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The SANDmath Package

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Abstract

This is a basic documentation explaining how to use the SANDmath macros with a LaTeX 2ε document pertaining to the SANDreport class.

Contents

The SANDmath Package

1 Introduction

1.1 What It Is

The file SANDmath.tex is a LaTeX 2ε file, to be used optionally with the SANDreport.cls LaTeX class file [1]. It provides:

- a set of mathematical environments, standardized for the use in the context of Sandia technical reports;
- a large number of mathematical macros.

This file is available for download at the following URL:
http://www.cs.sandia.gov/~rolf/SANDreport/sandDownload.html

1.2 How to Use It

SANDmath shall be inserted in the document preamble, *e.g.*, as follows:

```
\documentclass[options]{SANDreport}
\input{SANDmath}
```

2 Mathematical Environments

The following environments are predefined in `SANDmath` : `theo`, `prop`, `lemm`, `coro`, `defi`, `axio`, `rema`, `exam`, and `algo`. In addition, the standard `proof` environment can be used. Their are index with the form *m.n*, where *m* is the current section index.

Also note that the standard `equation` can obviously be used, with its counter being sub-indexed from the current section number:

```
\begin{equation}
\mbox{first equation}
\end{equation}
\begin{equation}
\mbox{second equation}
\end{equation}
```

first equation (2.1)

second equation (2.2)

2.1 Theorem-like Environments

Theorem-like environments are `theo`, `prop`, `lemm` and `coro`. They use the same *n* sub-counter, as follows:

```
\begin{theo}[Rule]
This is a theorem \dots
\end{theo}
\begin{proof}
\dots along with its proof \dots
\end{proof}
\begin{coro}[Consequence]
\dots and a subsequent corollary.
\end{coro}
```

Theorem 2.1 (Rule). *This is a theorem . . .*

Proof. . . . along with its proof . . . □

Corollary 2.2 (Consequence). *. . . and a subsequent corollary.*

Please note that the subcounter increases, notwidthstanding whether a `theo`, `prop`, `lemm`, or `coro` environment is used.

```
\begin{lemm}[Lemma A]
This is a lemma.
\end{lemm}
\begin{prop}[Proposition 13]
This is a proposition.
\end{prop}
```

Lemma 2.3 (Lemma A). *This is a lemma.*

Proposition 2.4 (Proposition 13). *This is a proposition.*

2.2 Definition-like Environments

Definition-like environments are `defi` and `axio`. They each have their own subcounter *n*:

```
\begin{defi}[Name]
This is a definition.
\end{defi}
\begin{axio}[Name]
This is an axiom.
\end{axio}
```

Definition 2.1 (Name). This is a definition.

Axiom 2.1 (Name). This is an axiom.

2.3 Remark-like Environments

Remark-like environments are `rema` and `exam`. They also each have their own subcounter *n*:

```
\begin{rema}[Name]
This is a remark.
\end{rema}
\begin{exam}[Name]
This is an example.
\end{exam}
```

Remark 2.1 *(Name).* This is a remark.

Example 2.1 *(Name).* This is an example.

2.4 The Algorithm Environment

Finally, a specific algorithm environment is offered:

```
\begin{algo}[Name]
\hfill
\begin{itemize}
  \item this is an algorithm
  \item while ( condition ), do:
  \begin{itemize}
    \item and this is
    \item a conditional loop
  \end{itemize}
\end{itemize}
\end{algo}
```

Algorithm 2.1 [Name]

- this is an algorithm
- while (condition), do:
  - and this is
  - a conditional loop

3 Mathematical Macros

3.1 Fields

The following enhanced "blackboard font" field letters are made available, since `\mathbb{}` is not really satisfactory:

```
$\K \quad \N \quad \Z \quad \R \quad \C$
```

$\mathbb{K} \quad \mathbb{N} \quad \mathbb{Z} \quad \mathbb{R} \quad \mathbb{C}$

3.2 Functional Spaces

`SANDmath` also provides some classical functional spaces:

```
$\CC{1} \quad \CCs{\infty}{0} \quad
\Lo \quad \Lt \quad \Li \quad \Lsp{p}$
```

$\mathscr{C}^1 \quad \mathscr{C}_0^\infty \quad \mathrm{L}^1 \quad \mathrm{L}^2 \quad \mathrm{L}^\infty \quad \mathrm{L}^p$

One can also specify the domain of the space, *e.g.*,

```
$\CC{1}(]a,b[) \quad \Lt(\Omega)$
```

$\mathscr{C}^1(]a,b[) \quad \mathrm{L}^2(\Omega)$

3.3 Differential Calculus

The package makes available a variety of differential calcul unary, binary and ternary operators. Please note that the differential d symbol is in straight font, as it *should* be. First, derivative operators:

```
$\displaystyle \dd{x}
\quad          \der{f}{x}
\quad          \lder{f}{x}
\quad          \dern{n}{f}{x}
\quad          \ldern{n}{f}{x}$
```

$\displaystyle \mathrm{d}x \quad \frac{\mathrm{d}f}{\mathrm{d}x} \quad \frac{\mathrm{d}}{\mathrm{d}x}f \quad \frac{\mathrm{d}^n f}{\mathrm{d}x^n} \quad \frac{\mathrm{d}^n}{\mathrm{d}x^n}f$

Second, partial derivative operators:

```
$\displaystyle \pder{f}{x}
\quad          \lpder{f}{x}
\quad          \pdern{n}{f}{x}
\quad          \lpdern{n}{f}{x}
\quad          \pxder{f}{x}{y}
\quad          \lpxder{f}{x}{y}$
```

$\displaystyle \frac{\partial f}{\partial x} \quad \frac{\partial}{\partial x}f \quad \frac{\partial^n f}{\partial x^n} \quad \frac{\partial^n}{\partial x^n}f \quad \frac{\partial^2 f}{\partial x \partial y} \quad \frac{\partial^2}{\partial x \partial y}f$

`SANDmath` also defines the divergence, gradient and curl operators, both in long:

```
$\displaystyle \dive{f}
\quad          \grad{f}
\quad          \curl{f}$
```

$\displaystyle \dive{f} \quad \grad{f} \quad \curl{f}$

and abridged ∇ forms:

```
$\displaystyle \Nd{f}
\quad          \Ng{f}
\quad          \Nc{f}$
```

$\displaystyle \Nd{f} \quad \Ng{f} \quad \Nc{f}$

3.4 Integral Calculus

SANDmath also provides a collection of simple:

```
$\displaystyle \sint{a}{b}{f(x)}{x}$
```

$\displaystyle \sint{a}{b}{f(x)}{x}$

double:

```
$\displaystyle \dint{U}{f(u)}{u}
\quad          \ddint{U}{f(x,y)}{x}{y}$
```

$\displaystyle \dint{U}{f(u)}{u} \quad \ddint{U}{f(x,y)}{x}{y}$

and triple integrals macros:

```
$\displaystyle \tint{V}{f(v)}{v} \quad
\ttint{V}{f(x,y,z)}{x}{y}{z}$
```

$\displaystyle \tint{V}{f(v)}{v} \quad \ttint{V}{f(x,y,z)}{x}{y}{z}$

3.5 Vector Operators

First, various usual norms:

```
$\displaystyle \norm{u}
\quad          \normone{u}
\quad          \normtwo{u}
\quad          \normsup{u}
\quad          \normgen{0,\Omega}{u}$
```

$\displaystyle \norm{u} \quad \normone{u} \quad \normtwo{u} \quad \normsup{u} \quad \normgen{0,\Omega}{u}$

Then, some norms specific to integration spaces:

```
$\displaystyle \normLo{u}
\quad          \normLt{u}
\quad          \normLi{u}
\quad          \normL{p}{u}$
```

$\displaystyle \normLo{u} \quad \normLt{u} \quad \normLi{u} \quad \normL{p}{u}$

More esoteric unary norm-like operators (seminorms, induced norms):

```
$\displaystyle \seminorm{1,\Omega}{u}
\quad          \indnorm{u}$
```

$$|u|_{1,\Omega} \quad |||u|||$$

Finally, some binary and ternary vector operators:

```
$\displaystyle \innprod{u}{v}
\quad          \dualpair{u}{v}
\quad          \mixprod{u}{v}{w}$
```

$$(u|v) \quad \langle u, v \rangle \quad [u, v, w]$$

3.6 Asymptotic Notations

The package provides in particular short-hand notations for the LANDAU notations ("small-o" and "big-o"), with what I think is the correct font family: straight and not slanted.

```
$\displaystyle \smallo{\normtwo{f}}
\quad          \bigo{h^n}
\quad          f(x) \aseq{x}{0} g(x)$
```

$$\mathrm{o}(\|f\|_2) \quad \mathrm{O}(h^n) \quad f(x) \underset{x \to 0}{\sim} g(x)$$

4 Brief Concluding Remarks

The SANDmath package is *not* intended to be frozen in its current state; comments and suggestions to improve it are more than welcome.

In particular, the choices made to define the mathematical environments in the current version of SANDmath *de facto* define a standard mathematical style for SAND reports. However, these style choices do not reflect any existing style policy, since there is not, to my knowledge, any such policy. Therefore, any SANDmath user willing to discuss the choices I made is strongly encouraged to do so.

References

[1] R. Riesen. The sand report class. LaTeX class, Sandia National Laboratories, 2004. Available at www.cs.sandia.gov/~rolf/SANDreport/sandUsage.html.

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