

# Assignment Project Exam Help

Application of Matlab for Finance

Week 1

<https://powcoder.com>

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## Today's Class

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- ▶ Outline of the Course
- ▶ Matlab Basics
- ▶ Matrices and Matrix Operation
- ▶ Indexing and Colon Operator
- ▶ Examples

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## What is Matlab?

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- ▶ A scientific programming Language: MATrix LABoratory
- ▶ A very fancy calculator
- ▶ A tool for econometrics and finance
- ▶ A tool for numerical methods, probability, and statistics
- ▶ A tool to produce graphics and plots

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## Outline of Course

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- ▶ Lecture 1: Variables, Matrices, Indexing and Operations
- ▶ Lecture 2: Logical Operators, Flow Control, User Defined Functions
- ▶ Lecture 3: Data Reading/Writing, Graphics with MATLAB
- ▶ Lecture 4: Portfolio Optimization
- ▶ Lecture 5: Trading Strategy
- ▶ Lecture 6: Simulation and Option Pricing
- ▶ Lecture 7: Regression Analysis
- ▶ Lecture 8: Revision
- ▶ Lecture 9: In-class Test

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## Teaching materials

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- ▶ Course materials are available on the HUB and consist of
  - ▶ Lecture slides
  - ▶ Example question solutions in m-file format

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- ▶ Each class consists of interactive sessions: a mix of the course leader demonstrating and the class students implementing example code.

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- ▶ Examination:
  - ▶ Coursework/Assignment (50%) - **comment on your code-file**
  - ▶ Individual Coursework / In class test in Lecture 9 (50%)

## Administrative Details

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### ► Class Materials

- Create a directory H://MyMATLAB in your H: drive
- For each class, create a sub-folder Class1 (Class2 for next week, etc )
- Download the material from Hub: <https://imperialbusiness.school/>
- Save the files to the relevant folder: H://MyMATLAB//Class1 for today (...//Class2 for next week etc)

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- MATLAB Download for personal PC:  
<http://www.imperial.ac.uk/admin-services/ict/training-resources/resources-and-services/more-free-software-students/>

## MATLAB Layout

- ▶ Command Window

- ▶ Type commands and display no-graphic output

- ▶ A `>>` prompt shows the system is ready for input

- ▶ Current Directory (CD)

- ▶ The directory (folder) that MATLAB is currently working in

- ▶ Always change the CD to where your MATLAB files are located

- ▶ `cd('H:/MyMATLAB/Class1')` for today

- ▶ **Note:** Make sure the path name is exactly the folder name you created: if you name your folder as 'Class1' without space, `cd('H:/MyMATLAB/Class 1')` will give you an error message.

- ▶ Editor

- ▶ The window where you edit and save m-files

- ▶ m-files: the files that save scripts and functions that you've defined/created

- ▶ Workspace:

- ▶ Store all the variables that you currently created and defined

## Help File

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- ▶ Search Field: right up corner: "Search Documentation"
  - ▶ Type a keyword (e.g. skewness)
  - ▶ Definition, function usage instructions etc.

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- ▶ Command window: `help` followed by the name of the function
  - ▶ `help skewness`: on-screen text with usage instructions

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- ▶ In script help: highlight the function name and press F1



## Editor and Comments

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- ▶ 'New' — 'Script': create a standard m-file
- ▶ Save the .m file as 'MyClass1.m', and do the following:
  - ▶ Change the current dictionary to the folder you created in H: drive.
  - ▶ Define a 100 by 1 vector of ones named A using `ones(m,n)`.
    - ▶ `ones(m,n)`: m for how many rows, n for how many columns
  - ▶ Comment on your code.
    - ▶ `%` comments identifier
    - ▶ `%%`: split m-file into subsections
  - ▶ Execute your code (commands).
    - ▶ Type/copy your command in the command window;
    - ▶ Execution by selection: F9
    - ▶ Execution by blocks: F5
  - ▶ Put a semi-colon ; behind `B = ones(100,1)` and comment
    - ▶ End a command with a semi-colon (;) to suppress the output.
    - ▶ Semi-colon (;) helps separate multiple commands that in one line

## Script vs. Live Script

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- ▶ With a standard script .m file, the codes are executed in the command window.
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  - ▶ 'New' — 'Live Script': create a live-script .mlx (>2016 version)
    - ▶ Write, execute and test code in a single interactive environment
    - ▶ No longer need the command window with very easy codes execution
    - ▶ But cannot be used to create function (Class2 for more details)

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- ▶ Repeat the previous exercise with a live Script 'MyClass1.mlx'.

## Variables

- ▶ A variable stores the assigned value in memory so that your programs can read it, operate on it, and save it back to memory.

- ▶ Variable names:

- ▶ it must begin with a letter

- ▶ uppercase and lowercase are distinguished  $A \neq a$

- ▶ ensure the name is not already used as a function name: myskew vs. skewness

- ▶ All MATLAB variables are stored and used as matrices.

- ▶ Elements: numbers, characters, logical statements (1 or 0), etc.

- ▶ Scalar (1-by-1):  $A = 3$

- ▶ Vector (1-by-n) or (n-by-1):  $B = [1 \ 2] \quad C = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

- ▶ Matrix (m-by-n)  $D = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$  for a 2-by-2 matrix

## Create Variables

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- ▶ Create  
 $A = 3$ ,  $B = [1 \ 2]$ ,  $C = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ ,  $D = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ ,  $E = [0 \ 0 \ 0]$ ,  $F = \begin{bmatrix} 1 & 3 & 5 & 7 \\ 0 & 0.5 & 1 & 1.5 \end{bmatrix}$
- ▶  $A = 3$
- ▶  $[]$ : Used to create matrix, not used to clarify order of operations
- ▶ Row vector: separate elements within a row with either a comma (,) or a space  
 $B = [1, 2]$  %or  $B = [1 \ 2]$
- ▶ A matrix has multiple rows, separate the rows with semi-colons (;)  
 $C = [1; 2]$   
 $D = [1 \ 2; 3 \ 4]$  %or  $D = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
- ▶ Functions: ones, zeros, rand, eyes  
 $E = \text{zeros}(1, 3)$
- ▶ Colon (:) to create a sequence of number: [start number:step size:end number]  
 $F = [1:2:7; 0:0.5:1.5]$

## Matrix Indexing and the Colon Operator

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- ▶ To reference a particular element in a matrix/variable, specify its row and column number within the matrix with a parentheses:  $A(\text{row}, \text{column})$ 
  - ▶  $A(2,3)$  refers to the 2nd row, 3rd column element.
  - ▶ Colon ( $:$ ) selects the complete rows or columns:
    - ▶  $A(2,:)$  refers to the entire 2nd row elements of matrix A
    - ▶  $A(:,3)$  refers to the entire 3rd column elements of matrix A
  - ▶ Colon ( $:$ ) also selects a particular range of values in a matrix
    - ▶  $A(2,1:3)$  selects the 1st, 2nd and 3rd elements on the 2nd row
    - ▶  $A(1:2,3:4)$  selects elements in the 1st and 2nd rows, 3rd and 4th columns of A, which answer is a 2-by-2 matrix.
  - ▶ A middle number specifies the step size
    - ▶  $A(1,1:2:5)$  selects the 1st, 3rd and 5th elements of the 1st row of matrix A.

## Matrix Indexing and the Colon Operator

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▶  $A = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 6 & 7 & 8 & 9 & 10 \end{bmatrix}$  <https://powcoder.com>

▶ Find  $A(2, 3)$ ,  $A(2, 1 : 3)$ ,  $A(1 : 2, 3 : 4)$  and  $A(1, 1 : 2 : 5)$

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## Matrix Indexing and the Colon Operator

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$$A = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 6 & 7 & 8 & 9 & 10 \end{bmatrix}$$

- ▶  $A(2,3) = 8$
- ▶  $A(2, 1 : 3) = [6, 7, 8]$
- ▶  $A(1 : 2, 3 : 4) = \begin{bmatrix} 3 & 4 \\ 8 & 9 \end{bmatrix}$
- ▶  $A(1, 1 : 2 : 5) = [1, 3, 5]$

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## Matrix Indexing and Colon Operator: Define Variables

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- Define  $X = [1 \ 2]$  with matrix indexing and then redefine  $X = [1 \ 15]$

```
X(1,1) = 1
```

```
X(1,2) = 2
```

```
X(1,2) = 15 %change the value to X(1,2)
```

- Define  $Y = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

```
Y(1,:) = 1:1:5
```

```
Y(2,:) = 6
```

```
% Way 2: use functions
```

```
Y1 = 1:1:5
```

```
Y2 = zeros(1,5)
```

```
Y = [Y1;Y2]
```

```
% Way 3
```

```
Y = [1:1:5;zeros(1,5)]
```

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## Simple Matrix Operations

- ▶ Matrix Multiplication  $A*B$  requires inner matrix dimensions agree: column number of  $A$  = row number of  $B$
- ▶ Matrix Power  $A^b$  requires matrix  $A$  is a square matrix

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$A + B$  Addition  
 $A - B$  Subtraction

$A * B$  Multiplication

$A / B$  Division (scalars)  
 $A^b$  Power (to a scalar)

$A'$  Transpose

$()$  evaluation order

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## Element-by-Element Operations

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MATLAB supports element-by-element arithmetic operations between matrices.

- ▶ The **period character (.)** distinguishes these operations from the linear algebra matrix operations.
- ▶ **Element-by-element operations require matrices of equal sizes.**
- ▶ Since the two classes of operations (linear algebra and element-by-element) are the same for addition and subtraction, the character pairs  $+$  and  $-$  are not used.

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$A.*B$

Element-by-element Multiplication

$A./B$

Element-by-element Division

$A.^B$

Element-by-element Power

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$$a = [1 \ 2 \ 3 \ 4] \quad b = \begin{bmatrix} 4 \\ -3 \\ 2 \\ 4 \end{bmatrix} \quad c = \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$$

$$a \cdot b = 1 \cdot 4 + 2 \cdot (-3) + 3 \cdot 2 + 4 \cdot 4 = 20$$

$$b \cdot a = \begin{bmatrix} 4 \\ -3 \\ 2 \\ 4 \end{bmatrix} \cdot [1 \ 2 \ 3 \ 4] = \begin{bmatrix} 4 \cdot 1 & 4 \cdot 2 & 4 \cdot 3 & 4 \cdot 4 \\ -3 \cdot 1 & -3 \cdot 2 & -3 \cdot 3 & -3 \cdot 4 \\ 2 \cdot 1 & 2 \cdot 2 & 2 \cdot 3 & 2 \cdot 4 \\ 4 \cdot 1 & 4 \cdot 2 & 4 \cdot 3 & 4 \cdot 4 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & 8 & 12 & 16 \\ -3 & -6 & -9 & -12 \\ 2 & 4 & 6 & 8 \\ 4 & 8 & 12 & 16 \end{bmatrix}$$

- ▶  $b' = [4 \ -3 \ 2 \ 4]$
- ▶  $a \cdot b'$ :  $(1 \times 4) \cdot (1 \times 4)$ : error message as  $1 \neq 1$
- ▶  $a \cdot b' = [1 \ 2 \ 3 \ 4] \cdot [4 \ -3 \ 2 \ 4] = [1 \cdot 4, 2 \cdot -3, 3 \cdot 2, 4 \cdot 4] = [4, -6, 6, 16]$
- ▶  $c^2 = \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix} \cdot \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 7 & 18 \\ 6 & 19 \end{bmatrix}$
- ▶  $c.^2 = \begin{bmatrix} 2^2 & 3^2 \\ 1^2 & 4^2 \end{bmatrix} = \begin{bmatrix} 4 & 9 \\ 1 & 16 \end{bmatrix}$

## Exercises

- ▶ (1) Create  $a = [1 \ 2 \ 3 \ 4]$   $b = \begin{bmatrix} 4 \\ -3 \\ 2 \\ 4 \end{bmatrix}$   $c = \begin{bmatrix} 2 & 3 \\ 4 \end{bmatrix}$ .

- ▶ (2) Calculate and create

▶  $X1 = a * b$

▶  $X2 = b * a$

▶  $X3 = X1 * X2$  (Do the two matrix dimensions match?)

▶  $M = [X3, b]$ : extend matrix  $X3$  with a 5th column whose value is  $b$

▶  $X4 = c^2$

▶ Try  $a * b'$  (What the message says, why?)

- ▶ (3) Element-by-element operation:  $a .* b$ ,  $a * b$ ,  $a ./ b$ ,  $a ./ c$ .

- ▶ (4) Using the colon(:) operator, create a 1-by-25 row vector:

▶ Var1 contains the integers 1 to 25.

▶ Var2 contains the first element 0 and the last element 12, with a step size of 0.5.

- ▶ (5) Use the Help Field to find out what the commands `clear a`, `clear all` do.

## Predefined Functions

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- ▶ MATLAB provides a large number of standard elementary mathematical functions, including `abs(.)`, `sqrt(.)`, `exp(.)`, and `sin(.)`, `cos(.)`, which require inputs.
- ▶ Basic graphic function `plot(.)` is used to visualize the evolution of the vector A. Also use `area(.)` to have a different type of graph.
- ▶ The best way to find a particular function along with its usage instructions is via the MATLAB help file.

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## Exercises 2

- ▶ (6) Using the functions `zeros(.)`, `ones(.)` and `eye(.)` to create

- ▶ a 3-by-4 matrix B full of ones
- ▶ a 4-by-4 matrix C full of 5
- ▶ a 5-by-5 identity matrix I

$$V = \begin{bmatrix} 1 & 5 & 5 & 5 \\ 5 & 1 & 5 & 1 \\ 5 & 5 & 1 & 5 \\ 5 & 5 & 5 & 1 \end{bmatrix}$$

- ▶ (7) Find the size and length of matrix B above

- ▶ `size(.)` returns the dimension size of a matrix (row number, col number)
  - ▶ Adding an dimension indicator as the second input:
    - ▶ `size(B,1)` returns the number of rows of matrix B=3
    - ▶ `size(B,2)` returns the number of columns of matrix B = 4
- ▶ `length(.)` returns the maximum dimension between the row number and col number of a matrix .

## Exercises 2

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- ▶ (8) Find the value of  $\sin(\pi/2)$ ,  $\cos(\pi)$ ,  $\exp(2)$ ,  $\abs{(-5)}$  and  $\sqrt{122}$

- ▶ (9) Create a vector  $A$  with values  $\begin{bmatrix} 1 & 3 & 5 & 4 & 7 & 3 \\ 1 & 4 & 3 & 2 & 1 & 9 \end{bmatrix}$  and find

- ▶ `mean(A)`, `mean(A,2)`

- ▶ `sum(A)`, `sum(A,2)`, `cumsum(A)`, `cumsum(A,2)`

- ▶ `prod(A)`, `prod(A,2)`, `cumprod(A)`, `cumprod(A,2)`

- ▶ (10) Create  $B$  equals to the second row of  $A$ , and make graphs

- ▶ `line plot plot(.)`

- ▶ `area figure area(.)`

- ▶ `bar figure bar(.)`

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