Heights Libraries COMPUTER CLASSES

I hear, and I forget.
I see, and I remember.
I do, and I understand.

- Confucius

Excel 2019
Part 6: Formulas and Functions

Revised January 2020

Formulas are one of the most useful features in Excel. Formulas can be used to perform basic number crunching, such as addition or subtraction, as well as more complex calculations such as payroll deductions or averaging a student's test results.

Overview of Formulas

Formulas are equations that perform calculations on numbers or values in a worksheet.

Examples of Formulas and Functions

=2*3+5	Multiplies 2 by 3, then adds 5
=A1+A2+A3	Adds the values in cells A1, A2, and A3
=SUM(A1:A5)	Sums the range of values in cells A1, A2, A3, A4 and A5
=TODAY()	Returns the current date
=UPPER("hello")	Converts the text **hello** to **HELLO** using the **UPPER** function
=IF(A1>0)	Tests the contents of cell A1 to determine if it contains a value greater than 0
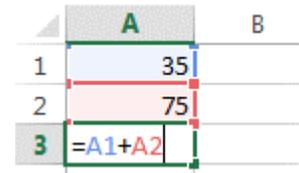
Using Basic Arithmetic operators

For performing basic mathematical operations such as addition, subtraction, or multiplication; combining numbers; and producing numeric results, use the following arithmetic operators:

ARITHMETIC OPERATOR	MEANING	EXAMPLE	RESULT
+ (plus sign)	Addition	=A1+A2	10
− (minus sign)	Subtraction or Negation	=A1-A2	6
* (asterisk)	Multiplication	=A1*A2	16
/ (forward slash)	Division	=A1/A2	4
^ (caret)	Exponentiation	=A1^A2	64

*When A1=8 and A2=2

Creating Formulas

Formula basics:

1. A formula may be entered either in the cell in which you want the answer of the calculation to appear, or alternatively, the cell may be selected and the formula can be entered in the formula bar.

For example, to add cells A1 and A2, and have the answer appear in A3, type =A1+A2 in cell A3. The formula =A1+A2 appears in the formula bar as you type. Once the formula is entered, only the result appears in the cell. The actual formula is only visible on the formula bar when the cell is selected.
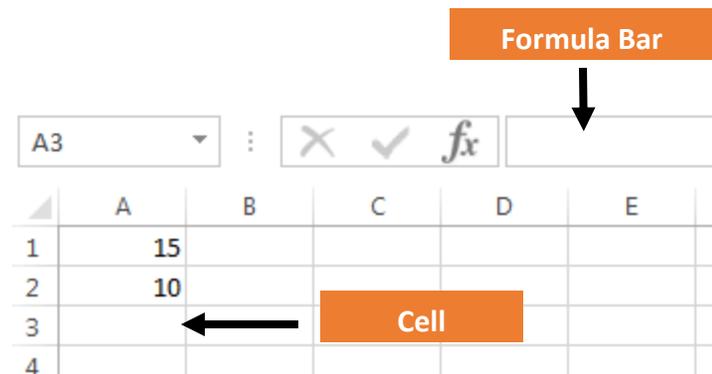
2. **Formulas must always begin with an equals sign (=)**. The **equals sign** at the beginning of a formula indicates to Excel that you are entering a formula rather than a value.

3. Enter the formula immediately following the equal sign with **no spaces**. For example, =A1+A2.

4. Generally, the cell addresses **not the values** (numbers) should be entered and calculated in the formula. This is known as making a cell reference. There are times when entering values is necessary, but for basic formulas and functions, enter cell addresses.
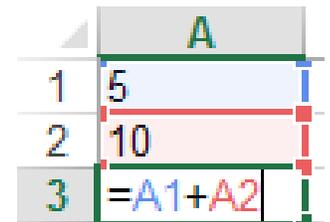
   NOTE: Every Excel worksheet is made up of thousands of rectangles, called **cells**. Each cell has its own name, called a **cell address**. A cell address is the intersection of the column (letter identifier) and a row (number identifier). For example, the cell address of the cell in the A column and the third row is A3.
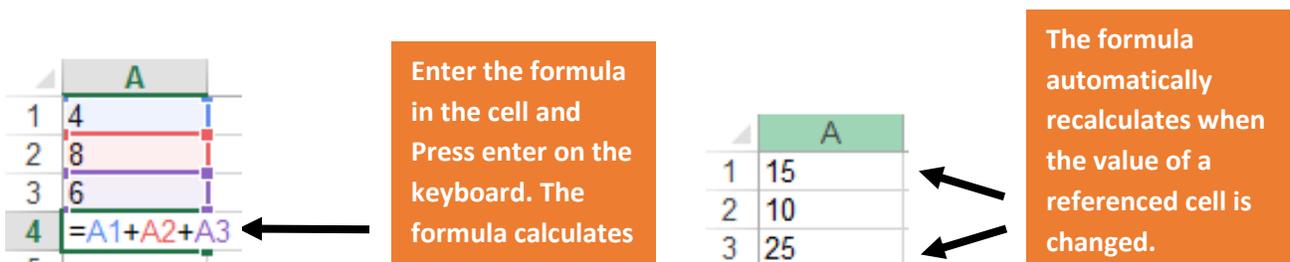
Practice Exercise: Using Arithmetic Operators

1. Open the **Excel_Practice_File** workbook from the Documents folder
2. Click on the **Formulas & Functions** sheet
3. Click in cell **B9**: type the formula for Addition , **=B4+B5+B6+B7+B8**, then press **Enter**
4. Click in cell **D9**: type the formula for Subtraction, **=D7-D8**, then press **Enter**
5. Click in cell **F9**: type the formula for Multiplication, **=F7*F8**, then press **Enter**
6. Click in cell **H9**: type the formula for Division, **= H7/H8**, then press **Enter**

Changing Values with Cell References

An advantage of using cell references in formulas is that they allow you to update data in your worksheet without having to rewrite the formula.

Practice Exercise: Changing Values with Cell References

In the exercise below, the value in a cell will be changed and the formula will automatically update.

1. In the **Excel_Practice_File** go to the **Formulas & Functions** worksheet
2. Click the **B4 cell** and change the value to **40**
3. Press **Enter** on the keyboard; the formula recalculates in the **B9 cell**

Edit or Double-Check your Formula

Sometimes it's necessary to edit or double-check your formula. In the exercise below we will look at an existing formula and edit it.

1. In the **Excel_Practice_File** go to the **Formulas & Functions** worksheet
2. Select the **cell** containing the formula to be edited. In our example, we'll click on cell **B9**

Look above at the formula bar. The formula is now visible in the formula bar.
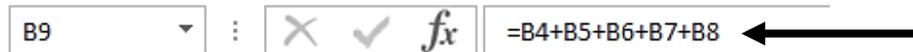
3. Click in the **formula bar** to edit the formula
4. Change one of the plus signs in the formula to a minus sign
5. Press **Enter**. The formula will recalculate and change the result in the **B9 cell**

NOTE: An alternate way to edit the formula is to **double-click the cell** to view and edit the formula directly within the cell.

Functions

A function is a **predefined formula** that performs calculations using specific values in a particular order. One of the key benefits of functions is that they can save you time since you do not have to write the formula yourself.

Excel has hundreds of different functions to assist with your calculations.

The Structure of a Function

- The order in which you insert a function is important. Each function has a specific order, called syntax, which must be followed for the function to work correctly.

- The basic syntax to create a formula with a function is to insert an equal sign (**=**), a function name (**SUM**, for example, is the function name for addition), and an **argument**. Arguments contain the information you want the formula to calculate, such as a range of cell references.
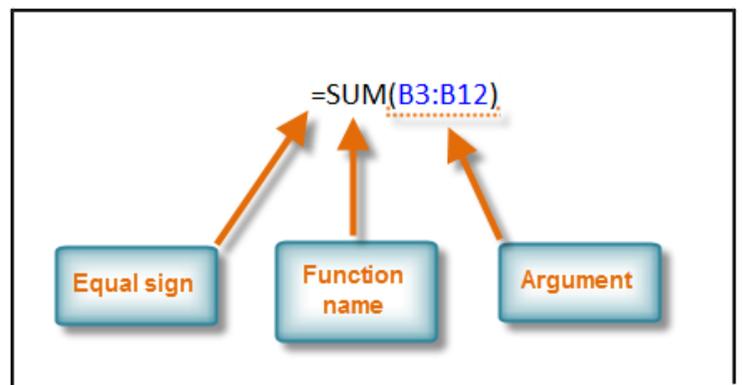
Function Basics:

- Functions always begin with an **=** sign
- Functions never contain spaces
- Functions can be typed in uppercase (CAPS) or lowercase letters.
- An opening and closing parenthesis must always be entered around the argument (the cells you want to calculate)
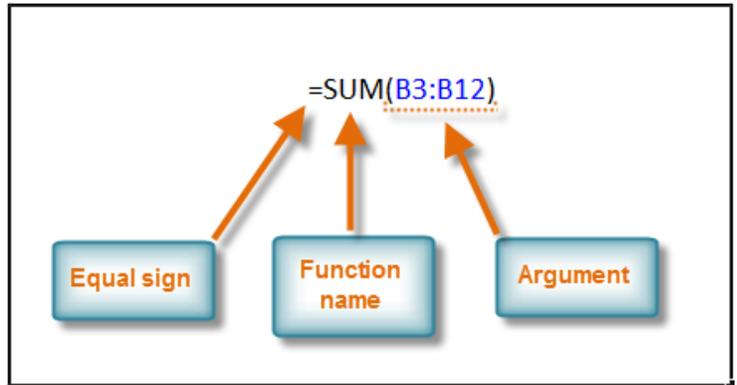
Examples of Basic Functions

FUNCTION	MEANING	EXAMPLE
=SUM(CELL RANGE)	Sums (adds) the value of cells	=SUM(A1:A5)
=AVERAGE(CELL RANGE)	Averages the values of cells	=AVERAGE(A1:A5)
=COUNT(CELL RANGE)	Counts number of non-blank cells	=COUNT(A1:A5)
=MIN(CELL RANGE)	Finds the minimum value in a range of cells	=MIN(A1:A5)
=MAX(CELL RANGE)	Finds the maximum value in a range of cells	=MAX(A1:A5)

Using Cell References in Formulas

A **reference** identifies a cell or a range of cells on a worksheet and tells Excel where to find the values or data for the formula. With references, data contained in different parts of a worksheet can be used in one formula or the value from one cell can be used in several formulas. Cells can also be referenced on other sheets in the same workbook and in other workbooks. References to cells in other workbooks are called **links** or **external references**.

TO REFER TO:	USE:
The cell in column A, row 10	A10
The range of cells in column A and rows 10 through 20	A10:A20
All cells in row 5	5:5
All cells in rows 5 through 10	5:10
All cells in column H	H:H
All cells in columns H through J	H:J
The range of cells in columns A through E and rows 10 through 20	A10:E20

The SUM function

SUM is a function in Excel that **adds values**. The SUM function can add individual values, cell references, ranges or a mix of all three. Most commonly people use ribbon commands or the function library to insert functions, but any function can also be typed into a cell manually.
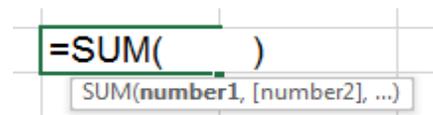
Practice Exercise: The Structure of a Function

In the **Excel_Practice_File**, go to the **utilities** worksheet

1. Click in **cell D8** to make it the active cell
2. Go to the **Home** tab → **Editing** group → Click the **AutoSum** command

Now, look back at the **D8** cell. The **SUM function** has been inserted in this cell. Let's look at the different parts of the function.

- The function starts with **=** (always!)
- **SUM**: is the **name of the function** we are using
- The **range of values** being used are inside the **parenthesis**
- The **:** (colon) symbol is being used to indicate all of the cells between the two cells listed in the function. In this example the cells between **D3 and D7** will be included in the function
- Excel also **highlights** the cells included in the function

3. Press **Enter** to finish the function and see the answer

March	Apr
$118.12	$
$56.53	
$215.29	
$48.91	
$0.00	
=SUM(D3:D7)	

Reference operators

To combine ranges of cells for calculations use the following operators:

REFERENCE OPERATOR	MEANING	EXAMPLE
: (colon)	Range operator, which produces one reference to all of the cells between two references, including the two references	B5:B15
, (comma)	Union operator, which combines multiple references into one reference	SUM(B5:B15,D5:D15)

Using the Comma Reference Operator

In the exercise above the function contained one argument **(D3:D37)**. In this next activity, the **comma reference operator** will be used to add multiple, separate arguments. Each argument must be separated by a comma. For example, the function =SUM(A1:A10, C1, E2) will add the values in all of the referenced cells.

In the **Excel_Practice_File**, go to the **utilities** worksheet

1. Click in cell **E8** to make it the active cell
2. Go to the **Home** tab → **Editing** group → click the **AutoSum** command
3. **Click and drag** the cursor over the **E3:E7** cell range
4. Press the **,** key on the keyboard
5. **Click** on the **F3** cell.
6. Look at the **E8** cell. The function in the cell should now be =SUM(E3:E7,F3)
7. Hit **Enter** to see the answer ($423.38)

April	May
$105.29	$121.65
$58.12	$62.04
$94.00	$31.58
$44.32	$45.87
$0.00	$73.00
=SUM(E3:E7,F3)	

Using the comma reference operator in the exercise above allowed for a cell range, E3:E7 to be added with cell E3.

Autosum

The AutoSum command is a shortcut to using Excel's **SUM function** and several other functions like AVERAGE, MIN, MAX etc. The SUM function provides a quick

Σ AutoSum ▾

way to add columns or rows of numbers in a spreadsheet. Excel inserts the built-in SUM function into the active cell and simultaneously selects what the program thinks is the most likely range of numbers that you want added together.

NOTE: Excel first looks above the selected cell for a group of numbers to add; if none are found, it looks to the left of the selected cell.

The AutoSum command icon is the Greek letter Sigma, which looks like an **E** or sideways **M**

1. In the **Excel_Practice_File**, go to the **numbers** worksheet
2. Click on the **A11** cell to make it the active cell
3. Go to the **Home** tab → **Editing** group → **AutoSum** command
4. Excel places "marching ants" around the numbers it assumes should be included in the function. If it's correct, press **Enter** on the keyboard and Excel automatically totals the selected numbers.

NOTE: If the marching ants are not around the correct cells, click and drag over the correct cells and hit **Enter** on the keyboard. To cancel the marching ants, hit the **Esc** key.

	A	B	C
1	152	29	654
2	55155	557	84
3	224	54	774
4	5568	659	3324
5	225	258	58
6	865	214	117
7	2217	2	2
8	221	54778	447
9	14	24	47
10	212	1	89
11	=SUM(A1:A10)		
12	SUM(**number1**, [number2], …)		

Copying Formulas using the Fill Handle

A quick way of copying formulas in Excel is to use the **Fill Handle**. In addition to copying formulas and data, the fill handle will also copy formatting.

1. Click on cell **A11** in the **numbers** worksheet to make it the **active cell**
2. Place the mouse pointer over the black square in the bottom right corner of the cell. The pointer will change to a dark plus sign " **+** "
3. Click and hold the left mouse button and drag the fill handle across to **cell G11**
4. Release the mouse button. The SUM function was copied and placed in the B11:G11 cells

The Fill Handle in the bottom right corner of the active cell

NOTE: When you release the fill handle the **Auto Fill Options** drop down menu should also appear below cell G11. Click on the down arrow in the menu to open it. The formula copied because the copy cells option is selected.

- Copy Cells
- Fill Series
- Fill Formatting Only
- Fill Without Formatting
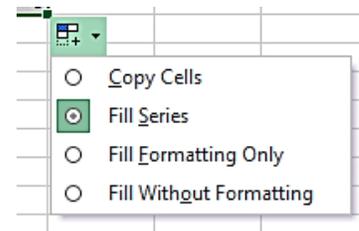
Practice Exercise: Copying Formulas using the Fill Handle

1. Select the **utilities** worksheet; click to make it the active sheet
2. Click the **G3** cell to make it the active cell to calculate the **totals** for each **utility**
3. Click the **AutoSum** button and hit the **Enter** key
4. Click back to the **G3 cell** to make it the active cell
5. Place the mouse pointer over the **Fill Handle** in the bottom right corner of the **G3 cell**. The pointer will change to a plus sign "**+** "
6. Click the left mouse button and drag the fill handle down to cell **G7**
7. Release the mouse button. Cells **G3** to **G7** contain the results for each **Utility**

Simple Calculations from the Home Tab

Functions are also available for other simple calculations. The **AutoSum** command builds formulas that compute the average value, count the number of values, or return the highest or lowest value in a range. Click the drop-down button that's attached to **the AutoSum command** on the Home tab and then click **Average**, **Count Numbers**, **Max**, or **Min** from the drop-down menu.

Practice Exercise: Using Functions

1. In the **Excel_Practice_File**, go to the **Formulas and Functions** worksheet

2. Enter the functions in the **highlighted cells** for each column

   - Cell **B17** type the function for Sum, **=Sum(B12:B16)**
   - Cell **D17** type the function for Average, **=Average(D12:D16)**
   - Cell **F17** type the function for Count, **=Count(F12:F16)**
   - Cell **H17** type the function for Maximum, **=Max(H12:H16)**
   - Cell **J17** type the function for Minimum, **=Min(J12:J16)**

	98			98
	56			56
	44			44
	27			27
	75			75
Average	=AVERAGE(D12:D16)		**Count**	=COUNT(F12:F16)

Correcting Cell Selection Errors

Excel functions from the AutoSum command automatically select the cell range to calculate. The way the Excel program selects cells is by first looking above the selected cell for values; if none are found, it looks to the left of the selected cell. In this next exercise we will pay attention to the cell ranges that Excel selects and correct errors.

Practice Exercise: AutoSum, Auto AVERAGE, Auto MAX and Auto MIN

1. In the Excel **Excel_Practice_File** go to the **romances** worksheet and select cell **B11**

2. Go to **Home** tab → **Editing** group → **AutoSum** command to insert the AutoSum function

3. Check that Excel has selected the correct cell range to include in the AutoSum function (B4:B10)

4. If the cell range is correct, press **Enter**

5. Select cell **B12** and go to **Home** tab → **Editing** group → **AutoSum** command arrow to insert the **Auto AVERAGE** formula to average cells **B4** to **B10**

6. Look in cell **B12** to check that the Auto AVERAGE function is selecting cells **B4:B10**.

   In this case Excel is selecting cells **B4:B11** which is not correct because the total amount in B11 should not be included in the average calculation. To correct the problem **click and drag the mouse** from cell **B4** to **B10**. Notice that the cell range changes in the function. Press **Enter** to finalize the function

7. Click the **B13** cell to make it the active cell, insert the **Auto MIN** function to find the minimum value in cells **B4** to **B10**

8. Look in cell **B13** to check that the correct cell range is selected. If not, correct the problem by **clicking and dragging** over the correct cell range

9. Press **Enter** to finalize the function and see the answer

10. Click the **B14** cell to make it the active cell, insert the **Auto MAX** function to find the minimum value in cells **B4** to **B10**

11. Look in cell **B14** to check that the correct cell range is selected. If not, correct the problem by clicking and dragging over the correct cell range

12. Press **Enter** to finalize the function and see the answer

Auto Calculate

Excel offers some of the most common computations in the **status bar** at the bottom of the screen.
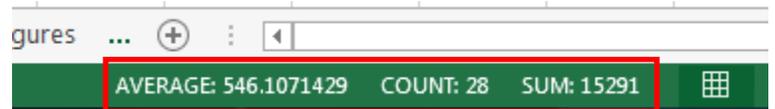
Click and drag over the cells containing the values to be **Auto Calculated** and look at the right half of the status bar at the bottom of the Excel window.

The calculated **Average**, **Count**, and **Sum** for the selection should be displayed.

On the **romances** worksheet, select cells **B4 through E10**.

To choose the functions displayed in the status bar, **right-click** the status bar and select and/or deselect functions from the **Customize Status Bar** shortcut menu.

Show Formulas

The **Show formulas** button allows you to quickly show all the formulas in your Excel Spreadsheet instead of the result. Doing so does not change your spreadsheet, just the way it is displayed. The **Show formulas** command allows you to quickly and easily check your spreadsheet for errors in your formulas.
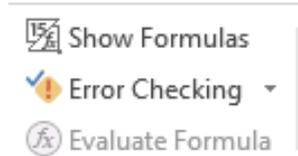
Practice Exercise: Show Formulas

1. Go to the **Romances** worksheet

2. Go to the **Formulas** tab → **Formula Auditing** group → **Show Formulas** to see the actual formula displayed in cell **F3**

To Turn off the **Show Formulas** and display the results, Go to the **Formulas** tab → **Formula Auditing** group → **Show Formulas**

Insert Function Dialog Box

So far in this class we have learned how to insert some basic functions using the AutoSum command. There are hundreds of functions in Excel, but there is no need to learn every single function in the program. All of Excel's functions are available through the program's **Function Library.** In this next section we will use the **Function Library** to insert functions.
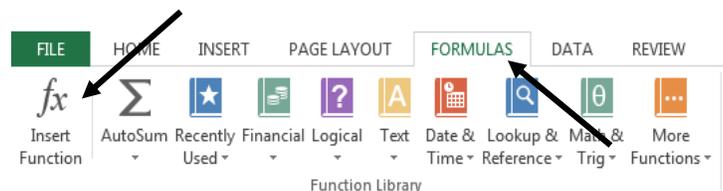
To insert a function, go to the **Formulas** tab → **Function Library** group → **Insert Function** command or click the fx command on the formula bar.

Function categories include:

- Add-in and Automation
- Cube
- Database
- Date and time
- Engineering
- Financial

- Information
- Logical
- Lookup and reference
- Math and trigonometry
- Statistical
- Text

In the next exercise we will insert a date function. In the sales world it is not beneficial to keep inventory for too long. A salesman might insert the **TODAY function** to keep track of the current date, but can also include the function in a separate formula to quickly determine how long a vehicle has been part of the dealership's inventory.

TODAY Function

The **TODAY()** function is a non-mathematical date function that takes no argument and returns today's date. If you use this function in an Excel worksheet, today's date will appear each time you reopen the file.

First, let's make space for the function:

1. In the **Excel_Practice_File**, go to the **PivotTable** worksheet
2. Click on the **row heading** for row 1
3. Go to **Home** tab → **Cells** group → Click the **Insert** command **three times**
4. Click on cell **A1** and type the words **Today's Date:**
5. Press **Tab** to move the cursor to cell **B1**

Now, we will insert the **TODAY function**:

1. Make sure that your cursor is in the **B1 cell**. If not, click on cell **B1** - this is the cell where the function will be placed
2. Go to **Formulas** tab → **Function Library** group → **Insert Function** command
3. Click in the **Search for a function** text box and type **today**
4. Click **Go**; the **TODAY function** is now highlighted in the select a function box
5. Click **OK** in the **Insert Function** dialog box
6. The **Function Arguments** dialog box appears; click **OK** to continue
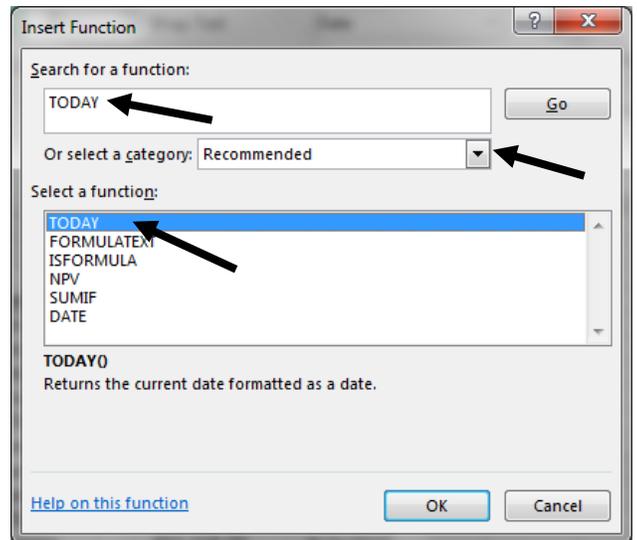
Today's date appears in cell A2
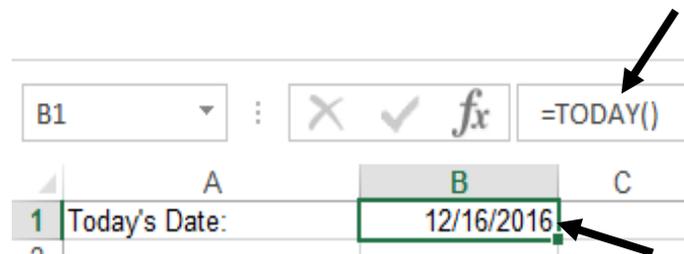
Comparison operators

When two values are compared using these operators, the result is a logical value: either TRUE or FALSE. Compare two values using the following operators:

COMPARISON OPERATOR	MEANING	EXAMPLE
= (equals sign)	Equal to	A1=B1
> (greater than sign)	Greater than	A1>B1
< (less than sign)	Less than	A1<B1
>= (greater than or equal to sign)	Greater than or equal to	A1>=B1
<= (less than or equal to sign)	Less than or equal to	A1<=B1
<> (not equals to sign)	Not equal to	A1<>B1

IF Function

The **IF function** tests a user-defined condition and returns one result if the condition is true, and another result if the condition is false. This is where Excel starts to "think" and make decisions based on criteria entered in the spreadsheet.

There are three distinct parts to any IF statement:

1. logic test
2. value if true
3. value if false

Syntax: =IF(logical test, value if true, value if false)

All three parts of the IF statement must always appear in the formula, and always in the correct order.
Example

The math teacher has decided that students who scored an 88% average on the first four tests are exempt from having to take the final. Use the IF formula to determine who will and will not have to take the final. The question being asked is: **Does this student need to take the final?**

1. In the **Excel_Practice_File**, go to the **math scores** sheet

2. Calculate the average for each student's scores by inserting the **AVERAGE function** in cell **F3**

3. Use the **autofill tool** to copy the AVERAGE function to cells **F4:F52**

4. Click in the **G3** cell to make it the active cell
5. Go to the **Formulas** tab → **Function Library** group → **Insert Function** command

6. In the **Insert Function** dialog box, select the **IF** function

7. Click **OK** in the **Insert Function** dialog box

8. The **Function Arguments** dialog box opens and displays three parts of the IF statement that must be entered to create the function.

9. In the **Logical_test** box, type **F3>=88**

10. If students score an 88 or higher, they do not have to take the test, so enter **No Test Needed** next to **Value_if_true**

11. Enter **Test Needed** next to **Value_if_false**

12. Click **OK**

Function Arguments

IF

Logical_test	F3>=88	= TRUE
Value_if_true	"No Test Needed"	= "No Test Needed"
Value_if_false	"Test Needed"	= "Test Needed"

= "No Test Needed"

Checks whether a condition is met, and returns one value if TRUE, and another value if FALSE.

Value_if_true is the value that is returned if Logical_test is TRUE. If omitted, TRUE is returned. You can nest up to seven IF functions.

Formula result = No Test Needed

Help on this function   OK   Cancel

Practice Exercise – IF Function

Complete the rest of the IF statements for the other students. This can be done most simply by copying the existing IF function in the **G4** cell using the **Autofill Handle**.