The `tma` Package

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Contents

1 Introduction

The `tma` package provides a set of macros and environments to assist in writing question papers or solutions to Tutor Marked Assessments (TMAs) for Open University courses. It simplifies the formatting of questions, parts, subparts, and includes useful mathematical commands.

2 Installation

To install the package, place the 'tma.sty' file in your LaTeX directory or project folder. If using a TeX distribution, you may place it in the local texmf tree.

3 Package Options

`alph` (default) Question numbering as 1(b)(iii).

`roman` Question numbering as 1(ii)(c).

`cleveref` Enables automatic referencing with the `cleveref` package.

`pdfbookmark` Adds PDF bookmarks for each question using the `hyperref` package.

`legacy` Enables old definitions of `\vec` and `\C` for backward compatibility with earlier versions of the package. *Deprecated.*

4 Usage

Include the package in your LaTeX document:

```
\documentclass[a4paper,11pt]{article}
\usepackage[alph,cleveref]{tma}
```

Set your personal information:

```
\myname{Your Name}
\mycourse{Course Code}
\mytma{TMA Number}
\mypin{Your PIN}
```

If you wish to set a specific date for your report:

```
\setdate{21 November 2024}
```

You can retrieve the report date within the report using the `\thedate` command.

5   Commands and Environments

5.1   Question Environment

Begin answering a question with the `question` environment:

```
\begin{question}
 % Question text
\end{question}
```

Questions are automatically numbered from 1 unless an integer parameter is given in square brackets after the opening of the environment, for example:

```
\begin{question}[6] % set the question number to be 6
 % Question text
\end{question}
```

5.2   Parts and Subparts

Within a question environment, divisions are achieved using `\qpart` and `\qsubpart` to create parts and subparts:

```
\qpart % For parts
\qsubpart % For subparts
```

Again, the numbering for parts and subparts begin at 1 unless otherwise prescribed by an integer within square brackets after the appropriate command.

5.3   Mathematical Commands

The package provides several mathematical commands:

- `\N, \Z, \Q, \R, \Complex`: Number sets.

- `\vect{v}`: Vector notation with an arrow over the variable.

- `\ve{v}`: Bold vector notation.

- `\dd, \e, \ii`: Differential operator, Euler's number, imaginary unit.

- Superscript ordinals: `\st, \nd, \rd, \nth`.

6 Examples

6.1 Sample Question

```
\begin{question}[4]
  Prove that the set \N{} of natural numbers is infinite.

  \qpart
    What does it mean for a set to be infinite?

  \qpart
    Assume, for contradiction the \N{} is a finite set.
    Under this assumption, what can you say about the
    number of elements in \N{} and the existence of a
    largest natural number?

  \qpart
    Explain how the successor function $s(n) = n + 1$
    leads to a contradiction when applied to the largest
    natural number assumption of part (b).

  \qpart
    Based on the contradiction found in part (c), conclude
    whether the set \N{} is finite or infinite, and briefly
    explain why.
\end{question}
```

Note that the default part numbering is in the form (a), (b), (c)... If the option [roman] is given when loading the tma package, then the numbering will be (i), (ii), (iii)... instead.

> Q 4
>
> Prove that the set $\mathbb{N}$ of natural numbers is infinite.
>
> (a)   What does it mean for a set to be infinite?
> (b)   Assume, for contradiction the $\mathbb{N}$ is a finite set. Under this assumption, what can you say about the number of elements in $\mathbb{N}$ and the existence of a largest natural number?
> (c)   Explain how the successor function $s(n) = n+1$ leads to a contradiction when applied to the largest natural number assumption of part (b).
> (d)   Based on the contradiction found in part (c), conclude whether the set $\mathbb{N}$ is finite or infinite, and briefly explain why.

6.2 Using subsections

```
  \setquestionstring{Question}
  \begin{question}[5]
    Find the roots of $x^2 +5x +6 = 0$
    \qpart %
```

```
\qsubpart %
The quadratic equation is \[
x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}
\]
\qsubpart %
When $a=1$, $b=5$ and $c=6$:
\begin{align}
  x &= \frac{-(5)\pm\sqrt{(5)^2-4\times1\times6}}{2\times1} \\
    &= \frac{-5\pm\sqrt{25-24}}{2}
    &= \frac{-5\pm\sqrt{1}}{2}
\end{align}
\qsubpart %
So, $x=\frac{-5+1}{2}$ or $x=\frac{-5-1}{2}$.\\[0.5cm]

Therefore the roots of $x^2 +5x +6 = 0$ are $x=-2$ or $x=-3$.
\end{question}
```

Question 5

Find the roots of $x^2 + 5x + 6 = 0$

(a)(i)   The quadratic equation is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

(ii)   When $a = 1$, $b = 5$ and $c = 6$:

$$x = \frac{-(5) \pm \sqrt{(5)^2 - 4 \times 1 \times 6}}{2 \times 1} \tag{5.1}$$

$$= \frac{-5 \pm \sqrt{25 - 24}}{2} \tag{5.2}$$

$$= \frac{-5 \pm \sqrt{1}}{2} \tag{5.3}$$

(iii)   So, $x = \frac{-5+1}{2} = -2$ or $x = \frac{-5-1}{2} = -3$.

Therefore the roots of $x^2 + 5x + 6 = 0$ are $x = -2$ or $x = -3$.

6.3   Using Mathematical Commands

```
Relationship between number sets:
\begin{itemize}
  \item \N{} (Natural numbers) $\subseteq \Z$ (Integers);
  every natural number is also an integer.
  \item \Z{} (Integers) $\subseteq \Q$ (Rational numbers);
  every integer is also a rational number.
  \item \Q{} (Rational numbers) $\subseteq \R$ (Real numbers);
```

```
      every rational number is also a real number.
      \item \Complex{} (Complex numbers) $\supseteq \R$ (Real number);
      complex numbers include real numbers as a subset, since they
      can be represented by $a+\ii b$ where $a$ and $b$ are real numbers.
   \end{itemize}
   Hence, $\N\subseteq\Z\subseteq\Q\subseteq\R\subseteq\Complex$.\\[0.5cm]


   Euler's formula states that $\e^{\ii\theta} = \cos\theta + \ii\sin\theta$


   A combination is a selection of objects without regard to order.
   \begin{align}
    C(n,r) &= \comb{n}{r}\\
    &= \frac{n!}{r!(n-r)!}
   \end{align}
   Where $n$ is the total number of objects, $r$ is the number of objects to be selecte


   A permutation is an arrangement of objects in a specific order.
   \begin{align}
    P(n.r) &= \perm{n}{r}\\
    &= \frac{n!}{(n-r)!}
   \end{align}
   Where $n$ is the total number of objects, $r$ is the number of objects to be selecte
```

Relationship between number sets:

- $\mathbb{N}$ (Natural numbers) $\subseteq \mathbb{Z}$ (Integers); every natural number is also an integer.

- $\mathbb{Z}$ (Integers) $\subseteq \mathbb{Q}$ (Rational numbers); every integer is also a rational number.

- $\mathbb{Q}$ (Rational numbers) $\subseteq \mathbb{R}$ (Real numbers); every rational number is also a real number.

- $\mathbb{C}$ (Complex numbers) $\supseteq \mathbb{R}$ (Real number); complex numbers include real numbers as a subset, since they can be represented by $a + \mathrm{i}b$ where a and b are real numbers.

Hence, $\mathbb{N} \subseteq \mathbb{Z} \subseteq \mathbb{Q} \subseteq \mathbb{R} \subseteq \mathbb{C}$.

Euler's formula states that $\mathrm{e}^{\mathrm{i}\theta} = \cos\theta + \mathrm{i}\sin\theta$

A combination is a selection of objects without regard to order.

$$C(n,r) = {}^nC_r \tag{5.4}$$

$$= \frac{n!}{r!(n-r)!} \tag{5.5}$$

Where n is the total number of objects, r is the number of objects to be selected and ! denotes the factorial (e.g., $5! = 5 \times 4 \times 3 \times 2 \times 1$). A permutation is an arrangement of objects in a specific order.

$$P(n,r) = {}^nP_r \tag{5.6}$$

$$= \frac{n!}{(n-r)!} \tag{5.7}$$

Where n is the total number of objects, r is the number of objects to be selected and ! denotes the factorial.

7 Vectors

```
\begin{question}[6]
Figure~\ref{fig:q6_vectors} shows the vectors involved in this problem.
\qpart % (a)
The given angles are bearings, from the compass North with a clockwise
positive reading.
\begin{align*}
 |\ve{b}| &= 120\qquad|\ve{w}| = 30\\
 \intertext{The vector \ve{b} in component form is made using the
  acute angle in the lower quadrant, i.e. $\ang{180}-\ang{120}=\ang{60}$,
  this implies that the \ve{j}-component is negative:}
 \ve{b} &= 170 \sin(\ang{60})\ve{i} - 170 \cos(\ang{60})\ve{j}\\
 &=\frac{170\sqrt{3}}{2}\ve{i} - \frac{170}{2}\ve{j}\\
 \vdots
```
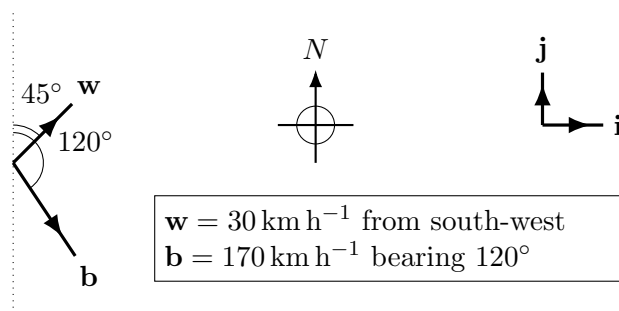
Figure 1: Vectors

```
\end{align*}
Therefore, the two vectors in component form are:\[
\ve{b}=(147.22\,\ve{i} - 85.00\,\ve{j})\,\unit{\km\per\hour}
\] and \[
\ve{w}=(21.21\,\ve{i} + 21.21\,\ve{j})\,\unit{\km\per\hour}
\] (all to 2 d.p.)
\end{question}
```

Q 6

Figure 1 shows the vectors involved in this problem.

(a)   The given angles are bearings, from the compass North with a clockwise positive reading.

$$|\mathbf{b}| = 120 \qquad |\mathbf{w}| = 30$$

The vector $\mathbf{b}$ in component form is made using the acute angle in the lower quadrant, i.e. $180° - 120° = 60°$, this implies that the $\mathbf{j}$-component is negative:

$$\mathbf{b} = 170\sin(60°)\mathbf{i} - 170\cos(60°)\mathbf{j}$$
$$= \frac{170\sqrt{3}}{2}\mathbf{i} - \frac{170}{2}\mathbf{j}$$
$$\vdots$$

Therefore, the two vectors in component form are:

$$\mathbf{b} = (147.22\,\mathbf{i} - 85.00\,\mathbf{j})\,\mathrm{km\,h^{-1}}$$

and

$$\mathbf{w} = (21.21\,\mathbf{i} + 21.21\,\mathbf{j})\,\mathrm{km\,h^{-1}}$$

(all to 2 d.p.)

Note, the command \ang{} is found in the package siunitx.

8   Command summary

`\st`

`\nd`

`\rd`

`\nth` Commands to set ordinal indicators after numbers. For example, 1st, 2nd, 3rd and 4th.

9   Change Log

- **v1.15 (2024/11/21)**: Added `\setdate{}` and `\thedate` for setting and using a fixed report date.

- **v1.14 (2024/11/17)**: Allow setting of question string with `\setquestionstring{}`; set indentation for `\qpart` and `\qsubpart` from Steve Mayers contribution.

- **v1.13 (2024/11/16)**: Attempt at placing part and subpart marks on the same line when there is no intervening text.

- **v1.12 (2024/11/08)**: Fixed error with `\renewcommand{\C}`; changed to `\providecommand{\C}`.

- **v1.11 (2024/11/08)**: Added 'legacy' option to allow old definitions of `\vec` and `\C`.

- **v1.10 (2024/09/10)**: Ensured commands are correctly defined before being redefined!

- **v1.09 (2024/09/10)**: Improved code readability.

- **v1.08 (2024/09/05)**: Consolidated geometry settings and adjusted package loading order.

- **v1.07 (2024/09/04)**: Avoided redefining standard LaTeX commands to avoid clashes. Fixed error with `\ExecuteOptions` in package file. Implemented flags to handle the various options simpler.

- **v1.06 (2024/08/28)**: Updated definitions of `\comb`, `\perm` to correctly work after a superscript.

- **v1.05 (2024/08/28)**: Updated definitions of `\ve`, `\vec` to allow use in both maths and text mode.

- **v1.04 (2024/08/26)**: Updated usage of 'fancyhdr' to remove deprecated commands.

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11   Acknowledgments

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