

# The `brandeis-problemset` Document Class

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## Abstract

Brandeis University’s computer science (“COSI”) courses often assign “problem sets” which require fairly rigorous formatting. The `brandeis-problemset` document class, which extends `article`, provides a simple way to typeset these problem sets in L<sup>A</sup>T<sub>E</sub>X.

Although `brandeis-problemset` is compatible with all L<sup>A</sup>T<sub>E</sub>X flavors, X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X or LuaL<sup>A</sup>T<sub>E</sub>X is recommended for `fontspec` support.

**Note:** The `brandeis-problemset` document class should be considered experimental; the only stable API is that of the `problem` environment.

**Note:** Browse the sources, contribute, or complain at  
[github.com/9999years/brandeis-problemset](https://github.com/9999years/brandeis-problemset)

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## 1 Default behavior

`brandeis-problemset` provides packages and well-formatted constructs (notably the `problem` environment) for problem-set writers. `brandeis-problemset` will always render its body copy as a Times variant (`stix` for plain L<sup>A</sup>T<sub>E</sub>X or `xits` with X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X or Lua<sub>T</sub><sub>E</sub>X) and always contains a useful header (which contains the page number, author’s name, course, instructor, and assignment due date).

### 1.1 Default packages loaded

1. `hyperref`, for a nicely-linked table of contents; `\href{url}{label}`.
2. `listings`, for verbatim code listings (including the `assembly`, `java`, and `pseudocode` environments).
3. `xcolor`, for gray line numbers in code listings (and perhaps colored listings in the future); e.g. `\color{gray}`.
4. `enumitem` for better control over the margins and spacing of the `enumerate`, `itemize`, and `description` environments.
5. Math packages:
  - (a) `amsmath` for tons of useful math commands, including `\text`, `\intertext`, and `\boxed` as well as the `bmatrix`, `multiline`, `gather`, `align`, and `alignat` environments. See “User’s Guide for the `amsmath` Package” for a more complete listing.
  - (b) `mathtools` for other useful/utilitarian commands.
6. Table packages:
  - (a) `multirow` for cells spanning multiple rows.
  - (b) `booktabs` for good-by-default tables and the `\cline` macro.
  - (c) `tabu`, the best table package with dynamically resizable columns, easy creation of new column types, and more.

## 2 Class configuration

### 2.1 Class options

Class options are limited to configuration options which require the loading of fonts or other packages; “string” settings like the assignment’s due date are configured either with the `\problemsetsetup` command or the commands described in section 2.2.1.

|                        |   |
|------------------------|---|
| <code>gantt</code>     | Load packages for the <code>ganttschedule</code> environment  |
| <code>scheme</code>    | Define the <code>scheme</code> language for the <code>listings</code> package as well as the <code>scheme</code> shorthand environment. |
| <code>antonella</code> | Use Dr. Antonella DiLillio’s preferred styles (Courier for code)  |
| <code>solutions</code> | Include <code>solution</code> environments in compiled document.  |

## 2.2 Setting options after loading brandeis-problemset

`\problemsetsetup`  $\{ \langle options \rangle \}$   
Sets global `brandeis-problemset` options; see table 1 for a list of valid options.

Table 1: Options for `\problemsetsetup`

|                           |   |
|---------------------------|---|
| <code>course</code>       | Course name in full.  |
| <code>coursenumber</code> | Course name shorthand; use 21a for “COSI 21a”.  |
| <code>assignment</code>   | Assignment name in full.  |
| <code>number</code>       | Assignment name shorthand; use 3 for “Problem Set 3”.   |
| <code>duedate</code>      | Due date, e.g. 2018-10-18; not parsed at all, but <code>ISO 8601 dates</code> are highly recommended.   |
| <code>instructor</code>   | Course instructor.  |
| <code>codefont</code>     | With <code>X<sub>La</sub>TeX</code> or <code>LuaTeX</code> , pass the given font to <code>\setmonofont</code> and enable Unicode shortcuts for the <code>pseudocode</code> environment. (If you need to specify options to <code>\setmonofont</code> , use <code>\setcodefont</code> .) |
| <code>gantt</code>        | Load packages for the <code>ganttschedule</code> environment  |
| <code>antonella</code>    | True/false (default: false; if no value specified, assumes true); use Dr. Antonella DiLillio’s preferred styles (Courier for code)  |
| <code>solutions</code>    | Include <code>solution</code> environments in compiled document.  |

### 2.2.1 Configuration commands

`brandeis-problemset` additionally provides a number of configuration commands for setting a single option with similar interfaces as the `TeX` macros `\author`, `\title`, and `\date`.

`\duedate`  $\{ \langle date \rangle \}$  sets the due date in full.  
`\instructor`  $\{ \langle name \rangle \}$  sets the instructor name.  
`\course`  $\{ \langle name \rangle \}$  sets the course name in full.

`\coursenumber`  $\{\langle number \rangle\}$  sets the course name by number; e.g. `\coursenumber{21a}` gives a course of “COSI 21a”.

`\assignment`  $\{\langle name \rangle\}$  sets the assignment name in full.

`\problemsetnumber`  $\{\langle number \rangle\}$  sets the assignment name by number; e.g. `\problemsetnumber{3}` gives an assignment of “Problem Set 3”.

`\setcodefont`  $[\langle fonts\text{spec options} \rangle]\{\langle font\ name \rangle\}$   
 Sets the monospaced font to  $\langle font\ name \rangle$  and uses it for shortcuts in the pseudocode environment.

## 2.3 Practical usage

You may find it useful to define a customized document class for each course. There’s no reason to install these to some system-wide directory; it makes sense for them to live in the same directory as the problem set source files. For instance, `cosi21a.cls` might read:

```
\LoadClass[antonella]{brandeis-problemset}

% set course/author data
\problemsetsetup{
  instructor=Dr.\ Antonella DiLillio,
  coursenumber=21a,
}
\author{Rebecca Turner}

% get a prettier code font -- these can be pretty big so they're not loaded
% by default
\setcodefont[
  Extension = .otf,
  UprightFont = *-Regular,
  BoldFont = *-Bold,
]{FiraMono}
```

and then `ps1.tex` might read:

```
\documentclass{cosi21a}
% stuff specific to this assignment
\problemsetnumber{1}
\duedate{2018-10-29}
\begin{document}
% etc.
\end{document}
```

See section 4 for a more complete example.

### 3 User commands and environments

`brandeis-problemset` provides a number of commands for typesetting problems.

**problem** [*options*]  
 Defines a problem. A problem is set 1 inch from the left margin (although this amount may be customized by modifying the `\problemindent` length) and begins a new page.

|                  |  |
|------------------|--|
| <b>title</b>     | A problem title, to be displayed after “Problem” and the problem’s number.   |
| <b>number</b>    | A problem number; if given, the problem-number counter will not advance. The number must be robust, because it goes inside a <code>\section</code> . |
| <b>pagebreak</b> | True/false (default: true). Add a pagebreak before the problem?  |
| <b>label</b>     | Adds a custom label to the problem with <code>\label</code> that can be used with <code>\ref</code>  |
| <b>part</b>      | Indicates that this problem starts a new “part” of the assignment  |
| <b>partlabel</b> | Adds a custom label to this part; see <code>label</code>   |

Vertical material is allowed in a **problem**.

**solution** Defines a solution for a problem; a solution prints in blue and is excluded from the compiled document entirely unless the `solutions` package option is given.

In this way, the same `.tex` file can serve as both a postable assignment prompt and an answer key.

**Note:** The style of solutions is customizable by redefining `\solutionstyle`; it’s defined to `\colorblue` by default.

**\subproblem** [*description*]  
 Prints a sub-problem, i.e. a `\subsection`. It doesn’t do very much at the moment.

**\Th** [*colspec*]{*header*}  
 Prints a table-header in bold. By default, the header is left-aligned, but arbitrary alignments can be specified with `colspec`. `\Th` is backed by `\multicolumn`.

**pseudocode** [*keywords*]  
 Prints pseudocode.<sup>1</sup>

Several “shortcuts,” which replace a source-code sequence like `->` with a symbol like  $\rightarrow$ , are shown in table 2.

These shortcuts display in `\pseudocodesymbolfont` (default: `\ttfamily`), which may be redefined if you prefer something else. The easiest way to change

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<sup>1</sup>Designed for COSI 21a as taught by Dr. Antonella DiLillo

`\pseudocodesymbolfont` is with `\setcodefont`. If you use the `antonella` option with  $\text{\LaTeX}$  or  $\text{\LuaTeX}$ , `brandeis-problemset` will load `lm-math` and display the symbols seen in table 2, which look significantly better with Courier than STIX' symbols.

Table 2: Shortcuts provided by the `pseudocode` environment

| Input              | Display       | Codepoint |
|--------------------|---------------|-----------|
| <code>&lt;-</code> | $\leftarrow$  | U+2190    |
| <code>-&gt;</code> | $\rightarrow$ | U+2192    |
| <code>(/)</code>   | $\emptyset$   | U+2205    |
| <code>inf</code>   | $\infty$      | U+221E    |
| <code>!=</code>    | $\neq$        | U+2260    |
| <code>&gt;=</code> | $\geq$        | U+2265    |
| <code>&lt;=</code> | $\leq$        | U+2264    |

**To-do:** Improve the font selection mechanism; maybe provide a command for each symbol?

**Note:** If your  $\text{\TeX}$  engine doesn't support UTF-8 input, the shortcuts might appear totally blank or garbled. Good luck! It will surely work with  $\text{\LaTeX}$  or  $\text{\LuaTeX}$ .

```
% the optional [Bar] makes [Bar] bold like the other keywords
\begin{pseudocode}[Bar]
Bar(a, n)
  Input:  two integers, a and n
  Output: a^n
  k <- n # k is a counter
  b <- 1
  c <- a
  while k > 0 do
    if k mod 2 = 0 then
      k <- k/2
      c <- c * c
    else
      k <- k - 1
      b <- b * c
  return b
\end{pseudocode}
```

`assembly` [*extra options*]  
typesets assembly code.<sup>2</sup> Several considerations are taken into account; most notably, line numbers are printed as `x + n`, where `n` starts at 0 and counts by 4; the line number actually indicates the instruction's location in memory as an

<sup>2</sup>Designed for COSI 131a as taught by Dr. Liuba Shrira

offset from the program start. Additionally, all valid instructions are treated as keywords and styled appropriately.

Any extra options are passed directly to the `listings` package.

```
\begin{assembly}
    LOAD  R4, $200      ; sum addr
    LOAD  R1, =0        ; sum
    LOAD  R2, =0        ; i
    LOAD  R3, =0        ; j
    BR    OUTER        ; we know i < 10
INNER:   ADD  R1, R3     ; sum += j
        INC  R3        ; j++
OUTER:   BLT  R3, R2, INNER ; while j < i goto inner
        INC  R2        ; i++
        LOAD R3, =0     ; j = 0
        BLT  R2, =10, OUTER ; while i < 10
        STORE R1, @R4   ; store sum into sum address
        HALT
\end{assembly}
```

`java` [*extra options*]

Tragically-common shorthand environment for a listing of Java code.

Any extra options are passed directly to the `listings` package.

`scheme` [*extra options*]

Shorthand environment for a listing of Scheme code, useful for COSI 121b. Requires the `scheme` package option to be loaded.

Any extra options are passed directly to the `listings` package.

`gantt``schedule` {*total cell count*}[*title*]

An environment for drawing Gantt charts indicating process scheduling. The mandatory argument indicates how small the grid should be; 19 subdivides the line into 19 cells.

To use the `gantt``schedule` environment, make sure to use the `gantt` package option.

Within a `gantt``schedule`, use the `\burst` command to indicate an active process (i.e. a process burst).

`\burst` {*pid*}{*burst length*}

Draw a burst for process {*pid*} of time length (*burst length*).

**Note:** These aren't really Gantt charts, but that's what Dr. Shriram calls them, so that's what they're called here.

**Note:** Because `gantt``schedule` relies on `tikz`, `fp`, and `calc`, it can add significantly to document compile times. If you intend to use the `gantt``schedule` environment, make sure to use the `gantt` class option or set `gantt` in `\problemsetsetup`. If you fail to include the `gantt` option, you will see an error message:

```
! Package brandeis-problemset Error: gantt schedule environment not
loaded in preamble.

See the brandeis-problemset package documentation for explanation.
Type H <return> for immediate help.
1.4 \burst
      {1}{1}

? H
Did you mean to use the 'gantt' option for the brandeis-problemset
document class?
```

```
\begin{gantt schedule}{19}
  \burst{2}{1}
  \burst{4}{1}
  \burst{3}{2}
  \burst{5}{5}
  \burst{1}{10}
\end{gantt schedule}
```

### 3.1 General formatting commands

- \ac**  $\{\langle acronym \rangle\}$   
Typesets an acronym. The  $\langle acronym \rangle$  should be lowercase (e.g.  $\text{\ac{cpu}}$  rather than  $\text{\ac{CPU}}$ ). Currently,  $\text{\ac}$  simply delegates to  $\text{\textsc}$ . In the future, I'd like to support a bit of letterspacing; "for abbreviations and acronyms in the midst of normal text, use spaced small caps."<sup>3</sup>
- \Sc**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\textsc}$
- \Rm**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\textrm}$
- \Up**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\textup}$
- \Bf**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\textbf}$
- \It**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\textit}$
- \Tt**  $\{\langle text \rangle\}$   
An abbreviation for  $\text{\texttt}$

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<sup>3</sup>*The Elements of Typographic Style* by Robert Bringhurst, 2nd. ed, § 3.2.2



## 4 Example

A brief example usage of `brandeis-problemset` follows. For a longer, more in-depth example, see [example.tex in the brandeis-problemset repository](#).

```
\documentclass[gentt]{brandeis-problemset}
\author{Rebecca Turner}
\problemsetsetup{
  coursenumber=21a,
  instructor=Dr.\ Liuba Shrira,
  duedate=2018-10-20,
  number=3,
}
\newcommand{\io}{\ac{io}}
\newcommand{\cpu}{\ac{cpu}}
\begin{document}

\begin{problem}
  Write an assembly program!
\end{problem}

\begin{assembly}
  LOAD  R1, $200      ; A = (program location) + 200
  LOAD  R2, =1        ; i = 1
\end{assembly}

\begin{problem}
  What does this algorithm do? Analyze its worst-case running time and
  express it using big- $O$  notation.

\begin{pseudocode}[Foo]
Foo(a, n)
  Input:  two integers, a and n
  Output:  $a^n$ 
  k  $\leftarrow$  0
  b  $\leftarrow$  1
  while k < n do
    k  $\leftarrow$  k + 1
    b  $\leftarrow$  b * a
  return b
\end{pseudocode}
\end{problem}

 $\text{\Rm{Foo}}(a, n)$  computes  $a^n$ , and will run in  $O(n)$  time always.

\begin{problem}[number=5.4]
  Consider the following set of processes, with the length of the
  \cpu\ burst given in milliseconds:

  \begin{center}
```

```

\begin{tabu} to 0.25\linewidth{X[1,$]rr}
\Th{Process} & \Th{Burst time} & \Th{Priority} \\
P_1 & 10 & 3 \\
P_2 & 1 & 1 \\
P_3 & 2 & 3 \\
P_4 & 1 & 4 \\
P_5 & 5 & 2 \\
\end{tabu}
\end{center}%$

Draw a Gantt chart to illustrate the execution of these processes
using the \ac{sjf} scheduling algorithm.
\end{problem}

\begin{ganttschedule}{19}
\burst{2}{1}
\burst{4}{1}
\burst{3}{2}
\burst{5}{5}
\burst{1}{10}
\end{ganttschedule}
\end{document}

```

## 5 Changelog

### 0.4.0 Rebecca Turner

#### Added

- solution environment and `solutions` class option.
- scheme shorthand environment and `scheme` class option.

#### Fixed

- Boolean class options being overwritten by keys defined for `\problemsetsetup`.
- Title-formatting errors

#### Removed

- Assignment- and course-specific class options `duedate`, `assignment`, `instructor`, and `course`. These settings should be configured with either `\problemsetsetup` or their specific commands. (`\duedate`, `\instructor`, etc.).

### 0.3.0 Rebecca Turner (2018-10-24)

#### Added

- changelog.

- support for `\parts` and referencing problems.
- options to `problem` environment: `part`, `label`, and `partlabel`.
- `\maketitle` (contrast with `\maketitlepage`).

**0.2.0** Rebecca Turner (2018-10-20)

#### **Changed**

- Class renamed to from `problemset` to `brandeis-problemset`.

#### **Added**

- license header.
- `ganttschedule` environment.
- keywords to pseudocode environment: `and`, `or`, `nil`, and `len`.
- `\ac` command for acronyms.
- package example.

**0.1.0** Rebecca Turner (2018-10-19) — Initial beta as `problemset`.

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Numbers written in *italic* refer to the page where the corresponding entry is described; numbers underlined refer to the definition; numbers in *roman* refer to the pages where the entry is used.

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