

# oststud — OST-Stud Style and Macros\*

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Released 2023/05/20

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\*This document corresponds to oststud v0.4, last revised 2023/05/20.

# 1 Purpose of this Package

This package is made for the OST Studenten organization to provide an easy to use interface that gives a more consistent look and feel to the works produced by its members. This package is the successor after the fusion of the old `hsrstud` package.

## 2 Package Options

- dontrenew** Do not renew existing L<sup>A</sup>T<sub>E</sub>X commands and environments. This is useful when the package is loaded on a document that is already partially written.
- textvecdiff** Disables the “Nabla” or “Del” notation for vector derivatives. Instead the symbols  $\nabla, \nabla \cdot, \nabla \times, \nabla^2, \nabla^2$  are replaced with grad, div, curl and div grad.
- bfemph** Change the behaviour of `\emph` to use a bold font for emphasis (instead of italics). This option cannot be used together with the `dontrenew` option.
- bbprobability** Use blackboard symbols  $\mathbb{P}, \mathbb{E}$  and  $\mathbb{V}$  instead of Pr, E and Var for the probability, expectation and variance respectively.
- scrtransforms** *Work in progress.*

## 3 Usage

### 3.1 Vectors and Vector Calculus

`\vec` In the physics used by electrical engineers it is common to use lowercase bold letters for vectors (with the exception of electromagnetic fields  $\mathbf{E}, \mathbf{B}, \mathbf{A}, \dots$ ). If the `dontrenew` option is set a new macro `\bvec` (bold `\vec`) that takes a  $\langle symbol \rangle$  defines the bold vector notation. Otherwise the default vector notation with the tiny ugly arrow ( $\vec{u}$ ) is replaced by bold and the arrow notation saved in `\oldvec`. In vector calculus it is common to denote unit vectors by putting a hat, so there is a macro `\uvec` that does just that:

$$\hat{\mathbf{u}} = \mathbf{u}/u.$$

`\dotp` To differentiate the dot and cross products (between vectors) from normal product between scalars ( $a \cdot b$  and  $a \times b$ ), the macros `\dotp` and `\crossp` provide a bold variant:

$$\mathbf{u} \cdot \mathbf{v}, \quad \mathbf{u} \times \mathbf{v}$$

`\grad` The macros `\grad`, `\div` and `\curl` provide symbols for the gradient, divergence and curl operators used in vector calculus. If the option `textvecdiff` is set, they symbols are written as words, otherwise they will be written (ab)using the Nabla symbol, i.e. by pretending that the symbol  $\nabla$  is a “vector” (sometime referred to as “del”) of partial derivatives:  $\nabla = (\partial_x, \partial_y, \partial_z)^T$ . Unless the option

When the option `dontrenew` is set, the division symbol is replaced by the divergence and the symbol  $\div$  is saved in `\divsym`. For a scalar field  $\phi$  or a vector field  $\mathbf{F}$  the notation (in order) of the gradient, divergence and curl appear as follows:

█ `\grad \phi`, `\div \vec{F}`, `\curl \vec{F}`

$$\nabla \phi, \quad \nabla \cdot \mathbf{F}, \quad \nabla \times \mathbf{F}.$$

`\laplacian` Continuing with the (ab)use of the “Nabla” or “Del” notation, there is a `\vllaplacian` macro `\laplacian` for the Laplacian operator

█ `\laplacian \equiv \div \grad \equiv \sum_i \partial_i^2`

$$\nabla^2 \equiv \nabla \cdot \nabla \equiv \sum_i \partial_i^2.$$

Notice that the Nabla symbol is not bold, that is because the Laplacian operator results in a scalar value. Though, sometimes in electrodynamics the vector Laplacian is used (which applies the Laplacian operator to each component). To differentiate the two there is a macro `\vllaplacian` which uses the bold nabla symbol:  $\nabla^2$ . If the option `dontrenew` is set both symbols are replaced by `\grad`.

### 3.2 Linear Algebra

`\mx` Similarly to vectors it is common to write matrices as uppercase bold letters, thus the `\mx` macro takes a  $\langle symbol \rangle$  and typesets it as upright bold.

`\mt` The “normal” and Hermitian (complex conjugate) transpose of a matrix  $\mathbf{F}$  are denoted by a superscript sans-serif T or H respectively ( $\mathbf{F}^T$  resp.  $\mathbf{F}^H$ ). The `\mt` and `\mh` macros (matrix transpose and Hermitian transpose) provide this notation; They both take a  $\langle symbol \rangle$ . In abstract vector spaces the Hermitian transpose becomes the adjoint, for which it is common to use a superscript dagger (adjoint of  $Q$  is  $Q^\dagger$ ), but since it does not come up very often this package does *not* provide a macro for the adjoint.

`\minv` Another common matrix operation that is annoying to write is the matrix inverse, which is usually written as a superscript -1. The `\minv` command takes a  $\langle matrix \rangle$  and adds the -1 superscript.

Using all of the above we can typeset the matrix form of the linear least squares approximation by writing

█ `\vec{a} = \minv{(\mt{\mx{Q}} \mx{Q})} \mt{\mx{Q}} \vec{y}`

which results in the following:

$$\mathbf{a} = (\mathbf{Q}^T \mathbf{Q})^{-1} \mathbf{Q}^T \mathbf{y} \iff \arg \min_{(a_1, a_2)} \left( \sum_{i=0}^n y_i - a_1 x_i + a_2 \right).$$

`\tr` This package also provides a macro for the trace of a matrix.

### 3.3 Mathematical Programming

`\argmin` *Work in progress.*

`\argmax`

### 3.4 Complex Numbers

`\Re` AMS maths’s default notation for the real and imaginary parts of a complex `\Im` number use the Fraktur font capital letters  $\Re$  and  $\Im$ . However, in engineering it is more common to see the notation  $\operatorname{Re}\{z\}$  and  $\operatorname{Im}\{z\}$ , thus, unless the `dontrenew` option is set this package replaces the notation with the former symbols. Both of the macros were also modified to take an argument  $\langle expression \rangle$ , to surround the expression with opening and closing curly brackets.

### 3.5 Probability Operators

`\Pr` Since according to quantum mechanics it seems that ultimately the universe can `\E` only be described using probabilities there are the operators `\Pr`, `\E` and `\Var` for `\Var` the probability, expectation and variance respectively. If the `dontrenew` option is set, the probability is defined in the csname `\P`.

All three operators take an argument  $\langle expression \rangle$  which is automatically surrounded using curly braces. If the expression contains multiple random variables, to disambiguate with respect to which variable the operation is being taken it is possible to specify an optional argument  $[rv]$ . An example:

`\E[x]{g(x)} = \int_{\mathcal{X}} g(\bar{x}) p_x(\bar{x}) d\bar{x}`

$$\mathbb{E}_x \{g(x)\} = \int_{\mathcal{X}} g(\bar{x}) p_x(\bar{x}) d\bar{x}.$$

Because some people like to use the blackboard font for the probability operators (such as in the machine learning community), there is an option `bbprobability` that changes the look of the three operators to  $\mathbb{P}$ ,  $\mathbb{E}$  and  $\mathbb{V}$ .

### 3.6 Transformation Operators

`\corresponds` When working with transformations it is common to use the “correspondence `\rcorresponds` symbol” show below for example with the Laplace transformation:

`\laplace\{f(t)\} = F(s) \corresponds f(t) \rcorresponds F(s)`

$$\mathcal{L}\{f(t)\} = F(s) \circ\bullet f(t) \bullet\circ F(s)$$

`\fourier` As shown in the example above the for the Laplace transform operator symbol `\ifourier` there is a macro `\laplace`. Similar operators are also defined for other transformations and their inverses. Here is their usual definition:

$$\begin{aligned} \text{\ilaplace} \quad & \mathcal{F}\{f(t)\}(\omega) = \frac{1}{\sqrt{2\pi}} \int_{\mathbb{R}} f(t) e^{-i\omega t} dt, & \mathcal{F}^{-1}\{F(\omega)\}(t) &= \frac{1}{\sqrt{2\pi}} \int_{\mathbb{R}} F(\omega) e^{i\omega t} d\omega, \\ \text{\iztransf} \quad & \mathcal{L}\{f(t)\}(s) = \int_{\mathbb{R}^+} f(t) e^{-st} dt, & \mathcal{L}^{-1}\{F(s)\}(t) &= \frac{1}{2\pi i} \int_{\gamma+i\mathbb{R}} F(s) e^{st} ds, \\ \text{\hilbert} \quad & \mathcal{Z}\{f_k\}(z) = \sum_{k \in \mathbb{Z}^+} f_k z^{-k}, & \mathcal{Z}^{-1}\{F(z)\}(k) &= \frac{1}{2\pi i} \oint_C F(z) z^{k-1} dz, \\ & \mathcal{H}\{f(t)\}(\tau) = \text{P.V.} \frac{1}{\pi} \int_{\mathbb{R}} \frac{f(t)}{\tau - t} dt, \end{aligned}$$

in order they are the Fourier transform (`\fourier`, `\ifourier`), the Laplace transform (`\laplace`, `\ilaplace`), the Z-transform (`\ztransf`, `\iztransf`), and the Hilbert transform (`\hilbert`). The Hilbert has no inverse since  $-\mathcal{H}\mathcal{H}f(t) = f(t)$ , though of course one could write `\hilbert^{-1}` to get  $\mathcal{H}^{-1}$ .

### 3.7 References

*Work in progress.*

### 3.8 OST Colors

The official OST color palette provides the following “primary” or “accent” colors.



And then there are the other “design colors”.



### 3.9 Sane Defaults

*Work in progress.*

## 4 Implementation

### 4.1 Dependencies and Parse Options

First, we have the dependencies necessary for typesetting.

```
1 \RequirePackage{xcolor}
2 \RequirePackage{amsmath}
3 \RequirePackage{amssymb}
4 \RequirePackage{bm}
```

This package also sets sane defaults to the following packages.

```
5 \RequirePackage{hyperref}
6 \RequirePackage{listings}
```

Then we create the options for the package.

```
7 \SetupKeyvalOptions{
8   family=ost,
9   prefix=ost@
10 }
11 \DeclareBoolOption[false]{dontrenew}
12 \DeclareBoolOption[false]{textvecdiff}
13 \DeclareBoolOption[false]{bfemph}
14 \DeclareBoolOption[false]{bbprobability}
15 % \DeclareBoolOption[false]{scrtransforms}
16 \ProcessLocalKeyvalOptions*
```

## 4.2 Bold emphasis

`\emph` Change the behaviour of `\emph`.

```
17 \ifost@bfemph
18   \ifost@dontrenew
19     \PackageError{The options \noexpand\dontrenew and \noexpand\bfemph cannot be used at
20   \fi
21   \long\expandafter\def\csname em \endcsname{%
22     \@nomath\em
23     \if b\expandafter\@car\f@series\@nil
24       \itshape\else\bfseries\fi
25   }
26 \fi
```

## 4.3 Vectors and Vector Calculus

`\vec` Set up bold notation for vectors.

```
27 \newcommand{\ost@vec}[1]{\mathbf{\bm{#1}}}
28 \ifost@dontrenew
29   \newcommand{\bvec}[1]{\ost@vec{#1}}
30 \else
31   \let\oldvec\vec
32   \renewcommand{\vec}[1]{\ost@vec{#1}}
33 \fi
```

`\uvec` In vector calculus unit vectors are usually denoted by a hat.

```
34 \newcommand{\uvec}[1]{\vec{\hat{#1}}}
```

`\dotp` To differentiate them from `\cdot` and `\times` which are for scalars.

```
\crossp 35 \DeclareMathOperator{\dotp}{\boldsymbol{\cdot}}
36 \DeclareMathOperator{\crossp}{\boldsymbol{\times}}
```

`\grad` Gradient of a vector valued scalar function.

```
37 \ifost@textvecdiff
38   \DeclareMathOperator{\grad}{grad}
39 \else
40   \DeclareMathOperator{\grad}{\vec{\nabla}}
41 \fi
```

`\div` Divergence operator. If the option `dontrenew` is a new macro `\divg` is defined. Otherwise `\div` is renamed to `\divsymb`.

```

42 \ifost@textvecdiff
43   \DeclareMathOperator{\ost@div}{div}
44 \else
45   \DeclareMathOperator{\ost@div}{\vec{\nabla}\dotp}
46 \fi
47 \ifost@dontrenew
48   \DeclareMathOperator{\divg}{\ost@div}
49 \else
50   \let\divsymb\div
51   \renewcommand{\div}{\ost@div}
52 \fi

```

`\curl` Curl of a vector field.

```

53 \ifost@textvecdiff
54   \DeclareMathOperator{\curl}{curl}
55 \else
56   \DeclareMathOperator{\curl}{\vec{\nabla}\crossp}
57 \fi

```

`\laplacian` Laplacian of a scalar and vector field.

```

\vlaplacian 58 \ifost@textvecdiff
59   \DeclareMathOperator{\laplacian}{\div\grad}
60   \DeclareMathOperator{\vlaplacian}{\div\grad}
61 \else
62   \DeclareMathOperator{\laplacian}{\nabla^2}
63   \DeclareMathOperator{\vlaplacian}{\vec{\nabla}^2}
64 \fi

```

## 4.4 Linear Algebra

`\mx` Notation for matrices as bold (uppercase) letters.

```
65 \newcommand{\mx}[1]{\mathbf{\bm{#1}}}
```

`\mt` Normal and Hermitian (conjugate) transpose of a matrix.

```

\mh 66 \newcommand{\mt}[1]{#1^{\mathsf{T}}}
67 \newcommand{\mh}[1]{#1^{\mathsf{H}}}

```

`\minv` Matrix inverse.

```
68 \newcommand{\minv}[1]{#1^{-1}}
```

`\tr` Trace of a matrix.

```
69 \DeclareMathOperator{\tr}{tr}
```

## 4.5 Mathematical Programming

`\argmin`

```
\argmax 70 \DeclareMathOperator*{\argmax}{arg\,max}
```

```
71 \DeclareMathOperator*{\argmin}{arg\,min}
```

## 4.6 Complex Numbers

`\Re` Replace the real and imaginary operators to look “normal”, that is not using the  
`\Im` Fraktur fonts.

```
72 \ifost@dontrenew\else
73   \let\oldRe\Re \let\oldIm\Im
74   \renewcommand{\Re}[1]{\mathrm{Re} \left\{#1\right\}}
75   \renewcommand{\Im}[1]{\mathrm{Im} \left\{#1\right\}}
76 \fi
```

## 4.7 Probability Operators

`\E` Expectation of a random variable.

```
77 \ifost@bbprobability
78   \DeclareMathOperator*\ost@expectation{\mathbb{E}}
79 \else
80   \DeclareMathOperator*\ost@expectation{E}
81 \fi
82 \newcommand*\E[2] []{\ost@expectation_{#1}\left\{#2\right\}}
```

`\Var` Variance of a random variable.

```
83 \ifost@bbprobability
84   \DeclareMathOperator*\ost@variance{\mathbb{V}}
85 \else
86   \DeclareMathOperator*\ost@variance{Var}
87 \fi
88 \newcommand*\Var[2] []{\ost@variance_{#1}\left\{#2\right\}}
```

`\Pr` Probability operator.

```
89 \ifost@bbprobability
90   \DeclareMathOperator*\ost@probability{\mathbb{P}}
91 \else
92   \DeclareMathOperator*\ost@probability{Pr}
93 \fi
94 \ifost@dontrenew
95   \newcommand*\P[2] []{\ost@probabiliy_{#1}\left\{#2\right\}}
96 \else
97   \renewcommand*\P[2] []{\ost@probabiliy_{#1}\left\{#2\right\}}
98 \fi
```

## 4.8 Transformation Operators

`\fourier` Fourier transform and its inverse.

```
\ifourier 99 \DeclareMathOperator{\fourier}{\mathcal{F}}
100 \DeclareMathOperator{\ifourier}{\mathcal{F}^{-1}}
```

`\laplace` Laplace transform and its inverse.

```
\ilaplace 101 \DeclareMathOperator{\laplace}{\mathcal{L}}
102 \DeclareMathOperator{\ilaplace}{\mathcal{L}^{-1}}
```

`\ztransf` Z-transform and its inverse.

```
\iztransf 103 \DeclareMathOperator{\ztransf}{\mathcal{Z}}
104 \DeclareMathOperator{\iztransf}{\mathcal{Z}^{-1}}
```



```

\hilbert Hilbert transform.
105 \DeclareMathOperator{\hilbert}{\mathcal{H}}

\corresponds Correspondence symbols.
\rcorresponds 106 \newcommand{\corresponds}{%
107     \mbox{\setlength{\unitlength}{0.1em}%
108         \begin{picture}(20,10)%
109             \put(5,3){\circle{4}}%
110             \put(7,3){\line(1,0){7}}%
111             \put(16,3){\circle*{4}}%
112         \end{picture}}}
113 \newcommand{\rcorresponds}{%
114     \mbox{\setlength{\unitlength}{0.1em}%
115         \begin{picture}(20,10)%
116             \put(5,3){\circle*{4}}%
117             \put(7,3){\line(1,0){7}}%
118             \put(16,3){\circle{4}}%
119         \end{picture}}}

```

## 4.9 References

```

\skriptum Reference material in the skriptum (lecture notes) of the course.
\sref 120 \newcommand{\ost@skriptum}{\PackageWarning{No \noexpand\skriptum given}}
121 \newcommand{\skriptum}[1]{\gdef\ost@skriptum{#1}}
122 \newcommand{\sref}[1]{%
123     \texttt{\textcolor{OSTBlackberry}{#1}}\nocite{\ost@skriptum}}

\textbook Reference material in the textbook of the course.
\bref 124 \newcommand{\ost@textbook}{\PackageWarning{No \noexpand\textbook given}}
125 \newcommand{\textbook}[1]{\gdef\ost@textbook{#1}}
126 \newcommand{\bref}[1]{%
127     \texttt{\textcolor{OSTRaspberry}{#1}}\nocite{\ost@textbook}}

```

## 4.10 OST Colors

Define the colors according to the OST corporate design. The code was kindly stolen from H. Badertscher’s OSTColors.sty [?]. First there are the “primary colors”.

```

128 \definecolor{OSTBlack}{RGB}{25,25,25}
129 \definecolor{OSTGray}{RGB}{198,198,198}
130 \definecolor{OSTBlackberry}{RGB}{140,25,95}
131 \definecolor{OSTRaspberry}{RGB}{215,40,100}

Then the “design colors”.

132 \definecolor{OSTPurple}{RGB}{149,96,164}
133 \definecolor{OSTDarkPurple}{RGB}{107,56,129}
134 \definecolor{OSTLightPurple}{RGB}{208,169,208}

135 \definecolor{OSTGreen}{RGB}{29,175,142}
136 \definecolor{OSTDarkGreen}{RGB}{0,126,107}
137 \definecolor{OSTLightGreen}{RGB}{167,213,194}

138 \definecolor{OSTRed}{RGB}{232,78,15}
139 \definecolor{OSTDarkRed}{RGB}{195,46,21}
140 \definecolor{OSTLightRed}{RGB}{243,154,139}

```

```

141 \definecolor{OSTBlue}{RGB}{0,134,205}
142 \definecolor{OSTDarkBlue}{RGB}{0,115,176}
143 \definecolor{OSTLightBlue}{RGB}{95,191,237}
144 \definecolor{OSTOrange}{RGB}{251,186,0}
145 \definecolor{OSTDarkOrange}{RGB}{209,143,0}
146 \definecolor{OSTLightOrange}{RGB}{253,214,175}

```

## 4.11 Sane Defaults

First, set up hyperref to not look hideous.

```

147 \hypersetup{
148   colorlinks=true,
149   linkcolor=OSTBlack,
150   citecolor=OSTBlackberry,
151   filecolor=OSTBlack,
152   urlcolor=OSTDarkBlue,
153 }

```

Then create a listings style.

```

154 \lstdefinestyle{ost-base}{
155   belowcaptionskip=\baselineskip,
156   breaklines=true,
157   frame=none,
158   inputencoding=utf8,
159   % margin
160   xleftmargin=\parindent,
161   % numbers
162   numbers=left,
163   numbersep=5pt,
164   numberstyle=\ttfamily\footnotesize\color{OSTGray},
165   % background
166   backgroundcolor=\color{white},
167   showstringspaces=false,
168   % default language
169   language=TeX,
170   % break long lines, and show an arrow where the line was broken
171   breaklines=true,
172   postbreak=\mbox{\textcolor{OSTDarkBlue}{$\hookrightarrow$}\space},
173   % font
174   basicstyle=\ttfamily\small,
175   identifierstyle=\color{OSTBlack},
176   keywordstyle=\color{OSTBlue},
177   commentstyle=\color{OSTGray},
178   stringstyle=\color{OSTBlackberry},
179 }

```

Then we set this style to be default.

```

180 \lstset{style=ost-base, escapechar=`}

```

## Change History

v0.1	v0.3
General: Initial version . . . . . 1	General: Cleanup for CTAN upload 1
v0.2	v0.4
General: Port features of <code>hsrstud</code> . 1	General: Fix probability operators and improve documentation . . 1

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