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# ***MATLAB Commands and Functions***

***Dr. Brian Vick***  
***Mechanical Engineering Department***  
***Virginia Tech***

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## **General Purpose Commands**

<b>Operators and Special Characters</b>	
+	Plus; addition operator.
-	Minus; subtraction operator.
*	Scalar and matrix multiplication operator.
.*	Array multiplication operator.
^	Scalar and matrix exponentiation operator.
.^	Array exponentiation operator.
\	Left-division operator.
/	Right-division operator.
.\	Array left-division operator.
./	Array right-division operator.
:	Colon; generates regularly spaced elements and represents an entire row or column.
( )	Parentheses; encloses function arguments and array indices; overrides precedence.
[ ]	Brackets; encloses array elements.
.	Decimal point.
...	Ellipsis; line-continuation operator.
,	Comma; separates statements and elements in a row.
;	Semicolon; separates columns and suppresses display.
%	Percent sign; designates a comment and specifies formatting.
'	Quote sign and transpose operator.
.'	Nonconjugated transpose operator.
=	Assignment (replacement) operator.

<b>Commands for Managing a Session</b>	
clc	Clears Command window.
clear	Removes variables from memory.
exist	Checks for existence of file or variable.
global	Declares variables to be global.
help	Searches for a help topic.
lookfor	Searches help entries for a keyword.
quit	Stops MATLAB.
who	Lists current variables.
whos	Lists current variables (long display).

## Special Variables and Constants

ans	Most recent answer.
eps	Accuracy of floating-point precision.
i, j	The imaginary unit $\sqrt{-1}$ .
Inf	Infinity.
NaN	Undefined numerical result (not a number).
pi	The number $\pi$ .

## System and File Commands

cd	Changes current directory.
date	Displays current date.
delete	Deletes a file.
diary	Switches on/off diary file recording.
dir	Lists all files in current directory.
load	Loads workspace variables from a file.
path	Displays search path.
pwd	Displays current directory.
save	Saves workspace variables in a file.
type	Displays contents of a file.
what	Lists all MATLAB files in the current directory.
wklread	Reads .wkl spreadsheet file.

## Input/Output and Formatting Commands

### Input/Output Commands

<code>disp</code>	Displays contents of an array or string.
<code>fscanf</code>	Read formatted data from a file.
<code>format</code>	Controls screen-display format.
<code>fprintf</code>	Performs formatted writes to screen or file.
<code>input</code>	Displays prompts and waits for input.
<code>;</code>	Suppresses screen printing.

### Format Codes for `fprintf` and `fscanf`

<code>%s</code>	Format as a string.
<code>%d</code>	Format as an integer.
<code>%f</code>	Format as a floating point value.
<code>%e</code>	Format as a floating point value in scientific notation.
<code>%g</code>	Format in the most compact form: <code>%f</code> or <code>%e</code> .
<code>\n</code>	Insert a new line in the output string.
<code>\t</code>	Insert a tab in the output string.

### Numeric Display Formats

<code>format short</code>	Four decimal digits (default).
<code>format long</code>	16 decimal digits.
<code>format short e</code>	Five digits plus exponent.
<code>format long e</code>	16 digits plus exponents.
<code>format bank</code>	Two decimal digits.
<code>format +</code>	Positive, negative, or zero.
<code>format rat</code>	Rational approximation.
<code>format compact</code>	Suppresses some line feeds.
<code>format loose</code>	Resets to less compact display mode.

## **Vector, Matrix and Array Commands**

### **Array Commands**

cat	Concatenates arrays.
find	Finds indices of nonzero elements.
length	Computes number of elements.
linspace	Creates regularly spaced vector.
logspace	Creates logarithmically spaced vector.
max	Returns largest element.
min	Returns smallest element.
prod	Product of each column.
reshape	Change size
size	Computes array size.
sort	Sorts each column.
sum	Sums each column.

### **Special Matrices**

eye	Creates an identity matrix.
ones	Creates an array of ones.
zeros	Creates an array of zeros.

### **Matrix Arithmetic**

cross	Computes cross products.
dot	Computes dot products.

### **Matrix Commands for Solving Linear Equations**

det	Computes determinant of an array.
inv	Computes inverse of a matrix.
pinv	Computes pseudoinverse of a matrix.
rank	Computes rank of a matrix.
rref	Computes reduced row echelon form.

## Cell Array Functions

cell	Creates cell array.
celldisp	Displays cell array.
cellplot	Displays graphical representation of cell array.
num2cell	Converts numeric array to cell array.
deal	Matches input and output lists.
iscell	Identifies cell array.

## Structure Functions

fieldnames	Returns field names in a structure array.
getfield	Returns field contents of a structure array.
isfield	Identifies a structure array field.
isstruct	Identifies a structure array.
rmfield	Removes a field from a structure array.
setfield	Sets contents of field.
struct	Creates structure array.

## **Plotting Commands**

### **Basic xy Plotting Commands**

axis	Sets axis limits.
fplot	Intelligent plotting of functions.
grid	Displays gridlines.
plot	Generates xy plot.
print	Prints plot or saves plot to a file
title	Puts text at top of plot.
xlabel	Adds text label to x-axis.
ylabel	Adds text label to y-axis.

### **Plot Enhancement Commands**

axes	Creates axes objects.
close	Closes the current plot.
close all	Closes all plots.
figure	Opens a new figure window.
gtext	Enables label placement by mouse.
hold	Freezes current plot.
legend	Legend placement by mouse.
refresh	Redraws current figure window.
set	Specifies properties of objects such as axes.
subplot	Creates plots in subwindows.
text	Places string in figure.

### **Specialized Plot Commands**

bar	Creates bar chart.
loglog	Creates log-log plot.
polar	Creates polar plot.
semilogx	Creates semilog plot (logarithmic abscissa).
semilogy	Creates semilog plot (logarithmic ordinate).
stairs	Creates stairs pot.
stem	Creates stem plot.



## Colors, Symbols and Line Types

Color		Symbol		Line	
y	yellow	.	point	-	solid
m	magenta	o	circle	:	dotted
c	cyan	x	x-mark	- .	dash dotted
r	red	+	plus	--	dashed
g	green	*	star		
b	blue	d	diamond		
w	white	v	triangle (down)		
k	black	^	triangle (up)		
		<	triangle (left)		
		>	triangle (right)		
		p	pentagram		
		h	hexagram		

## Three-Dimensional Plotting Commands

contour	Creates contour plot.
mesh	Creates three-dimensional mesh surface plot.
meshc	Same as mesh with contour plot underneath.
meshz	Same as mesh with vertical lines underneath.
plot3	Creates three-dimensional plots from lines and points.
surf	Creates shaded three-dimensional mesh surface plot.
surfc	Same as surf with contour plot underneath.
meshgrid	Creates rectangular grid.
waterfall	Same as mesh with mesh lines in one direction.
zlabel	Adds text label to z-axis.

## Histogram Functions

bar	Creates a bar chart.
hist	Aggregates the data into equally spaced bins.
histc	Aggregates the data into unequally spaced bins.

## **Programming**

### **Logical and Relational Operators**

==	Relational operator: equal to.
~=	Relational operator: not equal to.
<	Relational operator: less than.
<=	Relational operator: less than or equal to.
>	Relational operator: greater than.
>=	Relational operator: greater than or equal to.
&	Logical operator: AND.
	Logical operator: OR.
~	Logical operator: NOT.
xor	Logical operator: EXCLUSIVE OR.

### **Program Flow Control**

break	Terminates execution of a loop.
case	Provides alternate execution paths within switch structure.
else	Delineates alternate block of statements.
elseif	Conditionally executes statements.
end	Terminates for, while, and if statements.
error	Display error messages.
for	Repeats statements a specific number of times
if	Executes statements conditionally.
otherwise	Default part of switch statement.
return	Return to the invoking function.
switch	Directs program execution by comparing point with case expressions.
warning	Display a warning message.
while	Repeats statements an indefinite number of times.

### **Logical Functions**

any	True if any elements are nonzero.
all	True if all elements are nonzero.
find	Finds indices of nonzero elements.
finite	True if elements are finite.
isnan	True if elements are undefined.
isinf	True if elements are infinite.
isempty	True if matrix is empty.
isreal	True if all elements are real.

<b>M-Files</b>	
eval	Interpret strings containing Matlab expressions.
feval	Function evaluation.
function	Creates a user-defined function M-file.
global	Define global variables.
nargin	Number of function input arguments.
nargout	Number of function output arguments.
script	Script M-files

<b>Timing</b>	
cputime	CPU time in seconds.
clock	Current date and time as date vector.
tic, toc	Start, stop a stopwatch timer.

## **Mathematical Functions**

### **Exponential and Logarithmic Functions**

<code>exp (x)</code>	Exponential; $e^x$ .
<code>log (x)</code>	Natural logarithm; $\ln(x)$ .
<code>log10 (x)</code>	Common (base 10) logarithm; $\log(x) = \log_{10}(x)$ .
<code>sqrt (x)</code>	Square root; $\sqrt{x}$ .

### **Trigonometric Functions**

<code>acos (x)</code>	Inverse cosine; $\arccos x = \cos^{-1}(x)$ .
<code>acot (x)</code>	Inverse cotangent; $\text{arccot } x = \cot^{-1}(x)$ .
<code>acsc (x)</code>	Inverse cosecant; $\arcs x = \csc^{-1}(x)$ .
<code>asec (x)</code>	Inverse secant; $\text{arcsec } x = \sec^{-1}(x)$ .
<code>asin (x)</code>	Inverse sine; $\arcsin x = \sin^{-1}(x)$ .
<code>atan (x)</code>	Inverse tangent; $\arctan x = \tan^{-1}(x)$ .
<code>atan2 (y, x)</code>	Four-quadrant inverse tangent.
<code>cos (x)</code>	Cosine; $\cos(x)$ .
<code>cot (x)</code>	Cotangent; $\cot(x)$ .
<code>csc (x)</code>	Cosecant; $\csc(x)$ .
<code>sec (x)</code>	Secant; $\sec(x)$ .
<code>sin (x)</code>	Sine; $\sin(x)$ .
<code>tan (x)</code>	Tangent; $\tan(x)$ .

### **Hyperbolic Functions**

<code>acosh (x)</code>	Inverse hyperbolic cosine; $\cosh^{-1}(x)$ .
<code>acoth (x)</code>	Inverse hyperbolic cotangent; $\coth^{-1}(x)$ .
<code>acsch (x)</code>	Inverse hyperbolic cosecant; $\text{csch}^{-1}(x)$ .
<code>asech (x)</code>	Inverse hyperbolic secant; $\text{sech}^{-1}(x)$ .
<code>asinh (x)</code>	Inverse hyperbolic sine; $\sinh^{-1}(x)$ .
<code>atanh (x)</code>	Inverse hyperbolic tangent; $\tanh^{-1}(x)$ .
<code>cosh (x)</code>	Hyperbolic cosine; $\cosh(x)$ .
<code>coth (x)</code>	Hyperbolic cotangent; $\cosh(x)/\sinh(x)$ .
<code>csch (x)</code>	Hyperbolic cosecant; $1/\sinh(x)$ .
<code>sech (x)</code>	Hyperbolic secant; $1/\cosh(x)$ .
<code>sinh (x)</code>	Hyperbolic sine; $\sinh(x)$ .
<code>tanh (x)</code>	Hyperbolic tangent; $\sinh(x)/\cosh(x)$ .

## Complex Functions

<code>abs(x)</code>	Absolute value; $ x $ .
<code>angle(x)</code>	Angle of a complex number $x$ .
<code>conj(x)</code>	Complex conjugate of $x$ .
<code>imag(x)</code>	Imaginary part of a complex number $x$ .
<code>real(x)</code>	Real part of a complex number $x$ .

## Statistical Functions

<code>erf(x)</code>	Computes the error function $erf(x)$ .
<code>mean</code>	Calculates the average.
<code>median</code>	Calculates the median.
<code>std</code>	Calculates the standard deviation.

## Random Number Functions

<code>rand</code>	Generates uniformly distributed random numbers between 0 and 1.
<code>randn</code>	Generates normally distributed random numbers.

## Numeric Functions

<code>ceil</code>	Rounds to the nearest integer toward $\infty$ .
<code>fix</code>	Rounds to the nearest integer toward zero.
<code>floor</code>	Rounds to the nearest integer toward $-\infty$ .
<code>round</code>	Rounds towards the nearest integer.
<code>sign</code>	Signum function.

## String Functions

<code>findstr</code>	Finds occurrences of a string.
<code>strcmp</code>	Compares strings.
<code>char</code>	Creates character string array

## **Numerical Methods**

### **Polynomial and Regression Functions**

conv	Computes product of two polynomials
deconv	Computes ratio of polynomials.
eig	Computes the eigenvalues of a matrix.
poly	Computes polynomial from roots.
polyfit	Fits a polynomial to data.
polyval	Evaluates polynomial and generates error estimates.
roots	Computes polynomial roots.

### **Interpolation Functions**

interp1	Linear and cubic-spline interpolations of a function of one variable.
interp2	Linear interpolation of a function of two variables.
spline	Cubic-spline interpolation.
unmkpp	Computes the coefficients of cubic-spline polynomials.

### **Root Finding and Minimization**

fmin	Finds minimum of single-variable function.
fmins	Finds minimum of multivariable function.
fzero	Finds zero of single-variable function.

### **Numerical Integration Functions**

quad	Numerical integration with adaptive Simpson's rule.
quadl	Numerical integration with adaptive Lobatto quadrature.
trapz	Numerical integration with the trapezoidal rule.

### **Numerical Differentiation Functions**

diff(x)	Computes the difference between adjacent elements in the vector x.
polyder	Differentiates a polynomial, a polynomial product, or a polynomial quotient.

## ODE Solvers

ode23	Nonstiff, low-order solver.
ode45	Nonstiff, medium-order solver.
ode113	Nonstiff, variable-order solver.
ode23s	Stiff, low-order.
ode23t	Moderately stiff, trapezoidal rule solver.
ode23b	Stiff, low-order solver.
ode15s	Stiff, variable-order solver.
odeset	Creates integrator options structure for ODE solvers.

## Predefined Input Functions

gensig	Generates a periodic sine, square, or pulse input.
sawtooth	Generates a periodic sawtooth input.
square	Generates a square wave input.
stepfun	Generates a step function input.

## **Symbolic Math Toolbox**

### **Functions for Creating and Evaluating Symbolic Expressions**

class	Returns the class of an expression.
digits	Sets the number of decimal digits used to do variable precision arithmetic.
double	Converts an expression to numeric form.
ezplot	Generates a plot of a symbolic expression.
findsym	Finds the symbolic variables in a symbolic expression.
numden	Returns the numerator and denominator of an expression.
sym	Creates a symbolic variable.
syms	Creates one or more symbolic variables.
vpa	Sets the number of digits used to evaluate expressions.

### **Functions for Manipulating Symbolic Expressions**

collect	Collects coefficients of like powers in an expression.
expand	Expands an expression by carrying out powers.
factor	Factors an expression.
poly2sym	Converts a polynomial coefficient vector to a symbolic polynomial.
pretty	Displays an expression in a form that resembles typeset mathematics.
simple	Searches for the shortest form of an expression.
simplify	Simplifies an expression using Maple's simplification rules.
subs	Substitutes variables or expressions.
sym2poly	Converts an expression to a polynomial coefficient vector.

### **Symbolic Calculus Functions**

diff	Returns the derivative of an expression.
Dirac	Dirac delta function (unit impulse).
Heaviside	Heaviside function (unit step).
int	Returns the integral of an expression.
limit	Returns the limit of an expression.
symsum	Returns the symbolic summation of an expression.
taylor	Returns the Taylor series of a function.



## **Symbolic Solution of Algebraic and Transcendental Equations**

<code>solve</code>	Solves symbolic equations.
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## **Symbolic Solution of Differential Equations**

<code>dsolve</code>	Returns a symbolic solution of a differential equation or set of equations.
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## **Laplace Transform Functions**

<code>ilaplace</code>	Returns the inverse Laplace transform.
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<code>laplace</code>	Returns the Laplace transform.
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## **Symbolic Linear Algebra Functions**

<code>det</code>	Returns the determinant of a matrix.
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<code>eig</code>	Returns the eigenvalues (characteristic roots) of a matrix.
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<code>inv</code>	Returns the inverse of a matrix.
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<code>poly</code>	Returns the characteristic polynomial of a matrix.
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