagup
⅁	2061	\Game	╲	231F	\diagdown
𝕜	207C	\Bbbk			

- **Binary operators**

∔	1275	\dotplus	⋉	226E	\ltimes
∖	2272	\smallsetminus	⋊	226F	\rtimes
⋒	1265	\Cap, \doublecap	⋋	1268	\leftthreetimes
⋓	1264	\Cup, \doublecup	⋌	1269	\rightthreetimes
⊼	125A	\barwedge	⅄	1266	\curlywedge
⩒	1259	\veebar	⅄	1267	\curlyvee
⩚	125B	\doublebarwedge			
⊟	120C	\boxminus	⊝	127F	\circleddash
⊠	1202	\boxtimes	⊛	127E	\circledast
⊡	1200	\boxdot	⊚	127D	\circledcirc
⊞	1201	\boxplus	∙	1205	\centerdot
⋇	223E	\divideontimes	⊺	127C	\intercal

- **Binary relations**

$\leqq$	1335	\leqq	$\geqq$	133D	\geqq
$\leqslant$	1336	\leqslant	$\geqslant$	133E	\geqslant
$\eqslantless$	1330	\eqslantless	$\eqslantgtr$	1331	\eqslantgtr
$\lesssim$	132E	\lesssim	$\gtrsim$	1326	\gtrsim
$\lessapprox$	132F	\lessapprox	$\gtrapprox$	1327	\gtrapprox
$\approxeq$	2375	\approxeq			
$\lessdot$	236C	\lessdot	$\gtrdot$	236D	\gtrdot
$\lll$	136E	\lll, \llless	$\ggg$	136F	\ggg, \gggtr
$\lessgtr$	1337	\lessgtr	$\gtrless$	133F	\gtrless
$\lesseqgtr$	1351	\lesseqgtr	$\gtreqless$	1352	\gtreqless
$\lesseqqgtr$	1353	\lesseqqgtr	$\gtreqqless$	1354	\gtreqqless
$\doteqdot$	132B	\doteqdot, \Doteq	$\eqcirc$	1350	\eqcirc
$\risingdotseq$	133A	\risingdotseq	$\circeq$	1324	\circeq
$\fallingdotseq$	133B	\fallingdotseq	$\triangleq$	132C	\triangleq
$\backsim$	1376	\backsim	$\thicksim$	2373	\thicksim
$\backsimeq$	1377	\backsimeq	$\thickapprox$	2374	\thickapprox
$\subseteqq$	136A	\subseteqq	$\supseteqq$	136B	\supseteqq
$\Subset$	1362	\Subset	$\Supset$	1363	\Supset
$\sqsubset$	1340	\sqsubset	$\sqsupset$	1341	\sqsupset
$\preccurlyeq$	1334	\preccurlyeq	$\succcurlyeq$	133C	\succcurlyeq
$\curlyeqprec$	1332	\curlyeqprec	$\curlyeqsucc$	1333	\curlyeqsucc
$\precsim$	132D	\precsim	$\succsim$	1325	\succsim
$\precapprox$	2377	\precapprox	$\succapprox$	2376	\succapprox
$\vartriangleleft$	1343	\vartriangleleft	$\vartriangleright$	1342	\vartriangleright
$\trianglelefteq$	1345	\trianglelefteq	$\trianglerighteq$	1344	\trianglerighteq
$\vDash$	130F	\vDash	$\Vdash$	130D	\Vdash
$\Vvdash$	130E	\Vvdash			
$\smallsmile$	1360	\smallsmile	$\shortmid$	2370	\shortmid
$\smallfrown$	1361	\smallfrown	$\shortparallel$	2371	\shortparallel
$\bumpeq$	136C	\bumpeq	$\between$	1347	\between
$\Bumpeq$	136D	\Bumpeq	$\pitchfork$	1374	\pitchfork
$\varpropto$	135F	\varpropto	$\backepsilon$	237F	\backepsilon
$\blacktriangleleft$	134A	\blacktriangleleft	$\blacktriangleright$	1349	\blacktriangleright
$\therefore$	1329	\therefore	$\because$	132A	\because

- **Negated relations**

$\nless$	2304	\nless	$\ngtr$	2305	\ngtr
$\nleq$	2302	\nleq	$\ngeq$	2303	\ngeq
$\nleqslant$	230A	\nleqslant	$\ngeqslant$	230B	\ngeqslant
$\nleqq$	2314	\nleqq	$\ngeqq$	2315	\ngeqq
$\lneq$	230C	\lneq	$\gneq$	230D	\gneq
$\lneqq$	2308	\lneqq	$\gneqq$	2309	\gneqq
$\lvertneqq$	2300	\lvertneqq	$\gvertneqq$	2301	\gvertneqq
$\lnsim$	2312	\lnsim	$\gnsim$	2313	\gnsim
$\lnapprox$	231A	\lnapprox	$\gnapprox$	231B	\gnapprox

⊀ 2306 \nprec
⊁ 2307 \nsucc
⋠ 230E \npreceq
⋡ 230F \nsucceq
⋨ 2316 \precneqq
⋩ 2317 \succneqq
⋨ 2310 \precnsim
⋩ 2311 \succnsim
⪹ 2318 \precnapprox
⪺ 2319 \succnapprox
≁ 231C \nsim
≇ 231D \ncong
∤ 232E \nshortmid
∦ 232F \nshortparallel
∣ 232D \nmid
∥ 232C \nparallel
⊬ 2330 \nvdash
⊭ 2332 \nvDash
⊮ 2331 \nVdash
⊯ 2333 \nVDash
⋪ 2336 \ntriangleleft
⋫ 2337 \ntriangleright
⋬ 2335 \ntrianglelefteq
⋭ 2334 \ntrianglerighteq
⊄ 232A \nsubseteq
⊅ 232B \nsupseteq
⫋ 2322 \nsubseteqq
⫌ 2323 \nsupseteqq
⊊ 2328 \subsetneq
⊋ 2329 \supsetneq
⫋ 2320 \varsubsetneq
⫌ 2321 \varsupsetneq
⫋ 2324 \subsetneqq
⫌ 2325 \supsetneqq
⫋ 2326 \varsubsetneqq
⫌ 2327 \varsupsetneqq

- **Arrows**

⇇ 1312 \leftleftarrows
⇉ 1313 \rightrightarrows
⇆ 131C \leftrightarrows
⇄ 131D \rightleftarrows
⇚ 1357 \Lleftarrow
⇛ 1356 \Rrightarrow
↞ 1311 \twoheadleftarrow
↠ 1310 \twoheadrightarrow
↢ 131B \leftarrowtail
↣ 131A \rightarrowtail
↫ 1322 \looparrowleft
↬ 1323 \looparrowright
⇋ 130B \leftrightharpoons
⇌ 130A \rightleftharpoons (U)
↶ 2378 \curvearrowleft
↷ 2379 \curvearrowright
↺ 1309 \circlearrowleft
↻ 1308 \circlearrowright
↰ 131E \Lsh
↱ 131F \Rsh
⇈ 1314 \upuparrows
⇊ 1315 \downdownarrows
↿ 1318 \upharpoonleft
↾ 1316 \upharpoonright, \restriction
⇃ 1319 \downharpoonleft
⇂ 1317 \downharpoonright
⊸ 1328 \multimap
⇝ 1320 \rightsquigarrow
↭ 1321 \leftrightsquigarrow

- **Negated arrows**

↚ 2338 \nleftarrow
↛ 2339 \nrightarrow
⇍ 233A \nLeftarrow
⇏ 233B \nRightarrow
↮ 233D \nleftrightarrow
⇎ 233C \nLeftrightarrow

For further information

The AMSFonts collection was implemented and packaged by the Society's Technical Support Department. Questions or suggestions for improvements should be directed to that group at the following address:

Technical Support Department
American Mathematical Society
P. O. Box 6248
Providence, RI 02940

Phone: 800-321-4AMS or 401-455-4080
Internet: Tech-Support@Math.AMS.org

The cyrillic fonts included in the AMSFonts collection were developed at the Humanities and Arts Computing Center of the University of Washington. Questions regarding these cyrillic fonts should be directed to:

Director
Humanities and Arts Computing Center
DR-10
University of Washington
Seattle, WA 98195

Phone: 206-543-4218

The TEX Users Group is a good source of general information about fonts for use with TEX. Inquiries can be directed to:

TEX Users Group
P. O. Box 869
Santa Barbara, CA 93102-0869

Phone: 805-963-1338
Internet: TUG@Math.AMS.org

Obtaining the METAFONT source files

The AMSFonts collection has been prepared for a number of different resolutions suitable for use on what the AMS staff has determined to be the most popular devices currently being used to prepare TEX output. More such devices continue to appear, many of them with characteristics different from the devices that are currently supported.

Users of unsupported devices who have access to an operating version of METAFONT and have some experience with generating METAFONT fonts may also wish to obtain the METAFONT source files for the AMSFonts collection. METAFONT source files are available on diskette from the Society, as well as via anonymous FTP from the Internet node e-MATH.ams.org.

METAFONT source files for the cyrillic fonts in the AMSFonts collection can be obtained either from the Society or directly from the University of Washington. The sources available from Washington also include other fonts in different layouts.

Information can be obtained from the director of the Academic Computing Center at the address given above.

References

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Appendix A
Installation Guide for AMSFonts 2.1 on the PC

August 1991

A. Introduction

AMSFonts are a set of fonts which were developed at the American Mathematical Society (except the cyrillic fonts, which were developed at the University of Washington), for use with the TEX typesetting system. These fonts were intended for use with the $\mathcal{AMS}$-TEX or $\mathcal{AMS}$-LATEX macro packages, but they can be used with plain TEX also, independently of these packages.

AMSFonts can be used with any full implementation of TEX. The installation procedure automatically installs the fonts on your IBM PC or compatible machine. In this guide, it is assumed that you have TEX installed on your PC, and that you have at least some familiarity with it.

B. If you own a release of AMSFonts prior to version 2.0

If you own a release of AMSFonts earlier than version 2.0, then you must delete those fonts from your hard disk. Find where your printer driver or screen previewer looks for the .pk files which it uses. If you use a driver from Personal TEX, Inc., then probably those fonts are in subdirectories of a directory named `\pctex\pixel`. If you use a driver from ArborText, then probably those fonts are in subdirectories of a directory named `\texpixel\ampixel` or `\texpixel\cmpixel`. If your device driver is made by someone other than these two companies you will need to consult the documentation of that device driver in order to find the directory where it looks for .pk files of the fonts which it uses.

Once you have determined where to look on your hard disk, backup onto diskettes and delete all occurrences (.tfm and .pk files) of the following files from the old release of AMSFonts:

msxm5 thru msxm10	msym5 thru msym10	amcsc8 and 10
mcyr6 thru mcyr10	mcyb6 thru mcyb10	eufm5 thru eufm10

All of these except the eufm fonts have been replaced by fonts with different names. The eufm fonts have been updated and improved.

C. If you have AMSFonts 2.1 without $\mathcal{AMS}$-TEX 2.0+

If you purchased AMSFonts without the $\mathcal{AMS}$-TEX 2.0+ macro package,* then you will first need to place the diskette labeled **`AMSFonts 2.1 TFM files`** into drive A (or drive B, in which case you will substitute "b" for "a" in the following command), and copy the TFM files into the directory where your other TFM files are stored. If you are using PCTEX, then enter

```
copy a:\tfm  c:\pctex\textfms   ⟨return⟩
```

* $\mathcal{AMS}$-TEX 2.0+ refers to any release of $\mathcal{AMS}$-TEX from version 2.0 forward.

to copy the TEX font metric (TFM) files to your hard disk. If you are using an implementation of TEX other than PCTEX, you will substitute the name of your TFM directory for `\pctex\textfms`, and if you have TEX installed on a drive other than C, you will substitute its drive name for "c:" in the above command. After copying the TFM files, proceed with Section E.

D. If you have $\mathcal{AMS}$-TEX 2.0+

The TFM files are installed automatically as part of the installation of $\mathcal{AMS}$-TEX 2.0+. If you have not yet installed $\mathcal{AMS}$-TEX 2.0+, you should either install it or perform step C above before you proceed with section E.

E. How much disk space do you need?

The amount of disk space required for installation of the AMSFonts depends on the resolution of your output device and on which families of fonts you choose to install. The fonts have been divided into five families for the installation, and you may choose any or all of these families to install. Also, you may choose to install all of the magnifications or only magnifications 100%, 109.5% and 120% (TEX magsteps 0, $\frac{1}{2}$ and 1). For a more complete description of these families and magnifications, please see the appropriate sections of the *AMSFonts 2.1 User's Guide*. (Note: If you do not have a printed copy of the *User's Guide*, you may use the files `userdoc.*` on the TFM disk to produce it with TEX. However, you will not be able to print the entire document correctly until after you have installed AMSFonts.)

The following table lists all of the families and the disk space required for their installation. Before you begin the installation, decide which fonts and which magnifications you will choose, and make sure that you have enough disk space available.

Approximate Disk Space Required for AMSFonts Installation

		Extra CM	Euler Fraktur	Other Euler	Extra Symbols	Cyrillic	All Fonts
118dpi	100% thru 120%	200K	150K	350K	150K	250K	1100K
	all mags	550K	350K	850K	450K	750K	2950K
180dpi	100% thru 120%	250K	150K	350K	200K	300K	1250K
	all mags	750K	450K	950K	650K	1000K	3800K
240dpi	100% thru 120%	300K	150K	350K	250K	400K	1450K
	all mags	900K	500K	1000K	800K	1200K	4400K
300dpi	100% thru 120%	350K	200K	450K	350K	500K	1850K
	all mags	1100K	700K	1300K	1000K	1500K	5600K
400dpi	100% thru 120%	450K	250K	500K	400K	550K	2150K
	all mags	1450K	825K	1625K	1250K	1850K	7000K

F. Where do you put the fonts?

Now you will need to copy the .pk files which are the actual raster images for the fonts. These are spread over several disks (the actual number depends on the resolution of the output device), in seven directories. These seven directories represent the fonts at seven different magnifications available in TEX: \magstep 0, $\frac{1}{2}$, 1, 2, 3, 4, and 5. The directories are labeled `\amsfonts\dpiXXX`, where `XXX` is the resolution of the output device multiplied by the magnification. (The number is rounded to the nearest integer.) For example, the subdirectory containing raster images for 300 dot per inch output at \magstep1 (120%) will be called `\dpi360`, since 300 multiplied by 1.2 equals 360.

To install the fonts, find where the .pk files for your other fonts are stored on your hard disk. This is determined by the needs of the device driver which will read the fonts. If you are installing these fonts for screen previewing they should go where your previewer will find them. If you are installing the fonts for printing they should go where your printer driver can find them.

If you are using a device driver from Personal TEX, Inc., then most likely your other TEX fonts are stored in subdirectories of `\pctex\pixel`. If you are using a device driver from ArborText, then most likely your other TEX fonts are stored in subdirectories of `\texpixel\cmpixel`. If your device driver is made by someone other than these two companies you will need to consult the documentation of that device driver in order to find the directory where it looks for .pk files of the fonts which it uses.

G. Running the installation procedure

When you have determined where you are going to put the fonts, insert the first of the disks labeled `AMSFonts 2.1 XXXdpi` (where `XXX` is the resolution of your output device) into drive A or drive B, and type the following commands (if you put the disk in drive B, you will substitute 'b' for 'a' in the first command):

```
a:          ⟨return⟩
install     ⟨return⟩
```

You will be asked a number of questions. First, you will have to give the name of the hard drive on which you will install the fonts. Then, you will be asked for the name of the directory where you want the fonts to be placed. Next, you will be asked whether you wish to install all of the magnifications or only the magnifications 100%, 109.5%, and 120%. Finally, you will be asked whether you wish to install all of the families of fonts or only certain families. (If you skipped Section E above, please go back and read it.)

Once you have answered all of the questions, you will be prompted to insert the remaining disks of the distribution. The .pk files will be placed in subdirectories of the specified font directory, named `\dpiXXX`, where `XXX` again represents the resolution multiplied by the magnification.

H. Additional notes for users of AMSFonts

The device driver with which you are using these fonts may have a font table which needs to be updated in order for the driver to recognize the fonts. For instance, the TEX Preview software provided by ArborText has a file called `preview.fnt` which contains the names of all fonts which the Preview program is expected to find, and the effective resolutions (resolution multiplied by magnification) at which to find them. In order to use AMSFonts with this, or any other software which uses such a table, you must enter the names of each of the fonts in the AMSFonts package and the effective resolutions at which you have them installed. The file `amsfonts.lst` on the first distribution disk contains a list of all of the font names and all of the resolutions contained in your distribution. You may have to alter the format of this file to make it conform to your driver's needs or to reflect installation of only some of the fonts, but it provides you with the necessary data. See the documentation for your device driver to see what format is required. If your device driver does not depend on such a table, this step is not necessary.

I. For further information.

Questions or comments concerning AMSFonts 2.1 can be directed to:

Technical Support
American Mathematical Society
P.O. Box 6248
Providence, RI 02940
800-321-4AMS or 401-455-4080
Internet: tech-support@Math.AMS.org

Appendix B
Installation Guide for AMSFonts 2.1 on the Macintosh (with *Textures*)

August 1991

A. Introduction

AMSFonts are a set of fonts which were developed at the American Mathematical Society (except the cyrillic fonts, which were developed at the University of Washington), for use with the TEX typesetting system. These fonts were intended for use with the $\mathcal{AMS}$-TEX or $\mathcal{AMS}$-LATEX macro packages, but they can be used with plain TEX also, independently of these packages.

This distribution is designed for use with the *Textures* software on the Macintosh computer. These fonts require *Textures* version 1.2 or higher. If you have an earlier release of *Textures*, you must upgrade before using these fonts. To upgrade *Textures*, contact the manufacturer: Blue Sky Research, 534 SW Third Ave., Portland, OR 97204; (800) 622-8398. In this guide, it is assumed that you have a recent version of *Textures* installed on your Macintosh, and that you have at least some familiarity with it and with *The TEXbook*.

You have received either the standard distribution or the extended distribution. The standard distribution contains fonts in resolutions and magnifications corresponding to those included in the standard *Textures* distribution of Computer Modern fonts. The standard distribution is contained on three diskettes and has a fairly simple installation procedure. The extended distribution includes the fonts at several larger magnifications, in addition to the magnifications included in the standard distribution. That distribution is contained on six high-density (1.4M) diskettes, and its installation will require some decisions on your part.

Before you begin the installation you should first backup to diskette all files from previous releases of AMSFonts that are on your hard disk. (This includes AMSFonts 2.0 if you received that distribution.) Once you are sure that you have backed up all files containing previous releases of AMSFonts, delete them from your hard disk. You will have serious font ID conflicts if you do not do this. (See Section E.2 for an explanation.)

B. Installation of the Standard Distribution

B.1. What is on the diskettes?

The distribution contains three diskettes. The first disk contains a folder with some *Textures* files, the file `AMSFonts 2.1 metrics`, and the cyrillic text fonts. The `Textures files` folder contains eight files. Most of these files are explained in the *AMSFonts 2.1 User's Guide*. The TEX source for the user's guide is in the files `userdoc.*` in the `Textures files` folder. The file `userdoc.ins` is the TEX source for the installation guide you are now reading.

The second disk contains the extra CM fonts and the AMS Symbol fonts (MSAM and MSBM). The third disk contains the Euler fonts: Euler Fraktur (EUFB and EUFM), Euler Roman (EURB and EURM), Euler Script (EUSB and EUSM), and Euler Extension (EUEX).

B.2. How much space do you need?

Fonts take up lots of disk space. AMSFonts includes 89 fonts, each at either four or six resolutions (see Section E.1 for an explanation). This standard distribution takes up nearly four megabytes when installed. The table below shows the disk space required for each font suitcase file in this distribution. Consult it to make sure that you have enough space on your hard disk to install the fonts you need.

Approximate Disk Storage Requirements (Standard)

1600K	Extra CM fonts and AMS Symbol fonts
288K	Euler Fraktur fonts
1150K	All other Euler fonts
986K	Cyrillic fonts

Since you will be installing new fonts it would be wise to review the portions of the *Textures* manual relating to fonts. *Textures* has a complex method of including fonts and you should understand it before attempting to install or use AMSFonts. You may also wish to read the *AMSFonts 2.1 User's Guide* to decide which families of fonts you need to install. If you retrieved this distribution electronically and have no printed copy of the user's guide, you can find the TEX source for that document in the files `userdoc.*` in the `Textures files` folder on the first distribution disk.

B.3. Installing the fonts.

1. Copy the file `AMSFonts 2.1 metrics` from the first distribution disk to the `TeX Fonts` folder inside the `Textures` folder on your hard disk.
2. Decide which families of fonts you want to install on your system. For a full description of these families, see the appropriate section of the *AMSFonts 2.1 User's Guide.*
3. Make sure you have enough space on your hard disk for the families which you wish to install. See the table above for the amount of space required.
4. Extract the font files from the compressed files for each of the families which are to be installed. This is done in the following way.
   - 4.1 Double-click on the icon for the compressed file.
   - 4.2 In the dialog box which appears, click the "Drive" button so that the name of your hard disk appears at the top.
   - 4.3 Double-click on the name of your `Textures` folder in the scroll box.
   - 4.4 Double-click on the name of the `TeX Fonts` folder in the scroll box.
   - 4.5 Click "Install". When the AutoUnStuffIt installer finishes, there will be a new font suitcase file in your `Tex Fonts` folder.

You are now able to use AMSFonts in *Textures*. However, please read Sections D and E before attempting to use AMSFonts in *Textures*.

C. Installation of the Extended distribution

C.1. What is on the diskettes?

The distribution contains six high-density diskettes. The first disk contains a folder with some *Textures* files, the file `AMSFonts 2.1 metrics`, and the AMS Symbol

(MSAM and MSBM) fonts. The `Textures files` folder contains eight files. Most of these files are explained in the *AMSFonts 2.1 User's Guide*. The TEX source for the user's guide is in the files `userdoc.*` in the `Textures files` folder. The file `userdoc.ins` is the TEX source for the installation guide you are now reading.

The other disks include the other AMSFonts, as indicated on their diskette labels:

Disk 2	Extra CM Fonts (CMBSY, CMCSC, CMEX, CMMIB)
Disk 3	Euler Fraktur and Extension (EUF and EUEX)
Disk 4	Euler Roman and Script (EUR and EUS)
Disk 5	Cyrillic Upright and Italic (WNCYR and WNCYI)
Disk 6	Cyrillic Bold, Sans-Serif and Cap-small-cap (WNCYB, WNCYSS, WNCYSC)

C.2. How much space do you need?

Fonts take up lots of disk space. AMSFonts includes 89 fonts, each at either nine or eleven resolutions (see Section E.1 for an explanation). This extended distribution takes up over 20 megabytes of disk space. The table below shows the disk space required for each font family. Consult it to make sure that you have enough space on your hard disk to install the fonts you need.

Approximate Disk Storage Requirements (Extended)

5500K	Extra CM fonts
3200K	Euler Fraktur and Extension fonts
2700K	Euler Roman and Script fonts
4000K	AMS Symbol fonts
5500K	Cyrillic fonts

Since you will be installing new fonts it would be wise to review the portions of the *Textures* manual relating to fonts. *Textures* has a complex method of including fonts and you should understand it before attempting to install or use AMSFonts. You may also wish to read the *AMSFonts 2.1 User's Guide* to decide which families of fonts you need to install. If you retrieved this distribution electronically and have no printed copy of the user's guide, you can find the TEX source for that document in the files `userdoc.*` in the `Textures files` folder on the first distribution disk.

C.3. Installing the fonts.

1. Copy the file `AMSFonts 2.1 metrics` from the first distribution disk to the `TeX Fonts` folder inside the `Textures` folder on your hard disk.
2. Decide which families of fonts you want to install on your system. For a full description of these families, see the appropriate section of the *AMSFonts 2.1 User's Guide.*
3. Make sure you have enough space on your hard disk for the families which you wish to install. See the table above for the amount of space required.
4. Extract the font files from the compressed files for each of the families which are to be installed. This is done in the following way.
   4.1 Double-click on the icon for the compressed file.

4.2 In the dialog box which appears, click the "Drive" button so that the name of your hard disk appears at the top.
4.3 Double-click on the name of your `Textures` folder in the scroll box.
4.4 Double-click on the name of the `TeX Fonts` folder in the scroll box.
4.5 Click "Install". When the AutoUnStuffIt installer finishes, there will be a new font suitcase file in your `Tex Fonts` folder.

You are now able to use AMSFonts in *Textures*. However, please read Sections D and E before attempting to use AMSFonts in *Textures*.

D. Customizing Your Own Installation

D.1. Defining macros for the symbol fonts.

The files `amssym.def` and `amssym.tex` are included in the `Textures files` folder on the first disk of your distribution. These files are for use with the AMS symbol fonts (MSAM and MSBM). If you will be using these fonts you should place both of these files in the `TeX inputs` folder within your `Textures` folder.

The use of these files is described in the *AMSFonts 2.1 User's Guide*.

D.2. Adding fonts for display and printing.

As is explained in the *Textures* manual, the Show Fonts command displays those fonts whose font metrics are currently available to *Textures*. Additionally, when a font is selected the two scroll boxes in the Show Fonts dialog box display the point sizes available for display or printing. When *Textures* has opened `AMSFonts 2.1 metrics`, this permits TEX to run without errors on files with references to AMSFonts. However, it does not enable their display or printing. To enable display and printing you may use Add Fonts to bring in raster information from any of the font suitcases which you created by unstuffing the files in the distribution.

It is not necessary to keep using the menu item Add Fonts to import AMSFonts. You will probably determine through your own use which fonts you frequently use. Using *Font/DA Mover* from your Macintosh system software, you can construct a font file which contains these fonts, and place it in the `TeX fonts` folder inside your `Textures` folder. Make sure that the file `AMSFonts 2.1 metrics` is also in this folder. *(Note: Users who have upgraded to System 7 need not use* Font/DA Mover*. They should use the System 7 conventions for moving fonts between suitcases.)*

D.4. Consolidating AMSFonts suitcase files.

AMSFonts were distributed in several different suitcase files so they would fit on individual disks for distribution and installation. *Textures* and the Macintosh system will have a much easier time if you open fewer files. You should use *Font/DA Mover* (or System 7 conventions for moving fonts) to create a new file which includes the contents of several of the font suitcases which were provided in the distribution.

If you have the Standard Distribution, you may consolidate all three of the distribution suitcase files into one. Another alternative would be to simply not install some of the suitcases. The file on disk 2 (which includes extra CM fonts

and AMS symbol fonts), along with Euler Fraktur from disk 3, are all that the majority of users of AMSFonts will need.

If you have the Extended Distribution, you should consolidate the font suitcases as much as possible. If, like many users of AMSFonts, you use only the AMS Symbols, Euler Fraktur, and Extra CM fonts, you can consolidate all of these into a single suitcase file. If you use all of the fonts, you will need to use at least three suitcases unless you have upgraded to System 7, in which case two suitcases can contain the entire distribution.

Users who have not upgraded to System 7, please read Section E.3 for important information about *Font/DA Mover*.

E. Questions and Further Information

E.1. Why are some fonts included at fewer sizes?

You may have noticed that all of the AMSFonts (except the extra CM fonts), are included at two fewer magnifications than the *Textures* distribution fonts. This is because several AMSFonts do not give good results when run through METAFONT at very low resolutions, such as the 72dpi Macintosh screen resolution.

Because of the way in which the Macintosh system scales fonts when it doesn't have a font in the exact size it wants, the magnifications included in the distribution give the best combination of screen previewing and ImageWriter output for the AMSFonts. LaserWriter output is not affected in any way by this. LaserWriter output is always determined from the fonts at 417% and higher, which are handled in the same manner for all AMSFonts.

E.2. Help! The font doesn't display correctly!

The Macintosh system has a very ingenious way of handling fonts. Unfortunately, this ingenious and complex system sometimes leads to problems. There is a resource ID number for every point size of every font. For NFNT resources (the kind used for AMSFonts 2.1), these ID numbers are assigned arbitrarily by Macintosh software when a resource is moved into a font suitcase file. Within a single file, the Macintosh software prevents any duplication of these ID numbers.

Conflicts of ID numbers can (and occasionally will) occur when you have many different suitcase files open at the same time. This is one of the reasons for the instructions in Section D.4 — the fewer suitcases you have, the less likelihood of conflicts.

When a font ID conflict does occur, a font which you didn't want will be substituted for the font you wanted, at only a single point size at a single magnification. If all other sizes and magnifications of that font are the correct font, and if the font displays correctly when you View the document on the screen at a different magnification, it is a font ID conflict. To remedy this problem, do the following:

A. If you **have not** upgraded to System 7:
   1. Double-click on the icon for the font suitcase file containing the font which you were not able to display.

2. When *Font/DA Mover* starts, open a new temporary file on the right-hand side of the window.
3. Copy all sizes of the problem font from the original file into the temporary file, and remove them from the original file.
4. Copy the fonts back into the original file.
5. Quit *Font/DA Mover*, and delete the temporary file which you created.

B. If you **have** upgraded to System 7:
1. Create a temporary folder on your hard disk.
2. Double-click on the icon for the font suitcase file containing the font which you were not able to display.
3. In the new window showing the contents of that file, select all sizes of the problem font and drag them into the temporary folder which you created.
4. Open a window showing the contents of the temporary folder, select all of the contents, and drag them back into the font suitcase file. When asked if you want to replace existing ones, answer OK.
5. Delete the temporary folder.

These steps will cause the Macintosh system software to assign new arbitrary numbers to the NFNT resources in question and should clear up the conflict.

E.3. Important information about *Font/DA Mover*

If you are not using System 7, please take note of the following:

1. You must have *Font/DA Mover* Version 3.8 or later. Previous releases will not recognize font resources of the type used for AMSFonts 2.1.
2. Even Version 3.8 of *Font/DA Mover* has a bug of which you should be aware. If you copy a font of the type used for AMSFonts 2.1 into a file more than once, you will very likely end up with two copies of the font in that file. If you notice that this has occurred, simply delete one occurrence.

E.4. For further information.

Questions or comments concerning AMSFonts 2.1 can be directed to:

Technical Support
American Mathematical Society
P.O. Box 6248
Providence, RI 02940
800-321-4AMS or 401-455-4080
Internet: tech-support@Math.AMS.org

Questions or comments concerning *Textures* can be directed to:

Blue Sky Research
534 Southwest Third Avenue
Portland, OR 97204
800-622-8398 or 503-222-9571

	'0	*'1*	*'2*	*'3*	*'4*	*'5*	*'6*	*'7*	
'00x	𝔡	𝔡	𝔣	𝔣	𝔤	𝔨	𝔱	𝔲	"0x
'01x									
'02x			‘	’					"1x
'03x									
'04x		!					&	'	"2x
'05x	(	)	*	+	,	−	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;		=		?	
'10x		𝔄	𝔅	ℭ	𝔇	𝔈	𝔉	𝔊	"4x
'11x	ℌ	ℑ	𝔍	𝔎	𝔏	𝔐	𝔑	𝔒	
'12x	𝔓	𝔔	ℜ	𝔖	𝔗	𝔘	𝔙	𝔚	"5x
'13x	𝔛	𝔜	ℨ	[		]	^		
'14x		𝔞	𝔟	𝔠	𝔡	𝔢	𝔣	𝔤	"6x
'15x	𝔥	𝔦	𝔧	𝔨	𝔩	𝔪	𝔫	𝔬	
'16x	𝔭	𝔮	𝔯	𝔰	𝔱	𝔲	𝔳	𝔴	"7x
'17x	𝔵	𝔶	𝔷			"		𝔩	
	"8	"9	"A	"B	"C	"D	"E	"F	

Euler Fraktur medium weight – `eufm10`

	'0	*'1*	*'2*	*'3*	*'4*	*'5*	*'6*	*'7*	
'00x	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	"0x
'01x	Φ	Ψ	Ω	α	β	γ	δ	ϵ	
'02x	ζ	η	θ	ι	κ	λ	μ	ν	"1x
'03x	ξ	π	ρ	σ	τ	υ	ϕ	χ	
'04x	ψ	ω	ε	ϑ	ϖ			φ	"2x
'05x									
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	.	,	<	/	>		
'10x	∂	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z						
'14x	ℓ	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	ı	ȷ	℘			
	"8	"9	"A	"B	"C	"D	"E	"F	

Euler cursive (roman) medium weight – `eurm10`

	'0	*'1*	*'2*	*'3*	*'4*	*'5*	*'6*	*'7*	
'00x	–								"0x
'01x									
'02x									"1x
'03x	~								
'04x									"2x
'05x									
'06x									"3x
'07x			¬		ℜ	ℑ			
'10x	ℵ	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢	"4x
'11x	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪	
'12x	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲	"5x
'13x	𝒳	𝒴	𝒵				∧	∨	
'14x							{	}	"6x
'15x			|				\		
'16x									"7x
'17x	§								
	"8	"9	"A	"B	"C	"D	"E	"F	

Euler script medium weight – `eusm10`

	'0	*'1*	*'2*	*'3*	*'4*	*'5*	*'6*	*'7*	
'00x									"0x
'01x	{	}	{	}	{	}	{	}	
'02x									"1x
'03x	←	←	→	→					
'04x	←	→	↑	↓	↔	↗	↘		"2x
'05x	⇐	⇒	⇑	⇓	⇔	↖	↙		
'06x		∞							"3x
'07x	(	)	[	]	⌊	⌋	'		
'10x									"4x
'11x	∮	∮							
'12x	∑	∏	∫						"5x
'13x	∑	∏	∫						
'14x	⋃	⋃							"6x
'15x					↕	⇕			
'16x									"7x
'17x			⌢	⌣	⌣	⌣			
	"8	"9	"A	"B	"C	"D	"E	"F	

Euler-compatible extension font – `euex10`

	′0	′1	′2	′3	′4	′5	′6	′7	
′00x	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	"0x
′01x	Φ	Ψ	Ω	α	β	γ	δ	ϵ	
′02x	ζ	η	θ	ι	κ	λ	μ	ν	"1x
′03x	ξ	π	ρ	σ	τ	υ	ϕ	χ	
′04x	ψ	ω	ε	ϑ	ϖ	ϱ	ς	φ	"2x
′05x	$\leftharpoonup$	$\leftharpoondown$	$\rightharpoonup$	$\rightharpoondown$	‘	’	$\triangleright$	$\triangleleft$	
′06x	0	1	2	3	4	5	6	7	"3x
′07x	8	9	.	,	<	/	>	$\star$	
′10x	∂	A	B	C	D	E	F	G	"4x
′11x	H	I	J	K	L	M	N	O	
′12x	P	Q	R	S	T	U	V	W	"5x
′13x	X	Y	Z	$\flat$	$\natural$	$\sharp$	$\smile$	$\frown$	
′14x	ℓ	a	b	c	d	e	f	g	"6x
′15x	h	i	j	k	l	m	n	o	
′16x	p	q	r	s	t	u	v	w	"7x
′17x	x	y	z	$\imath$	$\jmath$	$\wp$	$\rightarrow$	$\frown$	
	"8	"9	"A	"B	"C	"D	"E	"F	

Computer Modern bold math italic – `cmmib10`

	′0	′1	′2	′3	′4	′5	′6	′7	
′00x	$-$	$\cdot$	$\times$	$*$	$\div$	$\diamond$	$\pm$	$\mp$	"0x
′01x	$\oplus$	$\ominus$	$\otimes$	$\oslash$	$\odot$	$\bigcirc$	$\circ$	$\bullet$	
′02x	$\asymp$	$\equiv$	$\subseteq$	$\supseteq$	$\leq$	$\geq$	$\preceq$	$\succeq$	"1x
′03x	$\sim$	$\approx$	$\subset$	$\supset$	$\ll$	$\gg$	$\prec$	$\succ$	
′04x	$\leftarrow$	$\rightarrow$	$\uparrow$	$\downarrow$	$\leftrightarrow$	$\nearrow$	$\searrow$	$\simeq$	"2x
′05x	$\Leftarrow$	$\Rightarrow$	$\Uparrow$	$\Downarrow$	$\Leftrightarrow$	$\nwarrow$	$\swarrow$	$\propto$	
′06x	$\prime$	∞	$\in$	$\ni$	$\triangle$	$\triangledown$	/	$\flat$	"3x
′07x	$\forall$	$\exists$	$\neg$	$\emptyset$	$\Re$	$\Im$	$\top$	$\bot$	
′10x	$\aleph$	$\mathcal{A}$	$\mathcal{B}$	$\mathcal{C}$	$\mathcal{D}$	$\mathcal{E}$	$\mathcal{F}$	$\mathcal{G}$	"4x
′11x	$\mathcal{H}$	$\mathcal{I}$	$\mathcal{J}$	$\mathcal{K}$	$\mathcal{L}$	$\mathcal{M}$	$\mathcal{N}$	$\mathcal{O}$	
′12x	$\mathcal{P}$	$\mathcal{Q}$	$\mathcal{R}$	$\mathcal{S}$	$\mathcal{T}$	$\mathcal{U}$	$\mathcal{V}$	$\mathcal{W}$	"5x
′13x	$\mathcal{X}$	$\mathcal{Y}$	$\mathcal{Z}$	$\cup$	$\cap$	$\uplus$	$\wedge$	$\vee$	
′14x	$\vdash$	$\dashv$	$\lfloor$	$\rfloor$	$\lceil$	$\rceil$	$\{$	$\}$	"6x
′15x	$\langle$	$\rangle$	$\mid$	$\parallel$	$\updownarrow$	$\Updownarrow$	$\backslash$	$\wr$	
′16x	$\surd$	$\amalg$	∇	$\int$	$\sqcup$	$\sqcap$	$\sqsubseteq$	$\sqsupseteq$	"7x
′17x	§	†	‡	¶	$\clubsuit$	$\diamondsuit$	$\heartsuit$	$\spadesuit$	
	"8	"9	"A	"B	"C	"D	"E	"F	

Computer Modern bold math symbols – `cmbsy10`

	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	⊡	⊞	⊠	□	■	∎	◊	⧫	"0x
'01x	◌	◌	⇌	⇋	⊟	⊩	⊪	⊨	
'02x	⇾	⇽	⇇	⇉	⇈	⇊	↾	↿	"1x
'03x	⇂	⇃	⇁	↽	⇆	⇄	↰	↱	
'04x	⇝	⇜	↫	↬	≐	≿	≳	≋	"2x
'05x	⊸	∴	∵	÷	≙	≾	≲	≊	
'06x	⋞	⋟	⋏	⋎	⋏	≦	≪	≦	"3x
'07x	\	–	≔	≕	⋎	≧	⩾	≧	
'10x	⊏	⊐	▷	◁	⊵	⊴	★	◊	"4x
'11x	▼	▶	◀	→	←	△	▲	▽	
'12x	≡	≦	≧	≦	≧	¥	⇒	⇐	"5x
'13x	✓	≨	≩	≩	∠	∡	◁	∝	
'14x	⌣	⌢	⋐	⋑	⋓	⋒	⋏	⋎	"6x
'15x	⋋	⋌	⊆	⊇	≏	≎	⋘	⋙	
'16x	⌜	⌝	®	Ⓢ	⋔	∔	∽	∽	"7x
'17x	⌞	⌟	✠	C	T	⊙	⊛	⊖	
	"8	"9	"A	"B	"C	"D	"E	"F	

Extra symbols, group 1, medium weight – `msam10`

	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	≠	≠	≰	≱	≮	≯	≮	≯	"0x
'01x	≠	≠	≰	≱	≤	≥	≠	≠	
'02x	≷	≷	≷	≷	≰	≱	≷	≷	"1x
'03x	≷	≷	≷	≷	≁	≇	⁄	⁄	
'04x	⊊	⊋	⊈	⊉	⊊	⊋	⊊	⊋	"2x
'05x	⊊	⊋	⊈	⊉	∤	∤	∤	∤	
'06x	⊬	⊮	⊭	⊮	⊬	⊭	⊲	⊳	"3x
'07x	↚	↛	⇍	⇏	⇎	⇎	∗	∅	
'10x	∄	𝔸	𝔹	ℂ	𝔻	𝔼	𝔽	𝔾	"4x
'11x	ℍ	𝕀	𝕁	𝕂	𝕃	𝕄	ℕ	𝕆	
'12x	ℙ	ℚ	ℝ	𝕊	𝕋	𝕌	𝕍	𝕎	"5x
'13x	𝕏	𝕐	ℤ	⌒	⌒	~	~		
'14x	∃	∋					ʊ	ð	"6x
'15x	≵	⊐	⊐	⊐	≮	≯	⋉	⋊	
'16x	∣	∥	∕	∼	≈	≊	≋	≋	"7x
'17x	↶	↷	F	ϰ	𝕜	ℏ	ℏ	ɔ	
	"8	"9	"A	"B	"C	"D	"E	"F	

Extra symbols, group 2, medium weight – `msbm10`

	'0	*'1*	*'2*	*'3*	*'4*	*'5*	*'6*	*'7*	
'00x	(	)	[	]	⌊	⌋	⌈	⌉	"0x
'01x	{	}	⟨	⟩	∣	∥	/	\	
'02x	(	)	(	)	[	]	⌊	⌋	"1x
'03x	⌈	⌉	{	}	⟨	⟩	/	\	
'04x	(	)	[	]	⌊	⌋	⌈	⌉	"2x
'05x	{	}	⟨	⟩	/	\	/	\	
'06x	⎛	⎞	⎡	⎤	⎣	⎦	∣	∣	"3x
'07x	⎛	⎞	⎡	⎤	⎧	⎫	∣	∣	
'10x	⎝	⎠	∣	∣	⟨	⟩	⊔	⊔	"4x
'11x	∮	∮	⊙	⊙	⊕	⊕	⊗	⊗	
'12x	∑	∏	∫	∪	∩	⊎	∧	∨	"5x
'13x	∑	∏	∫	∪	∩	⊎	∧	∨	
'14x	∐	∐	^	⌒	⌒	~	~	~	"6x
'15x	[	]	⌊	⌋	⌈	⌉	{	}	
'16x	√	√	√	√	√	∣	⌜	∥	"7x
'17x	↑	↓	⌢	⌣	⌣	⌣	⇑	⇓	
	"8	"9	"A	"B	"C	"D	"E	"F	

Computer Modern math extension font – `cmex10`

	′0	′1	′2	′3	′4	′5	′6	′7	
′00x	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	"0x
′01x	Φ	Ψ	Ω	↑	↓	'	¡	¿	
′02x	ı	ȷ	`	´	˘	ˇ	¯	˚	"1x
′03x	¸	ß	æ	œ	ø	Æ	Œ	Ø	
′04x	˝	!	”	#	$	%	&	’	"2x
′05x	(	)	*	+	,	-	.	/	
′06x	0	1	2	3	4	5	6	7	"3x
′07x	8	9	:	;	<	=	>	?	
′10x	@	A	B	C	D	E	F	G	"4x
′11x	H	I	J	K	L	M	N	O	
′12x	P	Q	R	S	T	U	V	W	"5x
′13x	X	Y	Z	[	“	]	^	˙	
′14x	‘	a	b	c	d	e	f	g	"6x
′15x	h	i	j	k	l	m	n	o	
′16x	p	q	r	s	t	u	v	w	"7x
′17x	x	y	z	–	—	”	~	¨	
	"8	"9	"A	"B	"C	"D	"E	"F	

Computer Modern caps and small caps – `cmcsc10`

	′0	′1	′2	′3	′4	′5	′6	′7	
′00x	Њ	Љ	Ц	Э	І	Є	Ъ	Ћ	"0x
′01x	њ	љ	ц	э	і	є	ъ	ћ	
′02x	Ю	Ж	Й	Ё	Ѵ	Ѳ	S	Я	"1x
′03x	ю	ж	й	ё	ѵ	ѳ	s	я	
′04x	¨	!	”	Ђ	˘	%	´	’	"2x
′05x	(	)	*	ђ	,	-	.	/	
′06x	0	1	2	3	4	5	6	7	"3x
′07x	8	9	:	;	«	ı	»	?	
′10x	ˇ	А	Б	Ц	Д	Е	Ф	Г	"4x
′11x	Х	И	Ј	К	Л	М	Н	О	
′12x	П	Ч	Р	С	Т	У	В	Щ	"5x
′13x	Ш	Ы	З	[	“	]	Ь	Ъ	
′14x	‘	а	б	ц	д	е	ф	г	"6x
′15x	х	и	ј	к	л	м	н	о	
′16x	п	ч	р	с	т	у	в	щ	"7x
′17x	ш	ы	з	–	—	№	ь	ъ	
	"8	"9	"A	"B	"C	"D	"E	"F	

Cyrillic, medium weight – `wncyr10`

	′0	′1	′2	′3	′4	′5	′6	′7	
′00x	Њ	Љ	Ц	Э	І	Є	Ѣ	Ћ	″0x
′01x	њ	љ	ц	э	і	є	ѣ	ћ	
′02x	Ю	Ж	Й	Ё	Ѵ	Ѳ	Ѕ	Я	″1x
′03x	ю	ж	й	ё	ѵ	ѳ	ѕ	я	
′04x	¨	!	”	Ђ	˘	%	´	’	″2x
′05x	(	)	*	ђ	,	-	.	/	
′06x	0	1	2	3	4	5	6	7	″3x
′07x	8	9	:	;	«	ı	»	?	
′10x	ˇ	А	Б	Ц	Д	Е	Ф	Г	″4x
′11x	Х	И	Ј	К	Л	М	Н	О	
′12x	П	Ч	Р	С	Т	У	В	Щ	″5x
′13x	Ш	Ы	З	[	“	]	Ь	Ъ	
′14x	‘	а	б	ц	д	е	ф	г	″6x
′15x	х	и	ј	к	л	м	н	о	
′16x	п	ч	р	с	т	у	в	щ	″7x
′17x	ш	ы	з	–	—	№	ь	ß	
	″8	″9	″A	″B	″C	″D	″E	″F	

Italic Cyrillic, medium weight – `wncyi10`