Faculty Development Program me on
Soft Computing and Programming for Science and Engineering Research
September 15-20, 2018

Starting with MATLAB

Instructor: Dr. P. K. Kankar
Chairman, Placement Cell
Assistant Professor ME Discipline

PDPM Indian Institute of Information Technology,
Design and Manufacturing Jabalpur, Jabalpur, INDIA
Resources: web.iiitdmj.ac.in/~kankar/
Contact: kankar@iiitdmj.ac.in, pavankankar@gmail.com
http://www.iiitdmj.ac.in/pavan.php

Outline

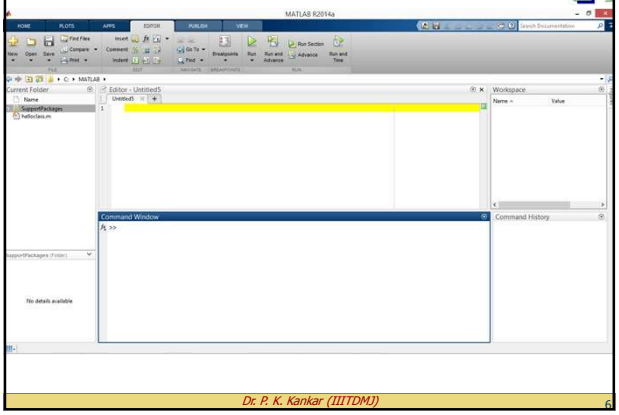
- Introduction
- MATLAB Windows
- Command Window Handling
- Basic Operations
- Using "Help/Demos/Toolboxes"
- Implementing MATLAB Operations
- References

Introduction

- MATLAB: Derived from Matrix Laboratory.
- It is basically a high level language which has many specialized toolboxes for making things easier for us.
- The fundamental unit of data in MATLAB is an Array.

➢ Why MATLAB?
- Numerical Computation
- Symbolic Algebra
- Scientific Visualization

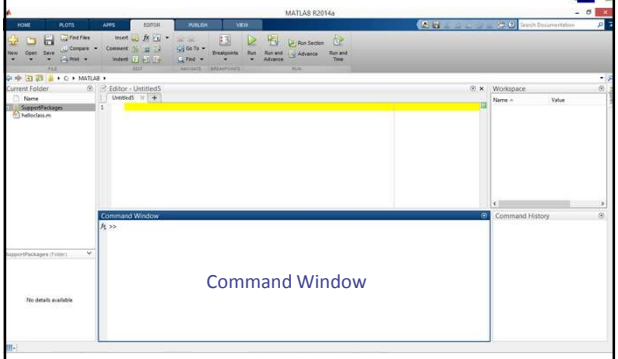
MATLAB Windows



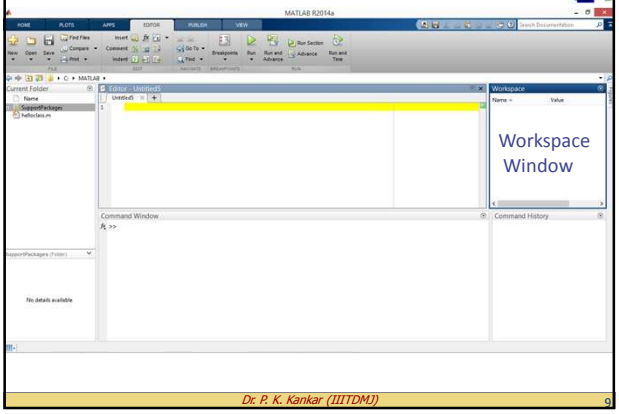
MATLAB Windows

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

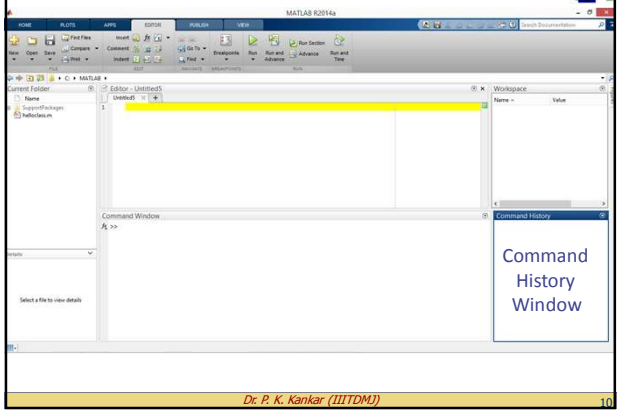
MATLAB Windows: Command Window



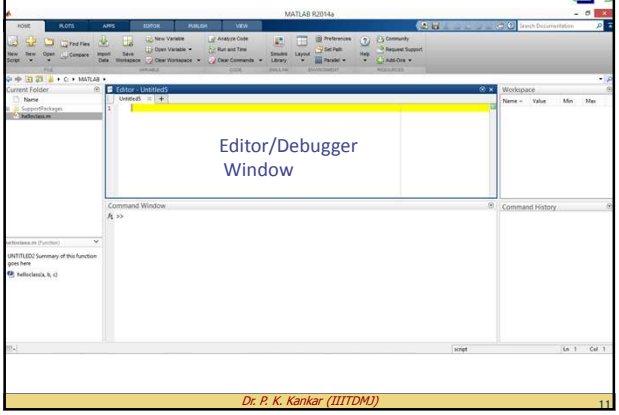
MATLAB Windows: Workspace Window



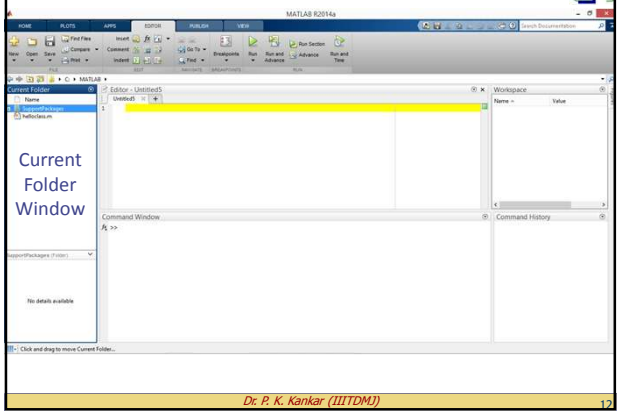
MATLAB Windows: Command History Window



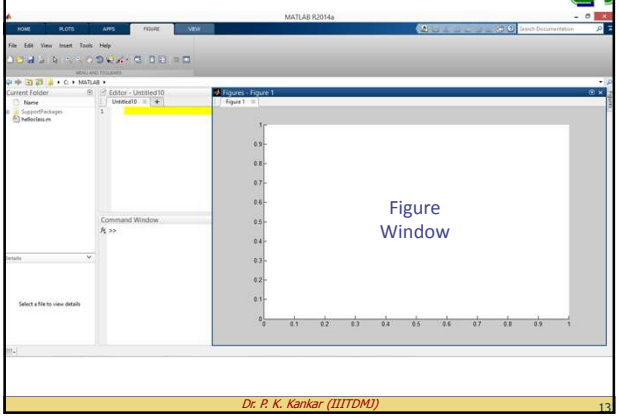
MATLAB Windows: Editor/Debugger Window



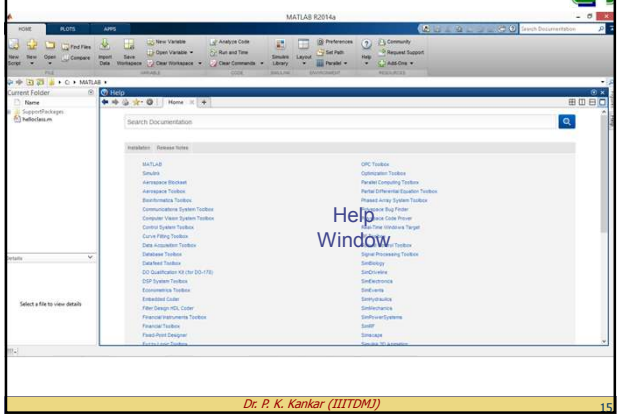
MATLAB Windows: Current Folder Window



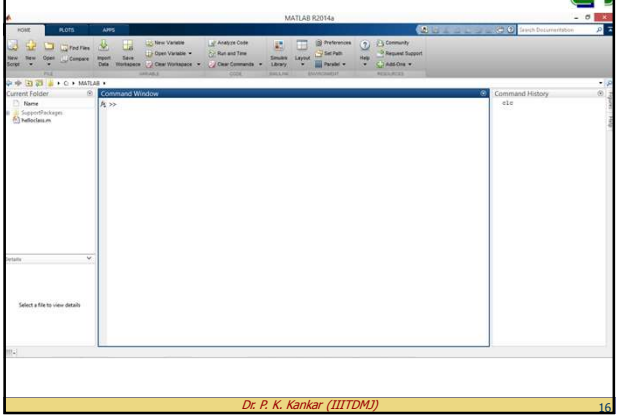
MATLAB Windows: Figure Window



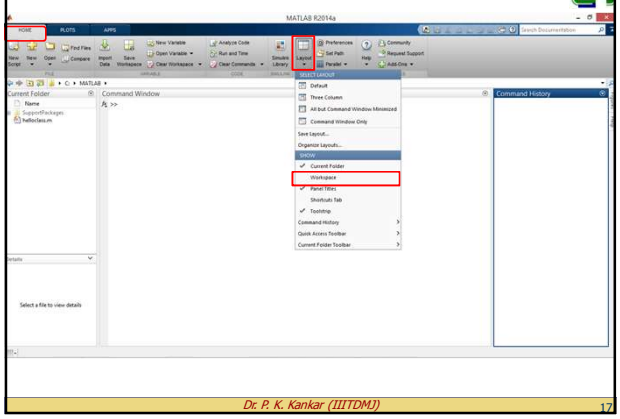
MATLAB Windows: Help Window



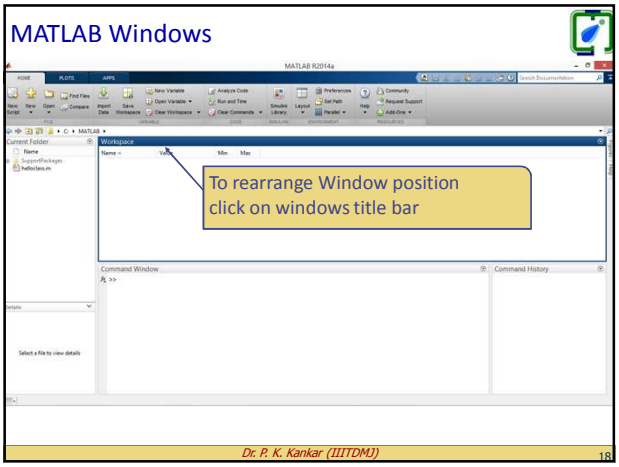
MATLAB Windows



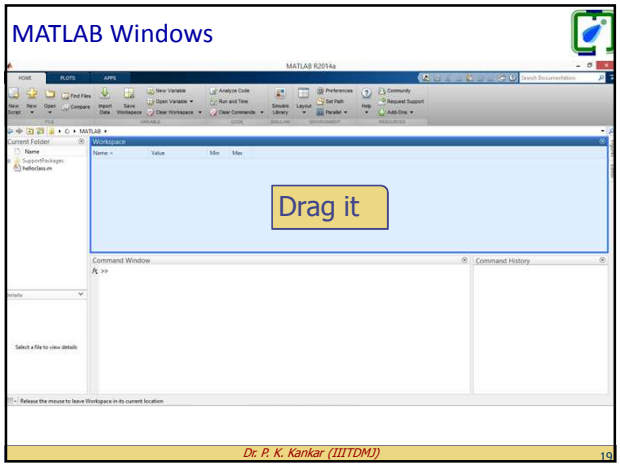
MATLAB Windows



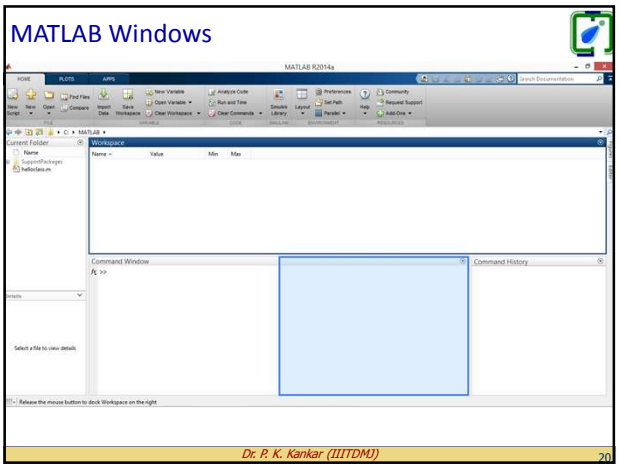
MATLAB Windows



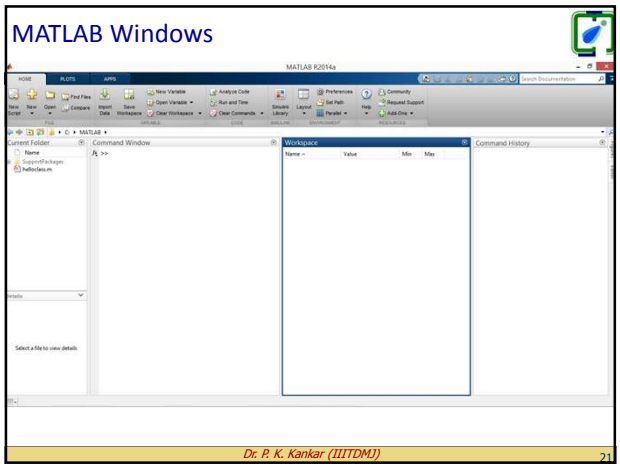
MATLAB Windows



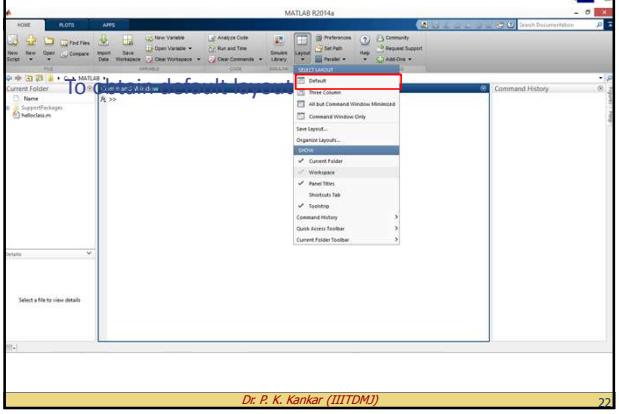
MATLAB Windows



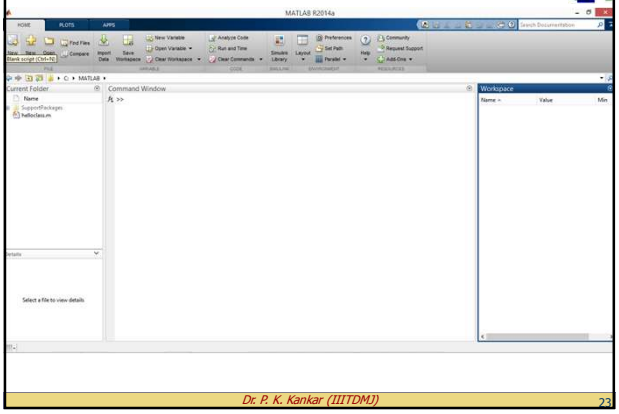
MATLAB Windows



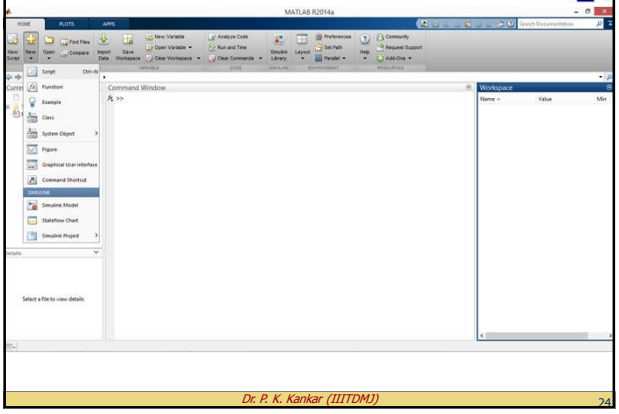
MATLAB Windows



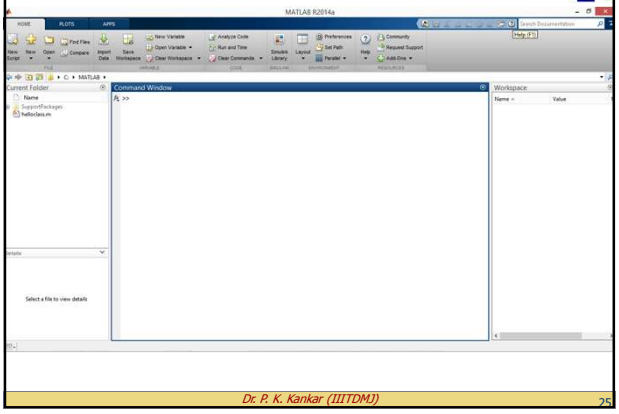
MATLAB Windows



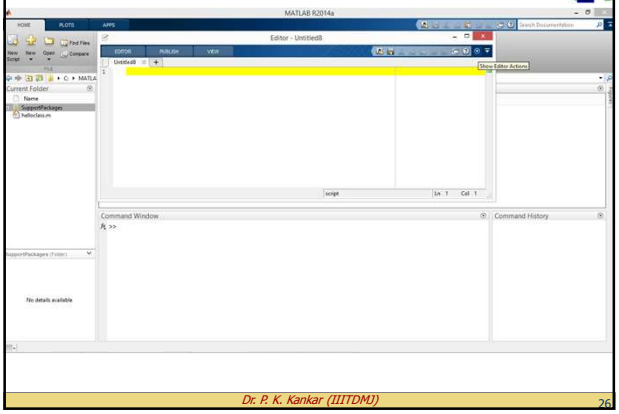
MATLAB Windows



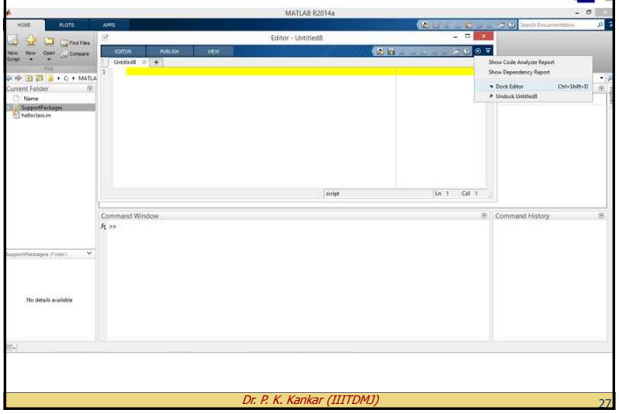
MATLAB Windows



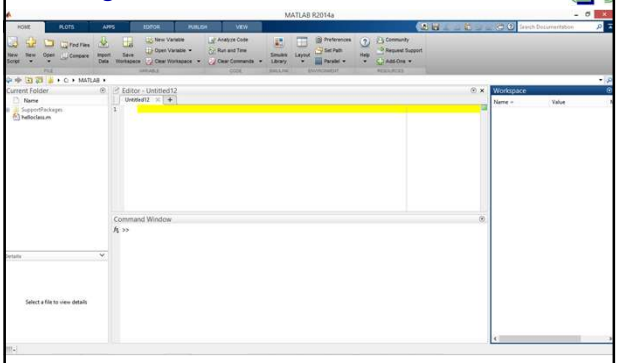
MATLAB Windows



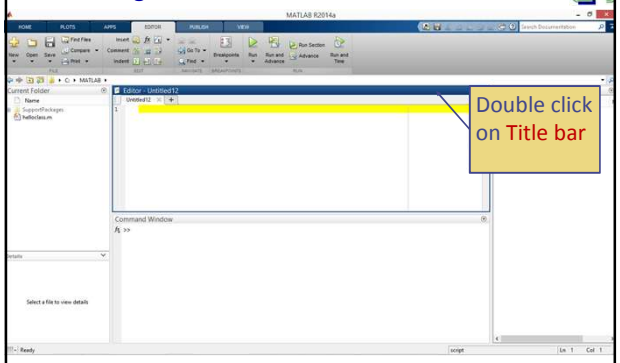
Docking Windows



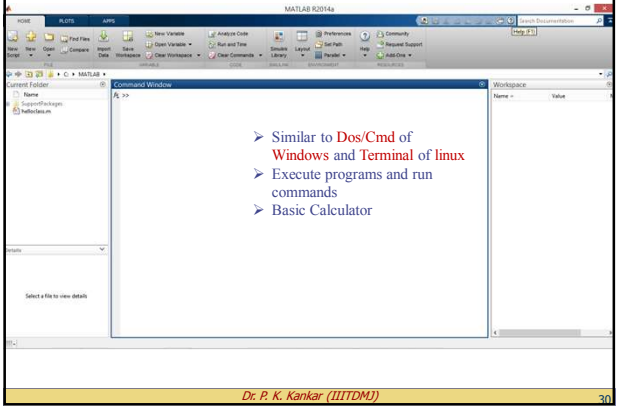
Docking Windows



Undocking Windows

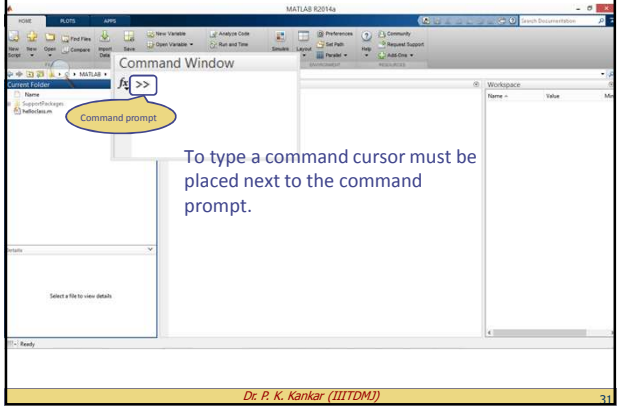


Command Window



- Similar to Dos/Cmd of Windows and Terminal of linux
- Execute programs and run commands
- Basic Calculator

Command Window



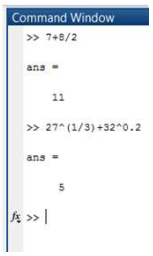
To type a command cursor must be placed next to the command prompt.

MATLAB as Calculator

Operation	Symbol	Example
Addition	+	8+2 = 10
Subtraction	-	8-2 = 6
Multiplication	*	8*2 = 16
Right Division	/	8/2 = 4
Left Division	\	8\2 = 2/8 = .025
Exponentiation	^	8^2 = 64

MATLAB as Calculator

- Simplest way to use MATLAB as a calculator. This is done in the command window by typing a mathematical expression and pressing Enter key.



MATLAB as Calculator

Order of Precedence

Precedence	Mathematical Operation
First	Parentheses. For nested parentheses, the innermost are executed first.
Second	Exponentiation
Third	Division and Multiplication
Fourth	Addition and Subtraction

MATLAB as 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
```


MATLAB as Calculator

```
>> 27^1/3+32^0.2
ans =11
>> 0.7854-(0.7854)^3/(1*2*3)+ (0.7854)^5/(1*2*3*4*5)...
+ (0.7854)^7/(1*2*3*4*5*6*7)
ans =0.7072
```


MATLAB as Calculator

Evaluate:

1. a. 124+12/4*30 b. 124+12/(4*30)
2. a. 124+12/4+3 b. 124*12/4+3
3. (124+12)/(4+3)
4. (14.8^2+6.5^2)/3.8^2+55

MATLAB as Calculator

Command	Description	Example
format short	Fixed point with 4 decimal digits for: 0.001 ≤ number ≤ 1000	>> 209/7 ans = 29.8571
format long	Fixed point with 15 decimal digits for: 0.001 ≤ number ≤ 100	>> 209/7 ans = 29.857142857142858
format short e	Scientific notation with 4 decimal digits	>> 209/7 ans = 2.9857e+01
format long e	Scientific notation with 15 decimal digits.	>> 209/7 ans = 2.985714285714286e+01

MATLAB as Calculator

Command	Description	Example
format short g	Best of 5 digit fixed or floating point	>> 209/7 ans = 29.857
format long g	Best of 15 digit fixed or floating point.	>> 209/7 ans = 29.8571428571429
format bank	Two decimal digits	>> 209/7 ans = 29.86

MATLAB as Calculator

Function	Description	Example
sqrt(x)	Square root	>> sqrt(81) ans = 9.00
exp(x)	Exponential	>> exp(5) ans = 148.41
abs(x)	Absolute value	>> abs(-24) ans = 24.00
log(x)	Natural logarithm, base e logarithm(ln)	>> log(1000) ans = 6.91
log10(x)	Base 10 algorithm	>> log10(1000) ans = 3.00
factorial(x)	The factorial function x(x must be a positive integer)	>> factorial(5) ans = 120.00

MATLAB as Calculator

Evaluate:

1. (14.8^2+6.5^2)/3.8^2+55/(sqrt(2)+14)
2. 16.5^2*(8.4-sqrt(70))/(4.3^2-17.3)
3. (5.2^3-6.4^2+3)/(1.6^8-2)+(13.3/5)^1.5
4. (-3.5)^3+exp(6)/log(524)+206^(1/3)

MATLAB as Calculator

Functions	Description	Example
sin(x)	Sine of angle x (x in radians)	>> sin(pi/6) ans = 0.50
cos(x)	Cosine of angle x (x in radians)	>> cos(pi/6) ans = 0.87
tan(x)	Tangent of angle x (x in radians)	>> tan(pi/6) ans = 0.58
cot(x)	Cotangent of angle x (x in radians)	>> cot(pi/6) ans = 1.73

MATLAB as Calculator

Functions	Description	Example
sind(x)	Sine of angle x (x in degrees)	>> sind(30) ans = 0.50
cosd(x)	Cosine of angle x (x in degrees)	>> cosd(30) ans = 0.87
tand(x)	Tangent of angle x (x in degrees)	>> tand(30) ans = 0.58
cotd(x)	Cotangent of angle x (x in degrees)	>> cotd(30) ans = 1.73

MATLAB as Calculator

Functions	Description	Example
asind(x)	Sine inv of angle x (output in degrees)	>> asind(0.50) ans = 30
acosd(x)	Cosine inv of angle x (output in degrees)	>> acosd(0.87) ans = 30
atand(x)	Tangent inv of angle x (output in degrees)	>> atand(0.58) ans = 30
acotd(x)	Cotangent inv of angle x (output in degrees)	>> acotd(1.73) ans = 30

MATLAB as Calculator

Functions	Description	Example
sinh(x)	Hyperbolic Sine	>> sinh(1) ans = 1.18
cosh(x)	Hyperbolic Cosine	>> cosh(1) ans = 1.54
tanh(x)	Hyperbolic Tangent	>> tanh(1) ans = 0.76
coth(x)	Hyperbolic Cotangent	>> coth(1) ans = 1.31

MATLAB as Calculator

Evaluate:

1. sin(7*pi/9)/cos(5*pi/7)^2+tan(5*pi/12)/7
2. sin(16.5)^2*(8.4-sqrt(70))/(4.3^2-17.3)
3. tan(pi/8)/cosd(14)^2-3*sind(80)/0.9^(1/3)+cosd(55)/(-3.5)^3+exp(6)/log(524)+206^(1/3)
4. log(abs(sin(16.5)^2*(8.4-sqrt(70))/(4.3^2-17.3)))

MATLAB as Calculator

Function	Description	Example
round (x)	Round to the nearest integer	>> round(17/5) ans = 3
fix(x)	Round towards zero	>> fix(15/6) ans = 2
ceil(x)	Round towards infinity	>> ceil(17/5) ans = 4
floor(x)	Round towards minus infinity	>> floor(17/5) ans = 3
rem(x,y)	Returns the remainder after x is divided by y.	>> rem(17,5) ans = 2

MATLAB as Calculator

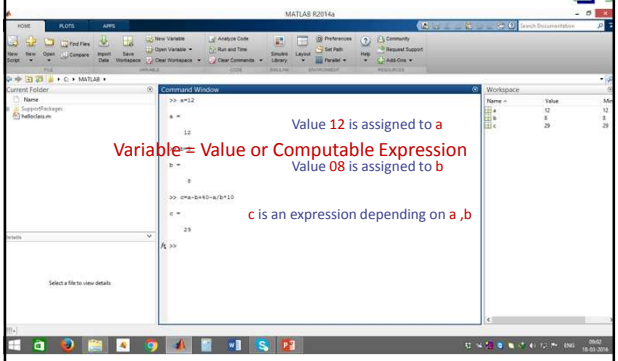
- No need for defining variable types. i.e.,

~~int a~~
~~float b~~

- All variables are created with double precision unless specified and they are matrices.

```
>>x=5
>>y=2.5
```


MATLAB as Calculator



Rules About Variable Names

- 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 e.g. AA, Aa, aA, & aa are four different variables.
- No spaces are allowed between characters (use underscore where a space is desired).
- Avoid using the name of a built-in function for a variable e.g. cos, sin, exp, sqrt)
- Once a function name is used to define a variable, the function cannot be used.

Predefined Keywords

Keywords	Description
ans	A variable that has the value of the last expression that was not assigned to a specific variable (see Tutorial 1-1). If the user does not assign the value of an expression to a variable, MATLAB automatically stores the result in ans.
pi	The number π.
eps	The smallest difference between two numbers. Equal to 2^(–52), which is approximately 2.2204e–016.
inf	Used for infinity.
i & j	Defined as sqrt(-1), which is: 0 + 1.0000i.
NaN	Stands for Not-a-Number. Used when MATLAB cannot determine a valid numeric value. Example: 0/0.

MATLAB as Calculator

Example:

A trigonometric identity is given by : $cos^2\frac{x}{2} = \frac{tanx+sinx}{2tanx}$

Verify that the identity is correct by calculating each side of the equation.

Substituting x = $\frac{\pi}{5}$

```
Command Window
>> x=pi/5
x =
    0.6283
>> LHS=cos(x/2)^2
LHS =
    0.9045
>> RHS=(tan(x)+sin(x))/(2*tan(x))
RHS =
    0.9045
```


MATLAB as Calculator

The semicolon (;) :

If semicolon is typed at the end of a command the output is not displayed in the command window. Useful when the result is obvious or known, or when the output is very large.

```
Command Window
>> x=pi/5;
>> LHS= cos(x/2)^2
LHS =
    0.9045
>> RHS=(tan(x)+ sin(x))/(2*tan(x))
RHS =
    0.9045
```


Basic Commands

Command	Outcome
clc	Clears Command Window
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
exit or quit	Stop MATLAB and exit
help	List topics on which help is available
help topic	Provide help on topic

Basic Notes about Command Window

1. Once a command is typed and Enter is pressed, the command is executed.
2. Several commands can be typed in the same line by typing a comma between the command. e.g. >> 2+5,3+6,5+4
3. It is not possible to make any correction and re-execute the command in command window.
4. Previously typed command can be recalled to command prompt with up arrow key ↑
5. 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 Enter key.

```
>> 5+3+...
3+4
ans =
    15
```


Problem on Heat transfer

Q.) An object with an initial temperature of T_o that is placed at time t =0 inside a chamber that has a constant temperature of T_s ,will experience a temperature change according to the equation:

$$T = Ts + (T_o - Ts)e^{-kt}$$

Where T is the temperature of the object at time t, and k is a constant. A soda can at temperature of 120 °F (was 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. calculate the temperature using one MATLAB command.

Problem on Heat transfer

```
Command Window
>> Ts = 38; To=120; k=0.45; t=3;
>> T=round(Ts + (To-Ts)*exp(-k*t))
T =
    59
```

Round to the nearest integer

Command Window Limitations

- So far all the commands were typed in the Command Window and were executed
- Series of commands will be executed specially if they are related to each other, which is not convenient and may be difficult to execute.
- If a change or a correction is needed in a command that was previously executed and the results of this command are used in commands that follow, all the commands have to be entered and executed again.

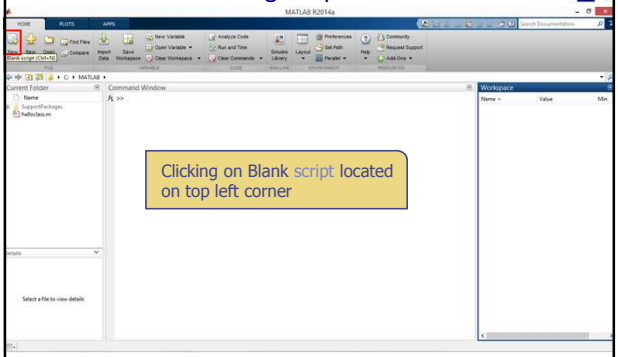
Scripts and functions

- A script file is a sequence of MATLAB commands, also called as program.
- When a script file runs (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.

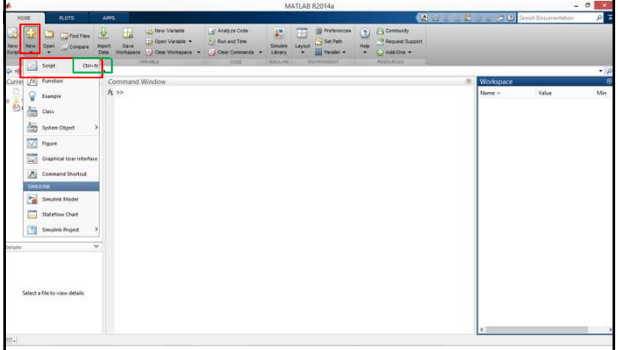
Creating Scripts

- Scripts are written in editor Window
- Scripts are created by three methods

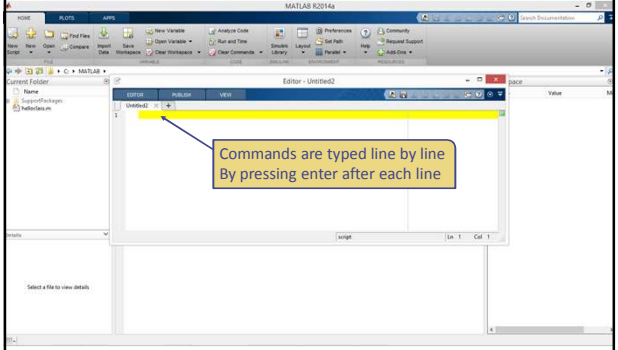
Creating Scripts



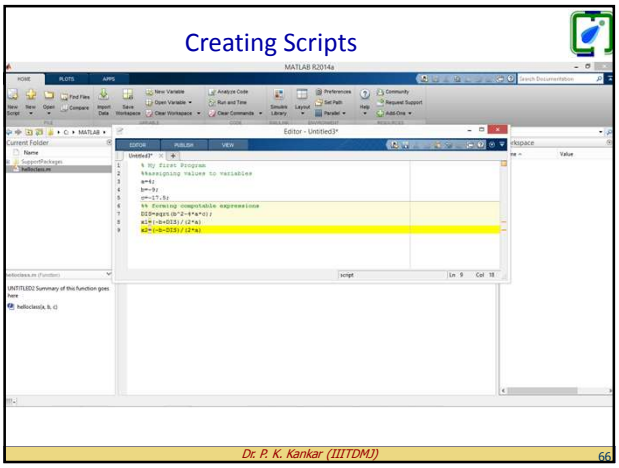
Creating Scripts



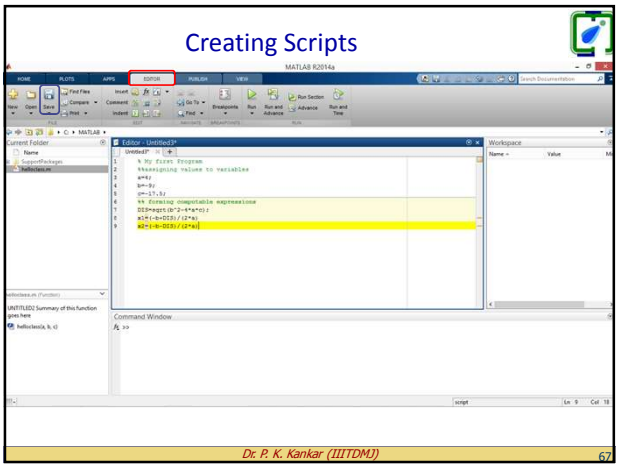
Creating Scripts



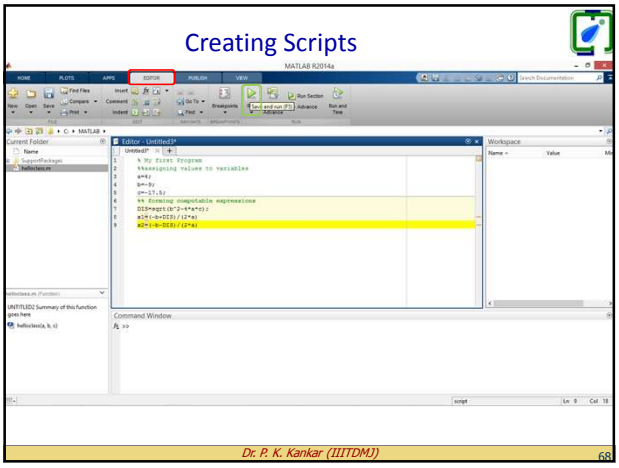
Creating Scripts



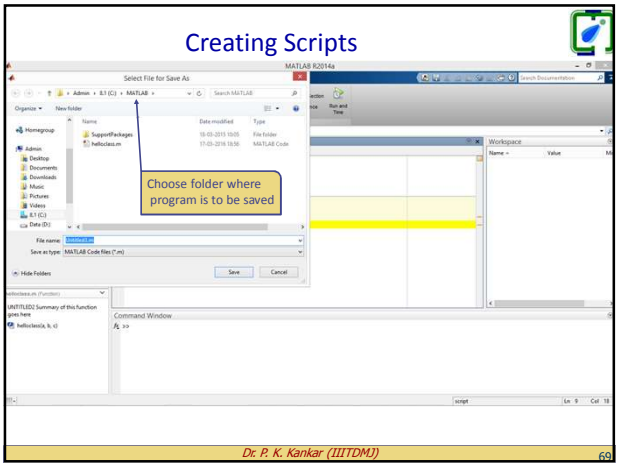
Creating Scripts



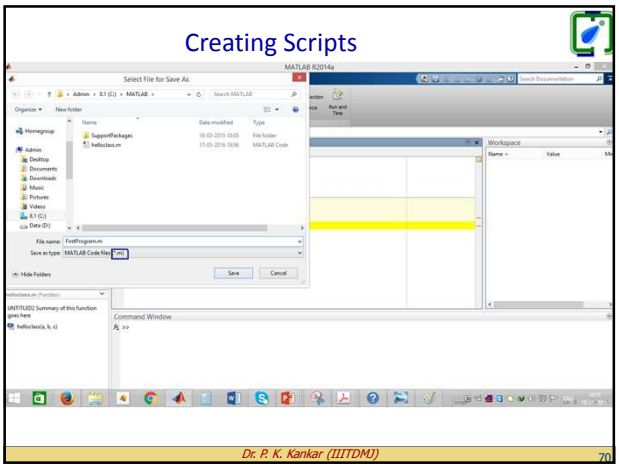
Creating Scripts



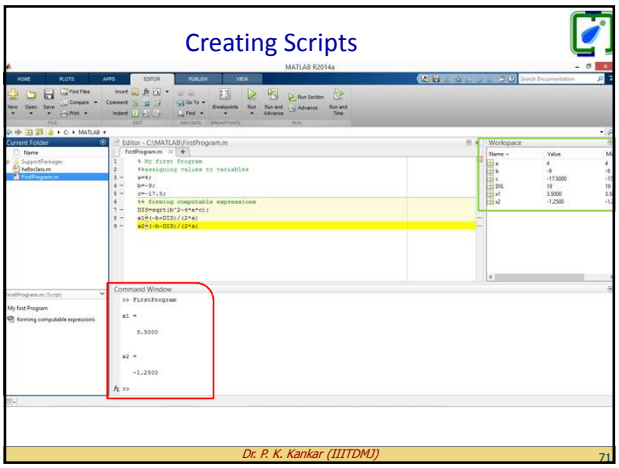
Creating Scripts



Creating Scripts



Creating Scripts



References:

- Amos Gilat, MATLAB An Introduction with Applications, Fourth Edition, JOHN WILEY & SONS, INC.
- Todd Young and Martin J. Mohlenkamp, Introduction to Numerical Methods and Matlab Programming for Engineers, May 5, 2015.
- http://in.mathworks.com/help/matlab/
- Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill Higher Education

THANK YOU