`EXAM`, A $\LaTeX\,2_\varepsilon$ CLASS FOR EXAMINATION PAPERS

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Introduction

`exam.cls` is a $\LaTeX\,2_\varepsilon$ class file for producing examination papers. It provides an automatically-numbered `question` environment, which does not allow questions to be broken across pages without specific instructions from the user, and an optional `solution` environment if you want to type solutions into the same file. The front page, with the examination's title, module number, duration and rubric is automatically set in the approved format and page footers like *turn over* and *continued on next page* are automatically generated. If you wish, you can add a marking scheme to the solutions and the system will total the marks for each question.

Installation

The current version of `exam.cls` and some supporting files are available from

`http://www-users.york.ac.uk~spe1/examclass/`

You should put the class file `examclass.cls` either in the same directory (folder) as the document you are working on, or in a global inputs directory. If you use the networked version of TeX, you can use `~/tex/inputs` under Unix or `h:\texmf\tex\latex\` under Windows (note that there is another file called `exam.cls` which ships with current versions of LaTeX, and it is important to put the local class ahead of this in the search order).

The file `examsamp.tex` is a complete examination paper, including solutions, produced in `exam` class. Take a look at it to see the way the system works, or use its skeleton as the basis for your own file.

Class Declaration

`exam` is a $\LaTeX\,2_\varepsilon$ class file, so your document should begin

```
\documentclass{exam}
```

By default, this class uses 12pt type on A4 paper and produces output suitable for double-sided duplication. There should be no need to change this, but you can if required: any option understood by the standard `article` class is also understood by `exam`.

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Packages

The `exam` class automatically loads the AMS packages `amsmath`, `amsfonts` and the extended vaerbatim environments from `verbatim`.

Any other packages required can be loaded with a `\usepackage{}` declaration, as usual.

Topmatter

Unlike most classes, topmatter is mandatory in the `exam` class. After the `\begin{document}` command, you must specify the paper's title, number, duration and year and provide a rubric. When specifying the duration, the macro `\half` is provided as a convenient way to produce $\frac{1}{2}$. For example,

```
\codenumber{12345}
\year{1996}
\title{Functional Analysis Sample Paper}
\duration{$1\half$ hours}

\begin{rubric}
  Answer not more than \underline{three} questions. \\
  Calculators may be used but should be unnecessary.
\end{rubric}

\maketitle
```

Note the `\maketitle` command, which actually prints the topmatter. In the `rubric` environment, indicate line breaks with `\\` where required. The rubric is printed in flush left italic type.

By default, the paper is headed 'BA, BSc and MMath Examinations.' To change this (for type III or IV third year courses, fourth year courses and masters courses), use some combination of the macros `\babscfalse`, `\mmathfalse`, `\msctrue` and `\mrestrue`. The synonyms `\MMathfalse`, `\BABScfalse`, `MSctrue` and `MRestrue` are available for those who like Capital Letters. The opposite switches are also available, e.g. `babsctrue`, but you're unlikely to want them.

If the paper is a resit paper, put `\resittrue` in the topmatter. This insert the word 'Resit' before 'Examinations' in the heading. You should also prefix the module number with `R`, e.g. `R12345`.

The `rubric` environment can contain most LaTeX constructs. The only exceptions are those relating to page layout: you cannot use footnotes or marginal notes and you cannot split the rubric across a page.

The other topmatter commands can contain any LaTeX macros you need, but for LaTeXnical reasons cannot contain environments. I can't imagine this being a problem, but let me know if it is.

Questions

Questions are entered in the `question` environment. For example,

```
\begin{question}
  Show that $1/n\to 0$ as $n\to\infty$.
\end{question}
```

You can put any LaTeX instructions you like inside the `question` environment, except those relating to page breaking. In practice, this means that you should not attempt to use `\newpage`, `\pagebreak` or `\clearpage` inside a `question`, but use the `\questionbreak` macro described below. Unlike earlier versions of `exam.cls`, footnotes and marginal notes will now work within questions. Whether one would ever want to use such things in a question is, of course, another matter.

As you would expect from LaTeX, questions are automatically numbered. If you want separate parts within a question, use the `enumerate` environment as usual. Parts will be numbered (a), (b), (c), ... Second-level enumerated lists (i.e. an `enumerate` environment inside another `enumerate` environment) have items numbered (i), (ii), (iii), ... (see 'Tweaking Things' below if you want your first order lists to be roman and your second-order lists to be alphabetic). I haven't specified the numbering of any higher-level enumerations: if you really need one, let me know and I can add it.

Questions are never broken across pages without specific instructions. If you need to break a question (typically because it is too long to fit on a single page even on its own), you can put a `\questionbreak` command where you want the break to occur. The break occurs exactly at this point, so you should normally put it between paragraphs or between a paragraph and a displayed equation: if you put a `\questionbreak` command inside a paragraph, the last line on the page will not be justified.

If you want to force a page break in between questions, as opposed to inside a question, use `\pagebreak` or `\newpage` in the usual way; for example

```
\end{question}

\pagebreak

\begin{question}
```

The reason for the separate commands is that a pagebreak inside a question prints '*x Cont.*' on the next page, where x is the page number (earlier versions also did a good deal of housekeeping to do with the *continued on next page* footers and *continued from previous page* headers, but this is now fully handled by the page style).

Parts

If the paper contains multiple parts, begin each one with the `\part` command, e.g. `\part{Hilbert Spaces.}`. This prints a bold heading on the lines of **Part A. Hilbert Spaces.** Note that `\part` does not cause a pagebreak. Use `\newpage` or `\pagebreak` before the `\nextpart` command (but after the preceding `\end{question}`) if you want your section to start on a new page. For backward compatibility, the `\nextpart` command is a synonym for `\part{}`.

If you are writing just one part of the paper and want to generate the correct heading without earlier parts being present, you can use `\skippart`. For example, to put a heading **Part B.** at the top of the paper, begin with `\skippart\nextpart`. The `\skippart` macro can take an optional argument: to skip two parts, use `\skippart[2]` (note square brackets; `\skippart{2}` *does not* work).

If you use `\skippart`, you probably also need to use `\skipquestion` and possibly `\skipsolution`, which step the question and solution counters. Like `\skippart`, they default to skipping one question, but take an optional argument to skip more.

For example, if parts A and B have three questions each and you are just writing part C, you might begin (imediately after `\begin{document}`) with

```
\skippart[2]
\skipquestion[6]
```

and, if you are typing solutions (see next section),

```
\skipsolution[6]
```

between the last question and first solution.

Solutions

You can (if you want to) put solutions into the same document as the questions, using the `solution` environment. You can put anything you like inside a `solution` environment, including footnotes and marginal notes. Solutions are subject to LaTeX's normal page-breaking algorithm: there is no `\questionbreak` or similar command.

One extra environment and one extra command are provided for convenience in typing solutions. The `remarks` environment, intended for remarks to the checker or external examiner, typesets its contents as a separate paragraph, in italics, with a bold heading **Remarks**. For example,

```
\begin{remarks}
  This question lifted verbatim from last year's paper.
\end{remarks}
```

produces

Remarks. *This question lifted verbatim from last year's paper.*

The `\marks{n}` command prints 'n Marks.' in a framed, right-aligned box. For example, `\marks{5}` produces $\boxed{\text{5 Marks.}}$ If there is not enough room on the current line, a new line will be created (blank except for the number of marks). The `\marks{}` command can be used inside displayed mathematics, in which case it puts the number of marks where the equation number would normally go (so don't use it in combination with equation numbers!) For example,

`$$\sum_{n=1}^\infty\frac{1}{n^2}=\frac{\pi^2}{6}\marks{5}$$`

produces

$$\sum_{n=1}^{\infty}\frac{1}{n^2}=\frac{\pi^2}{6} \qquad \boxed{\text{5 Marks}}$$

If you use any `\marks{}` commands in a question or solution, the total is printed at the end of the solution.

To supress the printing of marks and remarks, put the command `\nomarks` in your preamble. This might be useful if you want to distribute solutions to last year's paper, but not distribute the marking scheme or any comments to the external examiner.

To entirely suppress the printing of solutions (when you print the final copy for duplication, for example) put the command `\nosolutions` in your preamble.

Note that you *cannot* intersperse questions and solutions: you must have all of the questions in order, followed by all of the solutions in order. I might be able to allow them to be interspersed, if anyone really desperately wants it, but it won't be easy.

If you don't want to type solutions, there is no need to: the `solution` environments are entirely optional.

Tweaking things

There are a few tweakable parameters in the system.

By default, the `enumerate` environment numbers its items (a), (b), (c), ... and second-level enumerations are numbered (i), (ii), (iii), ... To swap these, so first-level enumerations are numbered in roman and second-level in alphabetic, put the command `\romantrue` in the document preamble.

There are five lengths you can change. Recall that (approximately) 1ex is the height of a lowercase 'x' in the current font and 1em is the width of a capital 'M.'

(1) `\qksip` is the vertical space left between questions (default 4ex).
(2) `\qindent` is the distance from the left margin of the paper and the left margin of the question (default 3em). It must be at least wide enough to contain the question number and the word *cont.*
(3) `\qlabelsep` is the space between the label and the item in secondary list environments (e.g. `enumerate`, `itemize` and `description`).

Default is currently 1em, which is quite wide; I might reduce this at some point.

(4) `\qparindent` is the extra paragraph indentation used inside a question (default 0pt).

(5) `\qparskip` is the space between paragraphs inside a question (default 1ex).

Note that `\footheight` is no longer available (did anyone ever use it?). Use the standard LaTeX 2_ε length `\footskip` instead (default length 6ex in this class).

You can change these using `\setlength` in the preamble of your document (that is, between the `\documentclass` declaration and the `\begin{document}`). For example, the default values are generated by

```
\setlength{\qindent}{4em}
\setlength{\qlabelsep}{1em}
\setlength{\qskip}{4ex}
\setlength{\qparindent}{0pt}
\setlength{\qparskip}{1ex}
```

Note that the usual approach of changing `\parindent` and `\parskip` will not affect the layout of paragraphs within a question, but will wreak havoc on the layout of questions within the paper. Use `\qparindent` and `\qparskip` instead.

Security

There are obvious security implications in keeping examination-related material on networked file systems. The best solution is simply not to do this: use your own local hard disk, or a floppy disk.

If you really must keep material like this on the network, the *minimum* level of security is to make the files and the directory containing them accessible only to you. To do this, at the Unix shell prompt or DOS prompt type

```
chmod go-rx <name>
```

where `<name>` is the name of the file or directory to protect. You can use wildcards: e.g. `*` under Unix or `*.*` under DOS to mean 'all files in the current directory.' It is especially important to protect the directory containing the files, since the protection on the `.dvi` and `.ps` files produced by TeX and `dvips` is somewhat hard to predict.

It is also possible to encrypt files, which is probably the best security of all. Unfortunately this is not really practical when it comes to TeX since one would need to encrypt the TeX source, the `.dvi` file and the PostScript file. See the manual entry for `crypt` on the Unix systems, or the MicroEMACS documentation for its `CRYPT` mode.

Bugs, Problems, Limitations

This class does some fairly complicated stuff with page headers and footers and with TEX penalties. Although I think it all works OK, there might well be bugs lurking which I haven't spotted. Some limitations have been pointed out above; let me know if they cause any major problems and I'll try to fix them.

I haven't really attempted to make the class entirely bomb-proof: there are some things which you can do which will upset it in a big way, such as making a `\pagestyle` or `\thispagestyle` declaration, using any sectioning commands other than `\part`, using a third level of enumeration, using `\pagebreak`, etc. Be gentle!

Changes made 27/4/2004

Rewrote the page header and footer mechanism using `\mark` to make the header and footer changes associated with `\questionbreak` more robust.

Changes made 4/4/2004

Rewrote `\marks{}` so it works inside display math.

Changes made 1/3/2002

(1) Added `\msctrue`, `\mrestrue` and friends, completely rewriting the title generator in the process.
(2) Added `\part` macro for giving titles to parts.

Changes Made 25/1/2000

(1) Added `\resittrue` and `\resitfalse` to control use of 'Examinations' v. 'Resit Examinations' in header.
(2) Added `\MMathfalse`, `\BABScfalse`, `\MMathtrue` and `\BABSctrue` as synonyms of their uncapitalised forms.

Changes Made 10/12/98

Commands `\babscfalse`and `\babsctrue` added to go with `\mmathfalse` and `\mmathtrue`.

Changes Made 1/7/97

Minor enhancements (I hope):

(1) `\nomarks` command suppresses the printing of marks and totals, and also of the contents of `remarks` environments. This is intended for printing papers with solutions for the library, without revealing the marking scheme or any remarks to the external examiner.

(2) `\nosolutions` suppresses the contents of the `solution` environments. This is intended for printing the final copy for duplication.

Note that these commands are irreversible: you can't switch the marking scheme back on again having switched it off with `\nomarks`. Note also that `\marksfalse` still works the way it used to, suppressing marks and totals but not `remarks` environments, but that `\nomarks` is now the preferred way to do this. I might withdraw `\marksfalse` at some point, as this would simplify the code.

Changes Made 3/3/97

(1) Page-breaking algorithm completely recoded so `\questionbreak` can be used anywhere you like, even within an item of a secondary or tertiary list.
(2) `\marks` now works, and also keeps track of totals for each question.
(3) There is now some space (`\qlabelsep`) between labels and items in labelled lists inside the `solution` environment. This also controls such spacing in the `question` environment, which was previously left at the `article.cls` default, so you might notice a slight difference in questions.
(4) The `rubric` environment is now much more flexible. You can put almost anything you like inside it, including labelled lists and aligned mathematics.