ON USING ICT FOSS SOFTWARE LATEX FOR EFFECTUAL TEACHING LEARNING PROCESS

Dr Urvashi Arora
Rajdhani College, University of Delhi,
Department of Mathematics, Raja Garden, Delhi

ABSTRACT

This paper discusses the use of free and open-source ICT software Latex for effective teaching learning process. The paper discusses how the typesetting software Latex with its wide collection of document classes and add on packages, can be used to make classroom teaching effective and engaging. The paper illustrates the use of document classes such as 'article' and 'beamer' in Latex to modify a given Latex code, to create lessons for student's use as well as elegant presentations for class room use by teachers. The paper explains as to how one can start working using Latex by installing the required resources from the internet. The paper briefly discuses some useful Latex packages as well as online resources for working with Latex codes

Keywords: Latex, beamer, typesetting, presentation, ICT

INTRODUCTION

The last few years have witnessed a significant paradigm shift in the methodology of imparting education (Siddiqui et al.,2021). Along with the traditional chalk and talk method in which the teacher writes on the black board and addresses an actual physical class room of students, the information and communication technology(ICT) has entered the education scenario for supporting, enhancing and optimizing the delivery of information. The use of ICT in education has made the teaching learning process very productive and meaningful(Sharma et al.,2011). One of the most popular ways of incorporating the use of ICT in education is via ICT softwares. There is a range of softwares available that can be

used for making teaching- learning process easy, interesting and also engaging for the learners. Over the last few years, there has been an emerging trend of use of Free and open-source softwares (FOSS) (Tuesday et al., 2019; Gupta, 2018; Kendall, 2021). Unlike a proprietary software, the use of which is restricted and the source code of which is not available to users, a FOSS software on the other hand is both free and open in the sense that a user is free to use, copy, study, and change the software in any way. Also, the source code of a FOSS software is openly shared so that users can improve upon the software (https://en.wikipedia.org/wiki/Free_and_open-source_software).There are various FOSS softwares that are available for use in varied fields such as, say, Blender software for creation of computer graphics, Openshot software for video editing, Jmol software for representing molecules as 3D structures for teaching students, Tux typing software for improving the typing speed of children in a play way manner (https://en.wikibooks. org/wiki/FOSS_Education/Research_using_FOSS).The focus of this paper is on the usefulness of a free and open (FOSS) typesetting software Latex as an educational aid for the ease of teachers and for engagement of learners in an effective manner.

For a mathematics teacher or a teacher in any other technical field such as physics, electronics and so on, typing text with mathematical content is a big task, as it requires typing too many mathematical equations and symbols. Thus, for a teacher of such technical subjects to typeset a lecture/ presentation for classroom teaching or for research purposes would amount to a tedious task involving a lot of efforts. The purpose of this paper is to make academicians familiar with a software for typing documents having content such as tough mathematical symbols, special symbols, languages with hard writing systems (Rosenberg, 1978; izmar, 2021) which are difficult to typeset using the usual known softwares. TEX is one such FOSS software invented by Donald Knuth which is very beneficial for typing documents in mathematics and other documents containing complex symbols. TEX can be considered as a computer language or a program or more precisely typesetting software that understands the commands given to output the required pages.' Latex' is a convenient and extremely popular version of Tex modified by Leslie Lamport

(Lamport,1994).Latex, nowadays is being used worldwide by scientists/mathematicians to communicate their research work (http://www.latex-project.org/).

PRELIMINARIES

A Latex file looks like an ordinary text file written using an ordinary text editor like Notepad. To create a Latex file, the editor called TeXnicCenter can be used. This editor in a way provides a page for writing the Latex code/program. Besides the text editor, a compiler named MiKTeX, is also required which works in coordination with TeXnicCenter. So briefly the preparation that is required for getting started with Latex is as follows:

- The compiler MiKTeX needs to be installed first. This can be done by downloading MiKTeX 2.9 using the link: https://miktex.org/2.9/setup.The operating system specifications (64 bit or 32 bit) should be checked for one's local computer to be used for download, before downloading MiKTeX. The MiKTeX compiler is then downloaded and then the installer is run.
- After installing MiKTeX, the appropriate version of editor TeXnic Centeris downloaded depending on operating system (64 bit or 32 bit)being used. This is done using link: https://www.texniccenter.org/download/.

Thus for working with Latex files, what one needs is a combination of an editor (for writing the Latex code) and a compiler (for using the Latex code to get the required output).There are several available combinations of the editor and the compatible compiler for working with Latex, apart from the combination of TeXnic Center editor and MiKTeX compiler used in this paper. One can choose a suitable option of an editor and a compiler, out of the several available options depending upon one's convenience and the type of system/operating system one is using(http://en.wikipedia.org/wiki/Comparison _of_TeX_editors).Also there is an option of downloading and then installing a Latex editor and its compiler together in the form one common package such as 'protext'software

(https://www.tug.org/protext/). Also various softwares which work in a similar manner as the 'protext' software are also available (https://getalternative.net/software/protext).

In the rest of this section, we briefly describe the techniques of writing a Latex code and then getting the output. A simple Latex file has a \documentclass command, a \begin{document}command, \end{document} command, and some text inside body. The portion of the code before the \begin{document} command is referred to as preamble. The commands are case sensitive and start with \ (backslash).Extra spaces are ignored by Latex and a blank line(s) in the code generates a new paragraph in the output. An example of a simple Latex Code is shown in Figure 1:

```
\documentclass{article}
\begin{document}
This shows how a basic latex file looks. This is
just a small paragraph.
\end{document}
```

Figure1: A simple Latex code

The above code is typed on the editor page and then saved in a file with extension.tex, say, the file name given is Latex1.tex.The code is then run using a button for the same or the keyboard alternative Ctrl +F7.If there are any errors in the code, then they are reported by the software. After correcting the code for errors, the file is again run to produce files like Latex1.dvi. (dvimeans 'device independent') and Latex1.pdf that are displayed by a built-in- viewer. The Latex window with the code and the output are shown in Figure2and Figure 3 respectively.
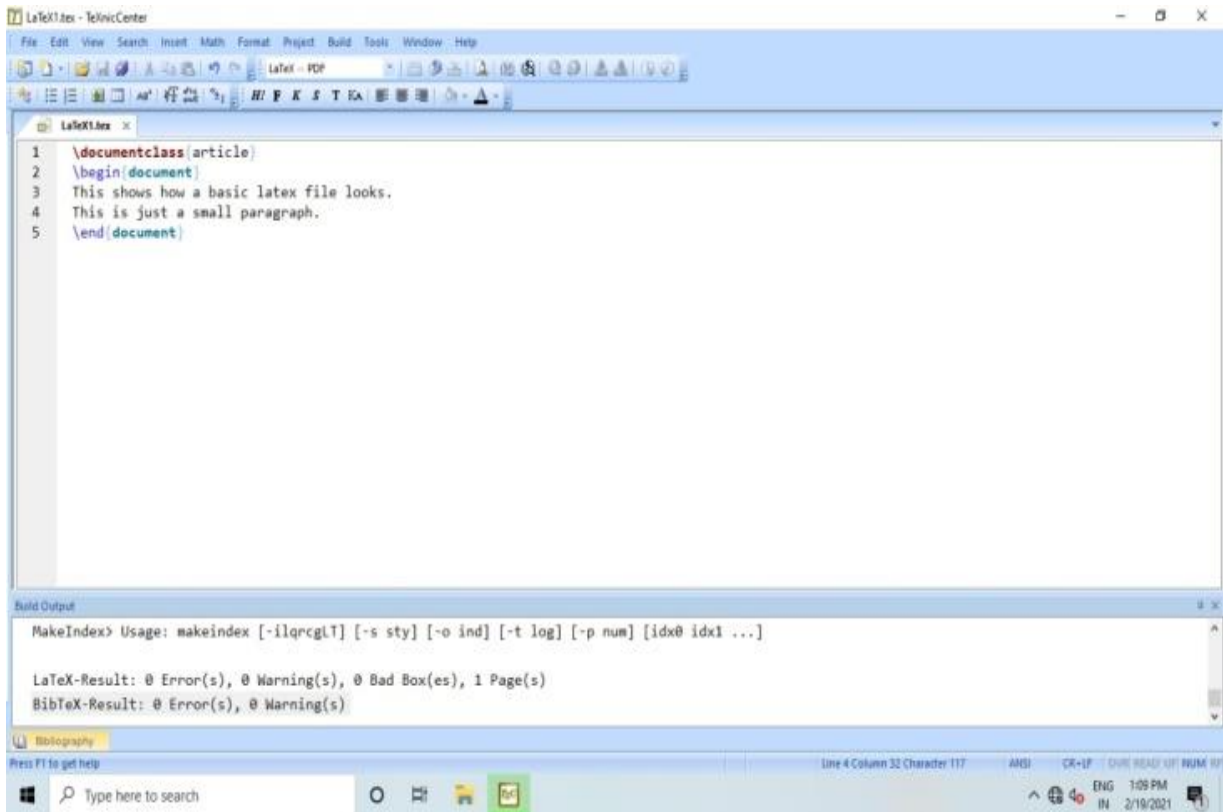
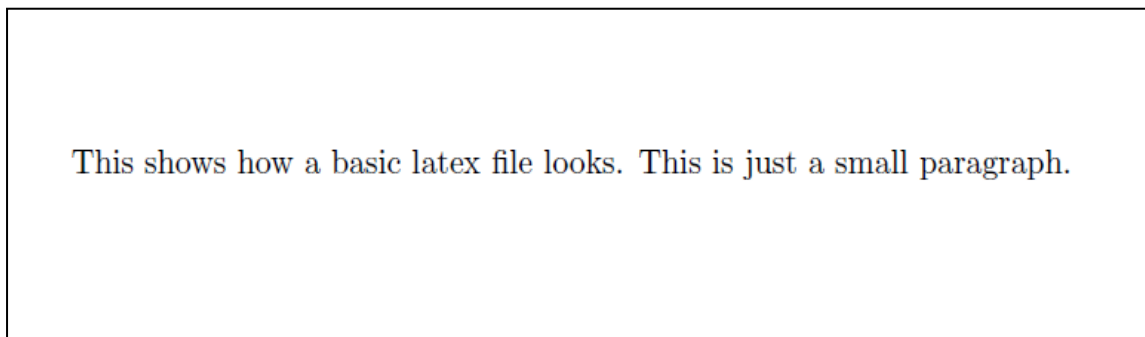**Figure 2:** Simple Latex code on editor window

Figure 3: The output of a simple Latex code

In a Latex code \title, \author, \date and \make title commands can be used to insert title, author and date.\begin{enumerate} command and \end{enumerate} command can be used to enumerate or display point wise items to be enumerated, by starting each item with \item

command inside the begin and end enumerate commands. Latex automatically adjusts as the items are added or removed from the list.

Bold letters are displayed using \textbfcommand and emphasized lettersusing\emph command. The size of the text can be controlled with commands such as \Large, \large, \normal size,\small, and \tiny. This is doneby placing these commands before the text whose size is to be changed and then putting everything in braces as in :{\small Hi}.
Mathematical expressions can be put in a Latex document by entering into math mode using a pair of $signs as in:$y=42$ or equivalently\(y=42 \) in the Latex code to give output y= 42. Writing \[y=42 \] justifies the output y = 42 centrally.
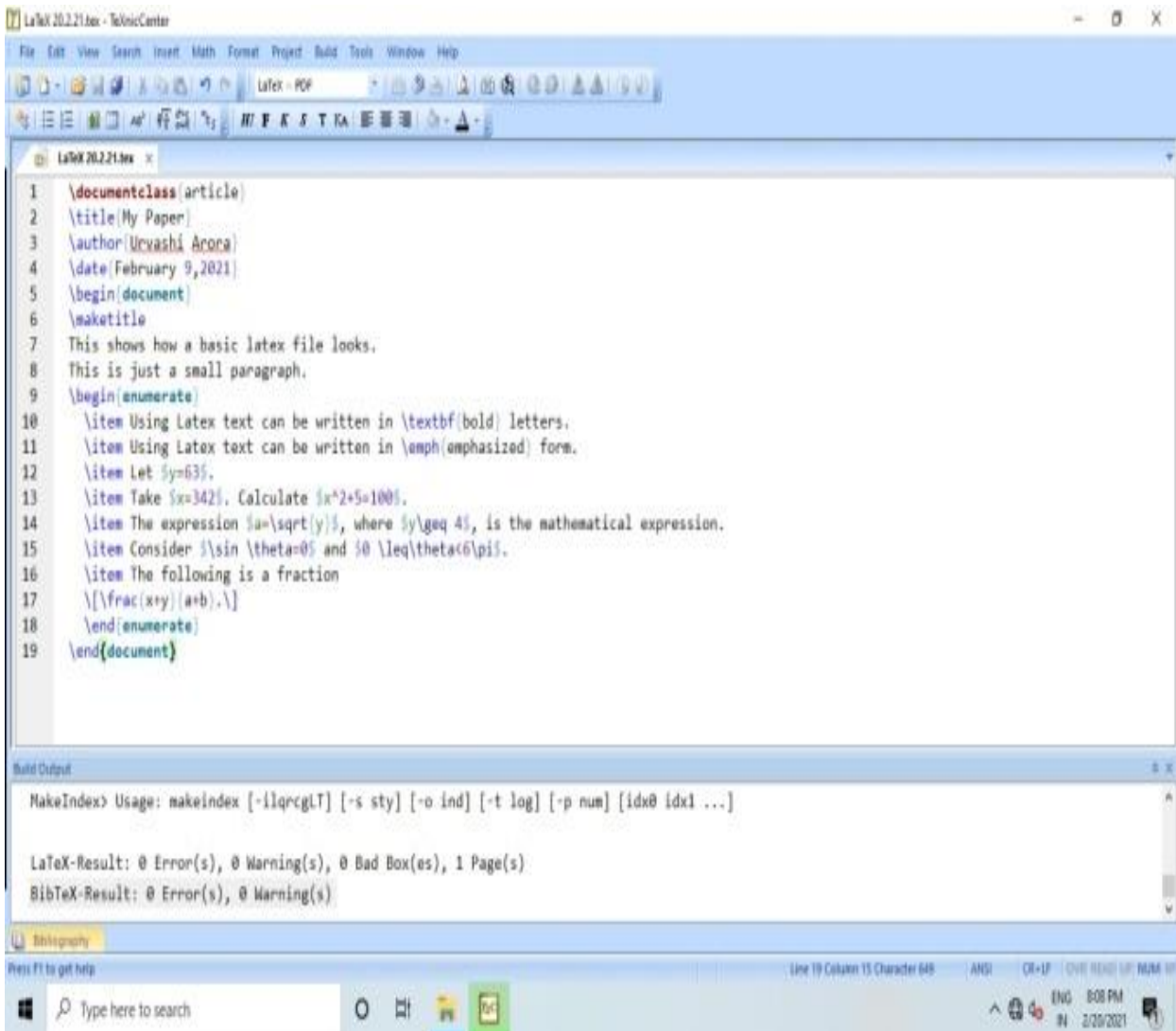
In math mode for extra spaces commands such as \, or \: or \; are used. Bold mathematical text can be obtained using a \mathbf command. The letters in Greek are written by commands such as \alpha, \beta, etc., for lowercase symbols, and \Alpha, \Theta, etc., for uppercase symbols. The symbols $+ - /() [] <> =$ can be typed using keyboard keys. There is vast list of latex commands, such as \sin for sin, \frac { } { } for producing fractions, \sqrt{y} for square root,\geq for ≥, \{ for { , \} for }etc (http://en.wikibooks.org/wiki /LaTeX).

 Another Latex document with various Latex commands is given in Figure 4.The screen shot of Latex code on the editor window and its output are shown in Figure 5 and Figure 6 respectively.

```
\documentclass{article}
\title{My Paper}
\author{Urvashi Arora}
\date{February 9,2021}
\begin{document}
\maketitle
This shows how a basic latex file looks.
This is just a small paragraph.
\begin{enumerate}
\item Using Latex text can be written in
\textbf{bold} letters.
\item Using Latex text can be written
in\emph{emphasized}form.
\item Let $y=63$.
\item Take $x=342$. Calculate $x^2+5=100$.
\item The expression $a= \sqrt{y}$, where $y \geq
4$, is mathematical expression.
\item Consider $\sin \theta = 0$ and $0 \leq \theta
< 6\pi$.
\item The following is a fraction
 \[\frac{x+y}{a+b}.\]
\end{enumerate}
\end{document}
```

Figure 4: An example of Latex code

Figure 5: Screen shot Latexcode on editor window

My Paper

Urvashi Arora

February 9,2021

This shows how a basic latex file looks. This is just a small paragraph.

1. Using Latex text can be written in **bold** letters.
2. Using Latex text can be written in *emphasized* form.
3. Let $y = 63$.
4. Take $x = 342$. Calculate $x^2 + 5 = 100$.
5. The expression $a = \sqrt{y}$, where $y \geq 4$, is the mathematical expression.
6. Consider $\sin\theta = 0$ and $0 \leq \theta < 6\pi$.
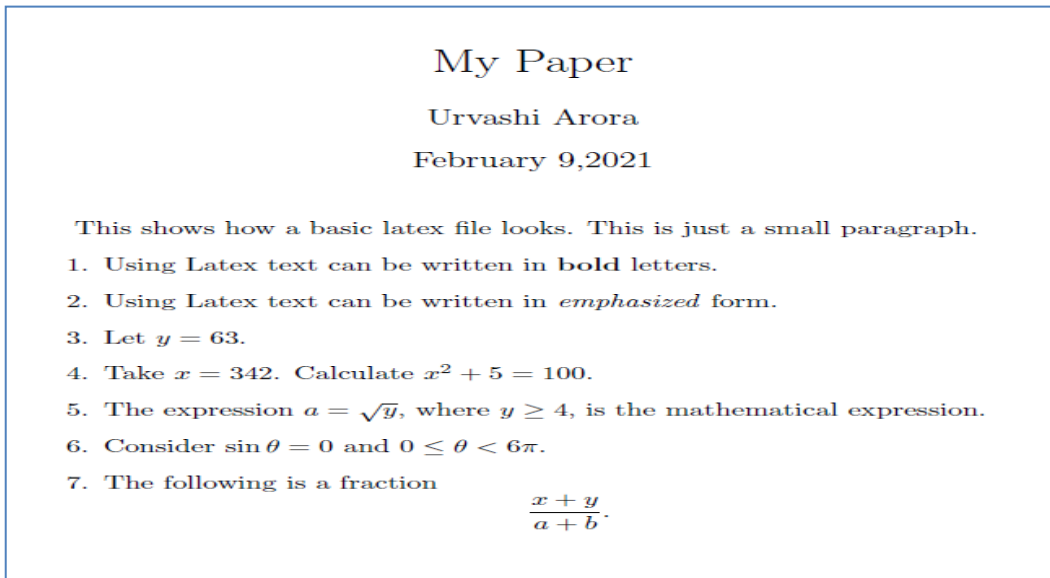7. The following is a fraction
$$\frac{x+y}{a+b}.$$

Figure 6: Output of Latex code

To include a picture/graphic in a Latex Code, one can use \begin{picture}(,) command and the \end{picture} command, that is in other words, one can use a picture environment. Inside these, the commands that can be used to draw simple diagrams are \put(,) , \line(,){ } , \circle{ } e.t.c.One can write\usepackage{graphicx} command inside preamble of the code and then write \includegraphics command inside the code, where a picture is required to be included.

For drawing complex pictures PSTricks package can be used for creating images inside the Latex code (https://www.tug.org/PSTricks/main.cgi).One has to write \usepackage {pstricks} command inside preamble of the Latex code to use PSTricks. Then one can use \begin{pspicture}(,) command and \end{pspicture} command to include a picture inside these built in commands, by using various other commands like \psline command , \pscirclecommand etc. to draw different pictures.

A graphing utility called gnuplot can also be used. Literature on graphics in Latex is readily available (Goossens & Mittelbach, 1997).

OBJECTIVES

The broad objective of this paper is:

- To Make teachers aware of how the FOSS software Latex which is a software mainly for complex typesetting, can be used to create elegant and engaging presentations for students as well.

The document class command of Latex for creating lectures is \documentclass{article}and that for presentations is \documentclass{beamer}.In this paper we illustrate through an example, the process of using a given Latex code for difficult mathematical typesetting and as well as for presentation by making use of document class beamer of Latex. The paper also discusses how pictures/graphs can be added in Latex codes. The paper discusses briefly some important Latex packages and online Latex editors.

METHODOLOGY

Method

To see how teachers can use the same Latex code for complex typesetting (say, complex mathematical symbols, complex script of a language, e.t.c.) as well as for presentation, we illustrate the procedure by taking a particular example of preparing a lesson and a presentation in the next subsection.

For presentation we use document class beamer of Latex. Beamer gives a PDF document which works in same way as a PPT of MSPowerPoint in terms of its application. In beamer a frame is synonymous to a slide of PPT. Creating frames for a presentation can be done using \begin{frame} command and a \end{frame} command. An already written Latexcode is divided into different frames/slides using \begin{frame} command and a \end{frame} command , keeping some lines of code between these two commands, depending on how much matter has to be kept on one frame. The first frame having \titlepage command can be the title page. The rest frames can be given title by using the \frametitlecommand .After creating each new frame, the beamer code may be run to check

for errors and to check if the right output is being obtained. The usual Latex commands can be used in the frames of the presentation. Images can be included in beamer codes in a similar way as in other Latex codes (Tantau et al., 2023).

Procedure

In this section we illustrate the method through an example. Suppose a maths teacher wants to prepare a class room lesson for student's use as well as a presentation for his/her own use on the topic 'partial differentiation of function of two variables'. Then this is how the teacher can proceed.

Step1:

For preparing the lesson, the teacher can first write the corresponding Latex code. The Latex code has been bifurcated into three parts to be written in that order, one after the other, as shown in Figure 7, Figure 8 and Figure 9respectively.

```latex
\documentclass{article}
\usepackage[utf8]{inputenc}
\usepackage{amsmath,amssymb}
\usepackage{enumitem}
\setlength{\parindent}{0cm}
\title{Partial Differentiation}
\author{Urvashi Arora}
\date{}
\begin{document}
\maketitle
\section*{Aim}
In this lecture we are going to learn about Partial Differentiation.
\vspace{20pt}
% Question 1
\textbf{Question 1:} What do you understand by a \textbf{function of two variables}?
\vspace{5pt}
A function of two variables is a function of the form $z=f(x,y)$, where $x$ and $y$ are
independent variables and $z$ is a dependent variable.
\textbf{eg:-} $z=ax^2+2\lambda xy + by^2$ is a function of two variables.
\vspace{10pt}
% Question 2
\textbf{Question 2:} What is \textbf{first order partial derivative of function of two
variables}?
\vspace{5pt}
For a function $z=f(x,y)$ of two variables $x$ and $y$,
\begin{enumerate}[label=(\roman*)]
    \item The \textbf{first order partial derivative of $f$ with respect to $x$} denoted by
$\frac{\partial z}{\partial x}$ or $\frac{\partial f}{\partial x}$ or $f_x$ is the ordinary
derivative of $f$, with respect to $x$, when $y$ is taken as a constant.\\
    i.e.
    $$\frac{\partial z}{\partial x} = \frac{\partial f}{\partial x} = \lim_{\Delta x \to 0}
\frac{f(x+\Delta x, y)- f(x,y)}{\Delta x},$$\\provided the limit exists.
    \item The \textbf{first order partial derivative of $f$ with respect to $y$} denoted by
$\frac{\partial z}{\partial y}$ or $\frac{\partial f}{\partial y}$ or $f_y$ is the ordinary
derivative of $f$, with respect to $y$, when $x$ is taken as a constant.\\
    i.e.
    $$\frac{\partial z}{\partial y}=\frac{\partial f}{\partial y}=f_y=\lim_{\Delta y \to
0}\frac{f(x,y+\Delta y) - f(x,y)}{\Delta y},$$\\provided the limit exists.
\end{enumerate}
```

Figure 7: Latex code of Class room lecture/lesson (part1).

```
\vspace{10pt}
% Remark 1
\textbf{Remark :- 1} Since $f_x=f_x(x,y)=\frac{\partial z}{\partial x}$ and
$f_y=f_y(x,y)=\frac{\partial z}{\partial y}$; Similarly second order partial derivatives of $f$
can be defined as:
\begin{enumerate}[label=\alph*)]
    \item $f_{xx}=\frac{\partial^2z}{\partial x^2}=\frac{\partial}{\partial x}\left(\frac{\partial
z}{\partial x}\right)=\frac{\partial}{\partial x}(f_x)$
    \item $f_{yy}=\frac{\partial^2z}{\partial y^2}=\frac{\partial}{\partial y}\left(\frac{\partial
z}{\partial y}\right)=\frac{\partial}{\partial y}(f_y)$
    \item $f_{xy}=\frac{\partial^2z}{\partial x\partial y}=\frac{\partial}{\partial
x}\left(\frac{\partial z}{\partial y}\right)=\frac{\partial}{\partial x}(f_y)$
    \item $f_{yx}=\frac{\partial^2z}{\partial y\partial x}=\frac{\partial}{\partial
y}\left(\frac{\partial z}{\partial x}\right)=\frac{\partial}{\partial y}(f_x)$
\end{enumerate}
```

Figure 8: Latex code of Class room lecture/lesson(part2)

```
The derivatives in c) and d), above are called \textbf{mixed second order partial derivatives}
of $f$.
\vspace{20pt}
\textbf{Q.1.} If $z=3xy-y^2+(y^2-2x)$, then verify that:
$$
\frac{\partial^2z}{\partial x \partial y}=\frac{\partial^2z}{\partial y \partial x}
$$
\textbf{Ans.} Now
$$\frac{\partial z}{\partial y}=3x-2y+2y=3x$$
$\therefore$
\begin{equation}
    \frac{\partial^2z}{\partial x\partial y}=\frac{\partial}{\partial x}\left(\frac{\partial
z}{\partial y}\right)=3
\end{equation}
Again,
$$
\frac{\partial z}{\partial x} = 3x-2
$$
$\therefore$
\begin{equation}
   \frac{\partial^2z}{\partial y \partial x} = \frac{\partial}{\partial y}\left(\frac{\partial
z}{\partial x}\right) = 3
\end{equation}
$\therefore$ by (1) and (2) $\implies \frac{\partial^2z}{\partial y \partial x} =
\frac{\partial^2z}{\partial x \partial y}$
\vspace{10pt}
\end{document}
```

Figure 9: Latex code of Class room lecture/lesson(part3)

The code when written and saved in theTeXnicCenterwindow and run using the run button gives the following pages as the output as shown in Figure 10 and Figure 11 respectively

Partial Differentiation

Urvashi Arora

Aim

In this lecture we are going to learn about Partial Differentiation.

Question 1: What do you understand by a **function of two variables**?

A function of two variables is a function of the form $z = f(x, y)$, where x and y are independent variables and z is a dependent variable.

eg:- $z = ax^2 + 2\lambda xy + by^2$ is a function of two variables.

Question 2: What is **first order partial derivative of function of two variables**?

For a function $z = f(x, y)$ of two variables x and y,

(i) The **first order partial derivative of f with respect to x** denoted by $\frac{\partial z}{\partial x}$ or $\frac{\partial f}{\partial x}$ or f_x is the ordinary derivative of f, with respect to x, when y is taken as a constant.

i.e.

$$\frac{\partial z}{\partial x} = \frac{\partial f}{\partial x} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x, y) - f(x, y)}{\Delta x},$$

provided the limit exists.

(ii) The **first order partial derivative of f with respect to y** denoted by $\frac{\partial z}{\partial y}$ or $\frac{\partial f}{\partial y}$ or f_y is the ordinary derivative of f, with respect to y, when x is taken as a constant.

i.e.

$$\frac{\partial z}{\partial y} = \frac{\partial f}{\partial y} = f_y = \lim_{\Delta y \to 0} \frac{f(x, y + \Delta y) - f(x, y)}{\Delta y},$$

provided the limit exists.

Remark :- 1 Since $f_x = f_x(x, y) = \frac{\partial z}{\partial x}$ and $f_y = f_y(x, y) = \frac{\partial z}{\partial y}$; Similarly second order partial derivatives of f can be defined as:

a) $f_{xx} = \frac{\partial^2 z}{\partial x^2} = \frac{\partial}{\partial x}\left(\frac{\partial z}{\partial x}\right) = \frac{\partial}{\partial x}(f_x)$

1

Figure 10: Page 1 of Class room lecture/lesson

b) $f_{yy} = \frac{\partial^2 z}{\partial y^2} = \frac{\partial}{\partial y}\left(\frac{\partial z}{\partial y}\right) = \frac{\partial}{\partial y}(f_y)$

c) $f_{xy} = \frac{\partial^2 z}{\partial x \partial y} = \frac{\partial}{\partial x}\left(\frac{\partial z}{\partial y}\right) = \frac{\partial}{\partial x}(f_y)$

d) $f_{yx} = \frac{\partial^2 z}{\partial y \partial x} = \frac{\partial}{\partial y}\left(\frac{\partial z}{\partial x}\right) = \frac{\partial}{\partial y}(f_x)$

The derivatives in c) and d), above are called **mixed second order partial derivatives** of f.

Q.1. If $z = 3xy - y^2 + (y^2 - 2x)$, then verify that:

$$\frac{\partial^2 z}{\partial x \partial y} = \frac{\partial^2 z}{\partial y \partial x}$$

Ans. Now

$$\frac{\partial z}{\partial y} = 3x - 2y + 2y = 3x$$

∴

$$\frac{\partial^2 z}{\partial x \partial y} = \frac{\partial}{\partial x}\left(\frac{\partial z}{\partial y}\right) = 3 \qquad (1)$$

Again,

$$\frac{\partial z}{\partial x} = 3x - 2$$

∴

$$\frac{\partial^2 z}{\partial y \partial x} = \frac{\partial}{\partial y}\left(\frac{\partial z}{\partial x}\right) = 3 \qquad (2)$$

∴ by (1) and (2) $\implies \frac{\partial^2 z}{\partial y \partial x} = \frac{\partial^2 z}{\partial x \partial y}$

2

Figure 11: Page 2 of Class room lecture/lesson

Step2: The teacher can now modify the Latex code written in step 1 and write a beamer code as shown in four parts below to create a presentation for explaining the concept to students. The beamer code has been bifurcated into four parts (for convenience while reading) to be written in that order, one after the other, as shown in Figure 12, Figure 13, Figure 14 and Figure 15 respectively.

```
\documentclass{beamer}

\usetheme{Warsaw}

\usepackage[utf8]{inputenc}

\usepackage{amsmath,amssymb}

\usepackage{enumitem}

\title{Partial Differentiation}

\author{Urvashi Arora}

\date{}

\begin{document}

\begin{frame}

   \titlepage

\end{frame}

\begin{frame}{Aim}

   In this lecture we are going to learn about Partial Differentiation.

\end{frame}

\begin{frame}{Question 1}

   \textbf{Question 1:} What do you understand by a \textbf{function of two variables}?

A function of two variables is a function of the form $z=f(x,y)$, where $x$ and $y$ are
independent variables and $z$ is a dependent variable.

\textbf{eg:-} $z=ax^2+2\lambda xy + by^2$ is a function of two variables.

\end{frame}
```

Figure 12: Beamer code for getting output in presentation format (part 1)

```
\begin{frame}{Question 2}

   \textbf{Question 2:} What is \textbf{first order partial derivative of function of two
variables}?

For a function $z=f(x,y)$ of two variables $x$ and $y$,

\begin{enumerate}[label=(\roman*)]

   \item The \textbf{first order partial derivative of $f$ with respect to $x$} denoted by
$\frac{\partial z}{\partial x}$ or $\frac{\partial f}{\partial x}$ or $f_x$ is the ordinary
derivative of $f$, with respect to $x$, when $y$ is taken as a constant.\\

   i.e.

   $$\frac{\partial z}{\partial x} = \frac{\partial f}{\partial x} = \lim_{\Delta x \to 0}
\frac{f(x+\Delta x, y)- f(x,y)}{\Delta x},$$\\provided the limit exists.

\end{enumerate}

\end{frame}

\begin{frame}{Question 2 Ctd.}

   \begin{description}

      \item[(ii)] The \textbf{first order partial derivative of $f$ with respect to $y$} denoted
by $\frac{\partial z}{\partial y}$ or $\frac{\partial f}{\partial y}$ or $f_y$ is the ordinary
derivative of $f$, with respect to $y$, when $x$ is taken as a constant.\\

   i.e.

   $$\frac{\partial z}{\partial y}=\frac{\partial f}{\partial y}=f_y=\lim_{\Delta y \to
0}\frac{f(x,y+\Delta y) - f(x,y)}{\Delta y},$$\\provided the limit exists.

   \end{description}

\end{frame}
```

Figure 13: Beamer code for getting output in presentation format (part 2)

```
\begin{frame}{Remark 1}

    \textbf{Remark :- 1} Since $f_x=f_x(x,y)=\frac{\partial z}{\partial x}$ and
$f_y=f_y(x,y)=\frac{\partial z}{\partial y}$; Similarly second order partial derivatives of
$f$ can be defined as:

\begin{enumerate}[label=\alph*)]

    \item $f_{xx}=\frac{\partial^2z}{\partial x^2}=\frac{\partial}{\partial
x}\left(\frac{\partial z}{\partial x}\right)=\frac{\partial}{\partial x}(f_x)$

    \item $f_{yy}=\frac{\partial^2z}{\partial y^2}=\frac{\partial}{\partial
y}\left(\frac{\partial z}{\partial y}\right)=\frac{\partial}{\partial y}(f_y)$

    \item $f_{xy}=\frac{\partial^2z}{\partial x\partial y}=\frac{\partial}{\partial
x}\left(\frac{\partial z}{\partial y}\right)=\frac{\partial}{\partial x}(f_y)$

    \item $f_{yx}=\frac{\partial^2z}{\partial y\partial x}=\frac{\partial}{\partial
y}\left(\frac{\partial z}{\partial x}\right)=\frac{\partial}{\partial y}(f_x)$

\end{enumerate}

The derivatives in c) and d), above are called \textbf{mixed second order partial
derivatives} of $f$.

\end{frame}

\begin{frame}{Q.1.}

    \textbf{Q.1.} If $z=3xy-y^2+(y^2-2x)$, then verify that:

$$

\frac{\partial^2z}{\partial x \partial y}=\frac{\partial^2z}{\partial y \partial x}

$$

\textbf{Ans.} Now

$$\frac{\partial z}{\partial y}=3x-2y+2y=3x$$

$\therefore$

\begin{equation}

    \frac{\partial^2z}{\partial x\partial y}=\frac{\partial}{\partial x}\left(\frac{\partial
z}{\partial y}\right)=3

\end{equation}

\end{frame}
```

Figure 14: Beamer code for getting output in presentation format (part 3)

```
\begin{frame}{Q.1. Ctd.}

Again,

$$

\frac{\partial z}{\partial x} = 3x-2

$$

$\therefore$

\begin{equation}

   \frac{\partial^2z}{\partial y \partial x} = \frac{\partial}{\partial y}\left(\frac{\partial z}{\partial x}\right) = 3

\end{equation}

$\therefore$ by (1) and (2) $\implies \frac{\partial^2z}{\partial y \partial x} = \frac{\partial^2z}{\partial x \partial y}$

\end{frame}

\end{document}
```

Figure 15: Beamer code for getting output in presentation format (part 4)

The output of the above code in the pdf format is given in the form of presentation slides 1 to 8in Figure 16

Figure 16: Output in presentation format

OBSERVATIONS

The example discussed in subsection 2 of the section on methodology, illustrates that when a Latex code has been written once for typesetting a particular classroom lecture having content with 'difficult to typeset' symbols, then the code can be easily converted into another Latex code whose output resembles a presentation by using the document class beamer via the command \documentclass{beamer}as the first line in the given Latex code, as can be seen in the code in figure 12. The layout/look of presentation slides in Figure 16 is due to the command \usetheme{Warsaw}.Different layouts of slides can be chosen by using different themes in the \usetheme command instead of Warsaw, such as Madrid, Berlin, Luebecke.t.c.Complete list of beamer themes is readily available(https://latex-beamer.com/tutorials/beamer-themes/.

CONCLUSION

From the discussion it is evident that the FOSS software Latex is a convenient type setting software for creating both documents and presentations having content which is otherwise difficult to typeset. One salient feature of this software, as mentioned before is that typesetting in this software can be done in various different languages of the world by the use of packages like Babel, Polyglossiae.t.c. In fact CTAN which is the Comprehensive Tex Archive Network has over four thousand Latex packages of utility such as 'kpfonts' package for a complete set of fonts and text in mathematics, 'redis' package for inserting Hebrew font, 'blfont' package for producing blackboard bold font,word2latex package for converting Ms word documents to latex documents and so on. These packages can be freely downloaded and used for many applications(https://ctan.org/pkg).

It is worth mentioning here that websites like:www.overeleaf.com, www.sharelatex.com, www.codecogs.com, www.tablesgenerator.com etc. allow users to create online documents/equations/tables in Latex and conveniently obtain their outputs in pdf format(http://en.wikipedia.org/wiki/Comparison_of_TeX_editors).Researches have shown that there is a considerable improvement in student's understanding, if the technical writing

skills of students are paired with computer programming learning, by encouraging students to use software Latex along with computer programming packages like Matlab(Sullivan& Melvin,2016).

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