Figure Insertion

LaTeX has the provision for inserting a figure from an external file in different formats. As stated in §1.4 on page 4, a LaTeX file can be compiled using either the latex or pdflatex command. When a LaTeX file involves figures from external files, either of the compilation commands is to be used based on the format of the figures. Note that the file formats of all the figures inserted in a LaTeX document must be supported by a single compilation command, either latex or pdflatex. Commands for compiling LaTeX files involving some standard and widely used figure formats are given in Table 9.1. It is to be mentioned that different tools, like xfig and gimp on Unix

Table 9.1 LaTeX compilation commands and supported figure formats

Compilation command	Supported figure format	
	Short name	Full name
latex	eps	Encapsulated PostScript
	ps	PostScript
pdflatex	pdf	Portable Document Format
	jpeg	Joint Photographic Expert Group
	tiff	Tag Index File Format
	png	Portable Network Graphic

system or ImageMagick and netpbm on both Unix and Windows systems, can be used for exporting figures from one format to another.

9.1 Commands and Environment for Inserting Figures

An eps format figure can be inserted using the **\epsfig{file=**fname**}** command defined in the **epsfig** package, where fname is the name of the figure file with or without the 'eps' extension. Apart from the mandatory fname, the size of a figure can also be specified in **\epsfig{}** through two optional fields, **width** and **height**, one separated from another by a comma. Without any of the **width** and **height**, a figure is printed in its original size. If one of them is specified, the other one

is automatically taken in proportion. On the other hand, the presence of both **width** and **height** prints a figure in the specified fixed size (in this case, the figure may get distorted if their values are not set properly). In addition to specifying the size, a figure can also be rotated through the option **angle=**theta, where a positive value of theta (in degree) will rotate the figure in counter-clockwise direction and a negative value in clockwise direction. With such provisions, a figure can be inserted as **\epsfig{file=**myfig.eps**}** or **\epsfig{file=**pics/myfig.eps**, width=**0.5**\linewidth}** or **\epsfig{file=**myfig.eps**, width=**30**mm, height=**40**mm, angle=**30**}**, where myfig.eps is the name of the figure file and pics is the folder containing the figure file.

The more general command for inserting a figure from an external file is **\includegraphics[**aopt**]{**fname**}** defined in the **graphicx** package, where fname is the name of the figure file without its extension, and aopt is(are) the option(s) like **width**, **height** and **angle**. The advantage of using **\includegraphics[]{}** is that a figure in any format can be inserted without making any change in the LaTeX input file[1].

Similar to nesting the **tabular** or **tabularx** environment in the **table** environment as discussed in §7.1 on page 59, the **\epsfig{}** and **\includegraphics[]{}** commands can be used in the **figure** environment, so that a figure can be assigned a serial number and a caption through the **\caption{}** command, as well as a reference key through the **\label{}** command for the purpose of referring it anywhere within a document. Further, similar to the **table** environment, the **figure** environment can also be created as **\begin{figure}[]** with optional preferences in **[]** for vertical positioning of a figure. The standard preferences for vertical positioning are **H**, and any or combination of **h**, **b** and **t** along with **!** (refer §7.3 on page 62 for detail of **[H]** and **[!hbt]**).

9.2   Inserting a Simple Figure

Three examples of inserting a figure, named as girl.eps, through the **\epsfig{}** command are shown in Table 9.2 on the next page. In the first example, the size of the figure is specified by both width and height, which have produced the figure in a distorted form due to the consideration of their non-proportionate values. In the second example, since only the width of the figure is specified, a scaled form of the original figure is produced by automatically adjusting its height. In the third example, apart from specifying the width of the figure, it is also rotated by 30° in the counter-clockwise direction.

The first command in the **figure** environment in Table 9.2 is **\centering**, which instructs for width-wise center alignment of its figure (other commands could be **\flushleft** for left alignment or **\flushright** for right alignment). After inserting the figure through **\epsfig{}**, the **\caption{}** command is used for assigning a serial number to the figure. The **\caption{}** command will also produce a title of the figure, if any is provided as the argument of the command (since the title usually comes at the bottom of a figure, **\caption{}** is used after **\epsfig{}**). The **\caption{}** command is followed

---

[1] The advantage of using the **\includegraphics[]{}** command for inserting figures from external files is that a figure in any format can be inserted without making any change in the LaTeX input file.

Table 9.2 Figure insertion through the **\epsfig{}** command

LATEX input	Output
\begin{figure}[!hbt] **\centering** **\epsfig{file=**girl.eps**, width=**2.0**cm, height=**2.0**cm}** **\caption{**A girl.**}** **\label{**girl1**}** **\end{figure}**	 Figure 1: A girl.
\begin{figure}[!hbt] **\centering** **\epsfig{file=**girl.eps**, width=**2.0**cm}** **\caption{**A girl.**}** **\label{**girl2**}** **\end{figure}**	 Figure 2: A girl.
\begin{figure}[!hbt] **\centering** **\epsfig{file=**girl.eps**, width=**2.0**cm, angle=**30**}** **\caption{**A girl.**}** **\label{**girl3**}** **\end{figure}**	 Figure 3: A girl.

by the **\label{}** command for assigning a unique reference key, which can be used for referring the figure through the **\ref{}** command. Note that **\label{}** does not have any effect without **\caption{}**, in which case a figure will not be assigned any serial number for referring it.

The same outputs, shown in Table 9.2, can be produced through the **\includegraphics[]{}** command also. In that case, just the **\epsfig{}** command from the examples is to be replaced by **\includegraphics[width=**2**cm, height=**2**cm]{**girl**}**, **\includegraphics[width=**2**cm]{**girl**}** and **\includegraphics[width=**2**cm, angle=**30**]{**girl**}**, respectively. Since a figure in any format can be inserted through **\includegraphics[]{}** without making any change in the LATEX input file, now onwards all figures in this book will be inserted through **\includegraphics[]{}** only, otherwise mentioned specifically.

9.3 Side-by-Side Figures*

In the examples in §9.2, only one figure is inserted in a row. Provision is also there in LATEX for inserting multiple figures side by side in a single row. As

Table 9.3 Side-by-side figures in a single row

LaTeX input	Output
\begin{figure}[!hbt] **\centering** **\includegraphics[width=**2.0**cm]**{girl}**\hfill** **\includegraphics[width=**2.0**cm]**{flower} **\caption{**A girl and a flower.**}** **\label{**girl_flower**}** **\end{figure}**	 Figure 4: A girl and a flower.

shown in Table 9.3, this can simply be done by inserting each figure through a separate **\includegraphics[]{}** in a single **figure** environment. The requirements for the same are: there should not be any line break or new line command between two **\includegraphics{}**, and total width of all the figures should not exceed the page width; otherwise the figures will be inserted one below another. However, **\hfill** can be used between two **\includegraphics{}** for separating the corresponding figures by available horizontal space.

Note that both the side-by-side figures in Table 9.3 are assigned a single serial number as a whole. If the side-by-side figures are to be assigned individual serial number, the **minipage** environment may be used. As stated in §8.3 on page 73, the **minipage** environment splits a page width-wise into a number of parts, each of which can be used for inserting a figure, drawing a table, or even for writing selected texts. Table 9.4 shows two figures, inserted side-by-side by using the **minipage** environment, which are assigned individual serial number by each **\caption{}** command. Within a single **figure** environment, two **minipage** environments, each of size 0.4**\linewidth**, are created for inserting the two figures.

Table 9.4 Side-by-side figures through the **minipage** environment

LaTeX input	Output
\begin{figure}[!hbt] **\begin{minipage}[c]{**0.4**\linewidth}** **\centering** **\includegraphics[width=**3.0**cm]**{girl} **\caption{**A girl.**}** **\label{**girl**}** **\end{minipage}\hfill** % **\begin{minipage}[c]{**0.4**\linewidth}** **\centering** **\includegraphics[width=**2.5**cm]**{flower} **\caption{**A flower.**}** **\label{**flower**}** **\end{minipage}** **\end{figure}**	 Figure 5: A girl. Figure 6: A flower.

9.4   Sub-numbering a Group of Figures

In some cases, a group of figures may need to be sub-numbered under a main number, e.g., 3(a) or 5(e). Within the **figure** environment, the **\subfigure**[atitle]**{**afig**}** command defined in the **subfigure** package[2] (or the new **\subfloat**[atitle]**{**afig**}** command defined in the **subfig** package) may be used for inserting a figure with a sub-numbering, where optional atitle is the title of the figure, and mandatory afig is the insertion of the figure either through the **\epsfig{}** or **\includegraphics[]{}** command. For the purpose of referring, a subfigure can be assigned a reference key through the **\label{}** command inside the mandatory argument of **\subfigure[]{}**. Moreover, the group of subfigures can be captioned and labeled as a whole using respectively the **\caption{}** and **\label{}** commands inside the **figure** environment. Table 9.5

Table 9.5   Sub-numbering a group of figures using the **\subfigure[]{}** command

LATEX input	Output

\begin{figure}[!htb]
\centering
\subfigure[A girl.**]**
{   \includegraphics[width=2.0**cm]{**girl**}**
    \label{girl**}**
}\hfill
\subfigure[A flower.**]**
{   \includegraphics[width=2.0**cm]{**flower**}**
    \label{flower**}**
}
\subfigure[A finger work.**]**
{   \includegraphics[width=4.0**cm]{**finger**}**
    \label{finger-work**}**
}
\caption{Girl, flower and finger work.**}**
\label{girl_flower_finger**}**
\end{figure}
%
In Figure~**\ref{**girl_flower_finger**}**, **\ref{**girl**}**
and **\ref{**flower**}** display a girl and a flower,
while **\ref{**finger**}** displays a beautiful finger
work.
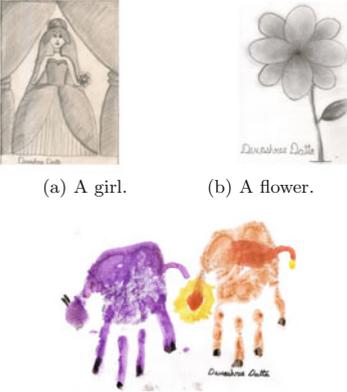	
	(a) A girl. (b) A flower.
	
	(c) A finger work
	Figure 7: Girl, flower and finger work.
	In Figure 7, 7(a) and 7(b) display a girl and a flower, while 7(c) displays a beautiful finger work.

shows such an example, which contains three figures in a group. It is also shown in Table 9.5 that the subfigures can be inserted in a single row or even in multiple rows (for inserting a subfigure in the next row, a line break command **** is to be used at the end of the previous **\subfigure[]{}** command).

---

[2]The **subfigure** package loaded as **\usepackage[tight]{subfigure}** with the **tight** option reduces the excess vertical blank space between a subfigure and its caption (the function of this **tight** is similar with those of the **\abovecaptionskip** and **\belowcaptionskip** commands addressed in §8.8 and §9.10).

The **\subfigure[]{}** command numbers a group of subfigures as (a), (b), etc. This default numbering can be changed by redefining the **\thesubfigure** command, e.g., **\renewcommand{\thesubfigure}{(\roman{subfigure})~}** for numbering subfigures by (i), (ii), etc. Note that a subfigure is not assigned any sub-number without the optional argument to **\subfigure{}**. However, it is counted while numbering the remaining subfigures of the group.

9.5   Figure Wrapped by Texts*

Like a table as stated in §7.8 on page 68, a figure can also be wrapped around by texts, which is done through the **wrapfigure** environment[3] defined in the **wrapfig**   package. The **wrapfigure** environment, which creates a space for inserting a figure, takes one optional and two mandatory arguments, i.e., **\begin{wrapfigure}[**aline**]{**aside**}{**asize**}**, where aside is the location of the space (**l** for left side or **r** for right side), while asize is the size of horizontal space and aline is the number of lines of texts for vertical space. If insufficient number of lines (i.e., aline) is opted, the figure will be overlapped with other lines of texts. If number of lines to be wrapped is not opted, it is set automatically to cover the size of the figure. An example of the **wrapfigure** environment is shown in Table 9.6, where

Table 9.6   Figure wrapped by texts

LaTeX input	Output
\begin{wrapfigure}[10**]{**r**}{**2.3**cm}** **\includegraphics[width=**2.0**cm]{**girl**}** **\caption{**Girl.**}** **\label{**girl**}** **\end{wrapfigure}** **%** The picture shown on the right side was drawn by Devoshree, a 8 year old girl....	The picture shown on the right side was drawn by Devoshree, a 8 year old girl. She loves arts from her childhood, starting from the age of around 2 years. Seeing her sketching something on a wall and enlarging it every day at that age, we did not stop her but encouraged for the same. Today she can do very beautiful sketching and other artistic works. Only three simple works from her activities are included in this Hour. Figure 8: Girl.

a figure of width 2.0 cm is inserted through **\includegraphics[]{}** in a horizontal space of 2.3 cm on the right side of the page wrapping 10 lines of texts of the document.

---

[3]The **wrapfigure** environment may not work properly inside other environments. Moreover, the environment should be put at the top of a paragraph, or between two words where a line break exists.

9.6 Rotated Figure

It is shown in Table 9.2 on page 83 that a figure can be rotated by a given angle through the **angle** option to the **\epsfig{}** (also to **\includegraphics[]{}**) command. Further, like the **sidewaystable** environment for producing a table on a landscape-size page as discussed in §8.4 on page 75, the **sidewaysfigure** environment can be used for producing a figure in landscape-mode on a new page. An example of the **sidewaysfigure** environment is shown in Table 9.7 (output is not shown).

Table 9.7 Rotated figure on a landscape page through the **sidewaysfigure** environment

```
\begin{sidewaysfigure}
\includegraphics[width=\linewidth]{computer}
\caption{A computer on a landscape page.}
\end{sidewaysfigure}
```

9.7 Mathematical Notations in Figures*

There is always a question how to put mathematical notations in figures, like σ_x or e^z. Generally graphics plotters do not have such provisions, but for plain texts and symbols only. The **\psfrag{**atag**}{**acomm**}** command, defined in the **psfrag** package, can replace an alphabetical or a numerical tag (atag) in an encapsulated postscript (eps format) figure with an arbitrary instruction including LaTeX commands (acomm). An application of **\psfrag{}{}** is shown in Table 9.8, in which the alphabetical and

Table 9.8 Mathematical notations in figures through the **\psfrag{}{}** command

Original figure	LaTeX input	LaTeX output
	\begin{figure}[!hbt] **\centering** **\psfrag{**x**}{σ_x}** **\psfrag{**y**}{σ_y}** **\psfrag{**n**}{σ_{θ}}** **\psfrag{**s**}{τ_{θ}}** **\psfrag{**t**}{θ}** **\psfrag{**1**}{τ}** **\includegraphics[width=5cm]{**psfrag**}** **\end{figure}**	

numerical tags of the original eps figure shown in the left column are replaced, in the figure shown on the right column, by the LaTeX commands inserted as the second argument of the **\psfrag{}{}** commands shown in the middle column. Note that the **\psfrag{}{}** commands are to be inserted before inserting the figure.

If a figure is prepared in the xfig software, LaTeX commands can directly be inserted in the .fig file. Then the required .eps file can be obtained from the .fig file using the fig2eps command in a terminal, e.g., '$ fig2eps mypic.fig' for
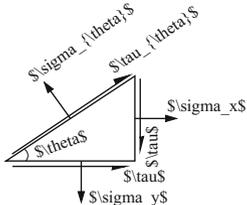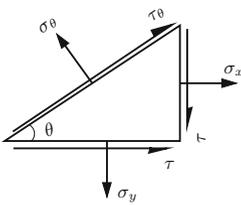
generating `mypic.eps` from `mypic.fig`. However, the process needs the `fig2ps` software installed in the computer.

Alternatively, if the `fig2ps` software package is not available, the `fig` file may be exported in a different way to generate a `.pstex_t` file, the contents of which can then be inserted (pasted) in the LaTeX input file in order to achieve the desired effect. The step-by-step procedure of this process is given below:

1. Draw the figure in the `xfig` software package.
2. Click the text-mode 'T' button on the top-left side of the `xfig` window. Then click the '`Text Flags hidden=off`' button on the bottom side of the `xfig` window, which will open a small dialogue box. In that dialogue box, change the status of '`Special Flag`' from '`Normal`' to '`Special`' and then click '`Set`'.
3. Now typeset LaTeX commands in the required locations of the figure. Math-mode commands are to be inserted between a pair of **$** symbols.
4. Save the file by a name, say `myfig.fig`.
5. Click '`Export`' under the '`File`' button in the menu bar on the top of the `xfig` window, which will open a new dialogue box. Under '`Language`' on the top side of that dialogue box, select '`Combined PS/LaTeX (both parts)`' and then click '`Export`' button.
6. Two new files now should be available in the working folder, `myfig.pstex` and `myfig.pstex_t` (if the figure file in Step (5) above was named by `myfig.fig`).
7. Open `myfig.pstex_t` in a text-editor, and then copy and paste its contents in the required location of the LaTeX input file.

An application of inserting mathematical notations in figures by putting LaTeX commands in the `xfig` software is shown in Table 9.9, in which the LaTeX commands of

Table 9.9 Mathematical notations in figures through `xfig` software

the original `fig` figure shown in the left column are executed, in the figure shown on the right column, by inserting the contents of the `myfig.pstex_t` file in the LaTeX input file as shown in the middle column. Since directly copied and pasted, it is not necessary to understand the contents of the self-generated `.pstex_t` file.

9.8 Figures in Tables*

Sometimes a figure may need to be produced in a cell of a table. In that case also, the figure can be inserted in the cell through **\includegraphics[]{}** just like an ordinary entry in a cell of a table. However, since the **figure** environment cannot be nested inside the **table** environment, **\includegraphics[]{}** cannot be put in a **figure** environment, and hence, the figure can neither be captioned nor numbered. A number of examples can be found in this book, where figures are inserted in tables, refer, e.g., Tables 9.2, 9.3, 9.4, 9.5 and 9.6.

9.9 Figures in Multi-column Documents

In a multi-column document, where the contents are produced in multiple columns on a page, a figure is also placed in a column (refer §4.3 on page 29 for detail of multi-column documents). However, if the width of the column is not large enough to accommodate a figure in it, the **figure*** environment can be used for inserting the figure on the entire width of the page[4]. In that case, the **\begin{figure}** and **\end{figure}** commands are to be replaced by the **\begin{figure*}** and **\end{figure*}** commands, respectively.

9.10 Changing Printing Format of Figures*

The serial number of a figure is preceded by the default label-word 'Figure', which can be changed by defining **\def\figurename{}** in the preamble, e.g., **\def\figurename{**Fig.**}** will replace 'Figure' by 'Fig.'. Moreover, the size and type of fonts for the label-word and caption can also be changed by using **\captionsetup{}** as discussed in §8.8 on page 79. Similarly, **\abovecaptionskip** and **\belowcaptionskip**, mentioned in §8.8 for reducing the excess vertical blank space before and after the main caption of a table, is applicable in the case of figures also.

In the document-class **book**, the serial number of a figure is composed of two parts. For example, refer Fig. 4.1 on page 27, where the figure number is composed of 4 and 1 separated by a period mark. In this case, 4 is the number of the Hour and digit 1 is the number of the figure in that Hour. In contrast, a figure in the document-class **article** is assigned its serial number only, i.e., not preceded the number of the section in which the figure belongs (§11.4.3 on page 105 and §19.2.5 on page 189 discuss the process for obtaining section-wise numbers to figures in the document-class **article**).

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[4]If the column width of a multi-column document is not sufficient to accommodate a figure in it, the **figure*** environment may be used for inserting the figure over the entire width of the page.

9.11   Figures at the End of a Document

Refer §8.9 on page 80 for detail.

9.12   Editing L^AT_EX Input File Involving Many Figures*

The compilation time of a L^AT_EX file involving a lot of figures may be very large. Hence, the **\psdraft** command may be inserted in the preamble when the file needs repeated editing and compilation. Instead of producing a figure, the command instructs the L^AT_EX compiler just print the name of the figure file in a box in the specified location, thus saves compilation time. However, **\psdraft** is to be deleted or commented before the final compilation. In an alternate way, the **epsfig** or **graphicx** package, as applicable, may be loaded with the **draft** option as **\usepackage[draft]{epsfig}** and **\usepackage[draft]{graphicx}** (or jointly as **\usepackage[draft]{epsfig,graphicx}**) for performing the same job. In this case also, the **draft** option is to be omitted before the final compilation.