

MATH 3341: Introduction to Scientific Computing Lab

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Lab 05: Formatting Output and \LaTeX

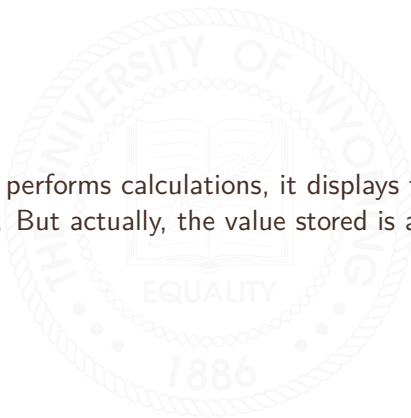


Format of Output in Command Window



“What You See Is Not What You Get”

When MATLAB performs calculations, it displays the result at a default precision. But actually, the value stored is actually in double precision.



Formatting Output using `format` command

We can specify the format of numerical output using `format` type in the command window. Here are format types available in MATLAB:

- `short/long`: Scaled fixed point format with 5 digits/15 digits for double and 7 digits for single.
- `shorte/longe`: Floating point format with 5 digits/15 digits for double and 7 digits for single.
- `shortg/longg`: Best of fixed or floating point format with 5 digits/15 digits for double and 7 digits for single.
- `shorteng/longeng`: Engineering format that has at least 5 digits/exactly 16 digits and a power that is a multiple of three
- `hex/+ /rat/compact/loose`.



Example

% Example 1

```
disp('Example 1 -- Output pi in different formats');  
format  
format('loose');    pi  
format('compact');  pi  
format('short');    pi  
format('long');     pi  
format('shorte');   pi  
format('longe');    pi  
format('shortg');   pi  
format('longg');    pi  
format('shorteng'); pi  
format('longeng');  pi  
format('rat');      pi
```



Example: Output

Example 1 -- Output π in different formats

ans = 3.1416

ans = 3.1416

ans = 3.1416

ans = 3.141592653589793

ans = 3.1416e+00

ans = 3.141592653589793e+00

ans = 3.1416

ans = 3.14159265358979

ans = 3.1416e+000

ans = 3.14159265358979e+000

ans = 355/113



Example: More Elegant Way of Doing Repeating Tasks

Can we make the code more elegant?

Yes! Using a for-loop!

```
disp('Example 2 -- Using a for-loop to output pi in different
% Using a cell-type variable to hold array of strings
types = {'loose', 'compact', 'short', 'long', ...
        'shorte', 'longe', 'shortg', 'longg', ...
        'shorteng', 'longeng', 'rat'};
format
for i = 1:length(types)
    format(types{i}); pi
end
```



The background of the slide features a large, faint watermark of the University of Wyoming seal. The seal is circular with a rope-like border. Inside the border, the words "UNIVERSITY OF WYOMING" are written in an arc at the top, and "1886" is at the bottom. In the center of the seal is an open book with a quill pen resting on it. Below the book, the word "EQUALITY" is written in an arc.

Write Formatted Data



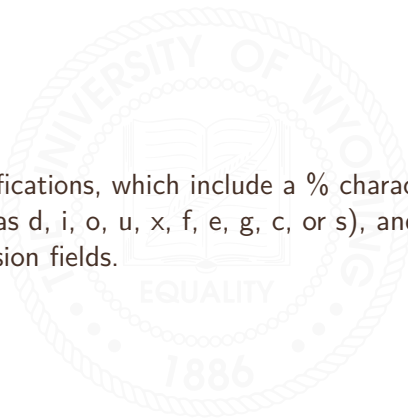
`fprintf` and `sprintf`

- `fprintf`: Write formatted data to text file.
 - `fprintf(fileID,formatSpec,A1,...,An)`
 - `fprintf(formatSpec,A1,...,An)`
- `sprintf`: Write formatted data to string or character vector.
 - `str = sprintf(formatSpec,A1,...,An)`



Conversion Specifications

Conversion specifications, which include a % character, a conversion character (such as d, i, o, u, x, f, e, g, c, or s), and optional flags, width, and precision fields.



Escape characters

Character	Details
<code>\b</code>	Backspace
<code>\f</code>	Form feed
<code>\n</code>	New line
<code>\r</code>	Carriage return
<code>\t</code>	Horizontal tab
<code>' '</code>	Single quotation mark
<code>%%</code>	Percent character
<code>\\</code>	Backslash
<code>\xN</code>	Hexadecimal number N
<code>\N</code>	Octal number N%



For more details: `doc sprintf`

Conversion	Details
<code>%d</code> or <code>%i</code>	Base 10
<code>%u</code>	Base 10
<code>%o</code>	Base 8 (octal)
<code>%x</code>	Base 16 (hexadecimal), lowercase letters a–f
<code>%X</code>	Same as <code>%x</code> , uppercase letters A–F
<code>%f</code>	Fixed-point notation
<code>%e</code>	Exponential notation, such as 3.141593e+00
<code>%E</code>	Same as <code>%e</code> , but uppercase, such as 3.141593E+00
<code>%g</code>	The more compact of <code>%e</code> or <code>%f</code> , with no trailing zeros
<code>%G</code>	The more compact of <code>%E</code> or <code>%f</code> , with no trailing zeros
<code>%c</code>	Single character
<code>%s</code>	Character vector or string array.



For more details: `doc sprintf`

Flags	Details
-	Left-justify.
+	Right-justify text.
	Insert a space before the value.
0	Pad to field width with zeros before the value.
#	Modify selected numeric conversions: <ul style="list-style-type: none">- For %o, %x, or %X, print 0, 0x, or 0X prefix.- For %f, %e, or %E, print decimal point even when precision is 0- For %g or %G, do not remove trailing zeros or decimal point.



Examples: sprintf

```
formatSpec = string('The current time is: %d:%d %s');  
A1 = 11;  
A2 = 20;  
A3 = 'a.m.';  
str = sprintf(formatSpec,A1,A2,A3)
```



Examples: `fprintf`

MATLAB code:

```
x = [0:.2:1]';  
A = [x exp(x)];  
A_size = size(A);  
  
file_handle = fopen('exp.txt','w');  
fprintf(file_handle,'%6s %12s\n','x','exp(x)');  
for i = 1:A_size(1)  
    fprintf(file_handle, '%6.2f %12.8f\n', ...  
            A(i, 1), A(i, 2));  
end  
% fprintf(file_handle,'%6.2f %12.8f\n', A');  
fclose(file_handle);
```



Examples: fprintf

Output:

x	exp(x)
0.00	1.00000000
0.20	1.22140276
0.40	1.49182470
0.60	1.82211880
0.80	2.22554093
1.00	2.71828183



Output for L^AT_EX Table

What if I want to put the output in L^AT_EX? Recall that the table in L^AT_EX has the following structure:

```
\begin{table}[!hbtpr]
\centering
\begin{tabular}{|r|c|l|}
\hline
Column 1 & Column 2 & Column 3 \\
\hline
Column 1 & Column 2 & Column 3 \\
\hline
Column 1 & Column 2 & Column 3 \\
\hline
\end{tabular}
\end{table}
```

So we can format our output for the use of L^AT_EX.



Example: fprintf for L^AT_EX

```
%% Example 4: fprintf for LaTeX
x = [0:.2:1]'; A = [x exp(x)]; A_size = size(A);
file_handle = fopen('exp.tex','w');
fprintf(file_handle, '\\begin{table}[!hbtpt]\n');
fprintf(file_handle, '\\centering\n');
fprintf(file_handle, '\\begin{tabular}{cc}\n');
fprintf(file_handle, '\\hline\n');
fprintf(file_handle, '%6s & %12s \\\n', '$x$', '$\exp(x)$');
fprintf(file_handle, '\\hline\n');
for i = 1:A_size(1)
    fprintf(file_handle, '$%4.2f$ & $%10.8f$ \\\n', A(i,
end
fprintf(file_handle, '\\hline\n');
fprintf(file_handle, '\\end{tabular}\n');
fprintf(file_handle, '\\end{table}\n');
```

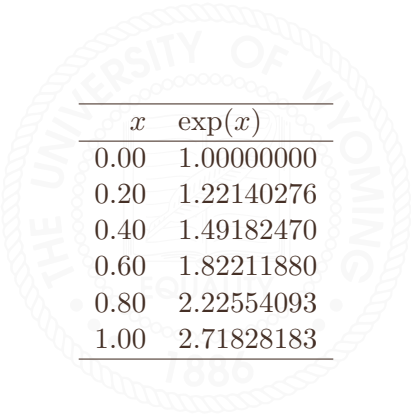


Output

```
\begin{table}[!hbtpt]
\centering
\begin{tabular}{cc}
\hline
     $x$  &  $\exp(x)$  \\
\hline
0.00 & 1.000000000 \\
0.20 & 1.22140276 \\
0.40 & 1.49182470 \\
0.60 & 1.82211880 \\
0.80 & 2.22554093 \\
1.00 & 2.71828183 \\
\hline
\end{tabular}
\end{table}
```



Compile in L^AT_EX



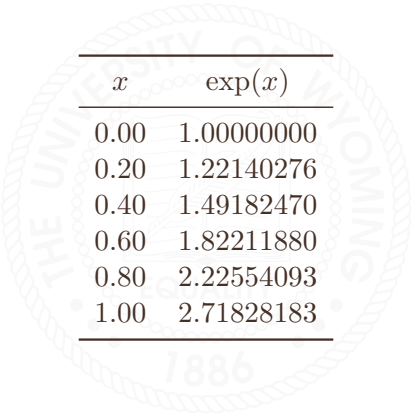
x	$\exp(x)$
0.00	1.00000000
0.20	1.22140276
0.40	1.49182470
0.60	1.82211880
0.80	2.22554093
1.00	2.71828183



`\usepackage{booktabs}`

```
\begin{table}[!hbt]  
\centering  
\begin{tabular}{cc}  
\toprule  
    $x$ &    $\exp(x)$ \\ \\\br/>\midrule  
$0.00$ & $1.00000000$ \\ \\\br/>$0.20$ & $1.22140276$ \\ \\\br/>$0.40$ & $1.49182470$ \\ \\\br/>$0.60$ & $1.82211880$ \\ \\\br/>$0.80$ & $2.22554093$ \\ \\\br/>$1.00$ & $2.71828183$ \\ \\\br/>\bottomrule  
\end{tabular}  
\end{table}
```





x	$\exp(x)$
0.00	1.00000000
0.20	1.22140276
0.40	1.49182470
0.60	1.82211880
0.80	2.22554093
1.00	2.71828183





\LaTeX Primer



figure Environment

```
\begin{figure}[!hbt]  
  \centering  
  \includegraphics{figure.pdf}  
  \caption{Plot of  $\sin{x}$ }  
  \label{fig:sin}  
\end{figure}
```

generates

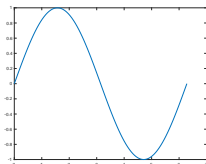


Figure 1:Plot of $\sin x$

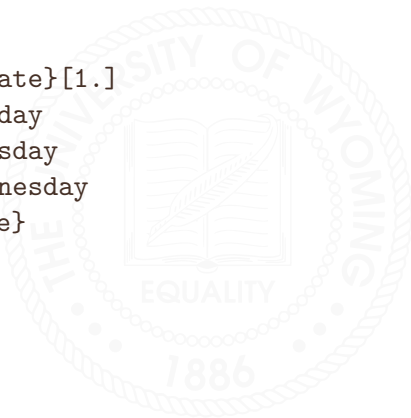


enumerate Environment

```
\begin{enumerate}[1.]  
  \item Monday  
  \item Tuesday  
  \item Wednesday  
\end{enumerate}
```

generates

1. Monday
2. Tuesday
3. Wednesday

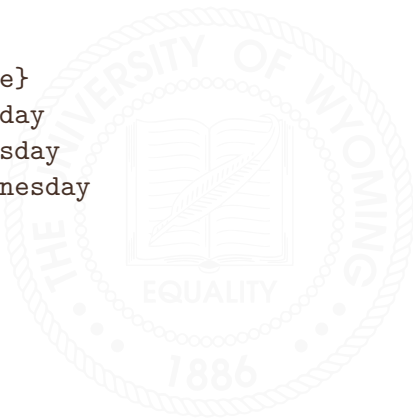


itemize Environment

```
\begin{itemize}  
  \item Monday  
  \item Tuesday  
  \item Wednesday  
\end{itemize}
```

generates

- Monday
- Tuesday
- Wednesday



lstlisting Environment

```
\begin{lstlisting}[style=MATLAB]
clear; clc;
x = linspace(0, 2 * pi, 100);
y = sin(x);
figure
plot(x, y)
xlabel('$x$')
ylabel('$y$')
title('$y = \sin\{x\}$')
\end{lstlisting}
```



lstlisting Environment

```
\lstinputlisting[style=MATLAB]{script.m}
```



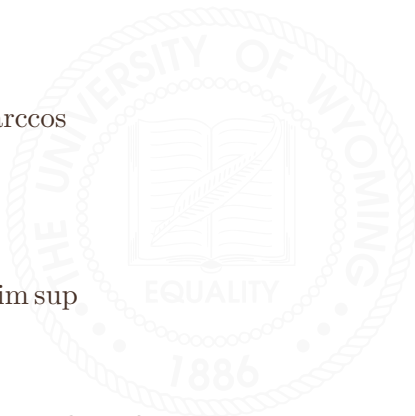
Greek Letters

- `\alpha`: α
- `\beta`: β
- `\gamma`: γ
- `\rho`: ρ
- `\phi`: ϕ
- `\varphi`: φ
- `:`



Standard Function Names

- `\cos`: \cos
- `\arccos`: \arccos
- `\dim`: \dim
- `\log`: \log
- `\ln`: \ln
- `\limsup`: \limsup
- `\min`: \min
- `\deg`: \deg
- `\operatorname{span}`: span



Binary Operation/Relation Symbols

- `\pm`: \pm
- `\oplus`: \oplus
- `\perp`: \perp
- `\subset`: \subset
- `\in`: \in
- `\leq`: \leq
- `\geq`: \geq
- `\neq`: \neq



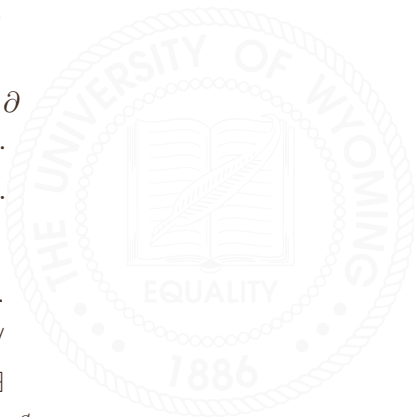
Arrow Symbols

- `\leftarrow`: \leftarrow
- `\Leftarrow`: \Leftarrow
- `\rightarrow`: \rightarrow
- `\Rightarrow`: \Rightarrow
- `\leftrightarrow`: \leftrightarrow
- `\Leftrightarrow`: \Leftrightarrow
- `\mapsto`: \mapsto
- `\leadsto`: \leadsto
- `\implies`: \implies
- `\impliedby`: \impliedby
- `\iff`: \iff



Miscellaneous Symbols

- `\infty`: ∞
- `\nabla`: ∇
- `\partial`: ∂
- `\cdots`: \cdots
- `\ldots`: \ldots
- `\vdots`: \vdots
- `\ddots`: \ddots
- `\forall`: \forall
- `\exists`: \exists
- `\emptyset`: \emptyset
- `\int`: \int
- `\iint`: \iint



Styles

- $\backslash\mathrm{mathcal}\{A\}$: \mathcal{A}
- $\backslash\mathrm{mathbb}\{A\}$: \mathbb{A}
- $\backslash\mathrm{mathfrak}\{A\}$: \mathfrak{A}
- $\backslash\mathrm{mathsf}\{A\}$: A
- $\backslash\mathrm{mathbf}\{A\}$: \mathbf{A}



Text Mode: Accents and Symbols

- `\'{o}`: ó
- `\.{o}`: ò
- `\b{o}`: ȯ
- `\o`: ø
- `\ae`: æ
- `\"{o}`: ö
- `\copyright`: ©
- `\S`: §



Text formatting

- `\textit{Italic}`: *Italic*
- `\textsc{Small Caps}`: SMALL CAPS
- `\textsl{Slanted}`: *Slanted*
- `\textup{Upright}`: Upright
- `\textbf{Boldface}`: **Boldface**
- `\textmd{Medium}`: Medium
- `\texttt{TypeWriter}`: TypeWriter
- `\textsf{Sans Serif}`: Sans Serif
- `\textrm{Roman}`: Roman

