

# The ExSol package\*

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## 1 Introduction

The package `ExSol` provides macros to allow embedding exercises and solutions in the  $\text{\LaTeX}$  source of an instructional text (e.g., a book or a course text) while generating the following separate documents:

- your original text that only contains the exercises, and
- a solution book that only contains the solutions to the exercises (a package option exists to also copy the exercises themselves to the solution book).

The former is generated when running  $\text{\LaTeX}$  on your document. This run writes the solutions to a secondary file that can be included into a simple document harness, such that when running  $\text{\LaTeX}$  on the latter, you can generate a nice solution book.

Why use `ExSol`?

- It allows to keep the  $\text{\LaTeX}$  source of your exercises and their solutions in a single file. Away with the nightmare to keep your solutions in sync with the original text.
- It separates exercises and solutions, allowing you
  - to only release the solution book to the instructors of the course;

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\*This document corresponds to `exsol 2.7a`, with `DG/SPQR` fixes, and `firstline=lastline` fix, dated 2008/02/07.

- to encourage students that you provide with the solution book to first try solving the exercises without opening the book; this seems to be easier than not peeking into the solution of an exercise that is typeset just below the exercise itself.

The code of the ExSol package was taken almost literally from `fancyvrb` [1]. Therefore, all credits go to the authors/maintainers of `fancyvrb`.

## 2 Installation

Either you are a package manager and then you'll know how to prepare an installation package for ExSol.

Either you are a normal user and then you have two options. First, check if there is a package that your favorite L<sup>A</sup>T<sub>E</sub>X distributor has prepared for you. Second, grab the TDS package from CTAN [2] (`exsol.tds.zip`) and unzip it somewhere in your own TDS tree, regenerate your filename database and off you go. In any case, make sure that L<sup>A</sup>T<sub>E</sub>X finds the `exsol.sty` file.

The ExSol package uses some auxiliary packages: `fancyverb`, `ifthen`, `kvoptions` and, optionally, `babel`. Fetch them from CTAN [2] if your T<sub>E</sub>X distributor does not provide them.

## 3 Usage

### 3.1 Preparing your document source

The macro package `exsol` can be loaded with:

```
\usepackage{exsol}
```

Then, you are ready to add some exercises including their solution to your document source. To this end, embed them in a `exercise` and a corresponding `solution` environment. Optionally, you may embed several of them in a `exercises` environment, to make them stand out in your text. E.g.,

---

```

\begin{exercises}

\begin{exercise}
  Solve the following equation for  $x \in \mathbb{C}$ , with  $\mathbb{C}$  the set of
  complex numbers:
  \begin{equation}
    5x^2 - 3x = 5
  \end{equation}
\end{exercise}

\begin{solution}
  Let's start by rearranging the equation, a bit:
  \begin{equation}
    5x^2 - 3.1x = 5.3 \\
    5x^2 - 3.1x - 5.3 = 0
  \end{equation}
  The equation is now in the standard form:
  \begin{equation}
    ax^2 + bx + c = 0
  \end{equation}
  For quadratic equations in the standard form, we know that two
  solutions exist:
  \begin{equation}
    x_{1,2} = \frac{-b \pm \sqrt{d}}{2a}
  \end{equation}
  with
  \begin{equation}
    d = b^2 - 4ac
  \end{equation}
  If we apply this to our case, we obtain:
  \begin{equation}
    d = (-3.1)^2 - 4 \cdot 5.7 \cdot (-5.3) = 130.45
  \end{equation}
  and
  \begin{equation}
    x_1 = \frac{3.1 + \sqrt{130.45}}{11.4} = 1.27 \\
    x_2 = \frac{3.1 - \sqrt{130.45}}{11.4} = -0.73
  \end{equation}
  The proposed values  $x = x_1, x_2$  are solutions to the given equation.
\end{solution}

\begin{exercise}
  Consider a 2-dimensional vector space equipped with a Euclidean
  distance function. Given a right-angled triangle, with the sides
   $A$  and  $B$  adjacent to the right angle having lengths,  $3$  and
   $4$ , calculate the length of the hypotenuse, labeled  $C$ .
\end{exercise}

```

```

\begin{solution}
  This calls for application of Pythagoras' theorem, which
  tells us:
  \begin{equation}
    \left|A\right|^2 + \left|B\right|^2 = \left|C\right|^2
  \end{equation}
  and therefore:
  \begin{eqnarray}
    \left|C\right| &= \sqrt{\left|A\right|^2 + \left|B\right|^2} \\
    &= \sqrt{3^2 + 4^2} \\
    &= \sqrt{25} = 5
  \end{eqnarray}
  Therefore, the length of the hypotenuse equals $5$.
\end{solution}

\end{exercises}

```

---

The result in the original document, can be seen below. As you can see, there's no trace of the solution.

---

## Exercises

*Exercise 3.1-1:* Solve the following equation for  $x \in C$ , with  $C$  the set of complex numbers:

$$5x^2 - 3x = 5 \tag{1}$$

*Exercise 3.1-2:* Consider a 2-dimensional vector space equipped with a Euclidean distance function. Given a right-angled triangle, with the sides  $A$  and  $B$  adjacent to the right angle having lengths, 3 and 4, calculate the length of the hypotenuse, labeled  $C$ .

---

When running L<sup>A</sup>T<sub>E</sub>X on your document (in our case on the `exsol.dtx` file, as a side effect a file with extension `.sol.tex` has been written to disk (in our case, the file `exsol.sol.tex`), containing all solutions in sequence.

Generating a solution book is as simple as including the file into a simple harness, that allows you giving it a proper title page and to add other bells

and whistles.

E.g.,

---

```
\documentclass{article}
\usepackage[english]{babel}
\title{Solutions to the exercises, specified in the \textsf{ExSol} package}
\author{Walter Daems}
\date{2013/05/12}

\begin{document}

\maketitle

\input{exsol.sol}

\end{document}
```

---

You may generate this solution book, by running  $\text{\LaTeX}$  on the file named `exsol-solutionbook.tex` that is generated when running  $\text{\LaTeX}$  on the `exsol.dtx` file.

The result approximately looks like this:

---

Solutions to the exercises, specified in the **ExSol** package  
Walter Daems  
2013/05/12

---

**Solution 3.1-1** Let's start by rearranging the equation, a bit:

$$5.7x^2 - 3.1x = 5.3 \quad (1)$$

$$5.7x^2 - 3.1x - 5.3 = 0 \quad (2)$$

The equation is now in the standard form:

$$ax^2 + bx + c = 0 \quad (3)$$

For quadratic equations in the standard form, we know that two solutions exist:

$$x_{1,2} = \frac{-b \pm \sqrt{d}}{2a} \quad (4)$$

with

$$d = b^2 - 4ac \quad (5)$$

If we apply this to our case, we obtain:

$$d = (-3.1)^2 - 4 \cdot 5.7 \cdot (-5.3) = 130.45 \quad (6)$$

and

$$x_1 = \frac{3.1 + \sqrt{130.45}}{11.4} = 1.27 \quad (7)$$

$$x_2 = \frac{3.1 - \sqrt{130.45}}{11.4} = -0.73 \quad (8)$$

The proposed values  $x = x_1, x_2$  are solutions to the given equation.

---

**Solution 3.1-2** This calls for application of Pythagoras' theorem, which tells us:

$$\|A\|^2 + \|B\|^2 = \|C\|^2 \quad (9)$$

and therefore:

$$\|C\| = \sqrt{\|A\|^2 + \|B\|^2} \quad (10)$$

$$= \sqrt{3^2 + 4^2} \quad (11)$$

$$= \sqrt{25} = 5 \quad (12)$$

Therefore, the length of the hypotenuse equals 5.

---

## 4 Implementation

```
1 <*package>
```

### 4.1 Auxiliary packages

The package uses some auxiliary packages:

```
2 \RequirePackage{fancyvrb}
3 \RequirePackage{ifthen}
4 \RequirePackage{kvoptions}
```

### 4.2 Package options

The package offers some options:

**exercisefontsize** This option allows setting the font of the **exercises** environment. You may choose one of tiny, scriptsize, footnotesize, small, normalsize, large, etc.  
E.g., `[exercisefontsize=small]`.

```
5 \DeclareStringOption[normalsize]{exercisefontsize}
```

**exerciseaslist** This boolean option (true, false) allows setting the typesetting of the **exercises** in a list environment. This causes the exercises to be typeset in a more compact fashion, with indented left and right margin.

```
6 \DeclareBoolOption[false]{exerciseaslist}
```

**copyexercisessolutions** This boolean option (true, false) allows copying the exercises in the solutions file, to allow for making a complete stand-alone exercises bundle.

```
7 \DeclareBoolOption[false]{copyexercisessolutions}
```

The options are processed using:

```
8 \ProcessKeyvalOptions*
```

The options are subsequently handled

```
9 \newcommand{\exercisefontsize}{\csname \exsol@exercisefontsize\endcsname}
```

### 4.3 Con- and destruction of the auxiliary streams

At the beginning of your document, we start by opening a stream to a file that will be used to write the solutions to. At the end of your document, the package closes the stream.

```
10 \AtBeginDocument{
11   \newwrite\solutionstream
12   \immediate\openout\solutionstream=\jobname.sol.tex
13 }
14 \AtEndDocument{
15   \immediate\closeout\solutionstream
16 }
```

### 4.4 Exercises counter

By providing an exercise counter, proper numbering of the exercises is provided to allow for good cross referencing of the solutions to the exercises.

```
17 \newcounter{exercise}[subsection]
18 \setcounter{exercise}{0}
19 \renewcommand{\theexercise}{%
20   \@ifundefined{c@chapter}{\if0\arabic{chapter}\else\arabic{chapter}.\fi}%
21   \if0\arabic{section}\else\arabic{section}\fi%
22   \if0\arabic{subsection}\else.\arabic{subsection}\fi%
23   \if0\arabic{subsubsection}\else.\arabic{subsubsection}\fi%
24   \if0\arabic{exercise}\else%
25     \@ifundefined{c@chapter}%
26       {\if0\arabic{section}\else-\fi}%
27       {-}%
28     \arabic{exercise}%
29   \fi
30 }
```

## 5 The user environments

**exercise** The `exercise` environment is used to typeset your exercises, provide them with a nice label and allow for copying the exercise to the solutions file (if the package option `copyexercisessolution` is set. The label can



be set by redefining the `\exercisename` macro, or by relying on the Babel provisions. The code is almost literally taken from the `FancyVerb` package.

```

31 \def\exercise{\FV@Environment{}}{exercise}}
32 \def\FVB@exercise{%
33   \refstepcounter{exercise}%
34   \newwrite\exercisestream
35   \immediate\openout\exercisestream=\jobname.exc.tex
36   \ifexsol@copyexercisesinsolutions
37     \typeout{Writing exercise to \jobname.sol.tex}
38     \immediate\write\solutionstream{\string\par---\string\newline
39       \string\textbf{\string{exercisename{}} \theexercise \string}}
40   \else
41     \immediate\write\solutionstream{\string\par---\string\newline}
42   \fi
43   \immediate\write\exercisestream{\string\begin{exsol@exercise}}
44   \@bsphack
45   \begingroup
46     \FV@UseKeyValues
47     \FV@DefineWhiteSpace
48     \def\FV@Space{\space}%
49     \FV@DefineTabOut
50     \ifexsol@copyexercisesinsolutions
51       \def\FV@ProcessLine{\immediate\write\solutionstream{\FV@Line}%
52         \immediate\write\exercisestream}%
53     \else
54       \def\FV@ProcessLine{\immediate\write\exercisestream}%
55     \fi
56     \relax
57     \let\FV@FontScanPrep\relax
58     \let\@noligs\relax
59     \FV@Scan
60   }
61 \def\FVE@exercise{
62   \endgroup\@esphack
63   \immediate\write\exercisestream{\string\end{exsol@exercise}}
64   \ifexsol@copyexercisesinsolutions
65     \immediate\write\solutionstream{\string~\string\newline}
66   \fi
67   \immediate\closeout\exercisestream
68   \input{\jobname.exc.tex}
69 }
70 \DefineVerbatimEnvironment{exercise}{exercise}{}

```

`exsol@exercise` The `exsol@exercise` environment is an internal macro used to typeset

your exercises and provide them with a nice label and number. Do not use it directly. Use the proper environment `exercise` instead.

```

71 \newenvironment{exsol@exercise}[0]
72 {%
73   \begin{minipage}[t]{\textwidth}%
74     \ifthenelse{\boolean{exsol@exerciseaslist}}
75       {\begin{list}%
76         {%
77           }%
78           {%
79             \setlength{\topsep}{0pt}%
80             \setlength{\leftmargin}{1em}%
81             \setlength{\rightmargin}{1em}%
82             \setlength{\listparindent}{0em}%
83             \setlength{\itemindent}{0em}%
84             \setlength{\parsep}{\parskip}}%
85           \item[\hspace*{\leftmargin}\textit{\exercisename{}
86                                                     \theexercise:}]
87         }%
88         {
89           \textit{\exercisename{} \theexercise:}~
90         }
91   }
92 {%
93   \ifthenelse{\boolean{exsol@exerciseaslist}}
94     {\end{list}}{}
95   \end{minipage}
96   \vspace{1ex}\par
97 }

```

**solution** The `solution` environment is used to typeset your solutions and provide them with a nice label and number that corresponds to the exercise that preceded this solution. Theno label can be set by redefining the `\solutionname` macro, or by relying on the Babel provisions. The code is almost literally taken from the `FancyVerb` package.

```

98 \def\solution{\FV@Environment{}{solution}}
99 \def\FVB@solution{%
100   \typeout{Writing solution to \jobname.sol.tex}
101   \immediate\write\solutionstream{\string\textbf\string\solutionname{}\string}
102   \ifexsol@copyexercisesinsolutions
103     \immediate\write\solutionstream{\string\newline}
104   \else

```

```

105     \immediate\write\solutionstream{\string\textbf\string{\theexercise\string}%
106                                     \string\newline}
107     \fi
108     \@bsphack
109     \begingroup
110         \FV@UseKeyValues
111         \FV@DefineWhiteSpace
112         \def\FV@Space{\space}%
113         \FV@DefineTabOut
114         \def\FV@ProcessLine{\immediate\write\solutionstream}%
115         \relax
116         \let\FV@FontScanPrep\relax
117         \let\@noligs\relax
118         \FV@Scan
119     }
120 \def\FVE@solution{\endgroup\@esphack}
121 \DefineVerbatimEnvironment{solution}{solution}{}

```

**exercises** The `exercises` environment helps typesetting your exercises to stand out from the rest of the text. You may use it at the end of a chapter, or just to group some exercises in the text.

```

122 \newenvironment{exercises}
123 {\par\exercisesfontsize\rule{.25\linewidth}{0.15mm}\\*~\\*%
124  \textbf{\normalsize \exercisename}\vspace*{1ex}\\}
125 {~\\*\rule{.25\linewidth}{0.15mm}\par}

```

## 5.1 Some Babel provisions

**\exercisename** The exercise environment makes use of a label `Exercise` macro.

```
126 \newcommand{\exercisename}{Exercise}
```

**\exercisename** The exercises environment makes use of a label `Exercises` macro.

```
127 \newcommand{\exercisename}{Exercises}
```

**\solutionname** The solution environment makes use of a label `Solution` macro.

```
128 \newcommand{\solutionname}{Solution}
```

You may redefine these macros, but to help you out a little bit, we provide with some basic Babel auxiliaries. If you're a true polyglot and are willing

to help me out by providing translations for other languages, I'm very willing to incorporate them into the code.

```

129 \addto\captionsdutch{%
130   \renewcommand{\exercisename}{Oefening}%
131   \renewcommand{\exercisesname}{Oefeningen}%
132   \renewcommand{\solutionname}{Oplossing}%
133 }
134 \addto\captionsgerman{%
135   \renewcommand{\exercisename}{Aufgabe}%
136   \renewcommand{\exercisesname}{Aufgaben}%
137   \renewcommand{\solutionname}{L"osung}%
138 }
139 \addto\captionsfrench{%
140   \renewcommand{\exercisename}{Exercice}%
141   \renewcommand{\exercisesname}{Exercices}%
142   \renewcommand{\solutionname}{Solution}%
143 }

```

Now the final hack overloads the basic sectioning commands to make sure that they are copied into your solution book.

```

144 \let\exsol@@makechapterhead\@makechapterhead
145 \def\@makechapterhead#1{%
146   \immediate\write\solutionstream{\string\chapter{#1}}%
147   \exsol@@makechapterhead{#1}
148 }
149 \ifdefined\frontmatter
150   \let\exsol@@frontmatter\frontmatter
151   \def\frontmatter{%
152     \immediate\write\solutionstream{\string\frontmatter}%
153     \exsol@@frontmatter
154   }
155 \fi
156 \ifdefined\mainmatter
157   \let\exsol@@mainmatter\mainmatter
158   \def\mainmatter{%
159     \immediate\write\solutionstream{\string\mainmatter}%
160     \exsol@@mainmatter
161   }
162 \fi
163 \ifdefined\backmatter
164   \let\exsol@@backmatter\backmatter
165   \def\backmatter{%

```

```

166     \immediate\write\solutionstream{\string\backmatter}%
167     \exsol@@backmatter
168 }
169 \fi

```

**\noexerciseshchapter** If you have chapters without exercises, you may want to indicate this clearly into your source. Otherwise empty chapters may appear in your solution book.

```

170 \newcommand{\noexerciseshchapter}
171 {
172   \immediate\write\solutionstream{No exercises in this chapter}
173 }

174 \</package>

```

## References

- [1] Timothy Van Zandt, Herbert Voß, Denis Girou, Sebastian Rahtz, Niall Mansfield The **fancyvrb** package. <http://ctan.org/pkg/fancyvrb>. online, accessed in January 2012.
- [2] The Comprehensive TeX Archive Network. <http://www.ctan.org>. online, accessed in January 2012.

## Change History

v0.1		lems . . . . .	11
General: . Initial version . . . . .	1	<b>exsol@exercise</b> : Attempted to fix MiKTeX formatting problems . . . . .	10
v0.2			
General: . Minor bug fixes based on first use by Paul Levrie . .	1	v0.3	
Added option <b>exercisefont</b> . .	7	General: . Minor bug fixes based on second use by Paul . . . . .	1
Fixed babel errors . . . . .	11	<b>exercises</b> : Added some extra whitespace below exercises-name . . . . .	11
Removed dash in counter when in document without sectioning commands . . . . .	8	<b>exsol@exercise</b> : Fixed labelsep to avoid cluttered itemize en-	
<b>exercises</b> : Attempted to fix MiKTeX formatting prob-			



