

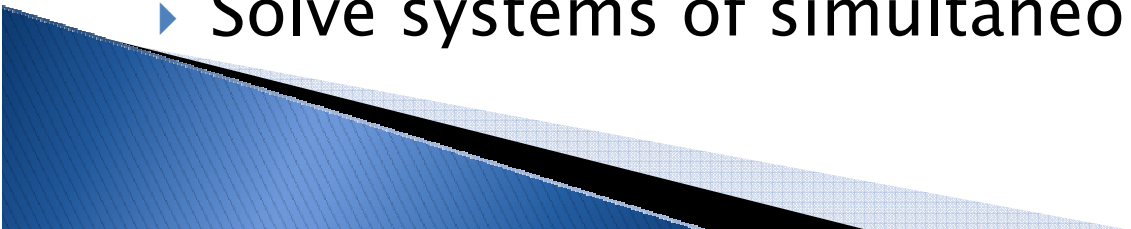
# CGN 2420

# Matrix Operations in Excel

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Department of Civil and Environmental Engineering  
Florida International University



# Objectives

- ▶ Learn how to define and name arrays.
  - ▶ Learn how to carry out standard matrix math:
    - Multiplying matrices by scalar values.
    - Matrix addition.
    - Matrix multiplication.
    - Transposing matrices.
    - Inverting a matrix.
  - ▶ Find the determinant of a matrix.
  - ▶ Solve systems of simultaneous linear equations.
- 

# Defining and Naming Arrays

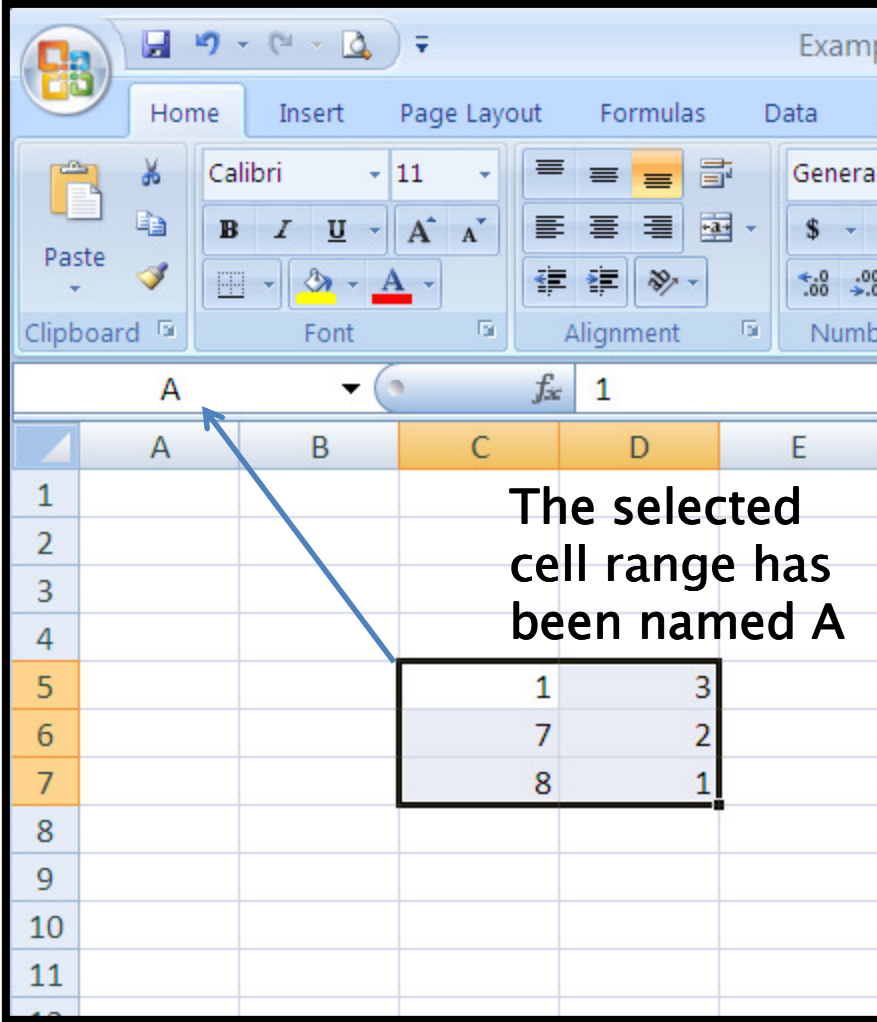
An array is defined by filling a range of cells with the contents of the array.

- ▶ Naming a range of cells allows you to use the name in place of the cell range.
- ▶ To give a name to the range of cells that hold an array:
  - Select the cells containing the array.
  - Enter the desired name in the name box at the left side of the formula bar.
  - Alternatively, a selected range can be assigned a name by using the ribbon options:



Formulas/Defined Names/Define Name

# Defining and Naming Arrays (Cont.)

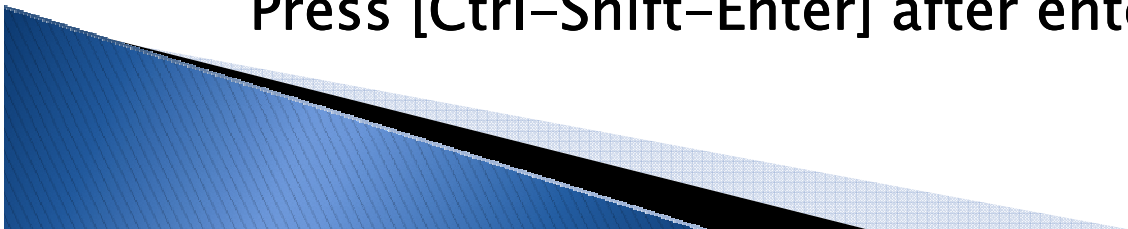


The screenshot shows the Microsoft Excel interface. The ribbon is set to 'Home', and the 'Font' group is active. The 'Clipboard' group shows 'Paste'. The 'Font' group shows 'Calibri' font and '11' size. The 'Alignment' group shows 'General' alignment. The 'Number' group shows '\$' as the currency symbol. The active cell is A1. The formula bar shows '1'. The grid shows columns A through E and rows 1 through 11. A blue arrow points from the text 'The selected cell range has been named A' to the cell A1. A black-bordered box highlights the range C5:D8, which contains the following data:

1	3
7	2
8	1

# Matrix Addition

- ▶ The two matrices to be added must be the same size.
- ▶ Matrices can be added using basic cell arithmetic or array math operation.
- ▶ Matrix addition using array math:
  - Name the cell ranges containing the arrays that will be added.
  - Select a cell range with same dimensions as parent matrices.
  - Then enter the formula = name matrix 1 + name matrix 2. Press [Ctrl-Shift-Enter] after entering formula.



# Matrix Addition (Cont.)

	A	B	C	D	E
1					
2	[A], 3x2		1	3	
3			7	2	
4			8	1	
5					
6	[B], 3x2		4	8	
7			6	1	
8			8	5	
9					
10	[A]+[B]				
11					
12					
13					

Select cell range

	A	B	C	D	E
1					
2	[A], 3x2		1	3	
3			7	2	
4			8	1	
5					
6	[B], 3x2		4	8	
7			6	1	
8			8	5	
9					
10	[A]+[B]		=A+B		
11					
12					
13					

Enter Formula

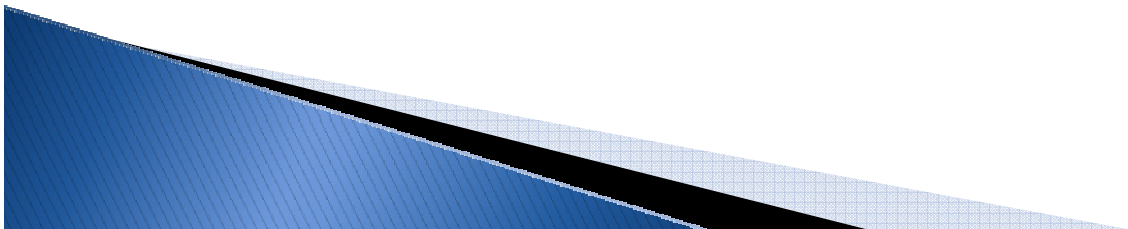
**Important!**  
Press [Ctrl-Shift-Enter]  
after entering formula

	A	B	C	D	E
1					
2	[A], 3x2		1	3	
3			7	2	
4			8	1	
5					
6	[B], 3x2		4	8	
7			6	1	
8			8	5	
9					
10	[A]+[B]		5	11	
11			13	3	
12			16	6	
13					

# Multiplying a Matrix by a Scalar

Multiplying a matrix by a scalar requires to multiply each element of the matrix by the scalar.

- ▶ Scalar multiplication using array math:
  - Enter and name the array that will be multiplied.
  - Indicate the size of the result matrix by selecting the desired cell range.
  - Enter the formula + [Ctrl-Shift-Enter]



# Multiplying a Matrix by a Scalar (Cont.)

Excel spreadsheet showing matrix A and scalar value. Matrix A is a 3x2 matrix with values 1, 3, 7, 2, 8, 1. The scalar value is 10. The cell range C8:D11 is selected.

	A	B	C	D
1				
2	[A], 3x2		1	3
3			7	2
4			8	1
5				
6	Scalar:	10		
7				
8	[A]x scalar			
9				
10				
11				

Select cell range

Enter Formula

Excel spreadsheet showing the formula being entered. The formula bar shows `=A*B6`. The cell range C8:D11 is selected.

	A	B	C	D
1				
2	[A], 3x2		1	3
3			7	2
4			8	1
5				
6	Scalar:	10		
7				
8	[A]x scalar		=A*B6	
9				
10				
11				

**Important!**  
Press [Ctrl-Shift-Enter]  
after entering formula

Excel spreadsheet showing the final result. The formula bar shows `=A*B6`. The cell range C8:D11 contains the result of the multiplication: 10, 30, 70, 20, 80, 10.

	A	B	C	D
1				
2	[A], 3x2		1	3
3			7	2
4			8	1
5				
6	Scalar:	10		
7				
8	[A]x scalar		10	30
9			70	20
10			80	10
11				



# Matrix Multiplication

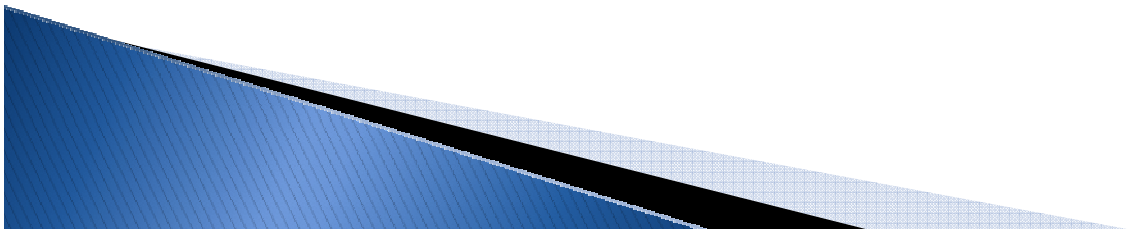
In order to multiply two matrices, the number of columns in the first matrix must equal the number of rows in the second matrix.

▶ Ex:

[A],  $3 \times 2$

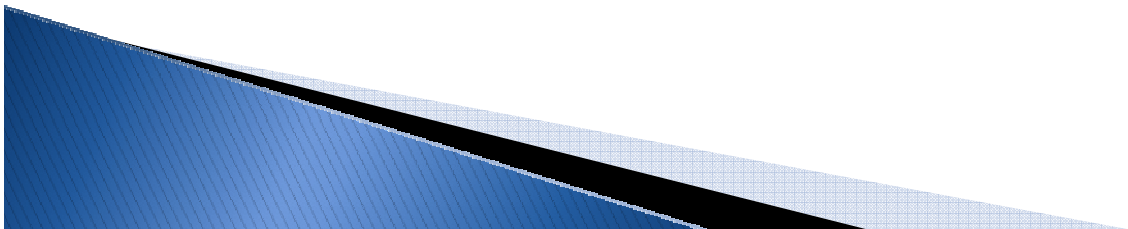
[e],  $2 \times 1$

To multiply these matrices, “inside” dimensions must match (2,2). The product matrix dimension will have “outside” dimensions (3x1).



# Matrix Multiplication (Cont.)

- ▶ Procedure:
  - Enter and name the arrays that will be multiplied.
  - Indicate the size of the result matrix by selecting the desired cell range.
  - Enter the following function:
    - `MMULT(first matrix, second matrix) + [Ctrl-Shift-Enter]`
  
- ▶ Note: Alternatively you can use the mouse to indicate the cell ranges instead of using arrays names.



# Matrix Multiplication (Cont.)

## Enter MMULT Function

	A	B	C	D	E	F
1						
2	[A], 3x2		1	3		
3			7	2		
4			8	1		
5						
6	[G], 2x4		1	2	3	4
7			5	6	7	8
8						
9	[A][G]					
10						
11						
12						

Select cell range  
(outside dimensions)

	A	B	C	D	E	F
1						
2	[A], 3x2		1	3		
3			7	2		
4			8	1		
5						
6	[G], 2x4		1	2	3	4
7			5	6	7	8
8						
9	[A][G]		=mmult(A,G)			
10						
11						
12						

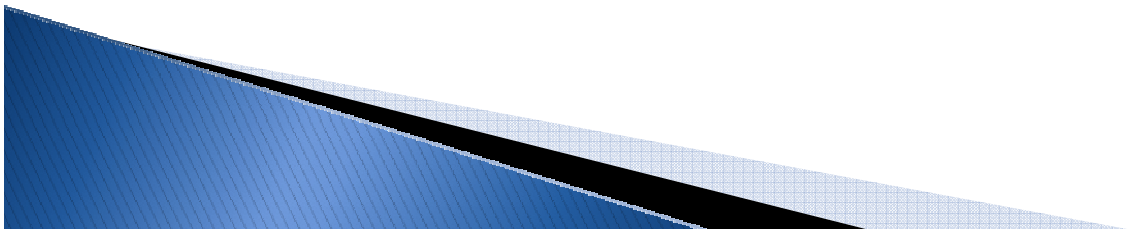
	A	B	C	D	E	F
1						
2	[A], 3x2		1	3		
3			7	2		
4			8	1		
5						
6	[G], 2x4		1	2	3	4
7			5	6	7	8
8						
9	[A][G]		16	20	24	28
10			17	26	35	44
11			13	22	31	40
12						

**Important!**  
Press [Ctrl-Shift-Enter]  
after entering formula

# Matrix Transpose

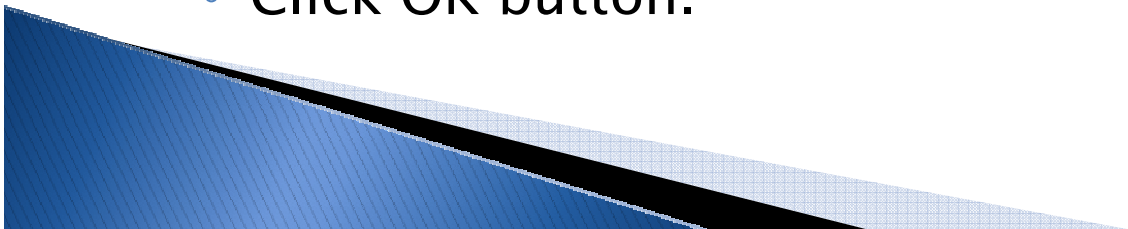
Any matrix can be transposed. To transpose a matrix, interchange the rows and columns.

- ▶ Excel features two methods to transpose a matrix:
  - By using PASTE SPECIAL (*does not automatically recalculates*)
  - By using the TRANSPOSE() array function (*automatically recalculates*)

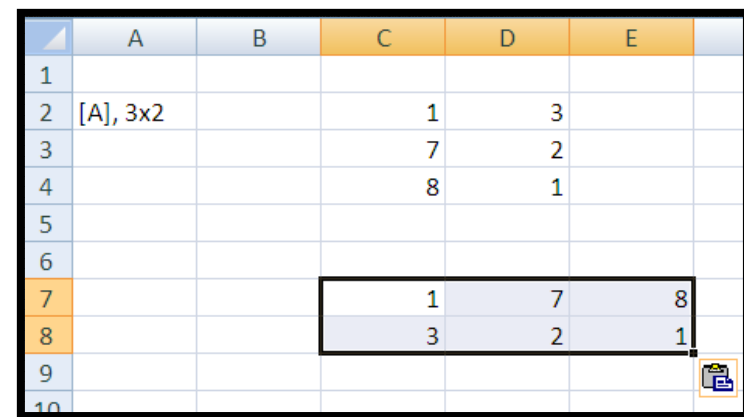
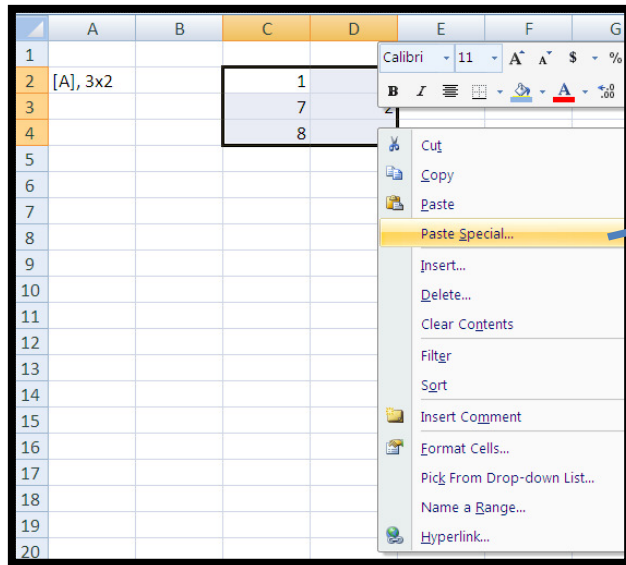


# Matrix Transpose (Cont.)

- ▶ Using PASTE SPECIAL:
  - Select and copy the array to be transposed.
  - Indicate the cell that will contain the top-left corner of the result matrix.
  - Open the PASTE SPECIAL dialog, using right click or ribbon options Home/Paste(menu)/Paste Special.
  - Select values in the paste selection, and check the transpose check near the bottom of the dialog.
  - Click OK button.

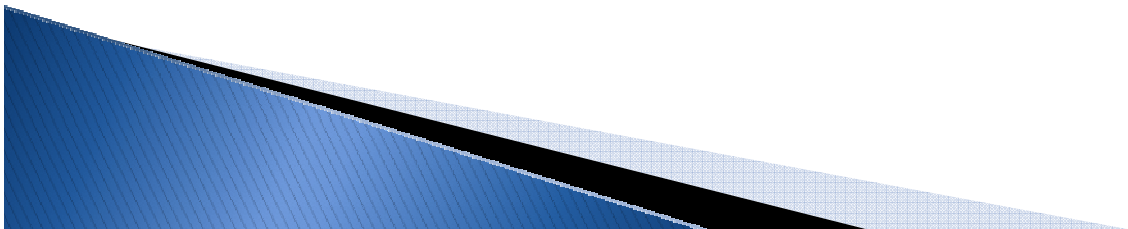


# Matrix Transpose (Cont.)



# Matrix Transpose (Cont.)

- ▶ Using TRANSPOSE array function:
  - Enter the original matrix.
  - Indicate where the result should be placed, showing the exact size of the transposed matrix.
  - Enter the TRANSPOSE() array function + [Ctrl-Shift-Enter].

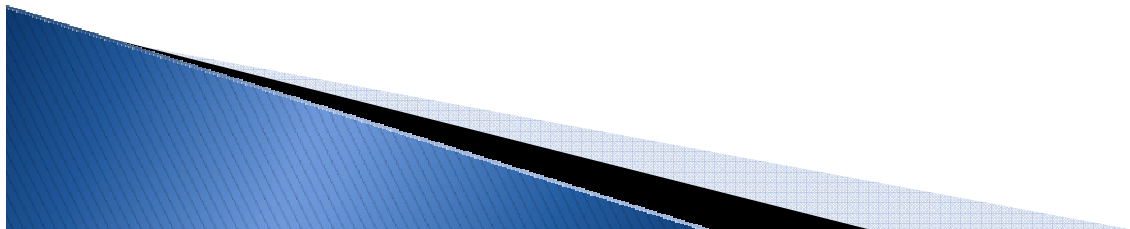


# Matrix Transpose (Cont.)

	A	B	C	D	E
1					
2	[A], 3x2		1	3	
3			7	2	
4			8	1	
5					
6					
7	Transpose		=transpose(A)		
8					
9					
10					



	A	B	C	D	E
1					
2	[A], 3x2		1	3	
3			7	2	
4			8	1	
5					
6					
7	Transpose		1	7	8
8			3	2	1
9					
10					



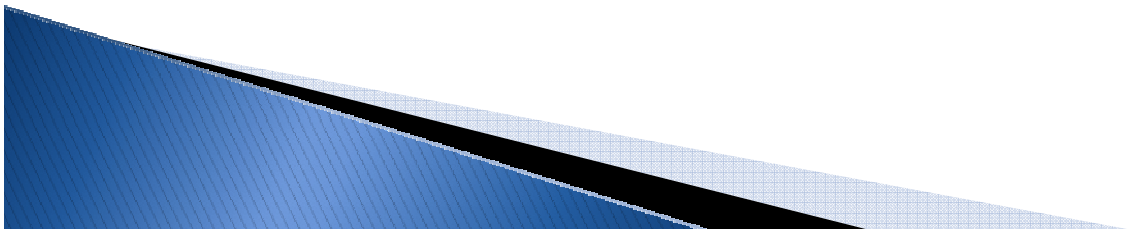


# Inverting a Matrix

Only square, non singular matrices can be inverted.

## Procedure:

- Enter the matrix to be inverted and name it if desired.
- Indicate where the result should be placed, showing the exact size (same as original matrix).
- Enter the MINVERSE() array function + [Ctrl-Shift-Enter].

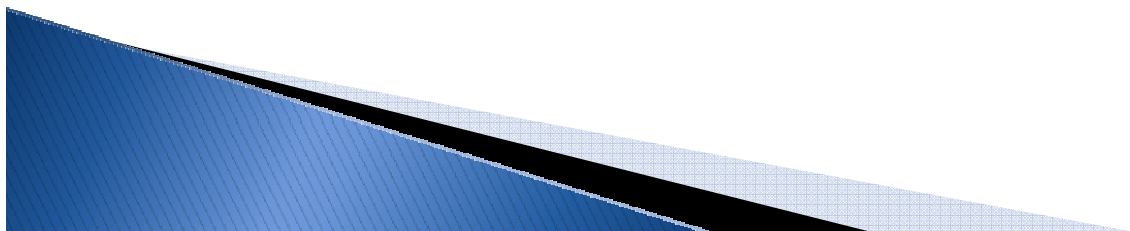


# Inverting a Matrix (Cont.)

	A	B	C	D	E
1					
2	[J],3x3		2	3	5
3			7	2	4
4			8	11	6
5					
6					
7	Inverse		inverse(J)		
8					
9					
10					



	A	B	C	D	E
1					
2	[J],3x3		2	3	5
3			7	2	4
4			8	11	6
5					
6					
7	Inverse		-0.15166	0.175355	0.009479
8			-0.04739	-0.1327	0.127962
9			0.2891	0.009479	-0.08057
10					

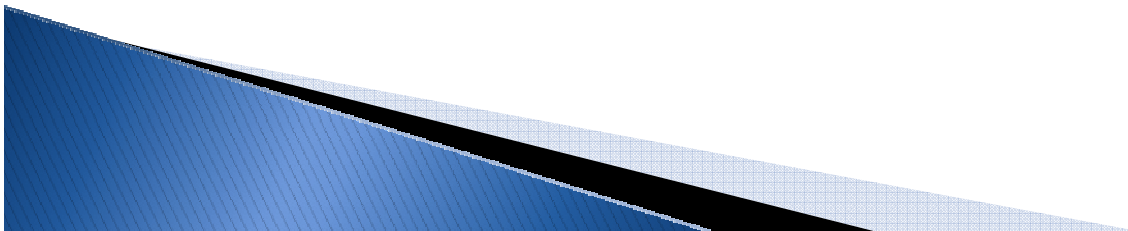


# Matrix Determinant

The determinant of a matrix is a single value .  
If determinant=0, matrix is singular and can not be inverted.

A matrix is singular if:

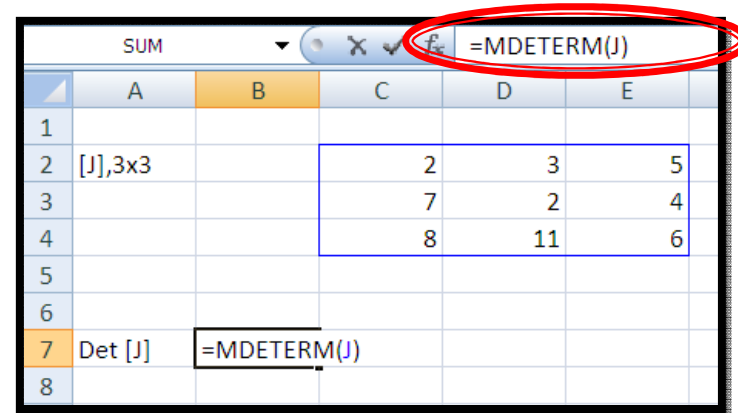
- ▶ Any row or column contains all zeros
- ▶ Any two rows or columns are identical
- ▶ Any row or column is a linear combinations of other rows or columns.



# Matrix Determinant (Cont.)

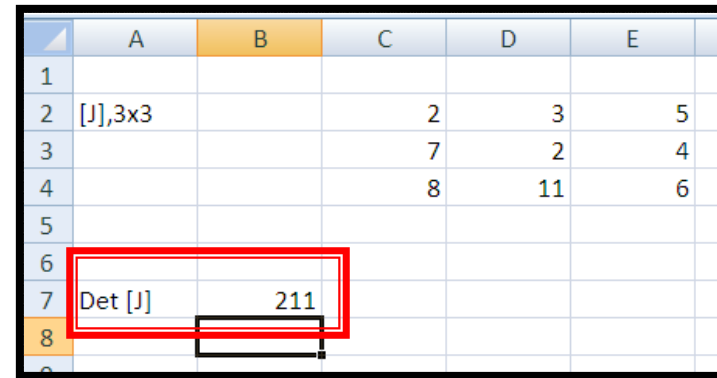
To calculate the determinant of a matrix:

MDETERM() function



The screenshot shows an Excel spreadsheet with a 3x3 matrix in cells C2:E4. The formula bar at the top shows the formula `=MDETERM(J)` being entered into cell B7. The formula bar is circled in red.

	A	B	C	D	E
1					
2	[J],3x3		2	3	5
3			7	2	4
4			8	11	6
5					
6					
7	Det [J]	=MDETERM(J)			
8					



The screenshot shows the same Excel spreadsheet as above, but now the result of the MDETERM function is displayed in cell B7. The value 211 is shown in the cell, and the cell containing the formula and its result is highlighted with a red box.

	A	B	C	D	E
1					
2	[J],3x3		2	3	5
3			7	2	4
4			8	11	6
5					
6					
7	Det [J]	211			
8					

# Solving Systems of Linear Equations

The process of solving simultaneous equations by using matrices works as follows:

1. Write equations in matrix form

$$\begin{aligned} 3x_1 + 2x_2 + 4x_3 &= 5 \\ 2x_1 + 5x_2 + 3x_3 &= 17 \\ 7x_1 + 2x_2 + 2x_3 &= 11 \end{aligned} \quad \Longrightarrow \quad [C][x] = [r]$$

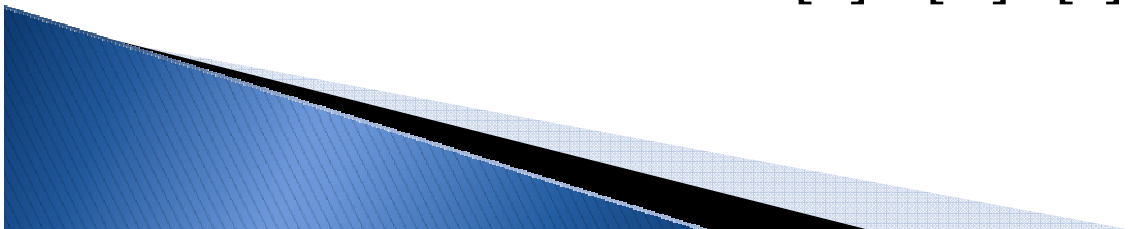
Where,

$$[C] = \begin{bmatrix} 3 & 2 & 4 \\ 2 & 5 & 3 \\ 7 & 2 & 2 \end{bmatrix} \quad [x] = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \quad [r] = \begin{bmatrix} 5 \\ 17 \\ 11 \end{bmatrix}$$

# Solving Systems of Linear Equations (Cont.)

2. Calculate the determinant of  $[C]$ 
  - If  $\text{Det}(C)=0$ , Solution undetermined
  - If  $\text{Det}(C)\neq 0$ , Solution can be determined
3. Invert the coefficient matrix  $[c]$
4. The solution to the system of equations is given by:

$$[x] = [C]^{-1} [r]$$



# Solving Systems of Linear Equations (Cont.)

	A	B	C	D	E	F	G	H
1								
2	[C]=Coeff		3	2	4		ro=	5
3			2	5	3			17
4			7	2	2			11
5								
6	Det( C )=	-78	≠0					
7								
8	inverse=		-0.05128	-0.05128	0.179487			
9			-0.21795	0.282051	0.012821			
10			0.397436	-0.10256	-0.14103			
11								
12	x=inverse*ro		0.846154					
13			3.846154					
14			-1.30769					
15								

