وزارة التعليم العالي والبحث العلمي
جامعة المعقل
كلية الهندسة
قسم هندسة النفط

Computer programming using MATLAB

Submitted by

Dr. Saib A. Yousif

Syllabus

الوحدة	عملي	مناقشة	نظري	المادة	الفصل	المرحلة	#
3	2	0	2	Computer Programming	الثاني	الاولى	12
Introduction to programming using MatLab, Variables, arrays, conditional statements, loops, functions, and plots are covered in addition to GUI.							مفردات المادة

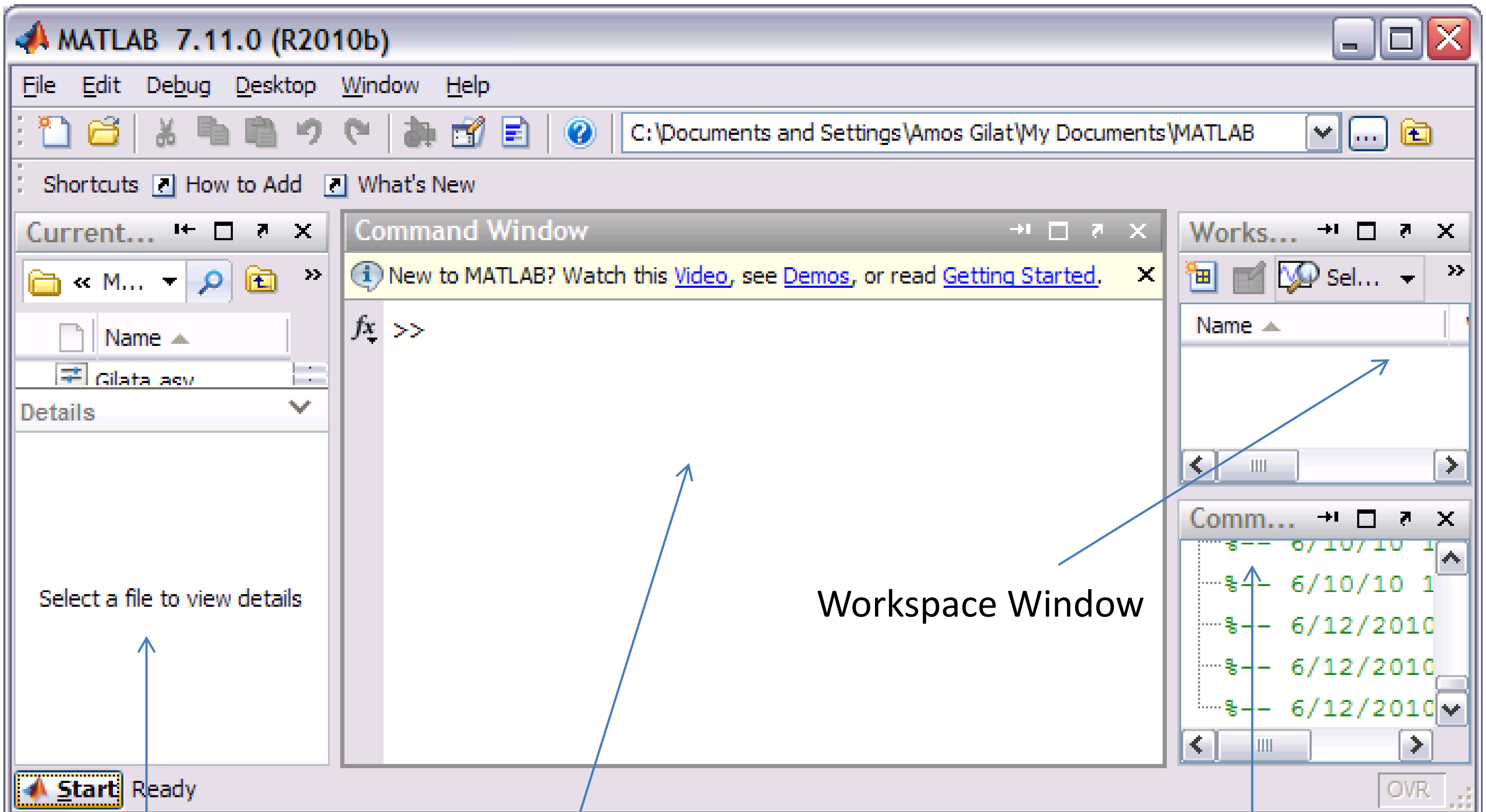
<u>Reference</u>:

Amos Gilat, MATLAB, An Introduction with application, 4th edition, John Wiley, Asia, 2011

Introduction

- MATLAB is a powerful language for technical computing.
- The name MATLAB stands for matrix laboratory, because its basic data element is a matrix (array).
- MATLAB can be used for math computations, modeling and simulations, data analysis and processing, visualization and graphics, and algorithm development.
- MATLAB is widely used in universities and colleges in introductory and advanced courses in mathematics, science, and especially engineering.
- In industry the software is used in research, development, and design.

MATLAB Desktop Window



Workspace Window

Current Folder Window

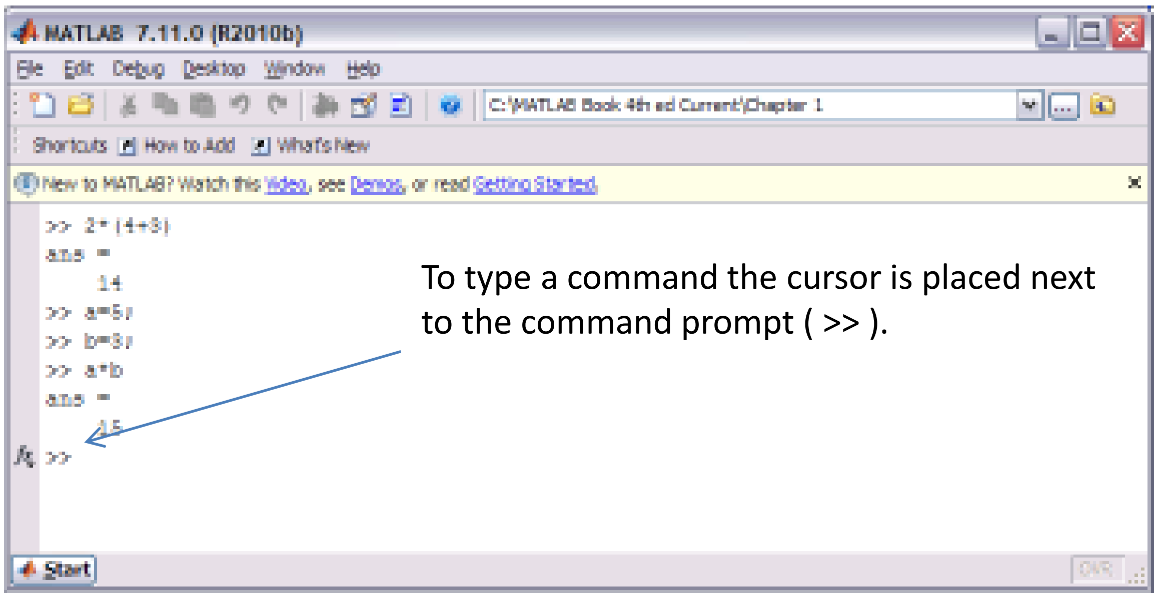
Command Window

Command History Window

MATLAB Windows

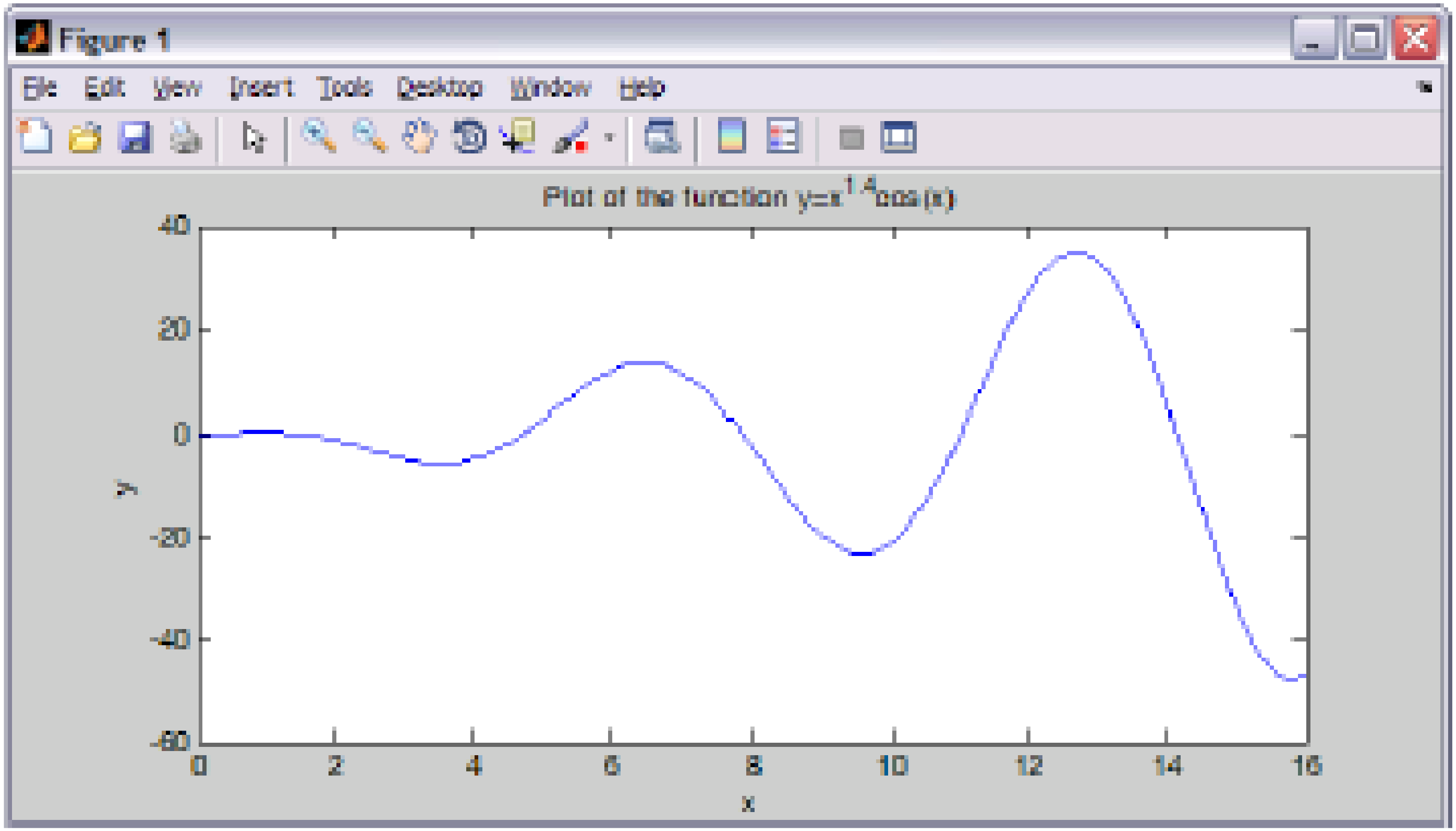
Window	Purpose
Command Window	Main window, enters variables, runs programs.
Figure Window:	Contains output from graphic commands
Editor Window	Creates and debugs script and function files
Help Window	Provides help information
Command History Window	Logs commands entered in the Command Window.
Workspace Window	Provides information about the variables that are used.
Current Folder Window	Shows the files in the current folder

Command Window

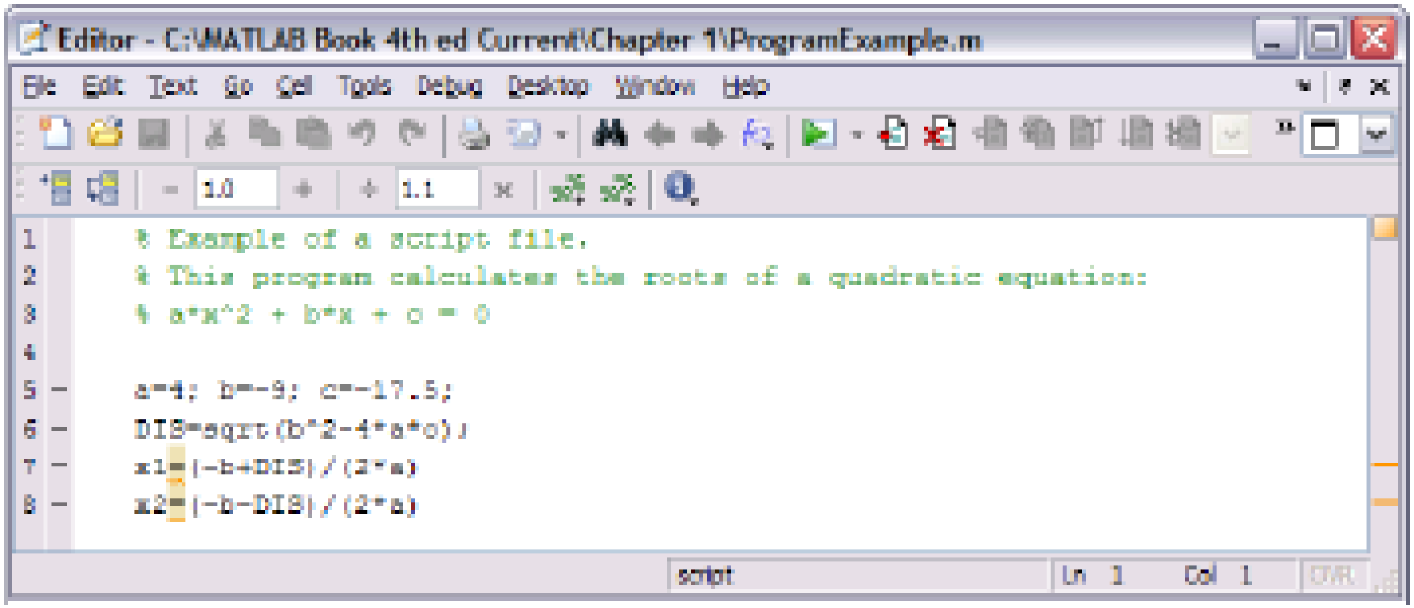


To type a command the cursor is placed next to the command prompt (>>).

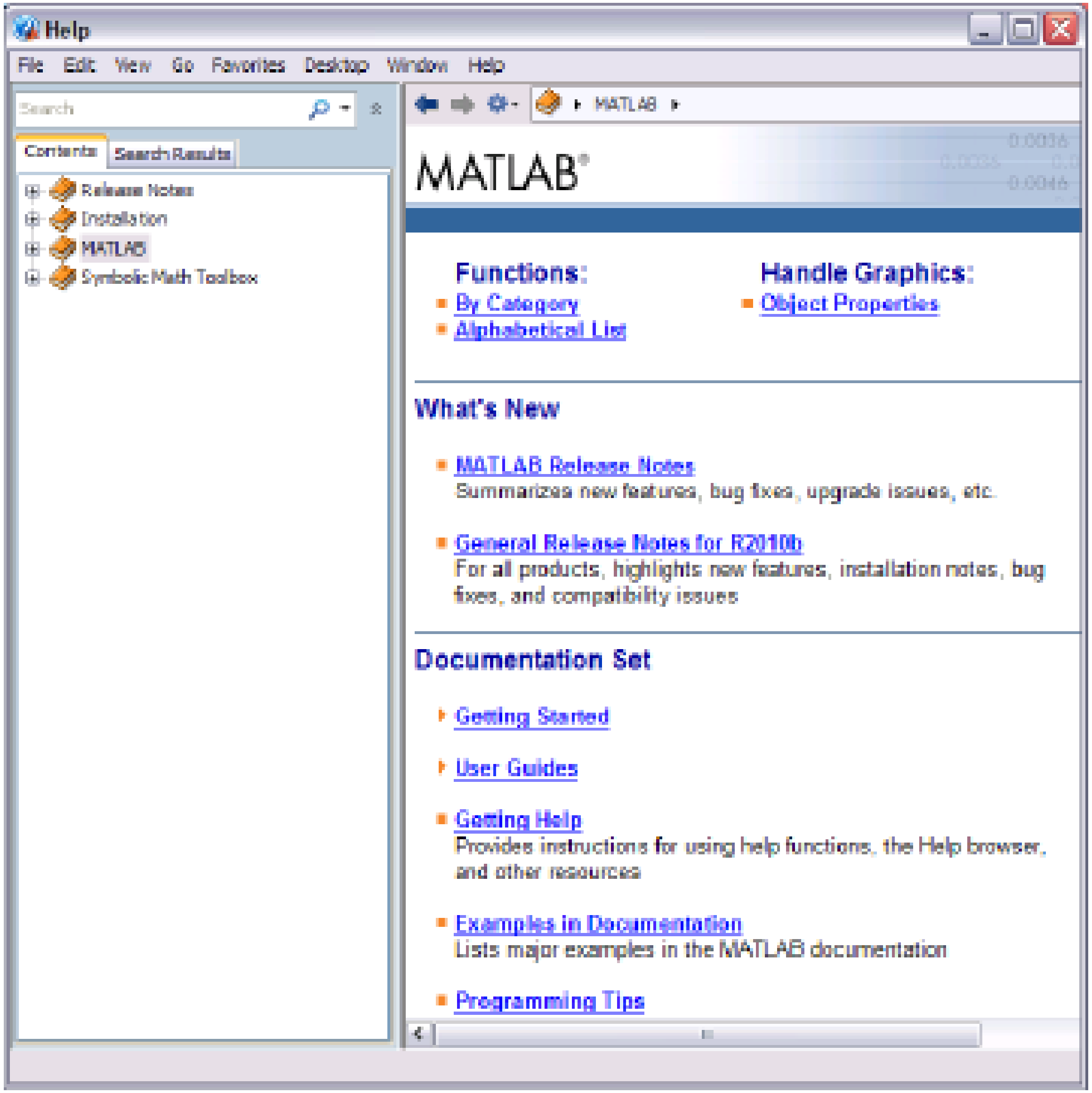
Figure Window



Editor Window:



Help Window

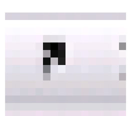

Help
File Edit View Go Favorites Desktop Window Help
Search
Contents
Search Results
Release Notes
Installation
MATLAB
Symbolic Math Toolbox
MATLAB
MATLAB®
Functions:
By Category
Alphabetical List
Handle Graphics:
Object Properties
What's New
MATLAB Release Notes
Summarizes new features, bug fixes, upgrade issues, etc.
General Release Notes for R2010b
For all products, highlights new features, installation notes, bug fixes, and compatibility issues
Documentation Set
Getting Started
User Guides
Getting Help
Provides instructions for using help functions, the Help browser, and other resources
Examples in Documentation
Lists major examples in the MATLAB documentation
Programming Tips

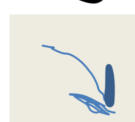
- للابقاء على نافذة واحدة :

- Menu bar → Desktop → Desktop layout → choose the window
- Or click (X) on the top right hand side of undesired window.

- لاعادة النوافذ:

- Menu bar → Desktop → Desktop layout → default

- يمكن عزل separate اي نافذة عن بقية النوافذ:
- by clicking  on the button on the upper right-hand corner.

- يمكن اعادة النافذة الى بقية النوافذ
- by clicking on the button the 

Notes for working in the Command Window

- To type a command the cursor must be placed next to the command prompt (>>).

- Once a command is typed and the **Enter** key is pressed, the command is executed. However, only the last command is executed. Everything executed previously (that might be still displayed) is unchanged.

- Several commands can be typed in the same line. This is done by typing a comma between the commands. When the **Enter** key is pressed the commands are executed in order from left to right.

- It is not possible to go back to a previous line that is displayed in the Command Window, make a correction, and then re-execute the command.

- A previously typed command can be recalled to the command prompt with the uparrow key (↑). When the command is displayed at the command prompt, it can be modified if needed and then executed. The down-arrow key (↓) can be used to move down the list of previously typed commands.

- If a command is too long to fit in one line, it can be continued to the next line by typing three periods … (called an ellipsis) and pressing the **Enter** key. The continuation of the command is then typed in the new line. The command can continue line after line up to a total of 4,096 characters.

The semicolon (;):

- If a semicolon (;) is typed at the end of a command the output of the command is not displayed.
- Typing a semicolon is useful when the output is very large.

Typing %:

When the symbol % (percent) is typed at the beginning of a line, the line is designated

as a comment. This means that when the **Enter** key is pressed the line is not executed.

- **The** clc **command:**

The clc command (type clc and press **Enter**) clears the Command Window

Notes on the Command History Window

- By double-clicking on the command, the command is reentered in the Command Window and executed.
- The list in the Command History Window can be cleared by selecting the lines to be deleted and then selecting **Delete Selection** from the **Edit** menu.
- (or right-click the mouse when the lines are selected and then choose **Delete Selection** in the menu that opens).

ARITHMETIC OPERATIONS WITH SCALARS

Operation	Symbol	Example
Addition	+	5+3
Subtraction	-	5-3
Multiplication	*	5*3
Right division	/	5/3
Left division	\	5 \ 3
Exponentiation	^	5 ^ 3 = 125

Order of Precedence

Precedence	Mathematical Operation
1^{st}	Parentheses. For nested parentheses, the innermost are executed first.
2^{nd}	Exponentiation.
3^{rd}	Multiplication, division (equal precedence).
4^{th}	Addition and subtraction.

Using MATLAB as a Calculator

```
>> 7+8/2

ans =
    11

>> (7+8)/2

ans =
    7.5000

>> 4+5/3+2

ans =
    7.6667

>> 5^3/2

ans =
   62.5000

>> 27^(1/3)+32^0.2

ans =   5

>> 0.7854-(0.7854)^3/(1*2*3)+0.785^5/(1*2*3*4*5)...
-(0.785)^7/(1*2*3*4*5*6*7)

ans =
    0.7071
```

Type and press **Enter**.

8/2 is executed first.

Type and press **Enter**.

7+8 is executed first

5/3 is executed first.

5^3 is executed first, /2 is executed next.

5^3 is executed first, /2 is executed next.

1/3 is executed first, 27^(1/3) and 32^0.2 and + is executed last.

Type three periods ... (and press **Enter**) to continue the expression on the next line

The last expression is the first four terms of the Taylor series for sin(π/4).

DISPLAY FORMATS

Command	Description	Example

`format short`	Fixed-point with 4 decimaldigits for: $0.001 \leq number \leq 1000$ Otherwise display format`short e`.	`>> 290/7`
		`ans =`
		`41.4286`

`format long`	Fixed-point with 15 decimaldigits for: $0.001 \leq number \leq 100$ Otherwise display format`long e`.	`>> 290/7`
		`ans =`
		`41.428571428571431`

`format short e`	Scientific notation with 4decimal digits.	`>> 290/7`
		`ans =`
		`4.1429e+001`

`format long e`	Scientific notation with 15decimal digits.	`>> 290/7`
		`ans =`
		
		`4.142857142857143e+001`

`format short g`	Best of 5-digit fixed orfloating point.	`>> 290/7`
		`ans =`
		`41.429`

`format long g`	Best of 15-digit fixed orfloating point.
	1.2345 = 12345 x 10^-4 (floating point)
		`>> 290/7`
		`ans =`
		
		`41.4285714285714`

`format bank`	Two decimal digits.	`>> 290/7`
		`ans =`
		`41.43`

`format compact`	Eliminates empty lines to allow more lines withinformation displayed on the screen.	
`format loose`	Adds empty lines (opposite of `compact`).	

ELEMENTARY MATH BUILT-IN FUNCTIONS

Elementary math functions

Function	Description	Example

`sqrt(x)`	Square root.	`>> sqrt(81)`
		`ans =`
		`9`

`nthroot(x,n)`	Real *n*th root of a real number *x*. (If *x* is negative *n* must be an odd integer.)	`>> nthroot(80,5)`
		`ans =`
		`2.4022`

`exp(x)`	Exponential (e^x).
	e=2.7183
		`>> exp(5)`
		`ans =`
		`148.4132`

`abs(x)`	Absolute value.	`>> abs(-24)`
		`ans =`
		`24`

`log(x)`	Natural logarithm.
	Base *e* logarithm (ln).
		`>> log(1000)`
		`ans =`
		`6.9078`

`log10(x)`	Base 10 logarithm.	`>> log10(1000)`
		`ans =`
		`3.0000`

Table 1-3: Elementary math functions (Continued)

Function	Description	Example

`factorial(x)`	The factorial function $x!$
	(x must be a positive integer.)
		`>> factorial(5)`
		`ans =`
		`   120`

=5*4*3*2*1=120

Tutorial :Using the sqrt built-in function

```
>> sqrt(64)
ans =
8
```

Argument is a number

```
>> sqrt(50+14*3)
ans =
9.5917
```

Argument is an expression

```
>> sqrt(54+9*sqrt(100))
ans =
12
```

Argument includes a function

```
>> (15+600/4)/sqrt(121)
ans =
15
```

Function is included in an expression

Trigonometric math functions

Function	Description	Example

`sin(x)`
`sind(x)`
	Sine of angle *x* (*x* in radians).
	Sine of angle *x* (*x* in degrees).
		`>> sin(pi/6)`
		`ans =`
		`0.5000`

`cos(x)`
`cosd(x)`
	Cosine of angle *x* (*x* in radians).
	Cosine of angle *x* (*x* in degrees).
		`>> cosd(30)`
		`ans =`
		`0.8660`

`tan(x)`
`tand(x)`
	Tangent of angle *x* (*x* in radians).
	Tangent of angle *x* (*x* in degrees).
		`>> tan(pi/6)`
		`ans =`
		`0.5774`

`cot(x)`
`cotd(x)`
	Cotangent of angle *x* (*x* in radians).
	Cotangent of angle *x* (*x* in degrees).
		`>> cotd(30)`
		`ans =`
		`1.7321`

`asin(x)` `asind(x)`	angle *x* (*x* in radians). angle *x* (*x* in degrees).	Inverse trigonometric function (angle) sin^{-1}(x)
`acos(x)` `acosd(x)`	angle *x* (*x* in radians). angle *x* (*x* in degrees).	Inverse trigonometric function (angle)
`atan(x)` `atand(x)`	angle *x* (*x* in radians). angle *x* (*x* in degrees).	Inverse trigonometric function (angle)
`acot(x)` `acotd(x)`	angle *x* (*x* in radians). angle *x* (*x* in degrees).	Inverse trigonometric function (angle)

```
>>asin(0.5)
ans
     0.5236
```

```
>>asind(0.5)
ans
     30.0000
```

Hyperbolic trigonometric math functions

Function	Description
`sinh(x)`	$\sinh(x) = (e^{x} - e^{-x})/\mathbf{2}$ **where, e =2.718**
`cosh(x)`	$\cosh(x) = (e^{x} + e^{-x})/\mathbf{2}$
`tanh(x)`	$\tanh(x) = \sinh(x)/\mathbf{cosh(x)} = (e^{x} - e^{-x})/(\mathbf{e^{x} + e^{-x}})$
`coth(x)`	$\coth(x) = \cosh(x)/\mathbf{sinh(x)} = (e^{x} + e^{-x})/(\mathbf{e^{x} - e^{-x}})$

Rounding functions

Function	Description	Example

`round(x)`	Round to the nearest integer.	`>> round(17/5)`
		`ans =`
		`3`

`fix(x)`	Round toward zero.	`>> fix(13/5)`
		`ans =`
		`2`

`ceil(x)`	Round toward infinity.	`>> ceil(11/5)`
		`ans =`
		`3`

`floor(x)`	Round toward minus infinity.	`>> floor(-9/4)`
		`ans =`
		`-3`

`rem(x,y)`	Returns the remainder after x is divided by y.	`>> rem(13,5)`
		`ans =`
		`3`

`sign(x)`	Signum function. Returns 1 if $x > 0$, -1 if $x < 0$, and 0 if $x = 0$.	`>> sign(5)`
		`ans =`
		`1`

The Assignment Operator

- In MATLAB the (=) sign is called the assignment operator. The assignment operator assigns a value to a variable.
- Variable_name = A numerical value, or a computable expression

The following shows how the assignment operator works

>>x=15	**The number 15 is assigned to the variable x**
X= 15	MATLAB displays the variable and its assigned value.
>> x=3*x-12 **x =** **33** **>>**	A new value is assigned to x. The new value is 3 times the previous value of x minus 12.

>> a=12 **a =** **12**	Assign 12 to a.
>> B=4 **B =** **4**	Assign 4 to B.
>> C=(a-B)+40-a/B*10 **C =** **18**	Assign the value of the expression on the right-hand side to the variable C.
>> a=12; **>> B=4;** **>> C=(a-B)+40-a/B*10;**	The variables a, B, and C are defined but are not displayed since a semicolon is typed at the end of each statement.
>> C **C =** **18**	The value of the variable C is displayed by typing the name of the variable.

>> a=12, B=4; C=(a-B)+40-a/B*10 **a =** **12** **C =** **18**	The variable B is not displayed because a semicolon is typed at the end of the assignment.
>> ABB=72;	A value of 72 is assigned to the variable ABB.
>> ABB=9;	A new value of 9 is assigned to the variable ABB.
>> ABB **ABB =** **9** **>>**	The current value of the variable is displayed when the name of the variable is typed and the **Enter** key is pressed.
>> x=0.75; **>> E=sin(x)^2+cos(x)^2** **E =** **1** **>>**	Once a variable is defined it can be used as an argument in functions. For example:

Rules About Variable Names

A variable can be named according to the following rules:

- Must begin with a letter.
- Can be up to 63 characters long.
- Can contain letters, digits, and the underscore character.
- Cannot contain punctuation characters (e.g., period, comma, semicolon).
- MATLAB is case sensitive: it distinguishes between uppercase and lowercase letters. For example, AA, Aa, aA, and aa are the names of four different variables.
- No spaces are allowed between characters (use the underscore where a space is desired).
- Avoid using the name of a built-in function for a variable (i.e., avoid using cos, sin, exp, sqrt, etc.). Once a function name is used to define a variable, the function cannot be used.

Keywords

- There are 20 words, called keywords, cannot be used as variable names:

break	case	catch	classdef	continue
else	elseif	end	for	function
global	if	otherwise	parfor	persistent
return	spmd	switch	try	while

- When typed, these words appear in blue.
- An error message is displayed if the user tries to use a keyword as a variable name.
- The keywords can be displayed by typing the command iskeyword

Predefined Variables

Variable	notation
ans	answer
pi	The number π
eps	The smallest difference between two numbers. Equal to 2^(–52), which is approximately 2.2204e–016
i	$\sqrt{-1}$
j	$\sqrt{-1}$
NaN	Stands for Not-a-Number, e.g. 0/0

SCRIPT FILES

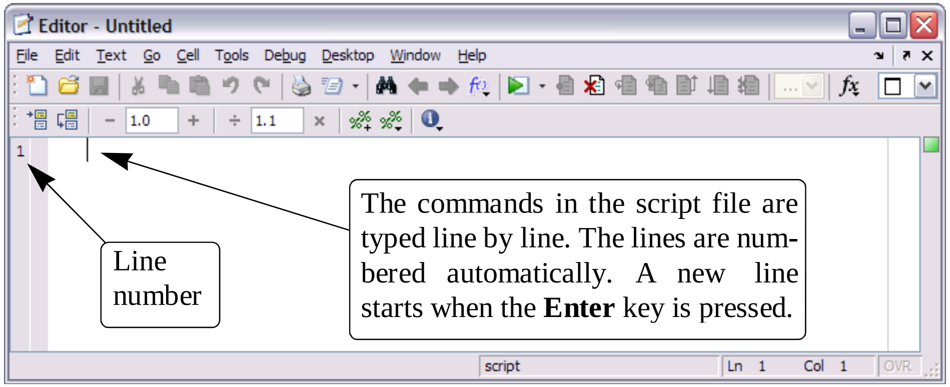
- A script file is a sequence of MATLAB commands, also called a program.
- When a script file runs (is executed), MATLAB executes the commands in the order they are written just as if they were typed in the Command Window.
- When a script file has a command that generates an output (e.g., assignment of a value to a variable without a semicolon at the end), the output is displayed in the Command Window.
- Using a script file is convenient because it can be edited (corrected or otherwise changed) and executed many times.
- Script files can be typed and edited in any text editor and then pasted into the MATLAB editor.
- Script files are also called M-files because the extension .m is used when they are saved.

Useful Commands for Managing Variables

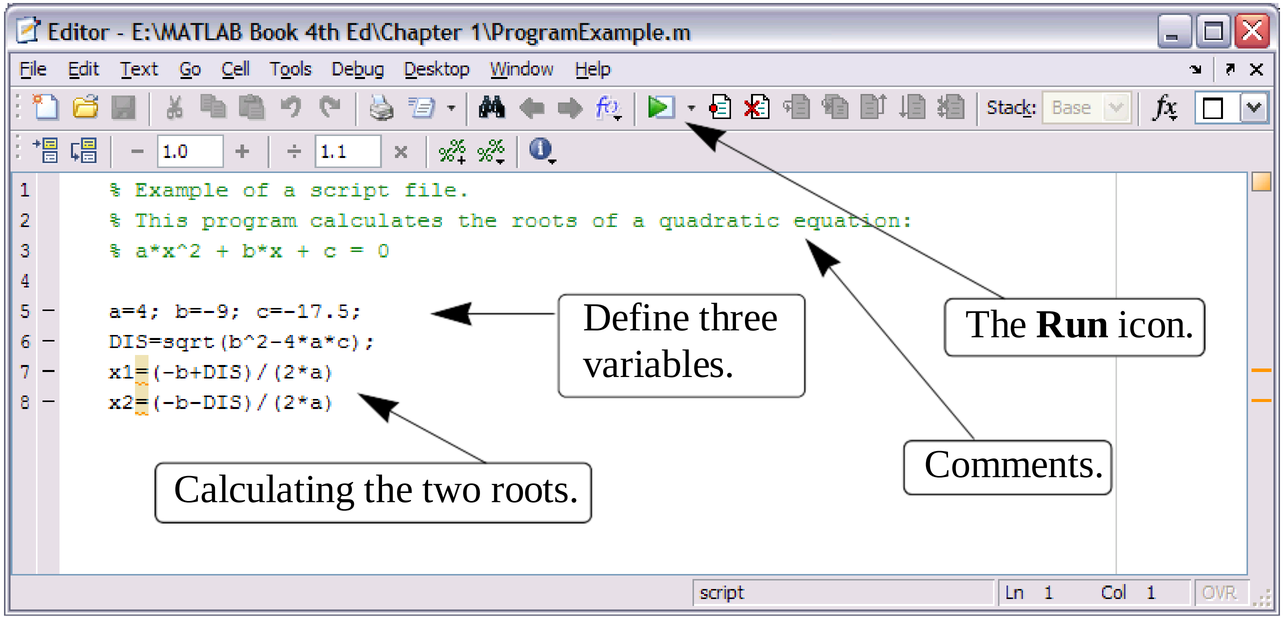
Command	Outcome
Clear	Removes all variables from the memory.
clear x y z	Removes only variables x, y, and z from the memory.
who	Displays a list of the variables currently in the memory.
whos	Displays a list of the variables currently in the memory and their sizes together with information about their bytes and class

Creating a Script File

File menu ⟶ new ⟶ script (Editor/Debugger Window will be opened)



Typing A program in the Editor/Debugger Window

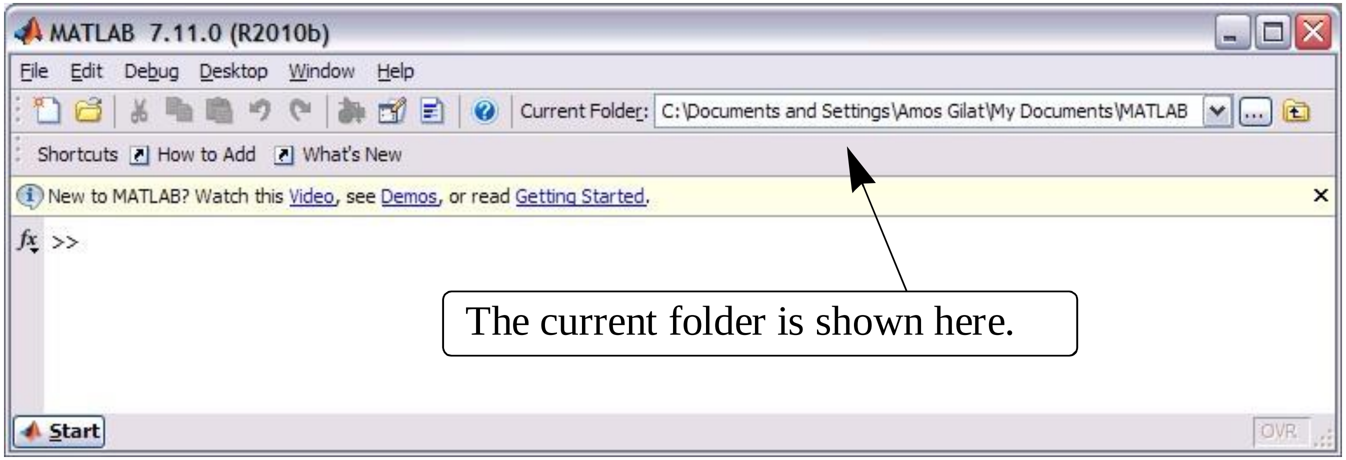


Saving a Script File

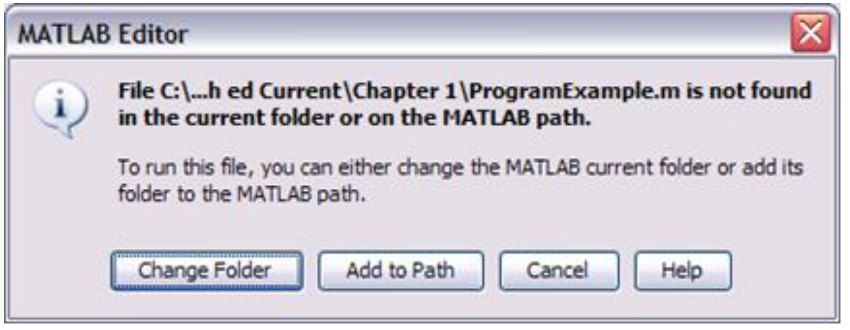
- Script file → File menu → Save as → Mat path location

Running (Executing) a Script File

- Editor Window: Run (tab panel) ← The results appear in command window
- Command window: Type program name → enter

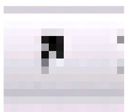


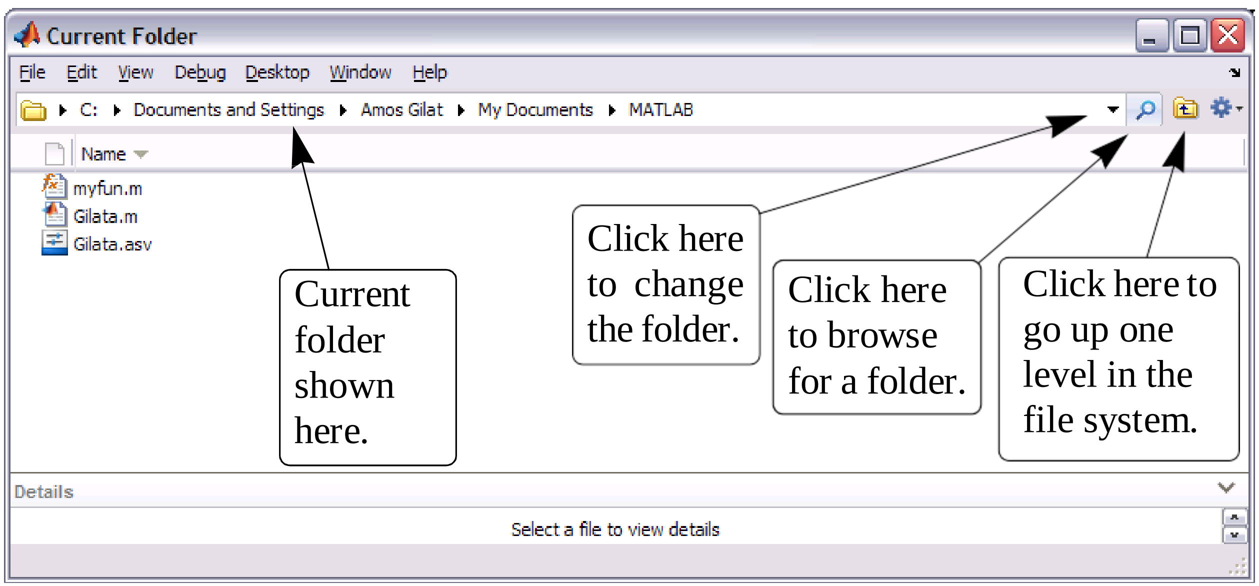
- **<u>Note</u>**: when the current folder is not the folder where the script file is saved, then the prompt shown in figure below will open:



- The user can then change the current folder to the folder where the script file is saved, or add it to the search path

- The current folder can also be opened or changed :

1. Command window: **Desktop** menu $\longrightarrow$ Current folder
2. Or click  on the upper right-hand corner of current folder window



3. Or use the cd command in the Command Window

Type: cd → space → directory → :

```
>> cd E:

>> ProgramExample
x1 =
    3.5000
x2 =
   -1.2500
```

The current directory is changed to drive E.

The script file is executed by typing the name of the file and pressing the **Enter** key.

The output generated by the script file (the roots `x1` and `x2`) is displayed in the Command Window.

Example 1

A trigonometric identity is given by:

$$cos^2 \frac{x}{2} = \frac{tanx+sinx}{2\ tanx}$$

Verify that the identity is correct by calculating each side of the equation, substituting $x = \pi/5$

Solution: create the following matlab program:

```
>> x=pi/5;                                   Define x.
>> LHS=cos(x/2)^2                            Calculate the left-hand side.
LHS =
    0.9045
>> RHS=(tan(x)+sin(x))/(2*tan(x))            Calculate the right-hand side.
RHS =
    0.9045
```

Example 2

An object with an initial temperature of T_0 that is placed at time t = 0 inside a chamber that has a constant temperature of Ts will experience a temperature change according to the equation

$$T = T_s + (T_o - T)\, e^{-k\,t}$$

where T is the temperature of the object at time t, and k is a constant. A soda can at a temperature of 120° F (after being left in the car) is placed inside a refrigerator where the temperature is 38°F. Determine, to the nearest degree, the temperature of the can after three hours. Assume k = 0.45. First define all of the variables and then calculate the temperature using one MATLAB command.

<u>Solution</u>

```
>> Ts=38;  T0=120; k=0.45; t=3;
>> T=round(Ts+(T0-Ts)*exp(-k*t))

T =
59
```

Round to the nearest integer.

Problems (pages 27-34)

1.10 PROBLEMS

The following problems can be solved by writing commands in the Command Window, or by writing a program in a script file and then executing the file.

1. Calculate:

   (a) $\dfrac{(14.8^2+6.5^2)}{3.8^2}+\dfrac{55}{\sqrt{2}+14}$

   (b) $(-3.5)^3+\dfrac{e^6}{\ln 524}+206^{1/3}$

2. Calculate:

   (a) $\dfrac{16.5^2(8.4-\sqrt{70})}{4.3^2-17.3}$

   (b) $\dfrac{5.2^3-6.4^2+3}{1.6^8-2}+\left(\dfrac{13.3}{5}\right)^{1.5}$

3. Calculate:

   (a) $15\left(\dfrac{\sqrt{10}+3.7^2}{\log_{10}(1365)+1.9}\right)$

   (b) $\dfrac{2.5^3\left(16-\dfrac{216}{22}\right)}{1.7^4+14}+\sqrt[4]{2050}$

4. Calculate:

   (a) $\dfrac{2.3^2\cdot 1.7}{\sqrt{(1-0.8^2)^2+(2-\sqrt{0.87})^2}}$

   (b) $2.34+\frac{1}{2}2.7(5.9^2-2.4^2)+9.8\ln 51$

5. Calculate:

(a) $\dfrac{\sin\left(\frac{7\pi}{9}\right)}{\cos^2\left(\frac{5}{7}\pi\right)} + \dfrac{1}{7}\tan\left(\dfrac{5}{12}\pi\right)$ (b) $\dfrac{\tan 64^\circ}{\cos^2 14^\circ} - \dfrac{3\sin 80^\circ}{\sqrt[3]{0.9}} + \dfrac{\cos 55^\circ}{\sin 11^\circ}$

6. Define the variable x as $x = 2.34$, then evaluate:

(a) $2x^4 - 6x^3 + 14.8x^2 + 9.1$ (b) $\dfrac{e^{2x}}{\sqrt{14 + x^2 - x}}$

7. Define the variable t as $t = 6.8$, then evaluate:

(a) $\ln(|t^2 - t^3|)$ (b) $\dfrac{75}{2t}\cos(0.8t - 3)$

8. Define the variables x and y as $x = 8.3$ and $y = 2.4$, then evaluate:

(a) $x^2 + y^2 - \dfrac{x^2}{y^2}$ (b) $\sqrt{xy} - \sqrt{x + y} + \left(\dfrac{x - y}{x - 2y}\right)^2 - \sqrt{\dfrac{x}{y}}$

9. Define the variables a, b, c, and d as:

$a = 13$, $b = 4.2$, $c = (4b)/a$, and $d = \dfrac{abc}{a + b + c}$, then evaluate:

(a) $a\dfrac{b}{c + d} + \dfrac{da}{cb} - (a - b^2)(c + d)$ (b) $\dfrac{\sqrt{a^2 + b^2}}{(d - c)} + \ln(|b - a + c - d|)$

10. A cube has a side of 18 cm.
(a) Determine the radius of a sphere that has the same surface area as the cube.
(b) Determine the radius of a sphere that has the same volume as the cube.

11. The perimeter P of an ellipse with semi-minor axes a and b is given approximately by: $P = 2\pi\sqrt{\frac{1}{2}(a^2 + b^2)}$.

(a) Determine the perimeter of an ellipse with $a = 9$ in. and $b = 3$ in.
(b) An ellipse with $b = 2a$ has a perimeter of $P = 20$ cm. Determine a and b.

12. Two trigonometric identities are given by:

(a) $\sin 4x = 4\sin x\cos x - 8\sin^3 x\cos x$ (b) $\cos 2x = \dfrac{1 - \tan^2 x}{1 + \tan^2 x}$

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = \frac{\pi}{9}$.

13. Two trigonometric identities are given by:

(a) $\tan 4x = \dfrac{4\tan x - 4\tan^3 x}{1 - 6\tan^2 x + \tan^4 x}$ (b) $\sin^3 x = \dfrac{1}{4}(3\sin x - \sin 3x)$

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = 12°$.

14. Define two variables: *alpha* $= 5\pi/8$, and *beta* $= \pi/8$. Using these variables, show that the following trigonometric identity is correct by calculating the values of the left and right sides of the equation.

$$\sin\alpha\cos\beta = \frac{1}{2}[\sin(\alpha - \beta) + \sin(\alpha + \beta)]$$

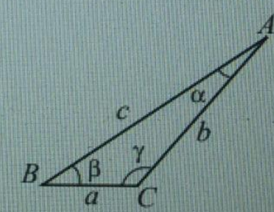
15. Given: $\int \cos^2(ax)dx = \frac{1}{2}x - \frac{\sin 2ax}{4a}$. Use MATLAB to calculate the following definite integral: $\int_{\frac{\pi}{9}}^{\frac{3\pi}{5}} \cos^2(0.5x)dx$.

16. In the triangle shown $a = 9$ cm, $b = 18$ cm, and $c = 25$ cm. Define a, b, and c as variables, and then:

(a) Calculate the angle α (in degrees) by substituting the variables in the Law of Cosines. (Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

(b) Calculate the angles β and γ (in degrees) using the Law of Sines.

(c) Check that the sum of the angles is $180°$.



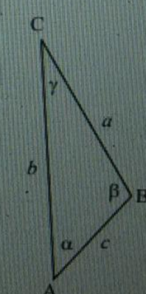
17. In the triangle shown $a = 5$ in., $b = 7$ in., and $\gamma = 25°$. Define a, b, and γ as variables, and then:

(a) Calculate the length of c by substituting the variables in the Law of Cosines. (Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

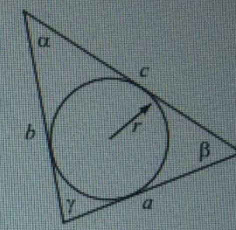
(b) Calculate the angles α and β (in degrees) using the Law of Sines.

(c) Verify the Law of Tangents by substituting the results from part (b) into the right and left sides of the equation.

(Law of Tangents: $\dfrac{a-b}{a+b} = \dfrac{\tan\left[\frac{1}{2}(\alpha - \beta)\right]}{\tan\left[\frac{1}{2}(\alpha + \beta)\right]}$)



18. For the triangle shown, $a = 200$ mm, $b = 250$ mm, and $c = 300$ mm. Define a, b, and c as variables, and then:



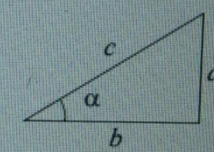
(*a*) Calculate the angle γ (in degrees) by substituting the variables in the Law of Cosines.

(Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

(*b*) Calculate the radius r of the circle inscribed in the triangle using the formula $r = \frac{1}{2}(a+b-c)\tan\left(\frac{1}{2}\gamma\right)$.

(*c*) Calculate the radius r of the circle inscribed in the triangle using the formula $r = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s}$, where $s = \frac{1}{2}(a+b+c)$.

19. In the right triangle shown $a = 16$ cm and $c = 50$ cm. Define a and c as variables, and then:



(*a*) Using the Pythagorean Theorem, calculate b by typing one line in the Command Window.

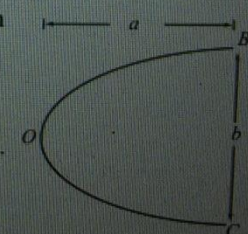
(*b*) Using b from part (*a*) and the `acosd` function, calculate the angle α in degrees by typing one line in the Command Window.

20. The distance d from a point (x_0, y_0, z_0) to a plane $Ax + By + Cz + D = 0$ is given by:

$$d = \frac{|Ax_0 + By_0 + Cz_0 + D|}{\sqrt{A^2 + B^2 + C^2}}$$

Determine the distance of the point $(8, 3, -10)$ from the plane $2x + 23y + 13z - 24 = 0$. First define the variables A, B, C, D, x_0, y_0, and z_0, and then calculate d. (Use the `abs` and `sqrt` functions.)

21. The arc length s of the parabolic segment BOC is given by:

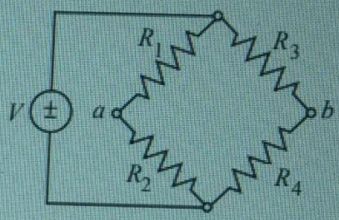


$$s = \frac{1}{2}\sqrt{b^2 + 16a^2} + \frac{b^2}{8a}\ln\left(\frac{4a + \sqrt{b^2 + 16a^2}}{b}\right)$$

Calculate the arc length of a parabola with $a = 12$ in. and $b = 8$ in.

22. Oranges are packed such that 52 are placed in each box. Determine how many boxes are needed to pack 4,000 oranges. Use MATLAB built-in function `ceil`.

23. The voltage difference V_{ab} between points a and b in the Wheatstone bridge circuit is:



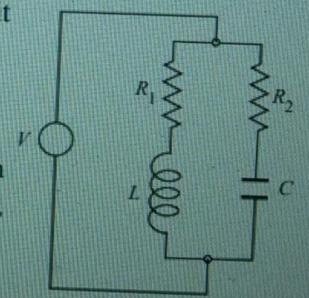
$$V_{ab} = V\left(\frac{R_2}{R_1+R_2} - \frac{R_4}{R_3+R_4}\right)$$

Calculate the voltage difference when $V = 12$ volts, $R_1 = 120$ ohms, $R_2 = 100$ ohms, $R_3 = 220$ ohms, and $R_4 = 120$ ohms.

24. The prices of an oak tree and a pine tree are \$54.95 and \$39.95, respectively. Assign the prices to variables named oak and pine, change the display format to `bank`, and calculate the following by typing one command:

(*a*) The total cost of 16 oak trees and 20 pine trees.
(*b*) The same as part (*a*), and add 6.25% sale tax.
(*c*) The same as part (*b*) and round the total cost to the nearest dollar.

25. The resonant frequency f (in Hz) for the circuit shown is given by:



$$f = \frac{1}{2\pi}\sqrt{LC\frac{R_1^2C-L}{R_2^2C-L}}$$

Calculate the resonant frequency when $L = 0.2$ henrys, $R_1 = 1500$ ohms, $R_2 = 1500$ ohms, and $C = 2 \times 10^{-6}$ farads.

26. The number of combinations $C_{n,r}$ of taking r objects out of n objects is given by:

$$C_{n,r} = \frac{n!}{r!(n-r)!}$$

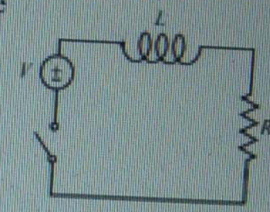
A deck of poker cards has 52 different cards. Determine how many different combinations are possible for selecting 5 cards from the deck. (Use the built-in function `factorial`.)

27. The formula for changing the base of a logarithm is:

$$\log_a N = \frac{\log_b N}{\log_b a}$$

(*a*) Use MATLAB's function `log(x)` to calculate $\log_4 0.085$.
(*b*) Use MATLAB's function `log10(x)` to calculate $\log_6 1500$.

28. The current I (in amps) t seconds after closing the switch in the circuit shown is:



$$I = \frac{V}{R}(1 - e^{-(R/L)t})$$

Given $V = 120$ volts, $R = 240$ ohms, and $L = 0.5$ henrys, calculate the current 0.003 seconds after the switch is closed.

29. Radioactive decay of carbon-14 is used for estimating the age of organic material. The decay is modeled with the exponential function $f(t) = f(0)e^{kt}$, where t is time, $f(0)$ is the amount of material at $t = 0$, $f(t)$ is the amount of material at time t, and k is a constant. Carbon-14 has a half-life of approximately 5,730 years. A sample of paper taken from the Dead Sea Scrolls shows that 78.8% of the initial ($t = 0$) carbon-14 is present. Determine the estimated age of the scrolls. Solve the problem by writing a program in a script file. The program first determines the constant k, then calculates t for $f(t) = 0.788f(0)$, and finally rounds the answer to the nearest year.

30. Fractions can be added by using the smallest common denominator. For example, the smallest common denominator of 1/4 and 1/10 is 20. Use the MATLAB Help Window to find a MATLAB built-in function that determines the least common multiple of two numbers. Then use the function to show that the least common multiple of:
(*a*) 6 and 26 is 78.
(*b*) 6 and 34 is 102.

31. The Moment Magnitude Scale (MMS), denoted M_W, which is used to measure the size of an earthquake, is given by:

$$M_W = \frac{2}{3}\log_{10} M_0 - 10.7$$

where M_0 is the magnitude of the seismic moment in dyne-cm (measure of the energy released during an earthquake). Determine how many times more energy was released from the earthquake in Sumatra, Indonesia ($M_W = 8.5$), in 2007 than the earthquake in San Francisco, California ($M_W = 7.9$), in 1906.

32. According to special relativity, a rod of length L moving at velocity v will shorten by an amount δ, given by:

$$\delta = L\left(1 - \sqrt{1 - \frac{v^2}{c^2}}\right)$$

where c is the speed of light (about 300×10^6 m/s). Calculate how much a rod 2 meter long will contract when traveling at 5,000 m/s.

33. The monthly payment M of a loan amount P for y years and interest rate r can be calculated by the formula:

$$M = \frac{P(r/12)}{1-(1+r/12)^{-12y}}$$

(a) Calculate the monthly payment of a \$85,000 loan for 15 years and interest rate of 5.75% ($r = 0.0575$). Define the variables P, r, and y and use them to calculate M.

(b) Calculate the total amount needed for paying back the loan.

34. The balance B of a savings account after t years when a principal P is invested at an annual interest rate r and the interest is compounded yearly is given by $B = P(1+r)^t$. If the interest is compounded continuously, the balance is given by $B = Pe^{rt}$. An amount of \$40,000 is invested for 20 years in an account that pays 5.5% interest and the interest is compounded yearly. Use MATLAB to determine how many fewer days it will take to earn the same if the money is invested in an account where the interest is compounded continuously.

35. The temperature dependence of vapor pressure p can be estimated by the Anteing equation:

$$\ln(p) = A - \frac{B}{C+T}$$

where ln is the natural logarithm, p is in mm Hg, T is in kelvins, and A, B, and C are material constants. For toluene ($C_6H_5CH_3$) in the temperature range from 280 to 410 K the material constants are $A = 16.0137$, $B = 3096.52$, and $C = -53.67$. Calculate the vapor pressure of toluene at 315 and 405 K.

36. Sound level L_P in units of decibels (dB) is determined by:

$$L_P = 20\log_{10}\left(\frac{p}{p_0}\right)$$

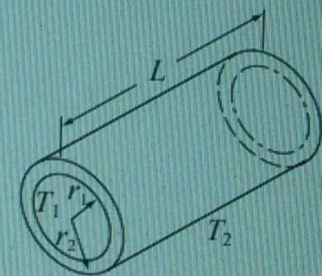
where p is the sound pressure of the sound, and $p_0 = 20 \times 10^{-6}$ Pa is a reference sound pressure (the sound pressure when $L_P = 0$ dB).

(a) The sound pressure of a passing car is 80×10^{-2} Pa. Determine its sound level in decibels.

(b) The sound level of a jet engine is 110 decibels. By how many times is the sound pressure of the jet engine larger (louder) than the sound of the passing car?

37. Use the Help Window to find a display format that displays the output as a ratio of integers. For example, the number 3.125 will be displayed as 25/8. Change the display to this format and execute the following operations:
(*a*) $5/8+16/6$ (*b*) $1/3-11/13+2.7^2$

38. The steady-state heat conduction q from a cylindrical solid wall is determined by:



$$q = 2\pi Lk\frac{T_1-T_2}{\ln\left(\frac{r_2}{r_1}\right)}$$

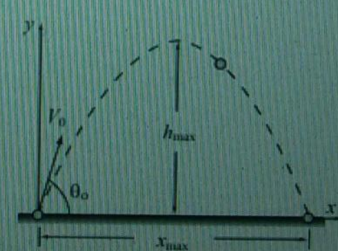
where k is the thermal conductivity. Calculate q for a copper tube (k = 401 Watts/°C/m) of length L = 300 cm with an outer radius of r_2 = 5 cm and an inner radius of r_1 = 3 cm. The external temperature is T_2 = 20°C and the internal temperature is T_1 = 100°C.

39. Stirling's approximation for large factorials is given by:

$$n! = \sqrt{2\pi n}\left(\frac{n}{e}\right)^n$$

Use the formula for calculating 20!. Compare the result with the true value obtained with MATLAB's built-in function `factorial` by calculating the error ($Error = (TrueVal-ApproxVal)/TrueVal$).

40. A projectile is launched at an angle θ and speed of V_0. The projectile's travel time t_{travel}, maximum travel distance x_{max}, and maximum height h_{max} are given by:



$$t_{travel} = 2\frac{V_0}{g}\sin\theta_0, \quad x_{max} = 2\frac{V_0^2}{g}\sin\theta_0\cos\theta_0,$$

$$h_{max} = 2\frac{V_0^2}{g}\sin^2\theta_0$$

Consider the case where V_0 = 600 ft/s and θ = 54°. Define V_0 and θ as MATLAB variables and calculate t_{travel}, x_{max}, and h_{max} (g = 32.2 ft/s^2).