Spreadsheet Functions

CEE3804: Computer Applications for Civil and Environmental Engineers

1. Topics to be Covered

- **Understanding Excel's Error Codes**
- **Auditing Worksheet Formulas**
- **Using Excel's Built-in Functions**
  - **Lookup Functions**
  - **Financial Functions**
  - **Date/Time Functions**
  - **Financial Functions**

1. Function Basics
a. Operator Sequencing & Precedence

- **Formula results depend on the operator sequencing and precedence:**
  - $(2+6)/2 = 4$
  - $2+6/2 = 5$

- **Excel sequence in operations:**
  - left to right:
    - parentheses
    - exponential calculations
    - multiplication and division
    - addition and subtraction

1. Function Basics
b. Reference Operators

- **Excel uses three reference operators:**
  - the colon: cells between and including two cell references
    - e.g. A1:A5 refers to A1, A2, A3, A4, and A5
  - the comma: indicates the union of two ranges
    - e.g. A1:A3,B4,B6:B7 refers to A1, A2, A3, B4, B6, and B7
  - the space: indicates the intersection of two ranges
    - C1:C5 B3:G3 refers to cell C3

1. Function Basics
c. Concatenation of Strings

- **Concatenation of strings (&):**
  - Most real data contains *numbers* and *strings*
  - A string is a variable represented by letters of a combination of letters and numbers
  - Sometimes we like to combine strings to better understand the data
  - Concatenation is the process of combining strings
    - Example
    - A3: Nice
    - B3: Person
    - C3: A3&" "&B3 gives Nice Person

1. Function Basics
d. Concatenation of Strings

● **Example**

– **For the given table below, concatenate the strings shown in columns 1 and 2**

	A	B	C	D	E	F
	Department	Course Number	Grade		Concatenated Name	Numerical Grade
	CEE	3804	A-			
	CEE	3684	A-			
	CEE	4674	B			
	CEE	4604	C+			
	CEE	4524	B-			
	CEE	4044	B			
	ECON	2004	B-			
	MATH	2020	A-			
	MATH	3014	B			
	PHY	2011	C-			
	PHY	2012	B			
	EF	2014	C+			
	EF	2024	B-			

1. Function Basics
e. Concatenation of Strings

● **Example Solution (1)**

 – **Use the & function in Excel to combine strings in columns 1 and 2. Add a "_" separator**

A	B	C	D	E	F
Department	Course Number	Grade		Concatenated Name	Numerical Grade
CEE	3804	A-		=A2 &"_"& B2	
CEE	3684	A-			

 – **The result is shown below**

A	B	C	D	E	F
Department	Course Number	Grade		Concatenated Name	Numerical Grade
CEE	3804	A-		CEE_3804	
CEE	3684	A-		CEE_3684	
CEE	4674	B		CEE_4674	
CEE	4604	C+		CEE_4604	

1. Function Basics
f. Concatenation of Strings

- **Example Solution (2)**

  - Use the "concatenate" function in Excel to combine strings in columns 1 and 2. Add a "_" separator

	A	B	C	D	E	F	G	H
	Departme	Course Nu	Grade		Concatena	Numerical Grade		
	CEE	3804	A-		=CONCATENATE(A2,"_",B2)			
	CEE	3684	A-		C CONCATENATE(text1, [text2], [text3], [text4], ...)			

  - The result is shown below

	A	B	C	D	E	F
	Department	Course Number	Grade		Concatenated Name	Numerical Grade
	CEE	3804	A-		CEE _3804	
	CEE	3684	A-		CEE _3684	
	CEE	4674	B		CEE _4674	
	CEE	4604	C+		CEE _4604	

1. Function Basics
g. Table Lookup Functions

- **Table lookup functions are very useful to translate numeric to string data (or to do the reverse)**

- **Most data has "equivalencies" that we need to transform before making computations**

- **Example:**
  - **Converting grades from letter to numeric**
  - **Converting types of soil mechanic properties to "stiffness" or soil bearing equivalents**
  - **Converting vehicle weight into classes, etc.**

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1. Function Basics
h. Table Lookup Functions

- **Convert letter grades in column "C" to numeric using a table lookup function**

- **Calculate the QCA for all courses**

	A	B	C	D	E	F	G
	Departme	Course Nu	Grade	Numerical Grade		Equivalency Table	
	CEE	3804	A-			Letter	Value
	CEE	3684	A-			A	4.00
	CEE	4674	B			A-	3.66
	CEE	4604	C+			B+	3.37
	CEE	4524	B-			B	3.00
	CEE	4044	B			B-	2.67
	ECON	2004	B-			C+	2.34
	MATH	2020	A-			C	2.00

1. Function Basics
i. Table Lookup Functions

- **Convert letter grades in column "C" to numeric using a table lookup function**

- **Syntax:**

  - **VLOOKUP(Lookup value, table array, column index number, [range lookup])**

	A	B	C	D	E	F	G	H
	Departme	Course Nu	Grade	Numerical Grade		Equivalency Table		
	CEE	3804	A-	=VLOOKUP(C2,$F$2:$G$14,2)		Letter	Value	
	CEE	3684	A-	VLOOKUP(lookup_value, **table_array**, col_index_num, [range_lookup])				
	CEE	4674	B	3.00		A-	3.66	

1. Function Basics
c. Table Lookup Functions

- **Converted letter grades in column "C" to numeric using a table lookup function**
- **The solution is shown in column "D"**

	A	B	C	D	E	F	G
	Departme	Course Nu	Grade	Numerical Grade		Equivalency Table	
	CEE	3804	A-	3.66		Letter	Value
	CEE	3684	A-	3.66		A	4.00
	CEE	4674	B	3.00		A-	3.66
	CEE	4604	C+	2.34		B+	3.37
	CEE	4524	B-	2.67		B	3.00
	CEE	4044	B	3.00		B-	2.67
	ECON	2004	B-	2.67		C+	2.34
	MATH	2020	A-	3.66		C	2.00
	MATH	3014	B	3.00		C-	1.67
	PHY	2011	C-	1.67		D+	1.33
	PHY	2012	B	3.00		D	1.00
	EF	2014	C+	2.34		D-	0.67
	EF	2024	B-	2.67		F	0.00

1. Function Basics
c. Table Lookup Functions

- **Calculate the grade point average (QCA) at the bottom of the table**

- **Syntax:**
  - **Average(number1, [number2], …)**

PHY		2012	B	3.00		D	1.00
EF		2014	C+	2.34		D-	0.67
EF		2024	B-	2.67		F	0.00
		QCA	=AVERAGE(D2:D14)				
			AVERAGE(**number1**, [number2], …)				

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2. Editing Formulas
a. Overview

- ## To edit a formula:
  - ### press F2 or double-click on the cell
    - – dependent cell references are color coded to simplify editing
    - – can dependent cell references with the mouse
  - ### Can edit formula in the formula palette
    - – result will be updated as the formula is edited

2. Editing Formulas
b. Decoding Error Values - Overview

- **Excel errors begin with a "#" sign:**
  - #DIV/0
  - #N/A
  - #NAME?
  - #NUM!
  - #REF!
  - #VALUE!
  - #NULL!

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2. Editing Formulas
c. Decoding Error Values - #DIV/0 and #N/A

- **#DIV/0: divide-by-zero error**
  - indicates that the denominator evaluates to zero
    - Note: empty cells evaluate to zero

- **#N/A: Not available error**
  - varies depending on formula:
    - lookup function: no value available
    - data: data not yet available
      - charting features ignore #N/A
      - can include in a formula - NA():
        - Example: if(B7=0,NA(),B7)

2. Editing Formulas
d. Decoding Error Values - #NAME? and #NUM!

- **#NAME?: Name Error**
  - Excel cannot evaluate a defined name used in formula

- **#NUM!: Number Error**
  - Number cannot be interpreted:
    - too small or too big
    - does not exist

2. Editing Formulas
e. Decoding Error Values - #REF!, #VALUE! and #NULL!

- **#REF!: Reference Error**
  - **problem with cell reference**
    - deleting rows, columns, or cells

- **#VALUE!: Value Error**
  - **trying to calculate text or incorrect arguments for a worksheet function**

- **#NULL!: Null Error**
  - **No intersection for the ranges identified in the formula**

2. Editing Formulas
f. Identifying Errors

- **To isolate an error:**
  - **break the formula into parts**
    - **select a portion of the formula that calculates properly and press F9**
  - **press Escape or press the Cancel button when finished**

Microsoft Excel - EssentialFunctions

File Edit View Insert Format Tools Data Window Help

Arial 10

INDEX =IF(TotalExpenses>Budget,"Over Budget",Budget-TotalExpenses)
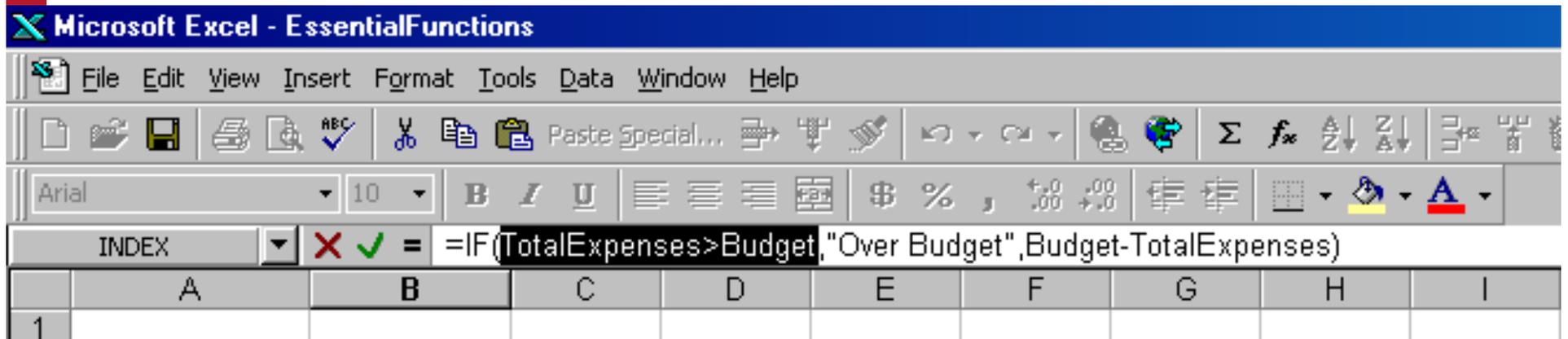
3. Auditing Workbooks
a. Circular References

- **A *circular reference* is a reference that refers back upon itself**
    - **Example:**
        - **A1 : = C1**
        - **B1 : = A1^2**
        - **C1 : = 5*B1**

- **To correct circular references use:**
    - **auditing tools**

- **Circular references are required for iterations**

3. Auditing Workbooks
b. Precedents and Dependents

- ## Dependent cells:
  - depend on another cell
  - Example: in cell A1 the formula = C1 means that
    - A1 is dependent on C1

- ## Precedent cells:
  - cells precede another cell
  - Example:
    - C1 is the precedent to cell A1
      - must determine the value of C1 before determining the value of A1

3. Auditing Workbooks
c. Determining Precedent and Dependent Cells

- **Excel's auditing tools trace:**
    - **dependent and precedent cells**

- **Activating auditing tools:**
    - **Tools/auditing or activate the "Circular Reference" toolbar**

- **Auditing scheme:**
    - **valid entries: blue**
    - **error values: red**
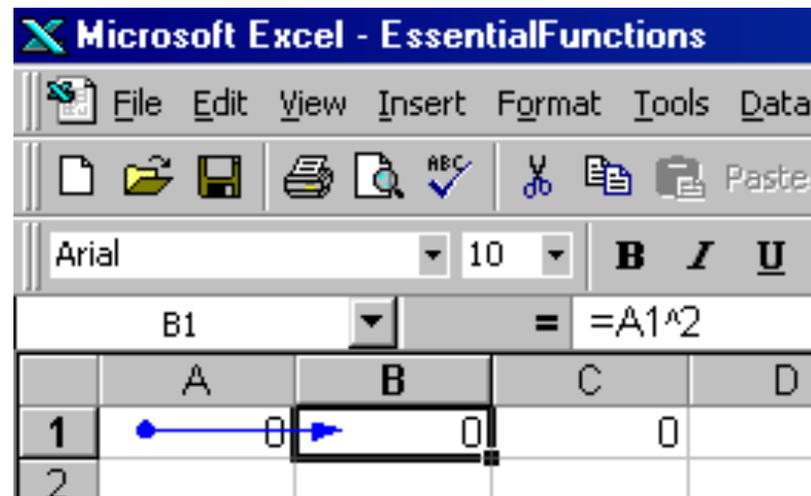
3. Auditing Workbooks
d. Tracing Errors

- ## To trace errors:
  - ### Tools/Auditing: Trace Errors
    - **highlight cell with error**
  - ### Example:
    - **A5: 1, A6: 2, A7: 3, and A8: #N/A**
    - **A10: Sum(A5:A8)**
    - **Error in the equation:**
      - **auditing tool indicates A8 as the cause of the error**
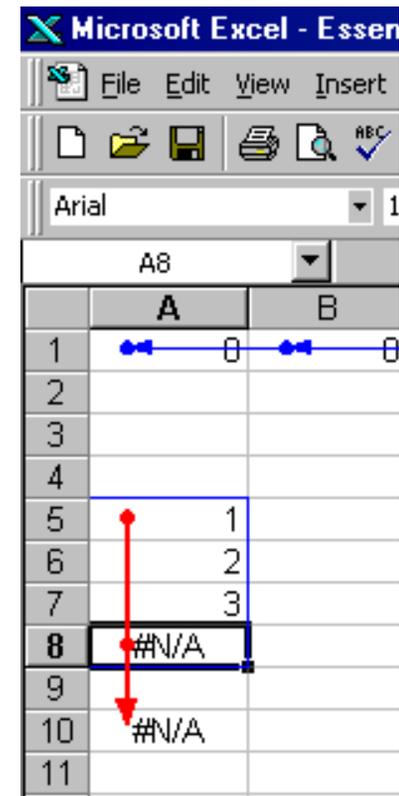
4. Functions
a. Overview

- **Functions are built-in formulas that perform calculations or a series of calculations:**
  - **typically require input arguments**
  - **return a result**

- **Custom made functions can be made using Visual Basic for Applications (VBA)**

- **Accessing Functions:**
  - **Insert/Function or use the function icon**
    - **formula palette**

4. Functions
b. Nesting Functions

- **Nested functions:**
  - functions within functions

- **Excel calculation:**
  - starts with innermost function and moves outward

- **If() function:**
  - logical_test: expression that evaluates to true or false
  - value_if_true: value displayed if logical test is TRUE
  - value_if_false: value displayed if logical test is FALSE

5. Essential Functions
a. Logical Testing - IF() Function

- **If() Function:**
  - **If(*logical_test,value_if_true,value_if_false*)**
  - **Example:**
    - **If(C3="",NA(),C3) replaces empty cells with #N/A**
  - **Example - Nested If() function:**
    - **=IF(Age>65,8.95,IF(Age<5,0,IF(Age<12,6.95,12.95)))**
      - **Age < 5   : $ 0.00**
      - **5 <= Age <12   : $ 6.95**
      - **12 <= Age <= 65   : $12.95**
      - **Age > 65   : $ 8.95**

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5. Essential Functions
b. Logical Testing - SUMIF() & COUNTIF() Functions

- **These functions allow the adding and counting for cells that meet a specific criteria**

- **Syntax:**
  - **SUMIF(range, criteria, sum_range)**
    - **range: range of cells to be evaluated if they meet the criteria**
    - **criteria: criteria to be used**
    - **sum_range: range to be summed**
  - **Example: EssentialFunctions.xls**
    - **=SUMIF(E6:E11,"Passed",TestScores)/ COUNTIF(E6:E11,"Passed")**

5. Essential Functions
c. Logical Testing - AND and OR Function Overview

- **The AND and OR functions evaluate up to 30 conditions:**
  - **AND(logical1,logical2, …)   OR(logical1,logical2, …)**

- **Evaluate to a TRUE or a FALSE**
  - **AND returns**
    - **TRUE if all arguments are TRUE**
    - **FALSE if any argument is FALSE**
  - **OR returns**
    - **TRUE if any argument is TRUE**
    - **FALSE if all arguments are FALSE**

5. Essential Functions
d. Logical Testing - AND and OR Function Example

- **Example:**
  - **Two variables**
    - **Sky: Blue or Cloudy**
    - **Sidewalk: Dry or Wet**
  - **Use umbrella when Sky=Blue and Sidewalk=Dry**
    - **If(AND(Sky="Blue",Sidewalk="Dry"),"Nice Day","Use Umbrella")**
    - **If(OR(Sky="Cloudy",Sidewalk="Wet"),"Use Umbrella","Nice Day")**

5. Essential Functions
e. Logical Testing - NOT Function

- **The NOT function reverses the meaning of a logical value:**
  - TRUE is changed to FALSE
  - FALSE is changed to TRUE

- **Example:**
  - Check a product is NOT(Red)
    - product is Yellow, Green, Blue, Purple, Brown, or Black

5. Essential Functions
f. Counting Functions - COUNT and COUNTA Functions

- **These functions count the number of items in a group of cells:**
  - COUNT(*value1,value2, …*) COUNTA(*value1,value2, …*)
- **COUNT:**
  - **only counts numbers, dates and times**
- **COUNTA:**
  - **counts numbers, text, logical values, and error values**
  - **does not count empty cells**

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5. Essential Functions
g. Counting Functions - COUNTBLANK Function

- **Counts the number of blank cells within a specific range:**
  - **COUNTBLANK(*range*)**

- **Counts:**
  - **empty cells**
    - **cleared contents, or**
    - **never had any data**
  - **null text ""**

5. Essential Functions
h. SubTotal Functions - Overview

- **Perform a number of mathematical functions on a range of data:**

  - **Advantages:**
    - **ignores other subtotal functions that may be nested**
    - **ignores hidden cells and applies to visible cells only**
      - **good with data filtering**
    - **outlines data by category**

- **To activate function: Data/Subtotals …**

5. Essential Functions
h. SubTotal Functions - Example

5. Essential Functions
h. SubTotal Functions - Manual Function

- ## Syntax:
  - **SUBTOTAL(*function_num,ref1,ref2, …*)**
    - function_num:
      - 1. AVERAGE
      - 2. COUNT

        .
      - 11. VARP
    - ref1: range of cells to use

- ## Example:
  - **SUBTOTAL(9,Quantity)**

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5. Essential Functions
i. Dividing, Multiplying and Square Root

- **PRODUCT(*number1, number2, …*)**
    - product of a sequence of numbers

- **MOD(*number,divisor*)**
    - remainder left over after the number argument is divided by the divisor argument
    - Example: mod(5,2) = 1

- **SQRT(*number*)**
    - square root of a number

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5. Essential Functions
j. Changing the Sign and Rounding a Number

- **ABS(*number*):**
  - negative numbers become positive
  - positive numbers unchanged

- **SIGN(*number*):**
  - returns the number sign

- **ROUND(*number,num_digits*):**
  - num_digits:
    - positive: number of digits right of decimal point
    - negative: number of digits left of decimal point
    - zero: round to next integer

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5. Essential Functions
k. Alternative Rounding of Numbers

- ## ROUNDUP():
  - **Rounds to nearest number up**
  - **Example:**
    - **ROUNDUP(1.45,0) = 2**
    - **ROUNDUP(-5.675,0) = -6**

- ## ROUNDDOWN():
  - **Similar to roundup except that it rounds down**

- ## EVEN() and ODD():
  - **round to the nearest even or odd number**
    - **+ve numbers rounded up and -ve numbers rounded down**

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5. Essential Functions
I. Alternative Rounding of Numbers

- **Rounding in Multiples:**
    - **FLOOR(number,significance):**
        - **FLOOR(145,12) = 144**
    - **CEILING(number,significance):**
        - **CEILING(145,12) = 156**

- **Truncating Numbers:**
    - **TRUNC and INT round to the nearest integer down**
        - **TRUNC deletes the decimal portion**

6. Manipulating Text
a. Formatting Text - Formatting

- **DOLLAR(*number,decimals*):**
  - Converts a number to <u>text</u> and displays it in the standard currency format
    - number of decimals displayed is controlled by 2nd argument

- **FIXED(*number,decimals,no_comma*):**
  - Converts a number to <u>text</u>
    - rounds the number to the decimals indicated and commas if last argument is omitted or FALSE

- **TEXT(*number,format_text*):**
  - Converts a value to <u>text</u> with the defined format

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6. Manipulating Text
b. Formatting Text - Capitalizing

- **UPPER(*text*):**
  - converts all letters to uppercase
- **LOWER(*text*):**
  - converts all letters to lowercase
- **PROPER(*text*):**
  - converts the first letter of each word to uppercase and the remaining letters are converted to lowercase

6. Manipulating Text
c. Character Manipulation - Removing Extraneous Characters

- **TRIM(*text*):**
  - **Removes extra spaces around text and leaves only a single space between words**

- **CLEAN(*text*):**
  - **Removes all non-printable characters:**
    - **end-of-line code**
    - **end-of-file code**

6. Manipulating Text
d. Character Manipulation - Finding a Text String

- **FIND(*find_text,within_text,start_num*):**
  - **Finds a specific text string within another text string**
  - **Gives starting position of "find_text" in "within_text" relative to a user defined starting point (default 1)**
  - **Case sensitive**

- **SEARCH(*find_text,within_text,start_num*):**
  - **Identical to FIND function except:**
    - **not case sensitive**
    - **allows the use of wildcards (*) and (?)**

- **LEN(text):**
  - Computes the length of a string

- **RIGHT(text,num_chars):**
  - Returns the rightmost characters of a string

- **LEFT(text,num_chars):**
  - Returns the leftmost characters of a string

- **MID(text,start_num,num_chars):**
  - Returns a predefined number of characters from a starting point within the string

6. Manipulating Text
f. Character Manipulation - Replacing Text Strings

- **REPLACE(***old_text, start_num, num_chars, new_text***):**
  - Replace a number of characters "num_chars" in a text string "old_text" starting from "start_num" with a new text string "new_text"

- **SUBSTITUTE(***text, old_text, new_text, instance_num***):**
  - Substitute a specific text string "old_text" within a text "text" with another text string "new_text" a number of times "instance_num"

- **Example: EssentialFunctions.xls**

- **EXACT(text1, text2):**
  - Compare two strings to determine if they match in all but formatting

- **REPT(text, number_times):**
  - Repeat a text string a number of times

- **CONCATENATE(text1, text2, …):**
  - Combine a number of strings together
  - Example: CONCATENATE("CEE"," ","3804) = CEE 3804

6. Manipulating Text (Importing Data)
## h. Importing ASCII Files (step 1)

- ## To import an ASCII or text file:
  - ### File/Open and browse all files

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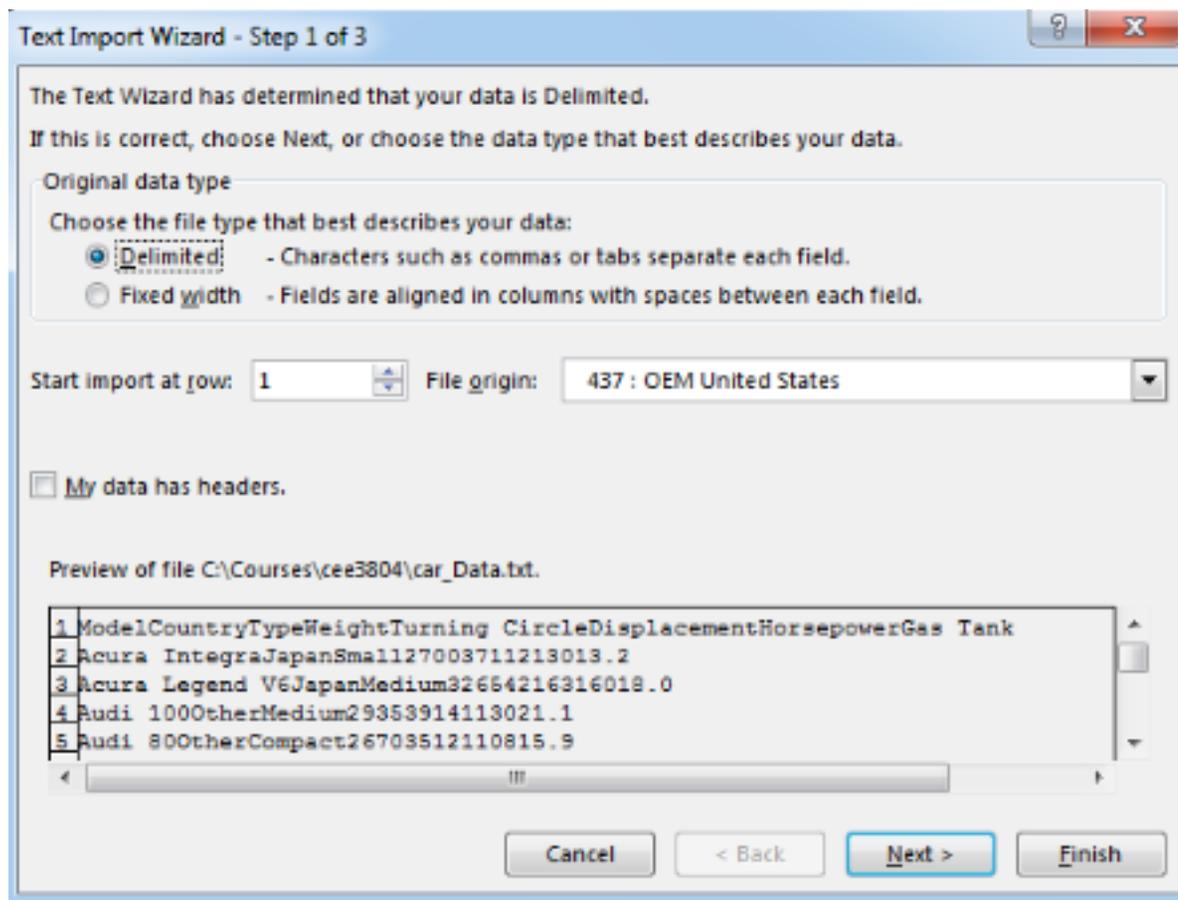
6. Manipulating Text
h. Importing ASCII Files (step 2)

- **To import an ASCII or text file:**
  - **File/Open and browse all files (use Car_Data file)**

Text Import Wizard - Step 2 of 3

This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.

Delimiters
- ☑ Tab
- ☐ Semicolon
- ☐ Comma
- ☐ Space
- ☐ Other:

☐ Treat consecutive delimiters as one

Text qualifier: "
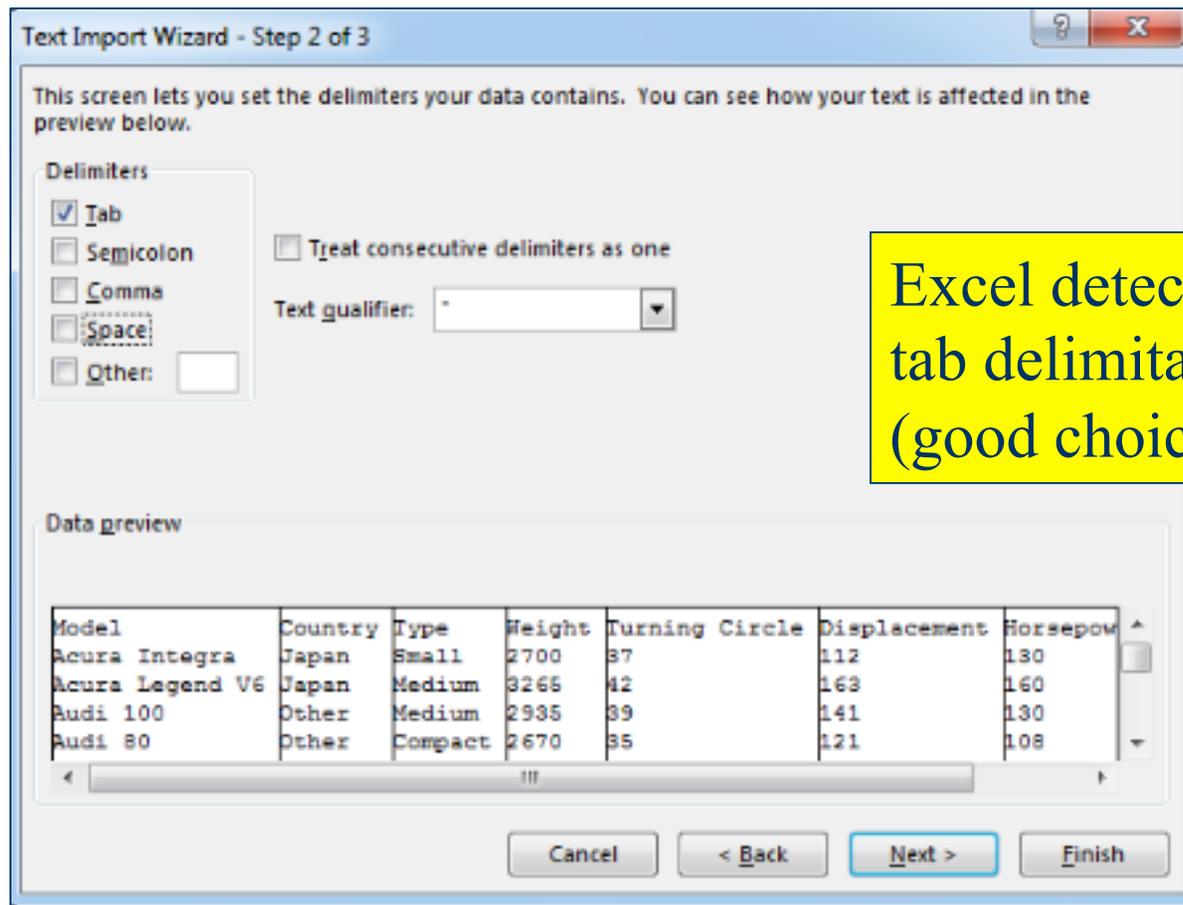
Excel detected tab delimitation (good choice)

Data preview

Model	Country	Type	Weight	Turning Circle	Displacement	Horsepow
Acura Integra	Japan	Small	2700	37	112	130
Acura Legend V6	Japan	Medium	3265	42	163	160
Audi 100	Other	Medium	2935	39	141	130
Audi 80	Other	Compact	2670	35	121	108

Cancel   < Back   Next >   Finish

6. Manipulating Text
h. Importing ASCII Files (step 3)

- ## To import an ASCII or text file:
  - ### File/Open and browse all files (use Car_Data file)

Text Import Wizard - Step 3 of 3

This screen lets you select each column and set the Data Format.

Column data format
- ● General
- ○ Text
- ○ Date: MDY
- ○ Do not import column (skip)

'General' converts numeric values to numbers, date values to dates, and all remaining values to text.

Excel uses general format as default

Data preview

General	General	General	General	General
Model	Country	Type	Weight	Turning Ci
Acura Integra	Japan	Small	2700	37
Acura Legend V6	Japan	Medium	3265	42
Audi 100	Other	Medium	2935	39
Audi 80	Other	Compact	2670	35

Cancel   < Back   Next >   Finish

	Model	Country	Type	Weight	Turning Ci	Displacem	Horsepow	Gas Tank Size
1	Model	Country	Type	Weight	Turning Ci	Displacem	Horsepow	Gas Tank Size
2	Acura Integra	Japan	Small	2700	37	112	130	13.2
3	Acura Legend V6	Japan	Medium	3265	42	163	160	18
4	Audi 100	Other	Medium	2935	39	141	130	21.1
5	Audi 80	Other	Compact	2670	35	121	108	15.9
6	Audi 90	Other	Compact	2790	35	141	130	15.9
7	BMW 325i	Other	Compact	2895	35	152	168	16.4
8	BMW 535i	Other	Medium	3640	39	209	208	21.1
9	Buick Century	USA	Medium	2880	41	151	110	15.7
10	Buick Electra V6	USA	Large	3350	43	231	165	18
11	Buick Le Sabre V6	USA	Large	3325	42	231	165	18
12	Buick Riviera V6	USA	Medium	3465	41	231	165	18.8
13	Buick Skylark	USA	Compact	2640	39	151	110	13.6
14	Cadillac Brougham V8	USA	Large	4285	44	307	140	25
15	Cadillac De Ville V8	USA	Large					

Imported data file

7. Information Functions
a. IS Functions

- **Perform a test on a value or a cell:**
- **Functions include:**
    - **ISBLANK: Determine if cell is blank**
    - **ISERR: Tests for all errors except #N/A**
    - **ISERROR: Tests for all errors**
    - **ISNA: Tests if cell contains the #N/A error**
    - **ISLOGICAL: Checks for either TRUE or FALSE values**
    - **ISNONTEXT: Tests for anything that is not text including blank**
    - **ISNUMBER: Tests for numbers**
    - **ISREF: Value is a valid reference**
    - **ISTEXT: Tests for text only**

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7. Information Functions
b. Type Functions

- **TYPE function: returns type of value in cell**
    - 1: Number, 2: Text, 4: Logical, 16: Error Value, 64: Array
    - Example:
        - **IF(TYPE(A1)<16,A1,B1)**

- **ERROR.TYPE: returns error number**
    - 1: #NULL!, 2: #DIV/0!, 3: #VALUE!, 4: #REF!, 5: #NAME?, 6: #NUM!, 7: #N/A, #N/A: all else
    - Example:
        - **IF(ERROR.TYPE(A1)=2),"Divide by Zero Error",A1)**

7. Information Functions
c. Cell Function

- **CELL(*info_type, reference*):**
    - Provides information about selected cell, including format, location, and/or contents
    - Some types of information:
        - address: Returns the address - CELL("address",B3) = $B$3
        - col: Returns the column - CELL("col",B3) = 2
        - contents: Returns the value of a cell
        - filename: Returns the path and filename
        - format: Returns a symbol description of the format
        - row: Returns the row
        - width: Returns the column width

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7. Information Functions
d. INFO Functions

- **INFO(*type_text*):**
  - directory: Path of current directory
  - memavail: Total amount of available, in bytes
  - memused: Total amount of memory being used, in bytes
  - numfile: Number of worksheets currently open
  - osversion: Operating system and version
  - recalc: Current recalculation mode
  - release: Version number of Excel
  - system: Operating environment
  - totmem: Total memory

9. Dates and Times
b. Basic Functions

- **The basic date functions include:**
  - **NOW(): Current date and time**
  - **TODAY(): Current date**
  - **DATE(*year, month, day*): Builds a custom date**
    - **Example: DATE(99,8,7) = 36379 or 8/7/99**
  - **TIME(*hour, minute, second*): Builds custom time**
  - **YEAR(*serial_number*): Get year portion of date**
    - **MONTH(*serial_number*) and DAY(*serial_number*): similar**
  - **WEEKDAY(*serial_number, return_type*): Returns day-of-week**
  - **DATEVALUE(*date_text*): Converts text to number**

10. Financial Functions
a. Overview

- **Functions can compute:**
  - internal rate of return of an investment
  - future value of an annuity
  - yearly depreciation of an asset

- **The arguments used most frequently are:**
  - rate: fixed rate of interest
  - nper: number of payment or deposit periods
  - pmt: periodic payment
  - pv: present value of a loan
  - fv: future value of a loan

10. Financial Functions
b. Commonly Used Functions

- **FV(*rate,nper,pmt,pv,type*):**
    - Returns the future value of an investment or loan

- **NPV(*rate,value1,value2, …*):**
    - Net present value on a series of cash flows

- **PPMT(*rate,per,nper,pv,fv,type*):**
    - Principal payment for a specified period of a loan

- **IPMT(*rate,per,nper,pv,fv,type*):**
    - Interest payment for a specified period of a loan

- **PMT(*rate,nper,pv,fv,type*):**
    - Payment for a loan with constant payments and constant interest rate

10. Financial Functions
c. Example Illustration

- **The ACME construction company wants to buy 10 Caterpillar 777F off-highway trucks to renew its fleet**

- **The cost each truck is $1.1 million dollars**

- **The company gets a loan from a local bank at 5% interest and payable to 15 years**

- **Find the monthly payments to the bank**

Caterpillar 77F
Source: Caterpillar

10. Financial Functions
d. Example Illustration of PMT function

- **Rate = Interest rate per month is (5/12) %**

- **Nper = No. of payment periods will be (15)*12 = 180 periods over 15 years**

- **Pv = present value of the loan is 11 million dollars**

Caterpillar 77F
Source: Caterpillar

	A	B	C
	Problem		
	ACME Company		
	Loan for 10 Cat 777F	11000000	dollars
	No. of Periods	180	periods in loan
	Interest	5%	percent
	Monthly Payment	=PMT(B6/12,B5,B4,0,1)	
	Yearly Payment	PMT(rate, nper, pv, [fv], [type])	

Monthly Payment	($86,626.36)
Yearly Payment	($1,039,516.27)

10. Financial Functions
d. Example Illustration of PMT function

- The PMT function calculates the payment for a loan assuming constant payments and a constant interest rate

- The solution shows that over the life of the loan, the construction company will pay $15,592,744.05

- This amounts to $4,592,744.05 in interest over the life of the loan

Caterpillar 77F
Source: Caterpillar

Monthly Payment	($86,626.36)
Yearly Payment	($1,039,516.27)

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10. Financial Functions
e. Example Illustration (Apartment Mortgage)

| | =IPMT($D$5,B8,$D$4,$D$3)*-1 | | | | | |

B	C	D	E	F		L
	Mortgage	110000				
	Period	20				
	Interest	8%				
Year	**Interest**	**Principal**	**Total**			
1	$8,800.00	$2,403.74	$11,203.74			
2	$8,607.70	$2,596.04	$11,203.74			
3	$8,400.02	$2,803.73	$11,203.74			
4	$8,175.72	$3,028.02	$11,203.74			
5	$7,933.48	$3,270.27	$11,203.74			
6	$7,671.86	$3,531.89	$11,203.74			
7	$7,389.30	$3,814.44	$11,203.74			
8	$7,084.15	$4,119.59	$11,203.74			
9	$6,754.58	$4,449.16	$11,203.74			
10	$6,398.65	$4,805.09	$11,203.74			
11	$6,014.24	$5,189.50	$11,203.74			
12	$5,599.08	$5,604.66	$11,203.74			
13	$5,150.71	$6,053.03	$11,203.74			
14	$4,666.47	$6,537.28	$11,203.74			
15	$4,143.48	$7,060.26	$11,203.74			
16	$3,578.66	$7,625.08	$11,203.74			
17	$2,968.66	$8,235.09	$11,203.74			
18	$2,309.85	$8,893.89	$11,203.74			
19	$1,598.34	$9,605.40	$11,203.74			
20	$829.91	$10,373.84	$11,203.74			
	$114,074.86	$110,000.00	$224,074.86			

Apartment Mortgage $110,000 value of the apartment

You will pay more than twice the amount of the loan over 20 years

11. User-defined Functions
Example Illustration

- **The best way to make your own calculations in Excel**

- **Extends the Excel functions defined in the program**

- **Relatively simple to implement**

- **A user-defined function is just a function created by yourself to make a useful computations**

- **Functions are reusable**

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11. Sample Function

- **The Army Corps of Engineers developed a simple formula to estimate the pavement thickness (t) required to support an aircraft at an airport.**

- **The formula is:**

- **t = sqr(Load / (8.1 * CBR) + Area/pi)**

- **Where:**

- **t = pavement thickness in inches**

- **Load = applied single wheel equivalent load (lb)**

- **Area = contact area of the tire (sq. inches)**

- **CBR = California Bearing Ratio (dimensionless)**

11. Excel 2003
c. Example Illustration

● **Enter the following information in Excel to set up the problem**

Make sure to enter your own comments and information about the problem that you are solving
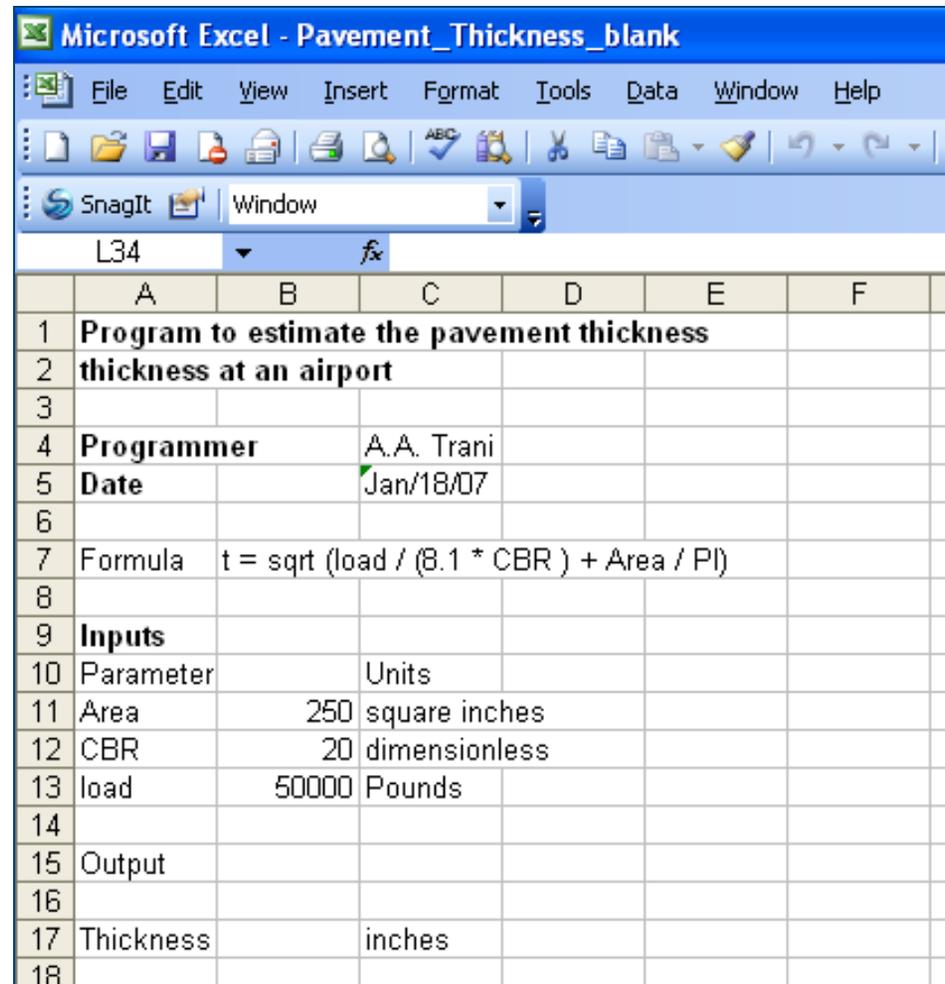
Microsoft Excel - Pavement_Thickness_blank

File   Edit   View   Insert   Format   Tools   Data   Window   Help

L34

	A	B	C	D	E	F
1	Program to estimate the pavement thickness					
2	thickness at an airport					
3						
4	Programmer		A.A. Trani			
5	Date		Jan/18/07			
6						
7	Formula	t = sqrt (load / (8.1 * CBR) + Area / PI)				
8						
9	Inputs					
10	Parameter		Units			
11	Area	250	square inches			
12	CBR	20	dimensionless			
13	load	50000	Pounds			
14						
15	Output					
16						
17	Thickness		inches			
18						

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11. Excel 2003 VBA
c. Example Illustration (cont.)

- **Lets start the function by opening the Visual Basic environment**

- **Go to Tools/Macro/Visual Basic Editor**

- **Add a Module**
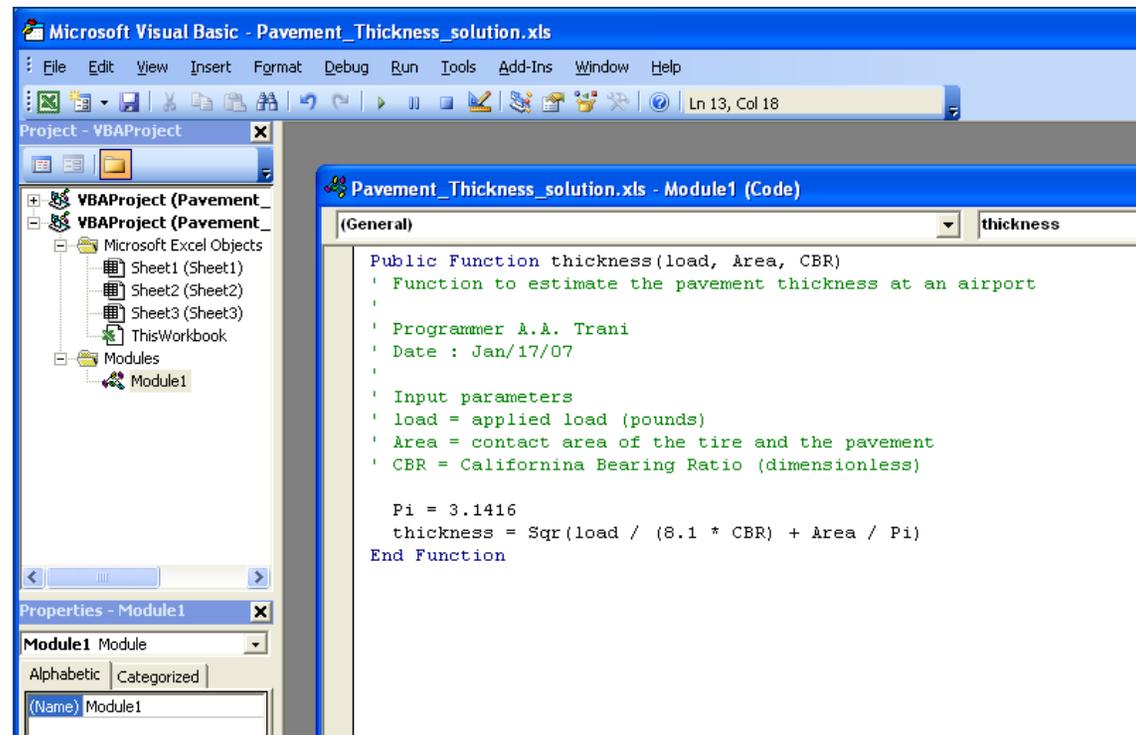
Getting to VBA in Excel 2007/2010

- **If Excel 2007 does not display the developer tab**
- **Select Excel Office - Excel Options (to activate)**
- **Add-in the VBA developer**
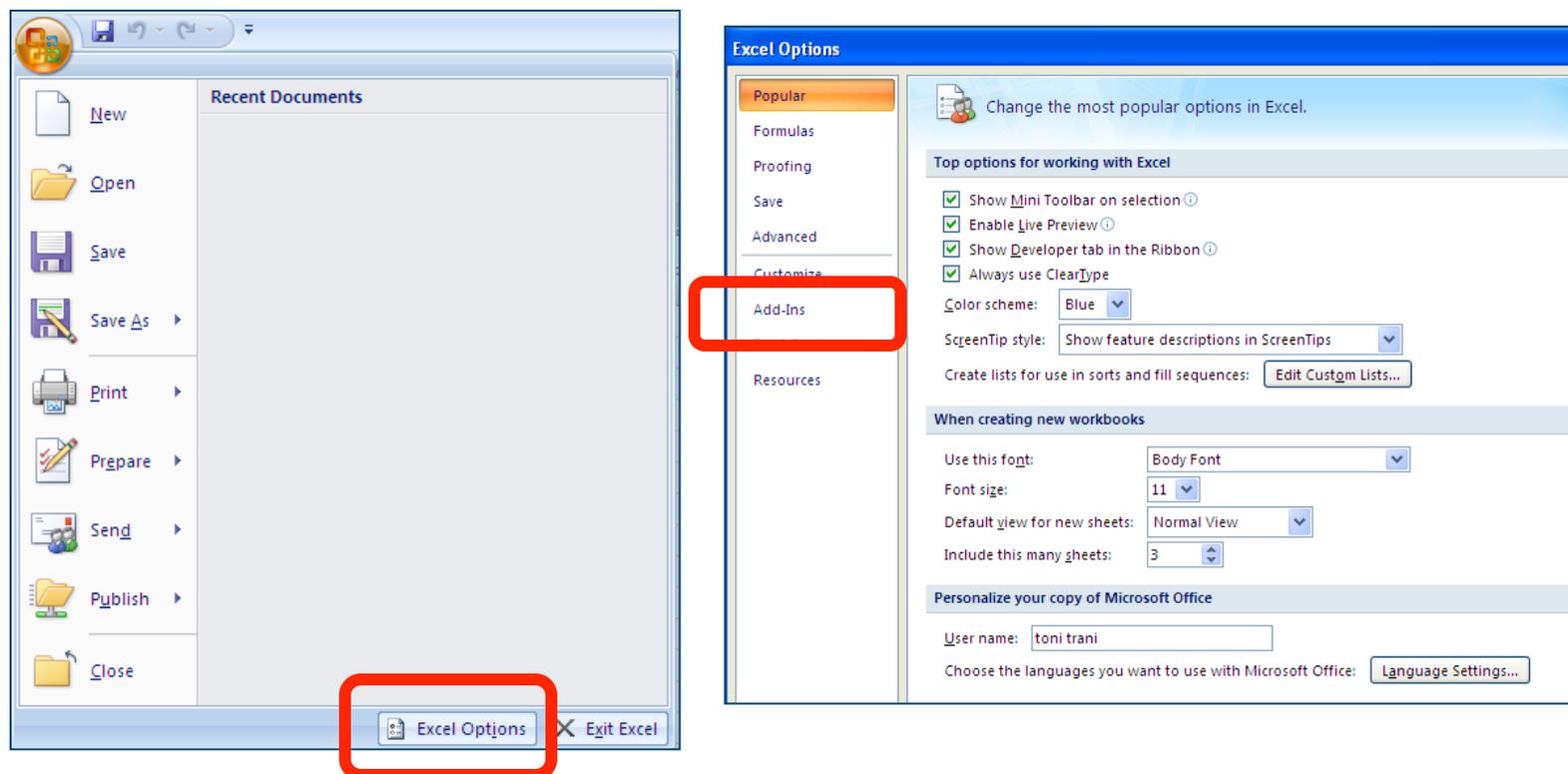
Excel 2013

- If Excel 2013 does not display the developer tab
- Select Excel Office - Excel Options (to activate)
- Add-in the VBA developer

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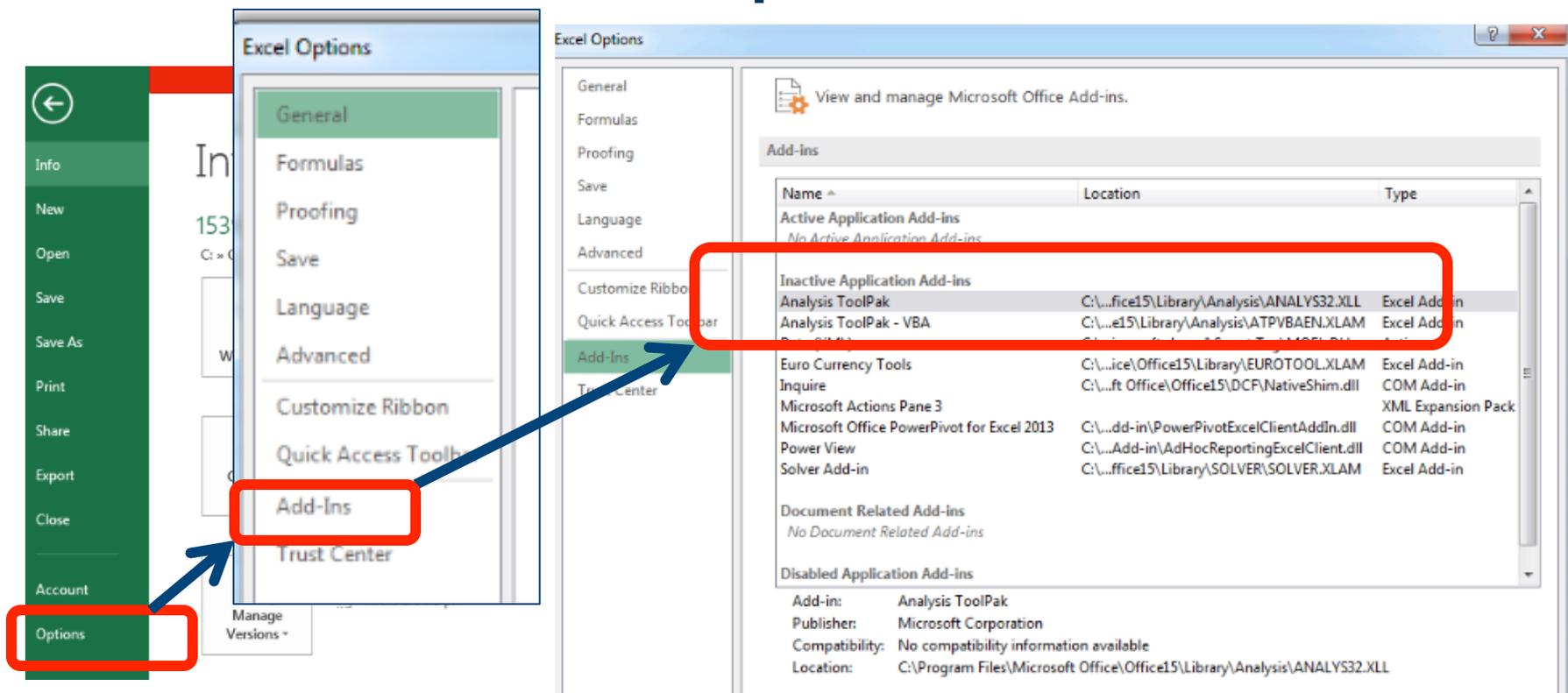
Getting to VBA in Excel 2013

- **Amazingly, after selecting Analysis ToolPak, the software still wants you to make more choices!!**

- **Is almost as if the the designer does now want you to use this feature**
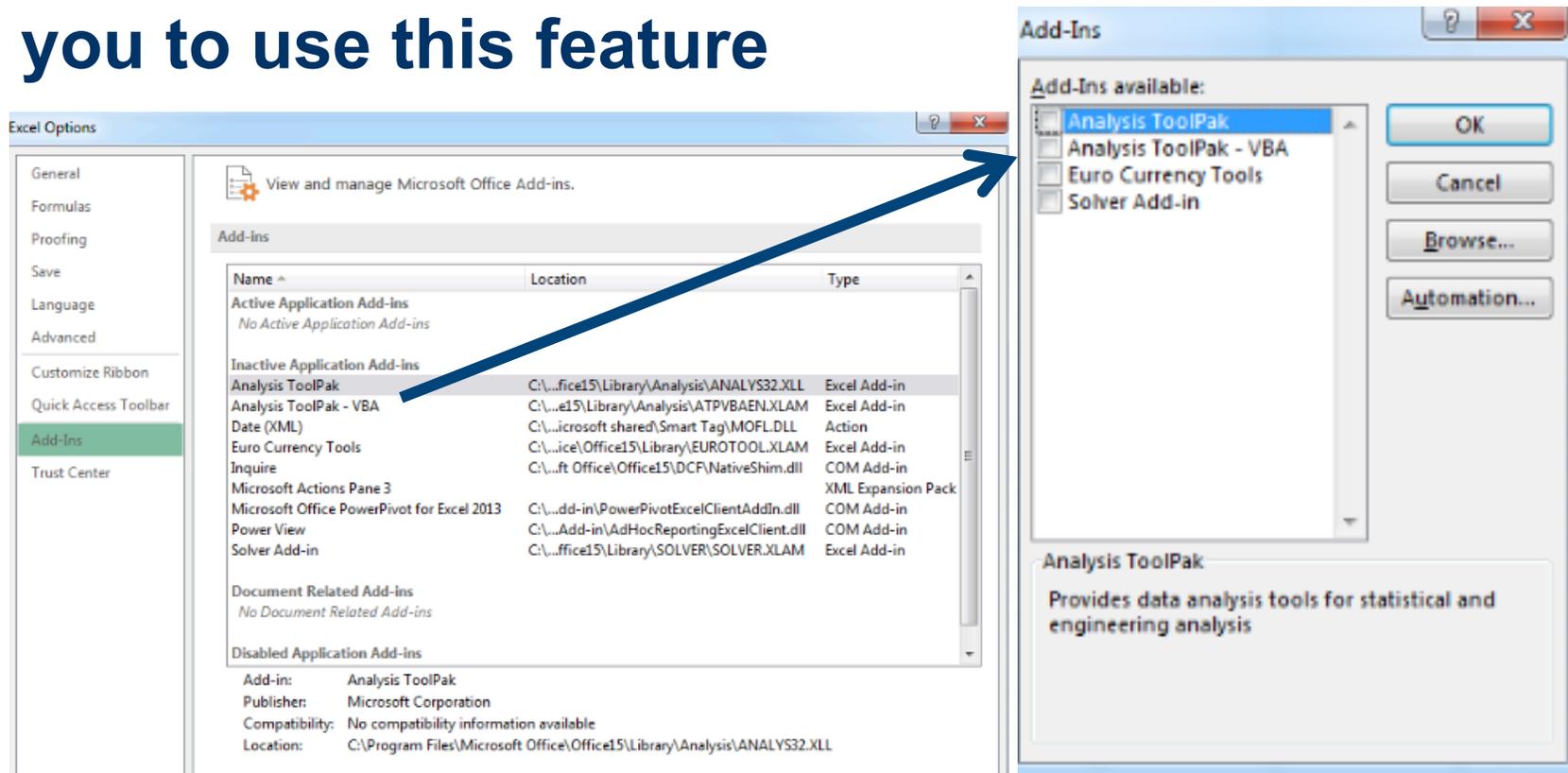
Excel 2013

- **By default, Excel does not show the Developer tab in the ribbon**
- **You need to add the Developer tab**
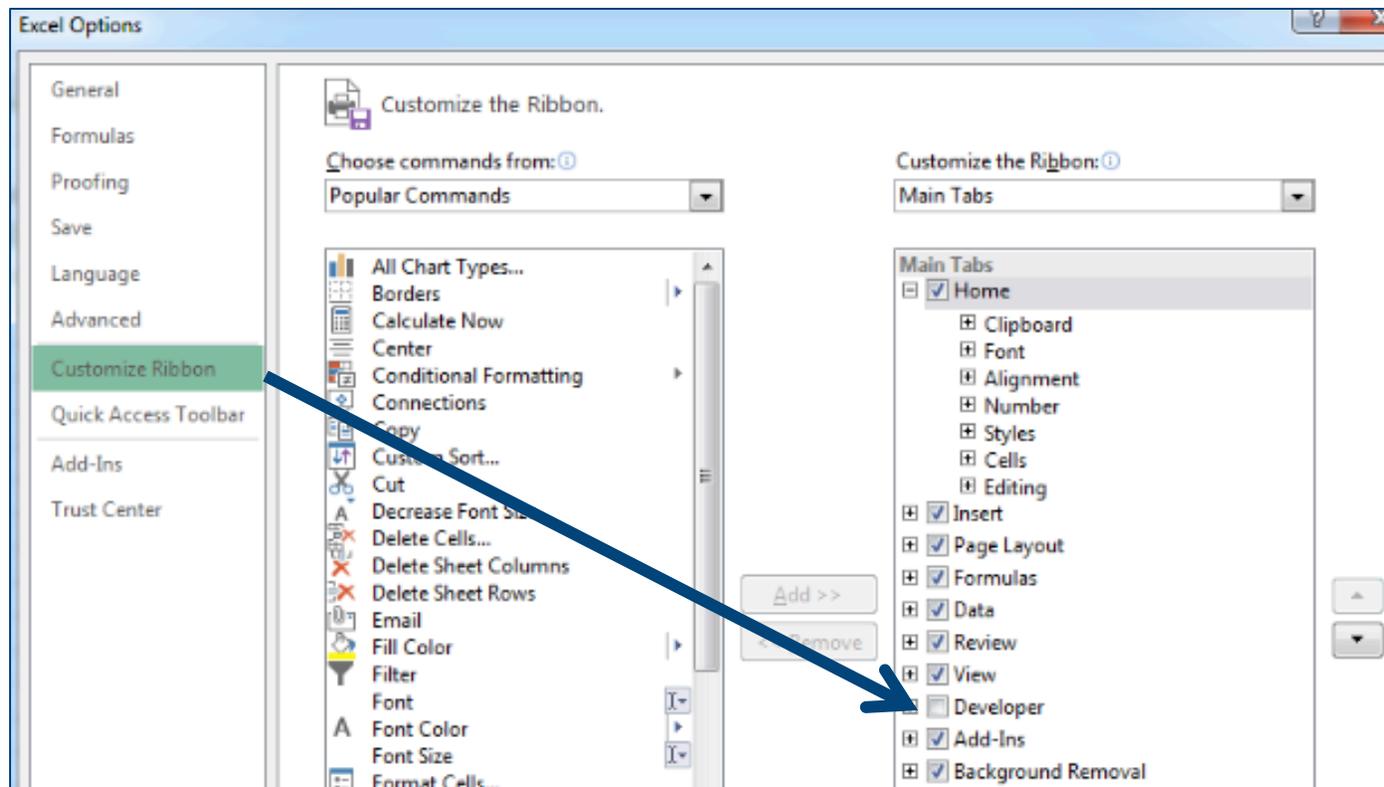
Developer Tabs in Excel 2010 and Excel 2013

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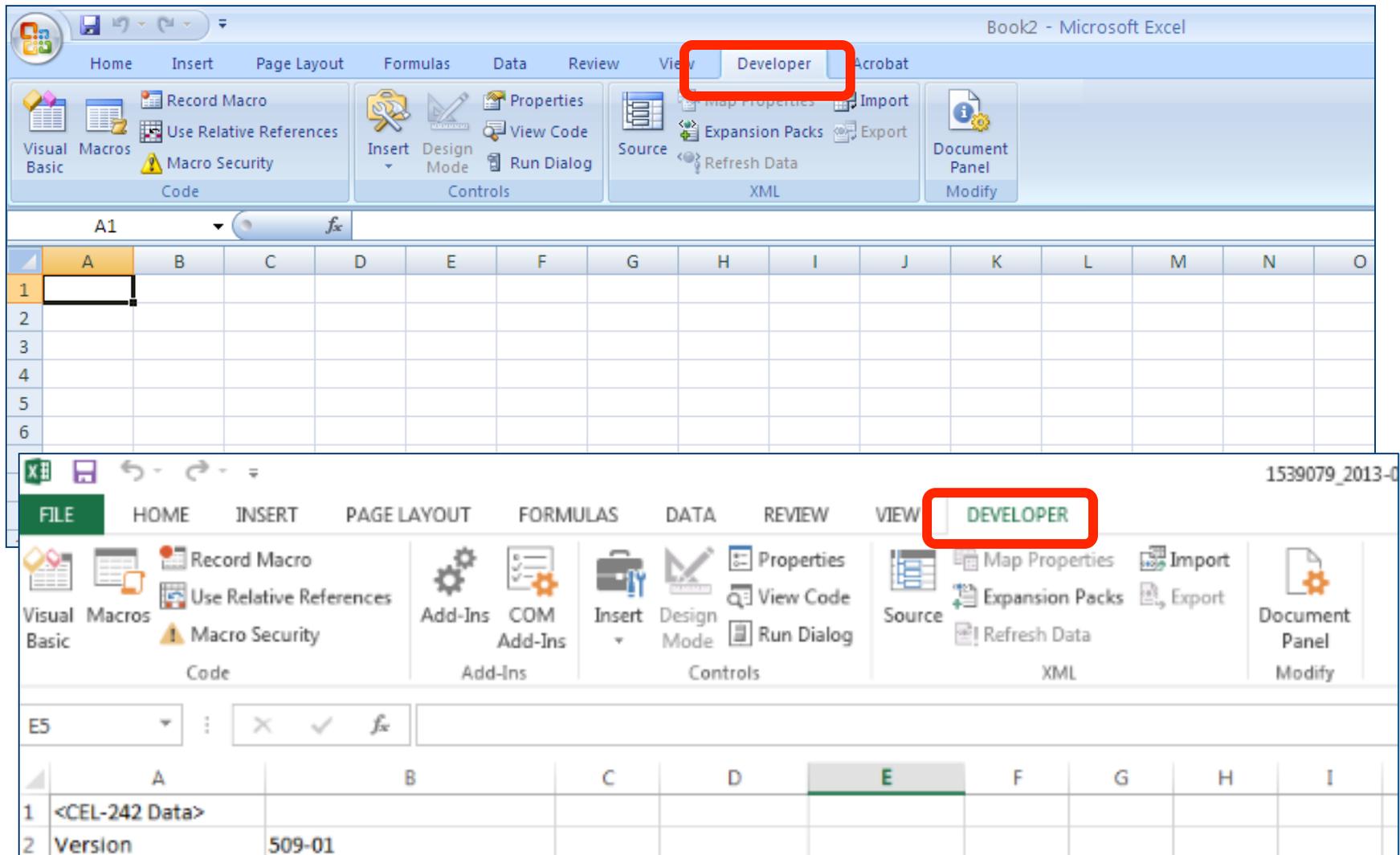
11. Excel Function
c. Example Illustration (cont)

● **Type the formula and comments to execute the pavement thickness function**
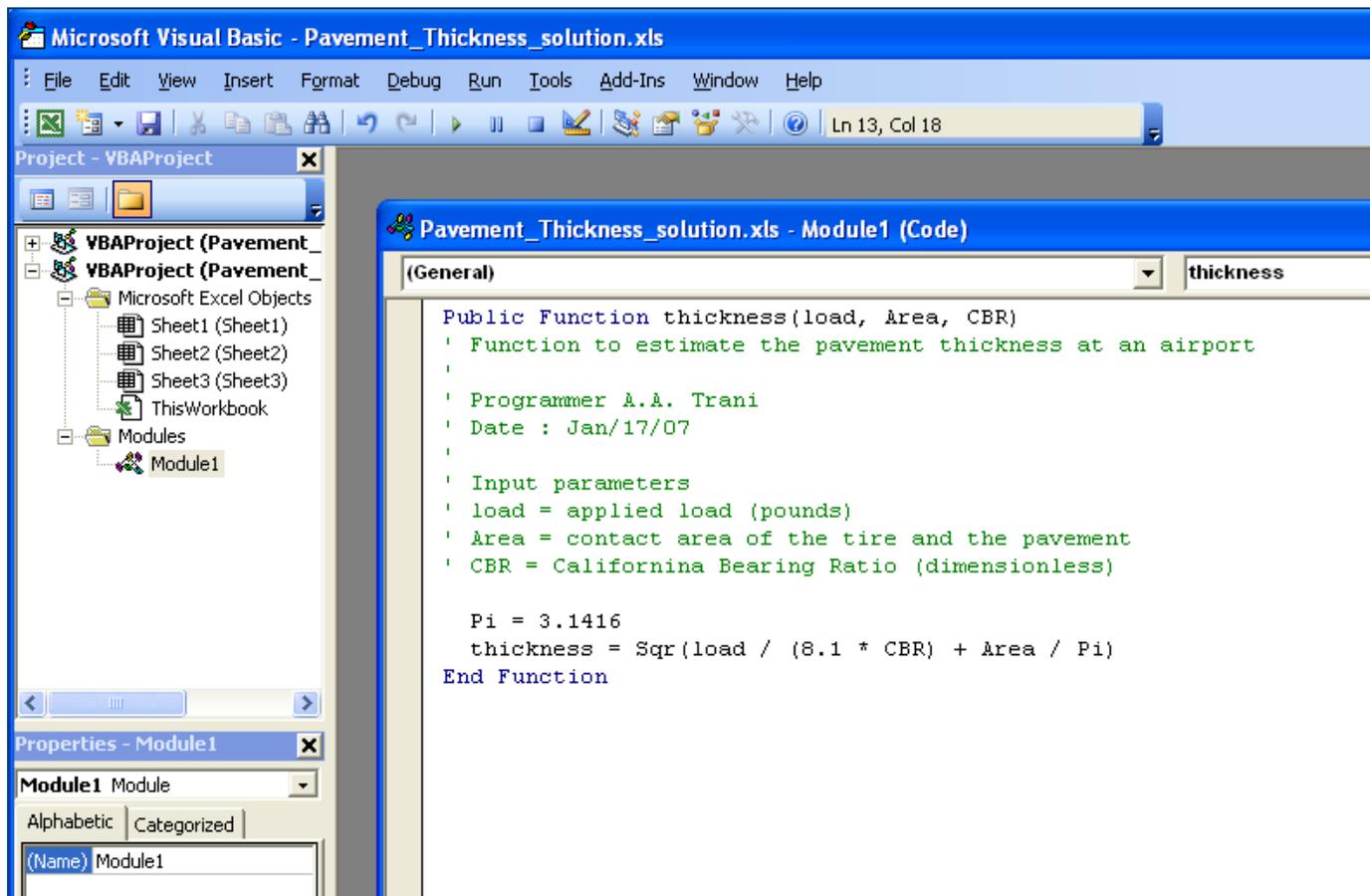
11. Excel Function
c. Example Illustration (cont)

- **Few things to observe:**

- **VBA has color coding for the code that we added to the function**

- **The function starts and ends with some key words (Sub Function and End Sub)**

- **Add as many comments as needed (use a single quote to tell VBA that a line of code is a comment)**

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11. Excel Function
c. Testing phase

- **Test the function that you just created**
- **Close the VBA environment**
- **Create a cell to calculate and "call the function"**
- **Go to insert/function**

Cell B17 is the one selected to test the function created
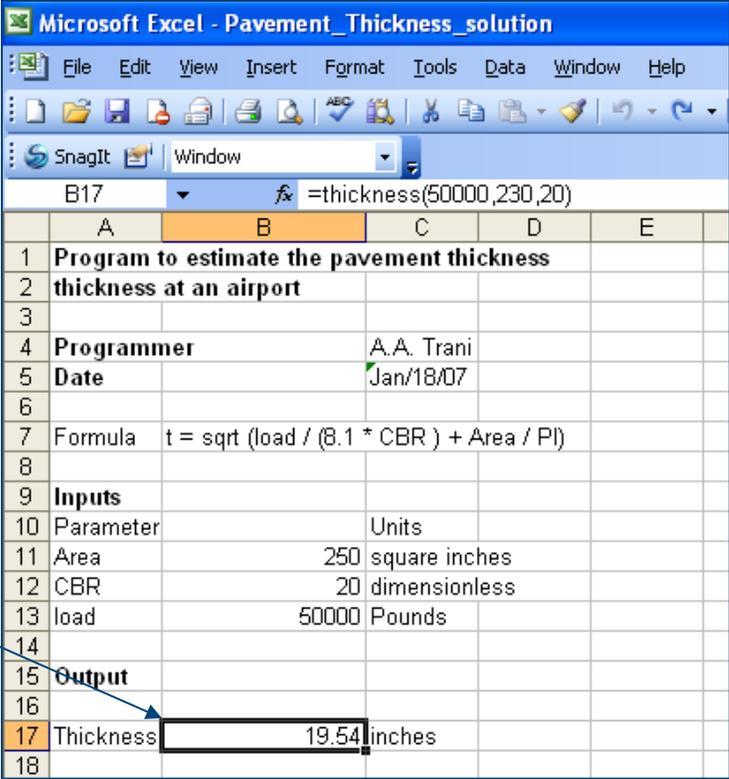
Microsoft Excel - Pavement_Thickness_solution

File Edit View Insert Format Tools Data Window Help

B17   fx =thickness(50000,230,20)

	A	B	C	D	E
1	Program to estimate the pavement thickness				
2	thickness at an airport				
3					
4	Programmer		A.A. Trani		
5	Date		Jan/18/07		
6					
7	Formula	t = sqrt (load / (8.1 * CBR) + Area / PI)			
8					
9	Inputs				
10	Parameter		Units		
11	Area	250	square inches		
12	CBR	20	dimensionless		
13	load	50000	Pounds		
14					
15	Output				
16					
17	Thickness	19.54	inches		
18					

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11. Excel Function
c. Testing phase

- **Excel opens a special box and prompts you to enter the parameters of the function**

- **Note that in our case there are three parameters labeled: load, Area and CBR**

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11. Excel Function
c. Apply the function to a set of numbers

- **Now create a parametric study and apply the function "thickness" to several values of load**
- **(say ranging from 10000 to 50000 lb)**

Thickness	19.54	inches

More computations
We try to plot thickness for various loads
ranging from 10000 to 50000

load (lb)	Thickness (in)
10000	11.62
15000	12.88
20000	14.02
25000	15.08
30000	16.07
35000	17.01
40000	17.89
45000	18.73
50000	19.54

Pavement Thickness Plot
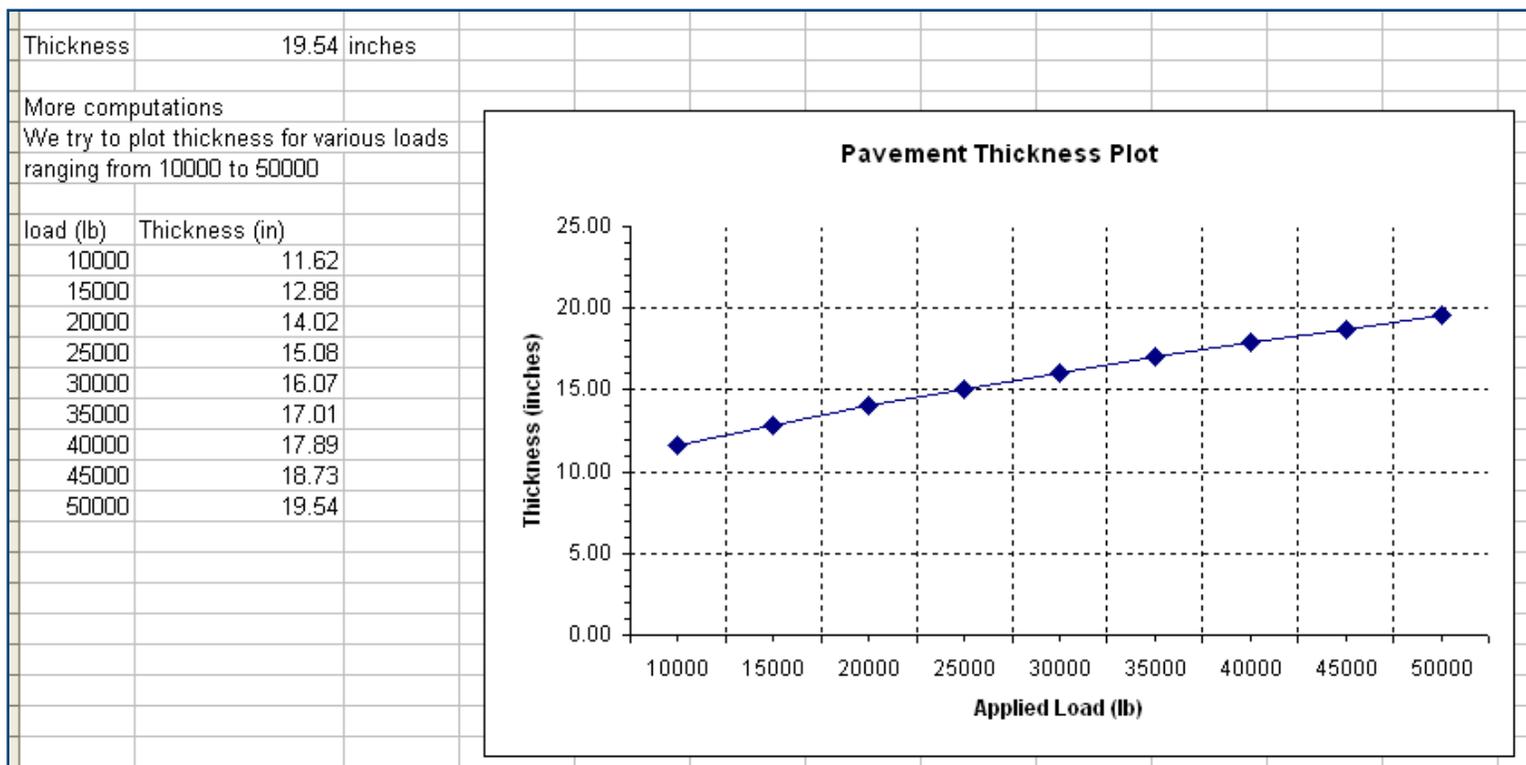
Conditional Formatting

- **Conditional formats available**
  - Data bar projections
  - Color gradients
  - Standard value based formats
- **Conditional format is available under the Home tab**

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Conditional Formatting

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